The Quarterly Journal

of the

Amateur Mechanical Society.

VOL. I.

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INTRODUCTION.

THE issue of the first number of a new mechanical paper requires at least a word of explanation from the pen of the Editor, setting forth the position it is designed to occupy amongst its contemporaries, and the special object of its publication.

The Journal of the Amateur Mechanical Society is almost the necessary result of the establishment of such society, which could hardly be said to exist at all, without some periodical record of its transactions. This would, in the first place, be confined to entries in the minute book of the names of new members, and of such resolutions as might be passed from time to time; or at most, to printed reports to be circulated exclusively within the limits of the Society.

The original intention of the promoters of the present periodical was indeed little more than this; but as the Society increased in numbers and importance, it seemed desirable to extend in some degree the original scheme, and to make the Journal a medium of mutual information upon all points connected with mechanical manipulation. The Lathe especially has of late years occupied more than ever the attention of amateurs and professional turners, and, in the course even of a few months, new chucks and appliances are invented, which would remain unknown to the majority, were it not for the descriptions casually sent to the various mechanical papers.

Among these, *The English Mechanic* has long held a conspicuous position, and is now the only paper in which the large class of amateur mechanics is fairly represented (*The Engineer*, *Engineering*, *and the Practical Mechanics' Journal* treating rather of the great public works in our own and other countries than of the discoveries and inventions of private individuals).

There is, however, still a gap, though not a very wide one, in this class of literature, which, it is believed, can be best filled by such a journal as the present. A large number of amateurs have, from one cause or another, refrained from appearing in the pages of any other mechanical paper, although an inspection of their workshops would prove that they might do so with benefit to the readers; and this reluctance is perhaps more likely to be overcome by the publication of a journal exclusively their own. In addition, therefore, to the mere quarterly statement of the position and prospects of the Amateur Mechanical Society, the pages of this Journal will be open to all, *whether members or not*, who wish to bring before their brother amateurs any question relating to mechanical science, or any design or invention which is likely to interest the readers.

It is further hoped that the circulation of this first number will make the Amateur Mechanical Society itself more widely known; for it were strange indeed, if among the hundreds, perhaps *thousands*, of amateurs who practise the mechanical arts during their leisure hours, there did not prevail a very general desire to unite for mutual interest. Hitherto, from the want of some such means as the present, comparatively few amateurs have received intelligence of the existence of a society in which they may naturally be expected to take an interest. The circulation of the Journal will probably, therefore, cause a material addition to our ranks, and hence, as a matter of course, strengthen the now small staff of contributors to our pages.

It seems reasonable, therefore, to hope that the Amateur Mechanical Society will ere long hold a more conspicuous place than it does at present, and that its Journal, intended, as it is, to *supplement*, and not to *rival* contemporary class periodicals, will be read with increasing interest beyond the limits of the Society which has given it birth.

What is an amateur mechanic? is a question, perhaps, more easy to ask than to answer. The professional will reply that he is Jack of all trades, and master of none; nevertheless, it must be allowed that some members of this class turn out work of a very high degree of excellence—far better, in point of fact, than is done by many after a regular apprenticeship. Others, of course, of less skill, practice, or patience, do not come up to the mark, and their productions accordingly will not bear comparison with those of a professional workman. The latter, however, it must be allowed, works under far greater advantages, because he applies himself to one particular trade only, and not unfrequently to one special branch of such trade. The "practice," too, "which makes perfect," is necessarily far greater in his case than in that of the amateur, who simply turns to mechanical pursuits as a relaxation from other more arduous labours,—labours too often of an over-wrought brain, continued daily to that wear and tear of the constitution, of which the professional mechanic knows but little.

The class of amateurs is a very large one, and it would seem as if it originated, in a great degree, from the common error of mistaking one's profession or calling. We have certainly seen, among all classes of the community, men, whom circumstances have induced to enter one line of business, pursuing at their leisure moments another evidently more in accordance with their natural tastes, becoming therefore amateurs in the latter, which they would evidently have adorned as professionals. Others, again, whose means permit them to live independently of any business or calling, turn to mechanical pursuits as an amusement congenial to their tastes, by which to wile away many an hour that, if it might be spent better, might, at any rate, be spent very much worse. As a rule, perhaps, we do not meet with our best mechanics among these, because men who have to work whether they will or no, contract habits of order, carefulness, and general assiduity, which tell favourably upon the pursuits which they take up as amateurs. On the other hand, nevertheless, men of independent means can command lathe apparatus and mechanical appliances which are altogether beyond the reach of their poorer brethren; so that, in such work as ornamental turning, in which perfection of apparatus is a greater desideratum than manipulative skill, they will always occupy the front rank.

Now that "The Amateur Mechanical Society" is an established fact, it is probable that lathe-work will be brought to a higher state of perfection than ever, and that we shall find many new and important machines for special work arise from this combination of mechanical talent. Hitherto amateurs have been altogether isolated from each other; and between them and the trade there has existed an unreasonable and destructive jealousy, which bids fair to be considerably lessened, if not altogether annihilated. Our list of members already contains the names of one or two eminent professionals, who, by thus joining our ranks, while yet sadly too thin, give us a moral support for which we cannot be too thankful; and their presence among us will do much towards breaking down the icy barrier which, as I have already stated, has hitherto existed between amateurs and the trade.

Addressing ourselves to the members generally, we must remind them that Union and Unity are the essential elements of success. The man who joins any society for self-gratification or personal gain alone, can hardly be called an eligible addition to the ranks, and all must be ready, upon introduction within the mystic circle, to exert themselves heartily to extend its boundaries. Most amateurs have friends or acquaintances of similar tastes, and it should not be deemed too great a trouble to try and extend to them the benefits which they have themselves received, or which they at any rate hope to gain. It would scarcely be wise at present to speak too enthusiastically of our hopes, but there is no reason why the Society should, by aiming at too little, fail to attain the magnitude and importance which it has a fair right to expect. Being in opposition to none, we can hardly incur the animosity of any, and, although to a certain extent exclusive, we are not sufficiently so, to make the election of any fairly eligible candidate a matter of uncertainty. The Report of the Honorary Secretary, and the Rules of the Society, annexed to the present number, will answer any questions upon this point which non-members who read these pages are likely to propose.

RISE AND PROGRESS OF THE SOCIETY.

Hon. Secretary's Report.

AS the recognised mouthpiece of the Amateur Mechanical Society, it will become our duty from time to time to furnish a report of its proceedings; and in this, our first number, it will be requisite to look back a little and glance at its origin and progress up to the present time. To such of our readers as are acquainted with the several prospectuses that have appeared, such a retrospect may seem in some degree super fluous; nevertheless, since the completeness of our record might suffer in its absence, we proceed to our task without further apology, merely remarking that, while possessing confidence in our claims as Amateur Mechanics, we are compelled to admit that, at present at least, there are few amongst us who can boast the ability to wield the hammer and the pen with equal dexterity. While therefore we deprecate criticism on our literary, we willingly court it in respect of our mechanical performances, being well persuaded that friendly and appreciative criticism will afford the utmost assistance towards the attainment of that mutual improvement and encouragement which it is the principal aim and object of our Society to bring about.

We believe there have been various attempts to form such an association as the Amateur Mechanical Society, but from some unexplained causes they all appear to have failed. Want of sufficient energy on the part of their promoters may have had much to do with their failure, as will be readily understood by all who know experimentally how difficult it is in such cases to "set the ball rolling," though when once that is satisfactorily done the task becomes comparatively easy. Nor need any one marvel at such lack of energy, for do we not all personally know how greatly the enjoyment derived from a couple of hours spent in the company of our lathe, however humble a machine, exceeds that of writing letters, concocting prospectuses, and the hundred other duties such an undertaking involves? Our Society first saw the light, so to speak, on the 1st January 1869, when the first prospectus was issued and circulated among the friends of the four original members. As, however, but few of these friends had mechanical proclivities, the process of recruiting was but slow, so slow indeed that by the end of the year the original number was little more than doubled; still this was the less to be regretted, since it was the natural result of a resolve in the first instance to be cautious in the selection of members, by admitting them only on personal introduction, in order to insure the maintenance of a certain social position, which, as the event has proved, was rightly judged necessary to the attainment of the objects of the Society. In January 1870, a fresh prospectus was prepared, and in that and the following month the numbers increased considerably. The first dinner took place on the 17th of March following, at the Freemasons' Tavern. Advantage was taken of that opportunity to discuss the prospects of the Society, and to make arrangements for its future government. The establishment of the present Journal was determined on, and it was agreed that there should be four meetings in each year,—viz., a dinner, a visit to some place of interest, and two conversazioni. In conformity with these arrangements, the Royal Arsenal at Woolwich was visited on the subsequent 22d June by special permission of the War Office. On arriving at the Gun Factory the members were informed that "something hot" had been prepared for them, and this something proved to be no less formidable an article than a huge forging for one of the twenty-five-ton guns. The first process exhibited was the formation of the breech coil, consisting of two bars of iron coiled at a red heat one over the other on a mandrel driven by steam-power. Close at hand was a similar coil brought to a white heat in a suitable furnace. This was presently lifted out by means of a crane and brought under the large steam-hammer, which, with ponderous blows, soon converted the double coil into a solid mass. An iron core was then forced into the central aperture, to enable the sides to withstand the blows necessary to their complete consolidation. The dexterous manipulation of this huge forging, weighing at least ten tons, under the steam-hammer by means of the "porter-bar," was certainly not the least wonderful or interesting part of the process. After witnessing the remaining operations necessary for the completion of these heavy guns (as, for example, turning, boring and shrinking the tubes one on to the other), and examining the Pattern Room, the members were shown the process of casting, finishing and testing (by hydraulic pressure) the various descriptions of shot and shell, and then passed on to the Rocket Manufactory and machinery for producing bullets of compressed lead and other parts of the central fire cartridges for breech-loaders. The manufacture and filling of percussion caps next claimed their attention, after which they were conducted to the Gun-carriage Department, where the exceedingly ingenious wood-shaping machinery attracted particular notice.—There, too, was shown one of the new Moncrieff Gun Carriages, which, by means of a clever though comparatively simple contrivance, enable heavy guns to be loaded and laid entirely under cover. The proceedings of the day were brought to a conclusion by a dinner at the "Ship" at Greenwich. We cannot take leave of this subject without expressing, on behalf of all who were fortunate enough to be present, our grateful acknowledgment of the kindness and courtesy displayed by Captain Stoney, R.A., on whom devolved the duty of acting as our guide. In further compliance with the arrangements of the 17th of March, a conversazionè took place on the 24th of November last at the Gallery of the Architectural Union Co., which, considering how widely scattered the members are, was very well attended. Owing to the unfitness of the rooms for the reception of heavy machinery, the lathe-makers were but scantily represented; but of amateur work there was a very fair collection, and, as a rule, the quality was good. We trust we may be here permitted to observe that on such occasions as these each individual has an admirable opportunity of profiting by a careful comparison of his own work with that of others, which he would do well to embrace, and that, so far as our experience of amateur work extends, we feel convinced that too little attention is given to the study of *form.* Amateurs are generally too prone to overload their work with ornament, many being apparently anxious that each piece of work should in itself exemplify the capabilities of the whole of their appliances.

The success of the evening was greatly enhanced by the beautiful productions of the London Photographic Society which adorned the walls of the Gallery. Under existing arrangements, another conversazione should take place this month; but as it would perhaps follow too closely on the last, we propose that it should be deferred until after Easter, when probably many country members will be in town. Few of the lathe-makers, especially those in the country, would, on account of the trouble and expense, care to exhibit for one evening only; it has therefore been suggested that the next exhibition should continue open one entire week, within which both the annual dinner and the next conversazione might take place. Before concluding this report, it will perhaps not be out of place to refer to the future of the Society, a subject to which the attention of those present at the meeting of March last was directed. In the success of the past meetings, the large increase in our numbers, and last, but not least, the establishment of the Journal, we believe we see signs of permanency; but in order to insure that most desirable end, we should possess something more than a name—we require a "local habitation" in the shape of some central place of meeting, where there might be a workshop containing heavier and more extensive mechanical accommodation than is possible generally in a private house, together with a library and other conveniences for the transaction of the business of the Society and the comfort of the members. It will be represented, no doubt, that this will involve great expense—unquestionably it will; but there will be no difficulty, we apprehend, in arranging the terms of entrance, subscription &c., in such a manner that the bulk of the expense may mainly fall on those who wish to avail themselves of any such increased facilities. This, however, is a wide subject, and one which need not at present be discussed in detail; we therefore prefer to leave it for the moment, in the hope that these remarks may elicit valuable suggestions from others. Meantime we remit our incipient enterprise to the kindly candour of our readers, and rejoice in the hope that it may prove a sterling success, and constitute even, it may be, an era in our history. Should it, as it well may, fall short of this, it will at least have the effect of stimulating others to render us such effective help as will ultimately bring about the success that we may now but have partially attained. Sure we are that, if conducted with intelligence and spirit, it cannot fail of being an instrument specially adapted to develop and propogate new and useful ideas amongst amateurs, and render important assistance in carrying out the objects they have at heart. To effect this there is but one thing required—the active and hearty co-operation and aid of all our members. Without this, the utmost efforts of a few can accomplish but little; with it, our success would seem assured.

ECCENTRIC TURNING.

RULES FOR DETERMINING THE SIZE, NUMBER, AND POSITION OF CIRCLES IN CONTACT.

By Howard Warburton Elphinstone.

ARTICLE I.—*Definitions*—*First.*—The distance of the centre of any circle cut in the lathe from the centre of the work is called the "eccentricity."

Second.—The radius of any such circle is called the "radius."

If the circle is cut by means of the eccentric cutting-frame, the radius equals the number of divisions that the cutter is thrown out; while the eccentricity is the number of divisions that the slide-rest is thrown to the left from the position "all at centre."

Third.—Any circle whose centre is not the centre of the work is called an "eccentric circle."

ARTICLE II.—Sometimes, in designing a pattern, we may wish to place a number of equal circles having the same eccentricity in contact.

Given any one of the three quantities—the number of the circles, the radius, or the eccentricity—to determine the other two. This can readily be done by the use of the table attached to this paper.

The table consists of two columns, the one headed "number of circles," the second headed "modulus."

Definition Fourth.—By the modulus corresponding to any given number of circles is meant the number in the second column opposite to the given number in the first column, and, conversely, the number of circles corresponding to any given modulus is the number in the first column opposite to the given modulus in the second.

For shortness, in the following rules I write radius, eccentricity, number, and modulus, where I mean the radius and eccentricity of any eccentric circle, the number of such circles, and the corresponding modulus. In making the numerical calculations, the unit is ·01 inches, or one division of the graduated screw-heads on the slide-rest, eccentric cutting-frame, and eccentric chuck.

Rule 1.—Given eccentricity and number, to find radius.

$$\text{Radius} = \text{eccentricity} \times \text{modulus.}$$

Example.—Let the eccentricity be 50, or five turns of the slide-rest screw, and the number be 16, the corresponding modulus is ·195.

$$50 \times \cdot 195 = 9 \cdot 75$$

the value of the radius required, *i.e.*, the cutter frame must be thrown out 9¾ divisions—(Compare Fig. 22, Engleheart).

Rule 2.—Given radius and number, to find eccentricity.

$$\text{Eccentricity} = \frac{\text{radius}}{\text{modulus}}$$

Rule 3.—Given radius and eccentricity, to find the number.

$$\text{Modulus} = \frac{\text{radius}}{\text{eccentricity}}$$

Whence the number can be found from the table. It will generally happen that the modulus, as determined by our rule, does not exactly correspond with any value of the modulus given in the tables. Should this be the case, it indicates that no number of circles that can be obtained by means of the division-plate will exactly form the pattern. Sometimes, when the modulus is small, we can make the pattern sufficiently accurate to the eye by taking the nearest value of the modulus given in the tables.

ARTICLE III.—*Definition.*—When the circles are to be arranged in contact with each other, and likewise with a given circle whose eccentricity is zero (or, in other words, whose centre is the centre of the work), the latter is called a "guide" circle, which is an "exterior" or "interior" guide-circle, according as it lies outside or inside the circles required.

Definition.—The radius of an exterior guide-circle is called the "outer eccentricity," that of an interior guide-circle the "inner eccentricity."

The rules for placing equal circles in contact with each other, and with an exterior guide-circle, are the following:—

Rule 4.—Given the radius—

$$\text{eccentricity} = \text{outer eccentricity} - \text{radius}$$

$$\text{modulus} = \frac{\text{radius}}{\text{eccentricity}}.$$

Rule 5.—Given eccentricity—

$$\text{radius} = \text{outer eccentricity} - \text{eccentricity},$$

$$\text{modulus} = \frac{\text{radius}}{\text{eccentricity}}.$$

Rule 6.—Given number—

$$\text{eccentricity} = \frac{\text{outer eccentricity}}{\text{modulus increased by unity}}$$

$$\text{radius} = \text{outer eccentricity} - \text{eccentricity}.$$

The rules for placing equal circles in contact with each other, and with an interior guide-circle, are the following :—

Rule 7.—Given radius—

$$\text{eccentricity} = \text{inner eccentricity} + \text{radius}$$

$$\text{modulus} = \frac{\text{radius}}{\text{eccentricity}}.$$

Rule 8.—Given eccentricity—

$$\text{radius} = \text{eccentricity} - \text{inner eccentricity}$$

$$\text{modulus} = \frac{\text{radius}}{\text{eccentricity}}.$$

Rule 9.—Given number—

$$\text{eccentricity} = \frac{\text{inner eccentricity}}{\text{unity diminished by the modulus}}$$

$$\text{radius} = \text{eccentricity} - \text{inner eccentricity}.$$

ARTICLE IV.—The rule for placing equal circles in contact with each other, and with an exterior and interior guide, is—

Rule 10.—

radius = ½ difference of the exterior and interior eccentricities

eccentricity = ½ the sum of the exterior and interior eccentricities

$$\text{modulus} = \frac{\text{radius}}{\text{eccentricity.}}$$

ARTICLE V.—Sometimes it is desired to place a number of circles touching one exterior and one interior guide-circle, and wholly including the latter; this is commonly called basket-work. The rule is—

Rule 11.—

radius = ½ the sum of the exterior and interior eccentricities.

eccentricity = ½ the difference of the exterior and interior eccentricities.

The mathematician will readily be able to verify the rules by observing that the modulus = the sine of the angle subtended by the radius at the centre of the work; and that if that angle be called α, and—

r = radius.
e = eccentricity.
a = interior eccentricity.
b = exterior eccentricity.

The first ten rules can easily be obtained from the equations—

$$r = e \sin. \alpha$$
$$e = b - r$$
$$e = a + r$$
$$e = \frac{a + b}{2}$$

While the eleventh rule is obtained from the equations—

$$r = \frac{a + b}{2}$$
$$e = \frac{b - a}{2}$$

Number of Circles.	Modulus.	Number of Circles.	Modulus.	Number of Circles.	Modulus.
2	1·000	16	·195	60	·052
3	·866	18	·174	64	·049
4	·707	20	·156	72	·044
5	·588	24	·131	90	·035
6	·5	28	·112	96	·033
7	·434	30	·105	112	·028
8	·383	32	·097	120	·026
9	·342	36	·087	144	·022
10	·309	40	·078	180	·017
12	·259	45	·070	192	·016
14	·223	48	·065	360	·009
15	·208	56	·056		

The table was calculated from the formula—

$$\text{modulus} = \sin.\frac{\pi}{\text{number of circles.}}$$

Examples.—Rule 1—

Given eccentricity = 50
number = 24
Then from table, modulus = ·131
and radius = 50 × ·131
= 6·55 = say, $6\frac{1}{2}$

Rule 2—

Given radius = 2·15
number = 32
Then from table, modulus = ·097
and eccentricity $= \frac{2·15}{·097} = 22\frac{1}{4}$ about

Rule 3—

Given radius = $12\frac{1}{4}$
eccentricity = 48
modulus $= \frac{12\frac{1}{4}}{48} = ·25$

This is not a value of modulus given in the tables, but we may take ·259, which is given in the tables, without producing any sensible error, and "number" = 12.

Rule 4—

Let external eccentricity or radius of guide-circle = 60
radius = 28
Then eccentricity = 60 − 28 = 32
modulus $= \frac{28}{32} = ·875$

The nearest tabular value of the modulus is ·866, corresponding to number = 3.

Rule 5—

Let external eccentricity = 100·5
eccentricity = 80
Then radius = 100·5 − 80 = 20·5

modulus $= \frac{20·5}{80} = ·256$

The nearest value of modulus given in the table is ·259, corresponding to number = 12.

Rule 6—

Let external eccentricity = 151
number = 12
Then from table, modulus = ·259

and eccentricity $= \frac{151}{1·259} = 120$ nearly

radius = 151 − 120 = 31

Rule 7—

Let internal eccentricity = $59\frac{1}{2}$
radius = $20\frac{1}{2}$
Then eccentricity = $59\frac{1}{2} + 20\frac{1}{2}$
= 80

modulus $= \frac{20\frac{1}{2}}{80} = ·25$

and number = 12

Rule 8—

Let internal eccentricity = 80
eccentricity = 60
Then radius = 80 − 60 = 20

modulus $= \frac{20}{60} = ·333$

which is most nearly = ·342 in the table, and number = 9.

Rule 9—

Let internal eccentricity = 100
number = 20
The corresponding modulus = ·156

Then eccentricity $= \frac{100}{1 - ·156}$

$= \frac{100}{·844}$

= $118\frac{1}{2}$ about

radius = $118\frac{1}{2} - 100$
= $18\frac{1}{2}$

Rule 10—

Let external eccentricity $= 100\frac{1}{2}$

internal eccentricity $= 59\frac{1}{2}$

Then radius $= \dfrac{100\frac{1}{2} - 59\frac{1}{2}}{2}$

$= 20\frac{3}{4}$

eccentricity $= \dfrac{100\frac{1}{2} + 59\frac{1}{2}}{2}$

$= 80$

modulus $= \dfrac{20\frac{3}{4}}{80} = \cdot 25$ nearly

and number $= 12$

Rule 11—

Let external eccentricity $= 60$

internal eccentricity $= 40$

Then radius $= \dfrac{60 + 40}{2}$

$= 50$

eccentricity $= \dfrac{60 - 40}{2}$

$= 10.$

MENSURATION AND ENUMERATION OF THE IMPALPABLE AND INVISIBLE.

By Rev. J. W.

THE operations comprehended in the above categories are among the most surprising efforts of scientific ingenuity. It is difficult for the unscientific to believe in their actual execution, and still more so to rely on the accuracy of their results. Yet the principles of most of them may be without much difficulty apprehended even by those who are but scantily versed in mathematics—the great grammar of the exact sciences.

The musical student is required to accept, as an ascertained fact, that when the middle C of the piano is struck, the corresponding wires, as long as they emit their proper sounds, vibrate at the rate of 512 oscillations per second. Busied in acquiring a practical mastery of his art, the student must assume the truth of this statement. But, if he be a person of inquiring mind, he cannot but recur to the subject in some idler moment, and puzzle himself with thinking how movements so rapidly performed, and so undistinguishable by sight, can be reckoned up.

A popular lecturer on physics informs his audience that our perception of colour is due to the communication to our optic nerve of certain undulations transmitted directly or indirectly from a luminous body through a medium pervading universal space, to which he gives the name of Ether. Of the nature of this medium he knows nothing, save that it is susceptible of such undulations. Its very existence is a mere matter of inference. Yet he bids his hearers believe that the number of undulations constituting a ray of red light have been ascertained; and that this amounts to 399,101,000,000,000—that is, three hundred and ninety-nine million of millions, with one hundred and one thousand millions more, per second. If the public instructor gives to his instructed no clear explanation of the method by which this huge number of movements has been counted, he will send them away with but a very wavering reliance on the certainty or accuracy of the enumeration.

Let us endeavour to convey to our readers some idea of the way in which these mysterious calculations have been performed.

First, then, as regards the vibrations of sonorous bodies, whether wires, catguts, or other musical strings in a state of tension, or columns of air contained in pipes, or elastic laminæ—as gongs, cymbals, musical-glasses, or, finally, the vocal chords and semi-elastic surfaces of the human larynx and fauces. All these various instruments may be made or adjusted to utter notes of the same pitch, however differing in other vocal qualities. Suppose this pitch to be that of the middle C. Let us see how the vibrations which those instruments must all alike perform are to be counted.

One method is this. Let an elastic lamina of brass be firmly fixed at one end, being free at the other. Let a toothed wheel be so placed that its teeth may all successively impinge upon the free extremity of the lamina, as the former revolves in a plane transverse to the surface of the latter. It is obvious that, if the wheel move with a certain rapidity, the lamina or spring may be kept in a state of continual vibration, being caught by each tooth ere it has quite completed its recoil from the deflexion occasioned by the tooth preceding.

As soon as the motion has become such that sixteen teeth pass the lamina per second, a musical sound, audible to some ears, will be emitted, especially if the block or clamp in which the spring is fixed be attached to some extensive sonorous surface, as of a deal table. As the motion of the wheel is accelerated, the musical note will become sharper and sharper. Let the middle C be continuously sounded by a violin or pipe, or let it be struck with constant repetition on a piano; as soon as the note uttered by the spring is heard to be in unison with the C, let him who maintains or regulates the motion of the train to which the toothed wheel belongs, keep it going at the same rate till the number per second of the turns of the winch, descents of the treddle, or other successive movements of the driving-gear shall have been ascertained. This being known, the number of teeth impinging per second on the sounding lamina is a matter of easy and familiar calculation.

The writer has seen in Germany another apparatus for the same purpose, uttering a purer tone. It consists of a circular board about two feet in diameter and three-fourths of an inch in thickness, and pierced near its circumference with a circular series of holes. This board revolves on its central point, being in contact with the upper surface of a table. In the table's top there is an orifice, over which every hole in the revolving board passes in succession. This orifice forms the termination of a pipe, into which air is driven by a small pair of bellows worked by a treadle underneath the table. This treadle also maintains, by such gear as is usually employed for similar purposes, the revolving motion of the circular board. A note, varying in pitch with the rate of revolution of the latter, is uttered by the pipe, the action of the slanting perforations of the board on the column of air in the pipe keeping this in perpetual vibration. The strokes of the treadle being numbered, the number of holes passing per second are, as in the case of the wheel and spring, of easy calculation.

The double vibrations of the spring or pipe uttering the note middle C* is found to be 256 per second. Each stroke of the tooth in the one apparatus, or of the unperforated portion of board in the other, causes two opposite movements in the spring or air column. The double movement communicated by these to the atmosphere are usually called waves or undulations, and this distinction will be observed throughout this paper, whether the immediate subject under discussion be light or sound.

* Of Hullah's tuning-fork.

The individual vibrations producing the note middle C are, of course, 512 per second. Those of C^1 are 1024, and those of C_1 256, for octaves rise by doubling the number of vibrations. The vibrations of the other notes of the scale may either be found by direct experiment, as now described, or by calculation. For as G is known to make $\frac{3}{2}$ of a vibration while C makes one, $\frac{3}{2} \times 512 = 768$, gives the vibration per second of middle G. If it be asked how the ratio $1 : \frac{3}{2}$ has been ascertained, the answer is, that if a string, giving forth, when sounding, the note C, be shortened by one-third of its entire length, it will give out the note G. But the vibrations per second are inversely proportional to the lengths of sounding strings of the same tension and diameter; therefore the vibrations of C and G are to each other $\frac{2}{3}$ to 1, and those of G to C as $\frac{3}{2}$ to 1. To measure the length of the air pulses or vibrations occasioned by the vibrations of the sources of musical sound, will be now a very simple matter.

A ray or succession of vibrations of sound is propagated—that is, the waves or pulses travel—in all directions from the sounding body, at the rate, experimentally ascertained, of 1120 feet per second, in air of temperature 62° Fahrenheit. During this time 512 vibrations are made, or 256 complete waves. Each of these latter, therefore, is $\frac{1120}{256}$ or 4.375 feet in length.

In order to prepare the reader for apprehending the principle on which the numeration of light-waves is accomplished, it will be necessary to consider first some phenomena exhibited by the visible and tangible waves of water. Let us suppose a series of undulations to be propagated along two channels of moderate width. Let these channels at length unite in one. If the wave processions are both crested at the point of union, the upward tendency of each will reinforce that of the other, and the rise will be nearly doubled. But, if the trough of one series of waves coincides at that point with the crest of the other, the contrary movements will neutralise each other, and smooth water will result.

There is a point in the German Ocean where the ebb of the tidal wave coming from the north meets the high-water of that coming up from the Straits of Dover. At this point the sea neither rises nor falls, but is tideless as the Black Sea or the Caspian.

The same phenomena are exhibited by what we may call the wave processions of sound and light.

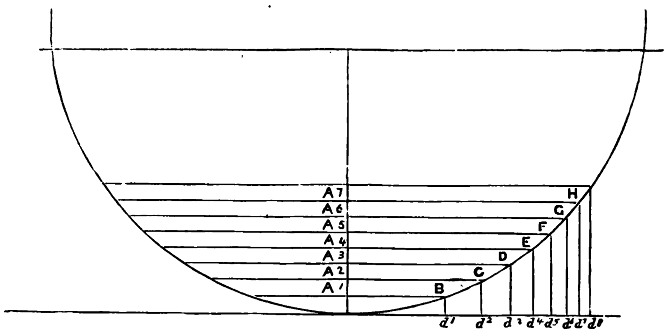
Let us consider a case of the coalition of two separated portions of a ray of light. But let that be first assumed, which want of space forbids us to demonstrate, viz., That the velocity of waves in different media of transmission is proportional to the sines of their angles of incidence and refraction.

Now, as it has been found by many experiments that these sines are, in the case of air and flint-glass, as $1\frac{1}{2}$ to 1 very nearly, it follows that the advance of a wave-procession in a given time will be one-half greater in air than in flint-glass.

Remembering this, let us proceed. If a ray of homogeneous light, say, from the yellow portion of the solar spectrum, fall upon a convex lens, the latter being at the same time powerfully pressed down upon a surface of plane glass, the following phenomena may be observed:—The point of contact, under the thickest portion of the lens, will be marked by a black spot, around this will be a series of concentric rings of alternate bright light and blackness, shading into each other by intermediate gradation.

What is the explanation of these appearances? It is this:—

From each of two surfaces in the above arrangement a portion of each ray is reflected, namely, from the under surface of the lens, which sends a portion back, inwards, and through the lens, and from the upper surface of the plane glass, which sends a portion back through the film of air between the glasses into and through the lens. At some distance or other from the central point, the thickness of this film of air will be equal to the length of one vibra-



tion or *half-wave*. The second portion of the ray has to traverse this twice, once before, and once after reflection. It would therefore rejoin the other portion, having lost exactly one wave length. They would therefore coalesce in like phases, and intense light would be the result. But the second part of the ray has at the same time made a slight countergain by its increased velocity in traversing air instead of glass. It has moved one-half faster than the other, at the rate, therefore, of $1\frac{1}{2}$ vibration-lengths, which the other moved through 1, and will, therefore, overtake it not one wave-length behind, but one vibration-length only. They coalesce, then, really in opposite phases, and darkness is produced instead of light. This will obviously be also the case wherever the interval between the glasses amounts to 2, 3, 4, or more vibration-lengths. Hence, a series of dark rings. At the intermediate distances, where the interval is equal to a half vibration-length, or to 3, 5, 7, &c., that is, to $1\frac{1}{4}$, $2\frac{1}{4}$, $3\frac{1}{4}$, &c., wave-lengths, the contrary result will ensue. There will be seen rings of intenser light. Measurement verifies this.

In the above section of the lens and plate-glass, the successive distances between the glasses are obviously proportional to the versed sines of the angles of which the horizontal distances A^1B, A^2C, A^3D, A^4E, A^5F, &c., represent the sines. The diameter of the tenth dark ring may be easily measured if the radius of the lens be one hundred feet, and the versed sine is as easily calculated. This will be, as above shown, ten times the interval d^1B. Since, then, the interval $d^{10}L$ is found by this measurement and calculation to be $\frac{1}{8900}$ of an inch for the purest yellow ray of the solar spectrum, the interval d^1B must be $\frac{1}{89000}$ of an inch. But this, as we have shown, is equal to the extent of one vibration. Hence the length of one undulation, consisting of two contrary vibrations, is $\frac{1}{44500}$ of an inch for the yellow ray, traversing atmospheric air, at its mean density near the earth's surface. The rings of light are found in the intermediate spaces at those exact distances, which give on calculation $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, &c., for the intervals between the glasses.

It is easy now to reckon the number of undulations per second, by which the sensation of pure yellow is produced, through impact on and consequent pulsation of the optic nerve. Light travels from the sun to the earth in seven minutes and a half. This is at the rate of about 1,000,000,000 feet per second, during which are made a succession of undulations each $\frac{1}{44500}$ of an inch, or $\frac{1}{12 \times 44500}$ of a foot in length. Therefore $12 \times 44{,}500 \times 1{,}000{,}000{,}000$, or 534,000,000,000,000, is the number of pulsations communicated per second to the optic nerve while we contemplate an object coloured with the purest yellow, and illuminated by the light of the sun. In like manner may be ascertained the number of undulations stated in the outset as those of red rays. Those of the violet ray of the solar spectrum are 831,479,000,000,000 per second. The statement of numbers so enormous produces in our minds no distinct conception. But we may derive from them the idea of certain relations. For instance, we can perceive that, of the extreme rays of the spectrum, the more refrangible is due to more than twice as many movements of the transmitting substance (call it ether or what we will) as the other. We can also perceive how immensely more sensitive an organ the eye is than the ear. The sharpest note which any ear can distinguish, or even hear, is due to 24,000 undulations, or double vibrations per second, whereas the violet ray is seen by the excitement of 831,479,000,000,000 per second. That is, the eye is sensible of movements 34,000 millions of times more minute than those appreciable by the ear.

But whether we talk of billions per second, or of thousands only, with what speechless admiration must we contemplate that Almighty Power, which has created substances capable of producing or performing such infinitesimal movements, living organs capable of receiving and continuing them, and minds capable of discriminating the minute differences of the resulting sensations.

When again we think of Him as the creator of intellects, endowed with that power of divination—for such we may well call it—which enabled Newton thus to discern and measure the unseen agitations of unknown media—an achievement which a most competent judge* has pronounced to be not inferior to that of his discovery of universal gravitation—what limit need we place to our own anticipations of intellectual advancement in that creation of the new heavens and new earth, whereof, if our moral progress justify it, we are destined one day to form a part!

NOTE.—Throughout the latter part of the above article we have assumed the truth of the undulatory theory of light. Newton's calculations were based on the corpuscular theory, but the metrical and arithmetical result was the same.

MEDALLION MACHINE BY MR JESSIE LOWE, BOLTON.

AMONG the many additions to the lathe which have been made of late years (tending to render it more than ever a universal machine), the apparatus for copying medals invented by Mr Lowe deserves special notice. Simple in construction, little liable to get out of order, and easily used, this

* Mrs Somerville, "Connection of the Physical Sciences," section xxi.

compact apparatus may well be added to the amateur mechanic's stock of tools for special purposes. The work done by its aid is executed with great rapidity and precision, and the medallion may be cut either more deeply than the original, or merely, so to speak, *engraved* as a block for the printing press.

As at present arranged, two parallel mandrels are required to the lathe, those of the inventor being five inches apart,—the one carrying the medal to be copied, the other, the block of wood upon which the counterpart is to be cut. The machine is driven by a short band carried from the chuck, which bears the copy, to the driving pulley at the bottom of the machine, or from a small grooved wheel at the

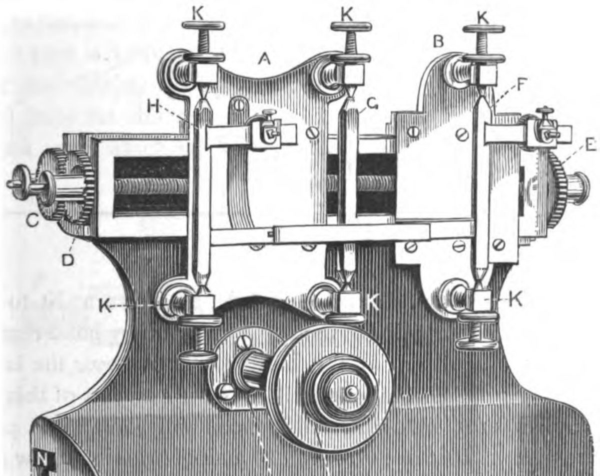


Fig. 1.

back of the chuck in question. L is the driving pulley, the spindle of which goes quite through a socket screwed to the main casting at M, much the same as the spindles of drill and eccentric cutters are now generally arranged. The end of the spindle projects at the back of the machine, and is cut with a screw gearing into a worm-wheel, F of Fig. 2. The spindle of the latter is perpendicular, and carries a bevil wheel to drive a similar one in the middle of the horizontal axle, carrying the wheel C, and a similar one behind E. This will be understood from Fig. 2, which represents the back of the machine.

g is here the worm driving the wheel F. D B are the bevil wheels ; *a a*, the spur wheels on the same axle, which act as drivers to those at each end of the screws, seen in Fig. 1, D E.

Turning our attention to the latter, which is copied from a photograph kindly supplied by Mr Lowe, we notice first—a main casting,

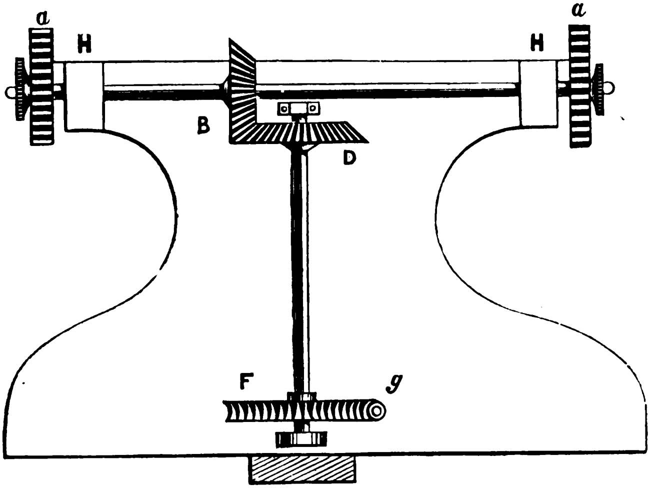


Fig. 2.

forming the body of the instrument, made, as shown at N, to receive the head of a holding-down bolt, like an ordinary hand-rest. The machine, which is planed at the bottom, stands *across* the lathe-bed (the side shown facing the mandrel). The upper part of this casting forms the bed of a slide-rest, and is faced and planed in a precisely similar manner. Instead, however, of a single driving-screw running the whole length, there are two—used each right-handed and containing 25 threads to the inch. Their inner ends work in a bearing in the centre of the slide-frame. A and B are the two main slides, carried along in the same direction by their respective screws. The slide A carries at the corner four short projecting studs or pillars, and the slide B. two similar ones K K, K, through which work steel screws, pointed and hardened at the end, to form centres of motion for the perpendicular steel rods H G F. These screws, therefore, give a power of adjustment for the height of centres. The upright bars H F carry each two horizontal arms, the lower ones being simply levers acted on and in turn giving motion to the single cross-bar or lever at the lower end of the central bar K. The upper arms, however, of H and F carry respectively the tracer and the cutting-tool, fixed on sliding pieces clamped at the desired position by two milled screws. The tracer upon F is simply a steel point carefully rounded off and burnished at the end. The cutting-tool upon H is pointed, and is sharpened to a very keen edge. A light spring behind the arm which carries the tool, serves to keep both it and the tracer up to its work. The central lever is added to cause the simultaneous movement of the tracer and tool, which would otherwise move in opposite directions. Mr Lowe now prefers making the farthest point the tracer, and thus bringing the tool near the operator. The part M L is so constructed as to allow L, with its axle, to be drawn forwards at pleasure, so as to remove the tangent screw out of gear with its worm-wheel at the back of the machine. This is necessary when any alteration is to be made in the setting of the tool. Fig. 3 shows how this part is arranged.

A is the driving pulley, worked, as before stated, by a band (elastic) from the chuck which holds the pattern, or that containing the blank upon which the medallion is to be cut. This is keyed or

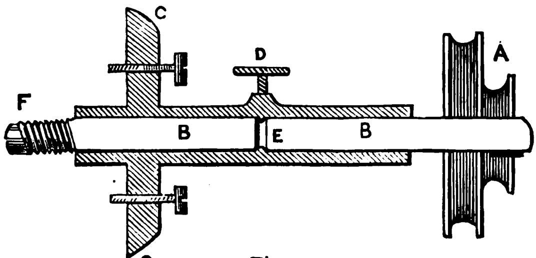


Fig. 3.

otherwise fixed to an axle B, of steel, which passes completely through the socket bored to receive it, and which is attached by screws to the body of the machine. This socket is marked M in Fig. 1, and is here shown in section. A light screw, D, descends into a groove, turned in the axle or spindle, preventing endwise motion, but not rotation; and this screw is relaxed when it is desired to draw out of gear this axle with its screw F. The casting at H H, Fig. 2, is turned down to form bearings, and is cut out and bushed with brass. Such is the simple but cleverly-arranged medallion machine of Mr Lowe, which does its work with rapidity, and in a masterly way, under the guidance of an efficient workman. The medal to be copied may be mounted upon a disc-chuck by means of cement, or in a self-centring-chuck, and the wood to be cut in another upon a second mandrel, gearing with the other so as to revolve at the same rate. The work must be accurately faced, and the centring carefully attended to. The tool and the tracer must also be adjusted with great nicety to the respective centres of the work and pattern, which can be readily effected by the milled screws which carry the arms H F, and the little tool-holders, which can be clamped at any required spot upon the horizontal arms. The tool must be well sharpened and burnished for fine work, and it is better to oil the face of the medal to be copied. As the work proceeds, the slide-rest screws cause both tool and tracer to travel slowly and simultaneously in a horizontal direction; and in effect the medallion is cut by a fine continuous spiral. The dimensions of the machine depend upon the lathe to which it is to be fitted. That for a 5-inch centre is $8\frac{1}{2}$ inches in width (or *length* of the upper slide-rest frame) by $1\frac{5}{8}$, as the width of such frame; the lower part, which rests on the lathe-bed, 10 inches. The number of cogs in the wheels should give 1000 to 1100 cuts or grooves in the spiral for an inch of traverse of the tool across the face of the work.

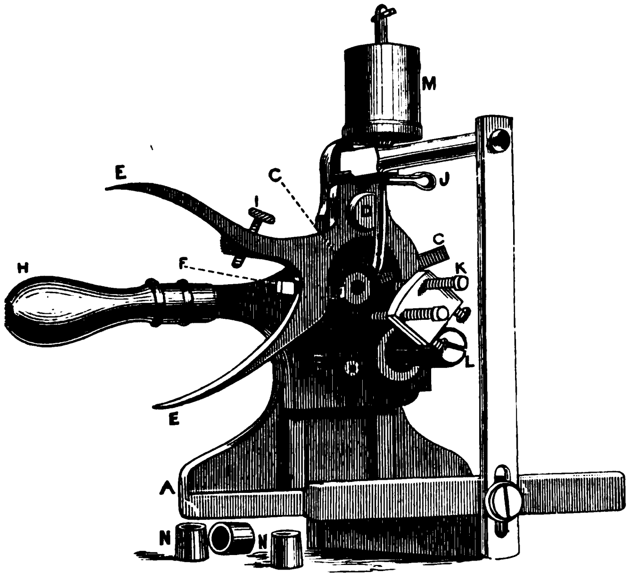
J. L.

A NEW SCREW-BLANK MACHINE.

THE accompanying illustration represents an excellent contrivance for making small metal screws in the lathe. Invented by a workman named Hoffman, it is specially serviceable when large quantities of the same size are required, for the inventor states that, with practice, as many as one gross per hour may be turned out complete, with the exception of the nick in the head.

The machine consists of a cast-iron bedplate A, having a projection underneath fitted to the bed of the lathe on which it is to be used. To this is bolted the plate B, which carries the working parts of the machine, and must be adjusted so that the centre of the circular opening C exactly coincides with the centre of the lathe. Working on the bolt D is a lever E, furnished with two handles similar to those of a pair of pliers, for bringing the two tools F and G into cut with the assistance of the fixed handle H, which latter also serves to move the machine on the bed of the lathe during its action. When the cutters are not in use the lever is held in an intermediate position by the spring J.

The diameter of the shank of the screw is determined by the penetration of the cutter F regulated by the screw I, while the length of shank and head are respectively determined by the two stop-screws K K, carried by an arm moving on a pivot at L, which enables either of them to be brought opposite the opening C, both being



held in position, when so placed, by a spring-catch. M is a reservoir, with a pipe to conduct the oil or other lubricant to the work. N N are steel collars, accurately turned to fit the opening C and pierced to admit wire of different sizes.

The machine is used in the following manner:—A straight piece of wire of a thickness equal to the diameter of the head of the intended screw having been chosen, it is fixed in an American or a die chuck and passed through a suitable collar fixed in the opening C; the length and diameter of shank are then adjusted respectively by the screws K and J; and the machine is moved away from the lathe head until the end of the wire is flush with the collar through which it passes. The lathe having been set in motion, the upper handle of the lever is depressed so as to bring the tool F into cut, and the machine is steadily moved from right to left until its progress is stopped by the end of the wire coming into contact with K, the handle of the lever is then released, the machine pushed away from the work and a screwplate applied to produce the thread. The stop-screw K having been adjusted for the length of head and brought opposite the work, the machine is again moved up and the screw cut off by the tool G actuated by the lower handle of the lever.

The adjustments once made, it is of course only necessary to repeat the process of cutting the shank, screwing and cutting off as often as may be required. A lathe with a hollow mandrel is preferable, for, as the wire can then be cut in double lengths, there is less waste.

DIRECTIONS FOR EXECUTING FANCY-TURNED TURKEY BOX-WOOD ORNAMENT.

NUMBERED 1858.

HAVING selected a piece of clean, well-seasoned box-wood of good colour, free from knots, about 1 inch in diameter larger than the largest part of the bottom piece, coloured red * on the full-size section drawing, viz., about 5½ inches diameter,

With the compasses find the centre of both ends, and with a centre-punch and hammer make an indent at each.

Put a prong-chuck on the mandrel, bring up the back poppet, and suspend the piece of box between the prong-chuck and back centre, placing the end from which you intend to cut a piece towards the back centre. If you find the piece is rather crooked, and that by altering the prong-chuck, that is, moving it a little out of the centre, you can make the end you are going to cut run more true, so much the better.

Throw the band off the mandrel pulley.

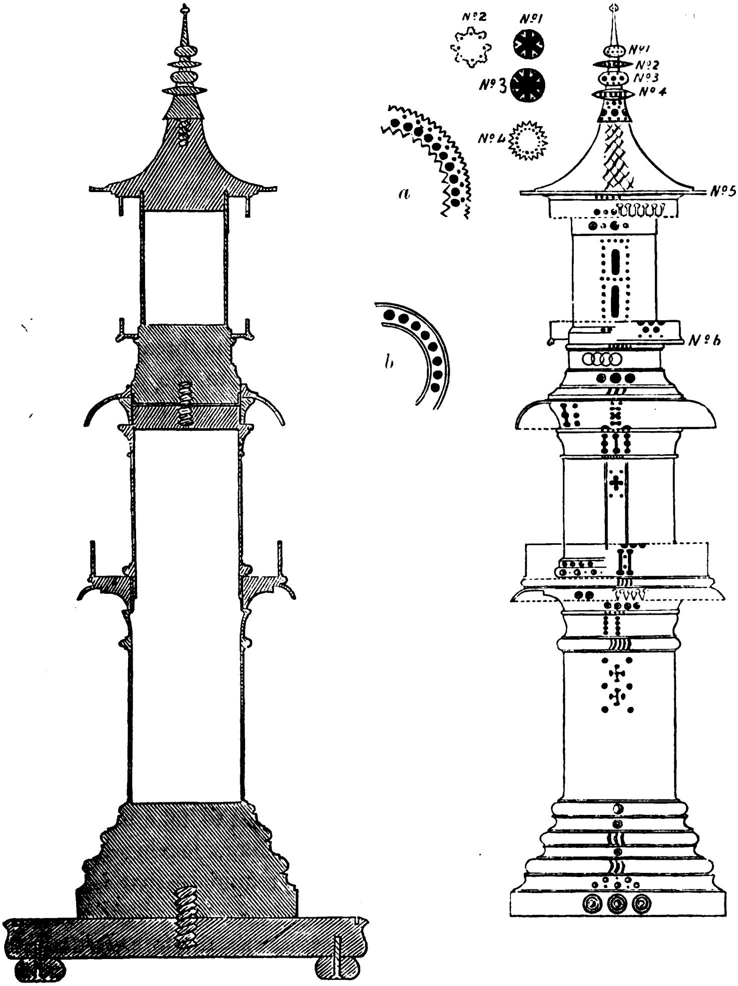
Fix the slide-rest towards the back centre, having first put a carpenter's pencil in the tool-slide, and mark with the pencil by turning the work with the hand *backwards*, keeping at the same time the pencil sliding backwards and forwards against the circumference of the work, so as to mark all round sufficiently to enable you, by sawing off this piece, to square up the end.

Take a saw and saw all round in the pencil-mark so made; then measure off the length of piece required, but about an eighth of an inch longer than the drawing. Bring the pencil and slide-rest

* The colours are denoted by different lines of shading, and the large drawing it has been found necessary to reduce.

opposite the place, and proceed to mark all round as before, that you may saw off, and trim this end also accurately.

You can now saw in deeper both cuts, or, if a pretty good hand at using the saw, you may take the work out of the lathe, and, placing



a. Round the edge of roof No. 5. *b*. Under side of top gallery No. 6.

it on something firm, proceed to saw by degrees all round until you have sawn both places quite through, and, if you have kept the saw in the kerfs marked, you will have a piece sawn off with both ends parallel and true to their axes.

This may seem taking an unnecessary amount of pains; some may think that they could easily saw off a piece in the ordinary way; but that is not so, because, if the end which is to be screwed on the mandrel or chuck is not at right angles to the axis of the work, the other end will be quite out of truth.

Take the piece cut off and with the compasses find both centres, and mark them as before.

Put it in the lathe again with the prong-chuck and back centre, then turn the end nearest the latter out, so as to let the outside project over beyond the centre about the sixteenth of an inch, taking care to leave the wood about the centre half an inch or so in diameter.

If your lathe has a male screw, you may mount the work directly thereon; but if a female screw, you must select a chuck with a male screw about three-quarters of an inch in diameter. In either case, you must take the size at the bottom of the threads, and put a drill of this size in the lathe, and drill a hole in the end you have turned off, letting the drill enter the centre hole you have left for the purpose, bringing up the back centre to push forward the work. Be sure to drill the hole rather deeper than what is required, so that there will be plenty of depth for the screw: put some oil in the hole; then with a tap corresponding with the mandrel screw, tap the hole and fix it either on the mandrel screw or chuck screw as the case may be. And having been thus particular, you will find the work run quite true.

The wood being thus properly mounted, commence to rough off the outside with a common gouge by hand, if sufficiently an adept to do so—that is, if you have acquired the art of preventing the tool following the undulations of the work, by holding it firm on the hand-rest; otherwise use the slide-rest, and put therein a tool-holder to take a gouge. With this, taking care not to take too much at a time, you will easily true the work to shape, leaving it all over about a quarter of an inch larger than required—that is, half an inch *in diameter* larger.

The work having been thus turned to shape, the fore part will be very much lightened. Next turn the front off true, and countersink a centre hole to commence turning out the inside (first operating with a small-nosed auger), and bore out a hole and keep on increasing it in size until you have made it large enough to allow you to insert a turning-tool. You must be sure to let the hole made by the auger be quite as deep as you have to turn it out. I use a hooked tool to rough out the inside by hand, but this requires some practice to use—yet, with perseverance, the knack is soon acquired. Inside tools are given in "The Lathe and its Uses," Figs. 51 to 57. Use these either by hand or in the slide-rest. When you have nearly got your work to size, use an inside tool, No. 51 or 52, to clean out, taking care to get the bottom as large round inside as required. It is best to leave quite finishing the front opening until you have the bottom large enough.

Having decided by careful examination with the calipers that the inside is turned out the right size, turn down with the slide-rest the outside, being careful to test it frequently with the calipers, lest you should get it too thin. The substance should be a little thicker than cardboard. Form all the mouldings as shown, and, if the work was chucked on the mandrel screw, it will overhang a little at the back part—just take off, therefore, sufficient to make the bottom quite true, which will cause it to stand upright when finished.

Commence the open work with the overhead motion, drilling the large holes first, having properly spaced them with the slide-rest screw, and the division plate on the mandrel pulley. Let them be at equal distances apart, both around and up and down (sixteen patterns round).

The intermediate pattern is placed in the centre between the large holes. First drill the extreme holes by arranging the division plate and slide-rest to correspond for equal distances. Then, with a smaller drill, connect the holes at right angles, as seen in the full-sized drawing, in all cases keeping a sharp drill for such work.

It will be observed, on the full-sized drawing, that the projection for the top moulding is thinned out on the inside, corresponding with the shape of the moulding. Drill the holes as shown, and connect the holes with rather a smaller drill than that by which the holes are bored out.

The notches on the intermediate moulding are done with the eccentric cutter; the slide-rest socket being first tilted on one side, and the slide-rest raised to allow the tool to cut only half round each time.

The base mouldings can be ornamented with the eccentric cutter, and any tools at hand, as near to drawing as may be. I have made myself the chief of my ornamental drill-tools as required.

Next proceed with the second piece of the ornament, in the same way as already described for the first. As it is not so heavy a piece of wood, a chuck with a $\frac{3}{8}$-inch screw will be sufficient to hold it.

This piece requires to be fitted into the bottom piece, but it must not be fitted until the inside is turned out, so as to allow it to contract, which it will do when hollowed out. Form the mouldings and ornaments to drawing. The long slots I cut with a small circular saw I made to work on my universal cutter, but if you have not one, use a small drill. The pattern is done with one drill, the holes being worked into each other at right angles (sixteen patterns round). With drills form the openings of the cornice.

A piece of the cornice under the veranda coming against a piece of the wood left solid, will have to be turned and fitted separately, which allows it to be drilled out much cleaner. The same observations about turning out the inside before fitting, applies to this and all similar work.

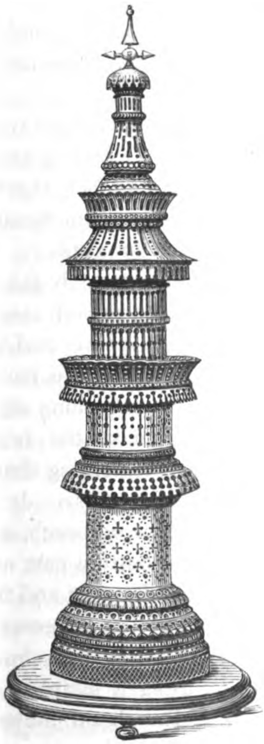
Cut off a piece of box of the required thickness, and chucking on a $\frac{3}{8}$-inch screw, turn off the face; then reverse the piece, and turn off to thickness; mark the size of the inside, and turn out a groove about half an inch wide, leaving about a sixteenth of an inch of thickness at the bottom. Turn to shape on the front part to drawing, and ornament with drills. Clean off the inside; make sure that you have the inside large enough to go on the place required, then cut it off the chuck.

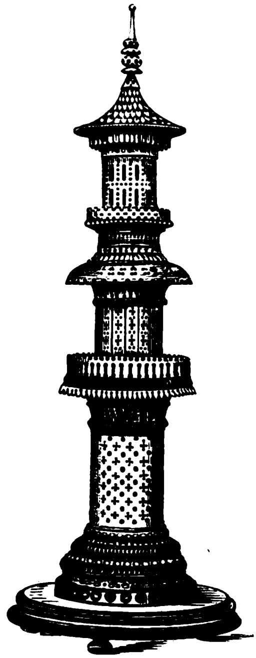
This second piece of the ornament requires to be turned out, for the next piece to fit into, and for this it requires to be chucked afresh, the reverse way. This will require a piece of common hard-wood (beech is as good as anything), to be chucked and turned off to size, leaving a shoulder for the piece of the ornament to fit against; then turn out about three-eighths of an inch deep, having been careful not to fit the work too tight, so as to split it,—rather put a brad or two through the holes to prevent the work turning round on the chuck, and go gently to work.

The third piece will require to be chucked (as before described) on the last-used chuck, or on one with the same-sized screw, so that the two screw holes, this one and the one in the second piece, may correspond. They can then be screwed together, as per drawing, by turning a piece of wood the right size, oiling it, and cutting the screw with a brass box. Part can be glued into one piece, and the remaining part screwed into the other piece of the ornament, to connect the two together; observing that a part of this third piece has to be turned down at the bottom to fit into the recess last made on the top of the second part.

Turn out the inside, and ornament as per drawing.

We next come to the roof. This piece of wood must be about an inch longer than required when finished. It has to be chucked (as previously described for the other pieces), taking care not to drill the hole for the chuck screw deeper than the extra length you have allowed. Turn the underpart to drawing, and ornament. The underpart of the drops and projecting edges of the roof of the original were cut with circular cutters, made by myself, which I have found much better for edges than fly-cutters. Drill the holes around the drops. The slits are cut with a small circular saw. Drill also the holes (see detail drawing) around the projecting edge of roof.





It must now be carefully rechucked the reverse way, by first turning out the hole for the chuck-screw with the slide-rest perfectly true, and tapping it as already described, taking care that the tap enters straight—that when rechucked the work may run true. Cut it off to the length required, and turn to shape. The roof was engine-tùrned by me with my rose-engine, described and illustrated in the appendix to "The Lathe and its Uses." It was done to represent shingles, used instead of slates abroad. Those that have no rose-engine can ornament with drills, forming the circles to overlap each other alternately.

Next turn out a small hole true for tapping, to fit a screw to be made on the lower part of the top piece.

The top piece will require to be a nice clean piece of box put in the lathe, and one end turned down the size to cut a small screw to fit a female chuck. I cut these small wood-screws with a brass box; my gun-metal chucks are all of my own construction, and are made for the male and female chuck-screws to correspond. Turn out about an eighth of an inch deep around the screw for it to fit over on the top of the roof.

When properly chucked, turn to shape of drawing, and ornament, as per detail drawings. The parts numbered 1 and 3 are drilled through, so as to leave the centres quite open; in fact, the whole is to be made as light as possible. It should be commenced at the extreme end, and each division finished as you proceed.

We next require a small piece of box, thick enough for the top gallery, which should be bored through the centre and screwed on to a $\frac{3}{8}$-inch screw male chuck. Turn off the face true, and turn out sufficient all round, as required per drawing, leaving the centre part around the screw. Ornament and finish this top portion; afterwards proceed to cut it off, taking care that you make the hole large enough for it to fit on the place required; remembering that it will be sure to contract; and therefore ought to go on easy. It will not matter if it is a little loose. Now chuck a piece of beech, and turn down for the gallery to fit on nicely, when the bottom part will have to be turned off, the holes drilled as per detail drawing, and finished.

The veranda will require a piece of box of the necessary thickness particularly clean and free from defects, bored and chucked as the last piece. Turn out the underside, using a template for the purpose (a piece of cardboard will do). Rough off the top side to shape, and cut it off the chuck, leaving a hole the necessary size to fit the place required. Observe the remarks previously made as to its contracting.

Chuck a piece of beech, and turn down with a shoulder for reversing the veranda piece as required. Finish the top part. It will be best, to make sure of its not moving on the chuck, to fix it more securely with three mushroom-headed screws screwed into the beech close enough for the heads to overlap and fix the piece of box. Then ornament it as per drawing. In all cases, ornament the edges before you cut out any other part. Circular cutters are best for this; otherwise use drills cutting on their edges in preference to fly-cutters, as box is much more delicate to work than ivory.

The previous directions will be quite sufficient for the bottom gallery.

The stand for the glass-shade is rosewood. I have shown the moulding and the groove for the glass. The glass should be quite an inch higher than the ornament. Cut a wood-screw, and screw the bottom part of the ornament to the stand. The latter requires to be first covered with crimson silk velvet; glue the top part of the stand, and smooth the velvet over.

General Remarks.—As you proceed, nicely clean off each part, and oil with clean linseed oil before commencing the ornamentation. The oil improves the colour, and prevents dry, well-seasoned box from splitting. Polish with bees-wax dissolved in turpentine. I use a piece of the list of flannel for the purpose. It does not require much polishing. It is best, after oiling, to let it remain a day or two, for the oil to dry before polishing. Another piece can be prepared in the meantime. After ornamenting, the front part requires cleaning out with a rather soft brush. In proportion to your drills being sharp, so will the inside be clean; and what little splinters there may be, will require to be rubbed off with fine sand-paper, although I generally clean them off with a tool—but this requires great care and some practice. I find small ward files very handy for cleaning out such work; you can have them with edges plain or cut, and the file on one side only. There are also small rat-tail files, which are sometimes useful.

I have, from experience, found taper drills best for very thin box. I make them very thin, to cut on their edges; and as they advance, they keep cutting out the hole all round, nice and clean; they are very handy in other respects.

BREECH-LOADING FIRE-ARMS.

THE object of this paper is to discuss the present state of the breech-loading question, as regards fire-arms, rather than minutely to describe their numerous varieties. Such discussion, by disclosing what has been already accomplished, and by pointing out certain objects aimed at, but as yet unattained, may possibly lead to the realisation of some of the latter, by bringing them under the notice of those who might not otherwise become aware of them; or, at least, by opening up and ventilating the matter amongst fresh societies of scientific men, some new light may be thrown upon certain vexed questions, the solution of which would be interesting and curious to many, and especially advantageous to certain portions of society. Such are— the best length of barrel for a given bore in the shot-gun; the cause of deterioration in the shooting of the sporting breech-loader, when compared with the muzzle-loader; and the reason why pairs of barrels, and even barrels in the same pair, differ so materially in their shooting properties.

To arrive, then, at the present state of the breech-loading question, we must trace the steps by which it has progressed, and we shall find that improvements in the ammunition have done more to overcome the difficulties which presented themselves than mechanical appliances in the breech action; in short, that the ammunition-case has become a very essential component of the gun-breech.

There are some, and able men too, who have long asserted that this must always be so,—who say the cartridge must be the foundation on which the weapon is built; and as we shall see that to a great extent it is so in the arms of the present time, the advocates of this opinion have some reason to triumph in this proof, so far as it goes, of the correctness of their predictions. But is it always to be so?

This is perhaps the most important question of the whole subject. Is the cartridge always to be, as it now is, a gas-tight lining for an imperfect breech? a costly component of the breech, which is of use but for one discharge, and is then rejected? Or may a perfect breech be constructed not dependent on the cartridge, the office of which would then only be to contain and protect the unexploded charge, projectile and ignition? Such is the problem proposed to the mechanic of the day; and it would be hazardous indeed, as this third quarter of the 19th century hastens to its close, to assert that it may not be solved. Clearly the gain would be a great one. Weapons are now made at a price which is moderate in the extreme, and of breech-mechanism that will stand the wear and tear as long as the barrel itself; but take the cartridge-case as a portion of the breech-construction (assuredly it is so), and the cost of these weapons becomes enormous. The value of the standing mechanism soon sinks into insignificance beside the expenditure on that part which has to be renewed after each discharge. Having stated this view of the subject, we will see how far it is borne out by past and present history; for which purpose it will be necessary to glance at the early breech-loaders, their causes of failure, and the remedies which have gradually led to the production of the breech-loaders of the present day.

We need not go back to the dark ages of breech-loaders, to the 15th or 16th centuries; though such research would go far to convince us that the question of twenty-eight centuries' standing, "Is there anything whereof it may be said—See, this is new?" must receive the same answer—"It hath been already of old time which was before us." We need only notice that the element wanting in these days to make these inventions of public utility was another mode of ignition. The old flint and steel was slow enough in operation when it had but a naked charge to deal with; there would indeed have been "many a flash in the pan" had that charge been clothed in a cartridge-case; and without such means of entering projectile and charge together, the process of loading a movable chamber with each separately would be as tedious as charging the weapon from the muzzle; and there would be no compensation for the more complex construction, whilst there doubtless were difficulties in the withdrawal and replacement of the chamber. When the percussion-cap had promoted to an *otium cum dignitate* in our ancestral halls the revered forms of its own ancestors, it opened a new field for breech-loading invention; and the actions adapted to its use were numerous, and many most ingenious; still these were either chambers requiring loading with loose charge, or with a cartridge of skin or other fragile material that would permit the penetration of the percussion spark.

Such case being wholly inadequate to the protection of the charge for sporting or military purposes without an additional wrapper, which had to be torn off before loading, and, moreover, providing no breech gas-stopper, but leaving that duty to the movable breech, so far the breech-loading difficulties were only partially reduced; and although the recognised advantages of introducing the charge at the end of the barrel, where it remains till discharged, instead of driving it there by the long road whereby it has to return, continued to stimulate the brains of the ingenious to solve the problem, and led to the partial adoption of those capping weapons both as military and sporting arms,—still, their defective cartridges, consequent deterioration in shooting qualities, and usual gas-leakage, enabled the constituents of their dear old muzzle-loading friend to return him again to his time-honoured seat, despite the struggles of the upstart candidate in each contested election for the Province of Slaughter in the Animal Kingdom.

To the aid of the muzzle-loader came that sure indicator of sound and ultimately successful principle, dogmatic denunciation, by "those who ought to know most about it." All attempts at uniting the ignition with the cartridge were snuffed out in high quarters by the death sentence, "dangerous," and, without further trial, your "self-contained ignition" was disposed of by that final court of appeal. Thus the very essence, the life and soul of the present systems, the solution of the greatest difficulties of some three centuries, proposed by Monsieur Robert in 1831, was only finally adopted in this country for military purposes in '67, and then, under pressure of the startling performances of the Prussian needle-gun, when roused to action from a tranquil existence of some ten years, an existence which, known to be on the denounced principle, was duly despised.

But though one of the poorest exponents of that principle, there was no longer a shadow of a doubt that capping arms (the only breech-loaders then in our service) were impotent in comparison with it, and so the principle, continually and persistently condemned from '31 up to that hour, was then perforce brought to impartial trial, found "perfectly safe" instead of "dangerous," and then—be it spoken with all honour to the authorities of that day, and the officials and inventors to whom they turned in their hour of need—a cartridge, and a breech-loader to fire it, were contrived, adopted, and manufactured with a well-directed skill and energetic zeal, which not only placed England first after Prussia in arming with the breech-loader, but gave her a far superior weapon to the child of that country, and even at the present time, 1870, superior to the breech-loader with which any other first-rate power is fully armed.

But let our military magnates have the grace to take off their caps (or rather cocked hats) to their sporting brethren, and admit their keener perception of a sound and good principle, since they had recognised and employed cartridges containing their own ignition ever since the invention by Lefaucheux, in '36, of the pin cartridge, and of the central fire by Potet (?) some years later. Inventors, too, may note the inference drawn from this as from the history of most inventions—that authoritative declaration against sound principle by the "knowing ones," and the cold shoulder turned on ingenious novelty by—dare we say it?—public pig-headedness, are rather the heralds of future success, than any cause for present discouragement.

Such obstacles to advance, however, are not wholly unattended with beneficial effect; they put the stuff of which inventions are made to the stern test of time, sift the specious in appearance from the true in principle, give the bubble time to burst and the good foundation to mature, only, unfortunately as a rule, nine-tenths of that time are superfluous. We may then dismiss the capping arms without further comment. An effectual permanent breech gas-stopper was their difficulty. The breech alone had to provide this, because the cartridge case must be of material to permit the penetration of the igniting spark from an external source.

It is, however, worth noting Green's ingenious method of combating the difficulty, since the same plan has been adopted in the French military arm, the Chassepot. Mr Green placed a caoutchouc wad between two metal discs; the front one being that operated on immediately by the explosion, and being supported against it by the hinder disc or metal block, which was rigid, and the intermediate cushion of india-rubber, which, expanding diametrically under its axial compression, effectually sealed the breech so long as its elastic properties remained uninjured; but, of course, these were liable to deterioration from climate, &c., and they required occasional renewal.

The history, then, with which we have to deal is the history of the last thirty-five years, and that has only reached the stage of active progress within the last five. The different mode of ignition that has given the new impetus, has marked the third epoch in the breech-loading history as the percussion cap did the second. The ignition has become a component of the cartridge, and is inserted in the form of a percussion cap, of a pellet of detonating composition, or of an annular distribution of the same round the rim or flange of the cartridge.

The latter plan has fallen for the most part into disuse, on account of the uncertainty of disposing a full proportion of the composition at all points of the rim (which may be struck in any unprovided place by the plunger).

The concentration, therefore, of the ignition in one spot, where the blow always falls, has been generally adopted, and it is commonly situated in the rear of the charge, but its best position is one of the vexed questions which is perhaps more important than is generally supposed. It has been said that igniting the charge in the centre gives less recoil, whilst it has been proved that primary ignition at the front end causes much the least sudden strain on the barrel, and, we should therefore suppose, least sudden recoil also. Indeed, the inertia of the projectile must be thus overcome more gradually, since the first grain which is evolved in gas commences its operation immediately upon it instead of through the medium of a portion or all of the charge, thus accumulating force much more rapidly behind it. This plan of ignition would seem eminently adapted to the shot-gun, where reduction of weight in the barrel is so much sought for, and the injury to shooting from the disfigurement of the pellets is in proportion to the suddenness of the force which drives them against each other. Besides, no grains can be thus lost by being blown into the wadding, nor can strain, beyond the pressure of the gas which the length of barrel will evolve before the projectile leaves it, be brought upon the gun, whatever overcharge of powder may be used. Front ignition is the principle on which the cartridge of the Prussian needle-gun is based, but it does not seem to have found favour in other quarters, probably from the defect experienced in that weapon of a long and comparatively fragile needle liable to fracture or deflection from the detonating spot. The question remains, and it is an important one—Is this the only or the best means for obtaining front ignition? We now turn to the more usual form of ignition,—a cap or other depository for the detonating patch placed in the centre of the cartridge base. The position here selected seems to be one rather for manufacturing convenience than for utmost effect; and perhaps this yielding to convenience has given something to the muzzle-loader as far as hard hitting is concerned. The best form of breech in the old gun was the subject of much careful investigation, but his rival and ultimate supplanter seems hitherto to have considered all such as superfluous. (The Selwyn cartridge is an exception.) Yet Joe Manton won for himself great honours by his patent breech; and perhaps this of all the forms experimented on, was nearest to the most perfect shape, theoretically speaking. It would seem that shape in section should be a parabola, and the point of ignition its focus; because, that point being thus the first centre of expansion, the gas radiating from it would be reflected from all points of the parabolic surface in lines parallel to the axis of the gun. If there is anything in this, we may say there is room for improvement in the position of the ignition and the shape of the base where it is placed, if, from other considerations, it seems desirable to retain that general position of it with respect to the charge. We may here notice some other causes of superior power in the breech-loader connected with the cartridge. Nothing is more certain than the loss of effect in the discharge when the tube confining its lateral expansion is wanting in elasticity. The difference in the shooting of shot-barrels before and after hammer-hardening has been found to be a very wide one, and latterly steel has been generally introduced—

1st, With undeniably good results, as the material for the barrel.

2d, For military purposes, and to a great extent for sporting guns also.

But of whatever substance the barrel may be, it is clear that the value of its elastic reaction on the expanding gas must be negatived to a great extent by the pasteboard packing which, in sporting guns for the most part, is interposed between the charge and the metal, acting as a deadening cushion to both action and reaction on the sides of the tube; and it is in those guns that inferior shooting is most perceived. If this is the case at the sides, much more is it so at the rear of the charge. There (for convenience of manufacture again) is a papier-maché wad coiled around the cup containing the anvil and cap, and closely pressed between it and the sides of the case, which it secures by that pressure to the external cup of brass; but this wad presents the edges of the coil to the backward explosion, and, closely as they are pressed together, the gas percolates through so readily, that, if any portion of brass be left unsupported in rear, it will be found bulged or burst, whilst the wad will exhibit no corresponding symptom.

Here, then, at the breech end itself, where so much pains were expended on the muzzle-loader, we have in the breech-loader a softening pad of a $\frac{1}{4}$ inch thick, through which the gas must squeeze its way before it arrives at a hard reacting surface, instead of being reflected muzzlewards at the instant of contact with nearly equal force.

It is not, perhaps, too much to say, that the material and construction of the cartridge-case has to answer for quite one-half the loss of power the breech-loader evinces in the field.

The material and construction of the cartridge-case deserves a wider consideration than the nature of this paper proposes.

Besides the pasteboard sporting-case, with brass-flanged cup, there are for those arms also cartridges semi-metallic, used principally in rifles, internally or externally lined to a greater or less extent, to obviate some of the defects referred to and strengthen the walls of the case. There is the cartridge, entirely metallic, of brass or copper, drawn, and the Americans are strong advocates of this description. Then our own military cartridge of composite construction, the combination of numerous inventions, and in itself a little history of the attempts, the failures, the hopes, the success, and the final reward of inventors gathered by the individual who best knows how to pick their brains. Truly he deserves a reward, but *he alone* gets it!

The coiled case and the solid base are the most distinguishing characteristics of the Boxer cartridge—the former to permit expansion without rupture, and the latter to afford a rectangular flange for the extractors to hold to, and prevent the bursting at the rim to which flanges pressed out of the metal of which the base or body of the cartridge is made are liable.

It is sufficient for our purpose merely to notice these varieties of the class known as non-consuming cartridges. Their office is to relieve the breech-joint of the duty of confining the gas, and by their aid a comparatively weak and open joint, as in the Lefaucheux crutch-gun, suffices.

In the balance against this is their expense in material and manufacture, which requires to be most accurate and careful; their weight, and the necessity for extraction, which demands an extra mechanical appliance in all arms employing them. The other class—chiefly represented now by the French Chassepot and Prussian needle-gun cartridges—are the self-consuming, or partially self-consuming cartridges. The Chassepot and needle-gun are instances of the former, the Westley-Richards and Needham needle-gun of the latter. In the first pair, the expanding india-rubber wad and the tight-fitting joint struggle with the slippery gas, but not with everlasting success. In the last pair, a felt wad in the cartridge itself and a shallow metal cap on the base expand into and fill the breech-joint with better effect and without need of extraction; but they have to be forced up in front of the new cartridge, to the detriment of the shooting, and frequently of the loading.

Lastly, there has been an attempt to combine the merits and eradicate the defects of these two classes for rifled arms, and, moreover, to shift the rifling from the barrel to the bullet. These are known as bullet-cartridges, which are either elongated bullets, with a large rear cavity sufficient to contain the charge, or tubular projectiles, rifled on their interior surface and filled with the powder-charge, having a wad at the base containing the ignition.

A projectile is entered, in the first instance, without its charge; thereafter a charged one is pushed into the barrel, and, on discharge, the front one is driven out, whilst the rear one, then empty, becomes the new projectile in front of another charged bullet, and so the game goes on. The remarkable ingenuity and originality of this system is very taking, and when we hear that it produces such astonishing results as increased accuracy at 2000 yards from a smooth-bore with the same elevation as an Enfield rifle requires to range 900 yards, we are struck with astonishment that this projectile, which has been before the public for about fourteen years, should be so little known or (officially at least) experimented on.

It may be the old story of giving it *plenty* of time, or it may be the other old story reversed—not the weapon which is looking for suitable ammunition, but the ammunition which is waiting a fitting weapon; possibly a little of both. We see some indications of the latter in the difficulties presented after a missfire of extraction, and of unloading at all times, and of loading, from the expansion of the projectile which has to be pushed forward; to diminish which last difficulty a felt jacket has been proposed or adopted, but with what effect on the subsequent career of the projectile does not appear.

The theory of that career is truly most captivating. Making the passage of the barrel without any of the friction, strain, and recoil consequent on taking the grooves of a rifle, it dismisses, on emerging into the open air, the wad which has hitherto been the "fire-block," and thenceforward, as it has been neatly expressed, "threads itself on a column of air," with a velocity, when compared with the solid bullet, the hindrance to which is diminished as to pressure in front and vacuum behind by the diametrical section of that column, and with a rotation constantly resulting from its speed.

It would seem that it waits but some combining invention to revolutionise the musketry science.

We now turn to the engines in which these cartridges are expended, and these fall into two grand divisions:—1. Actions working in guides parallel to the barrel axis; 2. Actions working on centres eccentric to that axis—guide actions and hinged actions, commonly classified under the names (inappropriate in many instances) bolt-guns and *block*-guns. Of the former, the needle-gun, the Chassepot, the Carter-Edwards, the Berdau (Russeau), the Remington, the Kerr, and a host of others, may be quoted as examples. Of the latter, the Martini, the Peabody (its parent), the Remington (discs), the Westley-Richards, rising and falling block, and improved (or modified) Martini, the Joslyn, the Lefaucheux, the Snider, and a list in addition which would fill more than the limits of this paper without description. There is, besides, a third class, known as chamber-loaders, which for the moment appear *passé*, having been employed chiefly for the capping-arms and gone out with them. They exist for the most part now in the form of revolving breech-loader pistols; which, with the magazine arms (of which we do not propose to treat here), appear to form the connecting link between breech-loaders proper and that faggot of breech-loaders the mittrailleur, which, in its turn, links small arms to great guns, bearing no exception to the rule of inanimate and, we may add, animate machines, where the less seems continually to grow into the greater, or the greater out of the less, with *the* notable exception only where the connecting link never has been and never will be found.

Returning to the block-guns, to examine their machinery in a general way, we glance back at their simple old ancestor, the muzzle-loader, and cannot help remarking what a *very* simple machine he would have been *without his lock*—a tube stopped up at one end. Simple enough indeed, yet that does the whole business when once the little spark has been driven into it. Yes, it is that bothering little spark that gives us all the trouble; if we could only call it forth and direct it with machinery as primitive as suffices to control and despatch where we will the vast power it wakens in the gun—What then? We need not speculate, for we cannot. Perhaps there are not elsewhere, side by side, in the same machine, such good examples of the properties of statical and dynamical force as these two. In the one there is an enormous force set in operation, needing a statical resistance in all directions but one, and a tube and stopper effects it. In the other a feeble blow has to be struck at the instance of the finger, and see what trouble it gives us to create that little motion—half a dozen screws, a bridle, a sear, a tumbler, a swivel, a rest-spring, a main-spring, a hammer, a lock-plate, a trigger, and a trigger-plate. Need we say, then, that the first aim of the mechanic, when he labours in the breech-loading field, should be to simplify the gun lock? An action alone, be it block or bolt, may be made simplicity itself, but when you come to apply a lock to it, we say (in mechanical * parlance) "look out for squalls." The feature in all block actions, which is absent in their bolt brethren, is the hinge, and this is the part in their construction most liable to wrack and strain. If we look at the Lefaucheux or a Snider as examples of sporting and military block-guns, we see this at once.

Then, as their action is never parallel to the axis of the bore, the extractor has to assume the form of a lever with one additional hinge at least, or requires a motion by hand in addition to the ordinary action of opening the block to operate it in the right direction. Once more, the lock requires a separate motion for compressing the main-spring, or there must be a lever to work the block, which shall also act on the lock, or conversely (perhaps the simplest form), a lever to compress the main-spring, which shall communicate the proper motion to the block. Whichever of these methods is adopted, it is evident that a direct acting plunger cannot be directly retracted by an indirect action, whilst if a striker be resorted to which is not in direct line of action on the central ignition, as in the ordinary side-lock, it requires an additional intermediate conductor of the blow, necessitating as a rule two or three more parts, including an extra spring, and frequently, after all, an indirect blow on the cap communicated by a similar blow upon itself.

Now, in all these respects, the bolt holds the advantage over the block system. It requires, it is true, a combined motion in opening and shutting, a partial revolution of a fixed lever followed by its retraction on the line of the axis; but it need hardly be pointed out that the loss of time in this as against a single motion is inappreciable. It is, of all others, the motion best adapted to withdraw the cartridge. It offers the double alternative of compressing a direct acting plunger directly or by screw power, and dispenses altogether with the ne-

* Query "Nautical."—Ed.

cessity for a hinge, whilst it is held in position and in work in a manner resembling the piston-rod—no mean example of endurance under constant operation—besides this, there is no more solid method of securing a breech than by the abutment of the lugs or cones employed in bolt actions immediately behind the pressure from explosion. Perhaps amongst the block-guns the nearest approach to these substantial qualities is to be found in the Henry action, where a block works across the breech in a vertical slot, but of course requires levers to work it, and its extractor and the side-lock which it employs rob it of simplicity.

On the side of the block-guns, it is urged that they are more secure from explosion before the breech is closed, less liable to become rusted up, occupy a less portion of the barrel-end, and are handiest to load in certain positions. The objection to the bolt-gun on the score of insecurity seems to belong exclusively to this country. The military authorities of the three greatest military nations have adopted the bolt system, viz., Prussia, France, and Russia; and two other governments have armed with the Remington (disc), which in the particular in which the bolt-gun is *supposed* to be dangerous is at least equally so. Our authorities have, however, pronounced, as they did on "self-contained ignition," the death sentence "dangerous," and apparently with as little foundation. Perhaps, too, as in that case, only hereafter to reverse it. The judges, however, who gave sentence were most honest in their admissions. They confess they tried the Bolt culprit with the preconceived conviction of his guilt; that they tried him with circumstances of severity contrived for his special benefit, and not extended to others; that after all, they could only prove that his striker would cause an explosion (the same which it is intended to do), whilst when properly constructed, they could find no case against him; and finally, that they condemned him on this charge solely on the ground of certain malpractices of the ammunition, which had, in cases of the utmost rarity, and where no similar conditions could be proved, occurred *out* of a gun, never in one, supposing that in the event of any one of these occurring, the bolt was less safe than the block.

The supposed danger is this, that a blow given to the cartridge base by the face of the bolt may ignite the percussion in the cap before the breech is locked. If so, we contend the block-actions are equally unsafe, and it is the ammunition which is at fault. The moment when danger exists (if there is danger), and where it is apprehended, is the moment of contact of the bolt-face with the cartridge-base after it is home, or of the jar received by the latter on being driven home with the bolt, and one of the two following defects must exist in the cartridge to produce any liability at all to ignition by this means:—1. A proud cap combined with a long anvil; 2. An anvil without the safety-shoulders on which the edges of the cap rest, to keep the point clear of the percussion.*

Now, in the first of these instances, the block must undeniably yield in safety to the bolt, for by simply counter-sinking the face of the latter in rear of the cap, which has no ill effect, the danger is at once removed; whilst block-actions have been known to explode their cartridges by the edge of the block, or of the percussion hole, scraping against the projecting cap, and then it is simply a race between the closing action and the exploding charge, whether the former can get into security before the latter attacks it.

In the second instance, the danger apprehended is from the loose anvil flying backwards into the percussion. Perhaps the consideration of the extreme lightness of the anvil alone would satisfy most people on this head; but we will examine its action:—1. Suppose the cartridge to be home, it cannot then move forwards without the barrel, and this motion is necessary before the inertia of the anvil can bring it in contact with the percussion. Considering the slight forward impetus given to the whole gun by the pressure of the one hand, which is resisted by the other, we may dismiss this case without further comment. 2. Suppose the cartridge driven home by the bolt, it requires an unusually stout flange to jar the former *in any degree* in a properly constructed piece, and then—oh, ye wisdom of ye objectors!—the check being in front of the flange, the anvil flies *forward away from the percussion.*

Let us turn to one more tedious examination before we sum up. It is the examination of the qualities of the spiral-spring as a gun-lock main-spring. The said spring has been sadly set upon and maligned, and well deserves to have its case fairly stated. Of all springs it is best adapted, by construction and form, for the main-spring of the bolt-action, being cylindrical and conveniently disposed within the cylindrical bolt, and again encasing in its turn the plunger

* To show to what lengths ingenuity has been strained to find cause against the bolt, it was stated before the Breech-loading Committee (inaccurately), that it put "a very heavy pressure on the powder from the bullet-end," and, "with a faulty construction of cartridge, you may get into trouble."

which it drives. It is unnecessary to point out to mechanics the excellence of this arrangement, and indeed they know too well the value of a *good* spiral-spring, for purposes where no other spring will avail them, not to recognise its merits. The compass in which it is contained is less than that in which any other spring of equal length will go to act in the same direction, and in proportion to its length, of course, is its ease in action and its endurance. Moreover, when coiled around a solid cylinder, it is much less liable to injury of any kind than any other spring, and no amount of extra compression can harm it. Furthermore, if it *is* broken, by whatever means, its action is not materially affected, for it is thus only shortened up one coil, and there is no other spring under the sun that can boast of this quality, which, for a gun-lock above all things, may be of vast consequence. What, then, is the reason it has fallen into such disfavour? We will quote two reasons given against it, one before a Scientific Society, and the other in evidence before the Special Breech-loading Committee, as specimens of the logic which, if it does not convince, is at least, to our surprise, tolerated. Here is the first of these:—

"To those who use an arm having the main-spring a spiral one, it is well known (from four years' daily experience we must deny it) that the force given to the striker is materially affected by the manner in which the trigger is pulled. . . . Attributed to the fact that the spiral or coil spring acts obliquely as regards the spring, although directly as regards the striker. . . . When released gently, the spring expands coil by coil; . . . when suddenly, a greater number of coils are brought into action. . . . In one case the contact on the cap is by a push; in the other it is, if I may use so unmechanical a term, by a shove. From this it is clear that a spiral-spring ought never to be used as a main or driving spring." Very clear indeed! is all the comment we shall make.

Here is the other:—

"Question. Do you see any objection to making locks depend upon a spiral spring?—Yes; the objection is this, whatever weight you make the spring, you must at all times have to pull back that weight in cocking the rifle, without any assistance whatever in the form of a lever."

As the Committee were then experimenting with the Martini, where the main-spring *is* spiral, and *is* compressed by a powerful lever, this evidence must have been somewhat amusing to them.

Now for our own version of the reasons spiral-springs have fallen into disrepute. At the outset we claimed a hearing only for a *good* spiral-spring, and we believe it is simply faulty manufacture and unfair treatment which has brought disgrace upon these springs. Every amateur who has tried, knows how difficult a matter it is to harden and temper a spiral coil of three inches length only, so that each coil shall appear in its place when viewed endwise. But go to the celebrated Salter, of West Bromwich, and he will make you a spiral a yard long, equally tempered throughout, and so little warped thereby that the perspective shall present the appearance of a well-turned rod; and on compression every coil shall collapse simultaneously on the coil behind it, evidencing the uniformity of temper and tension at every point, and the ease of that tension, from the great length through which it is distributed, as compared with ordinary main-springs.

The friction in the stroke is reduced to a minimum, for, since the diameter of a spiral coil enlarges as it is compressed, if free in the containing cylinder when so compressed, it becomes more free as it re-expands; and if free on the contained cylinder at the end of the stroke, it of necessity is free throughout it.

Those who assert that this spring is specially liable to the influence of climate must surely be dreaming; it is not made like other springs of steel—and we may remark, as to form, that the section of its steel is circular.

We have seen spiral-springs in course of manufacture for the plungers and extractors of our Government Sniders. A lad, who might have been just from the plough-tail, presided over the stew (we should say hash). On a rod he held perhaps a dozen of these springs right across a furnace, where, according to their position, they attained every degree of heat, from nearly white to barely red; but when some happy individuals seemed cooked to his liking, he plunged the whole into their cold bath. The further process we did not think it necessary to watch, but came away with the conviction there must indeed be virtue in the spiral principle, if such process sufficed to qualify for Government arms. The only subsequent test applied to these springs was a 10 lb. weight dropped endwise on each. It is not astonishing if such springs as these should fail to earn a character for durability; and it is the failure of some of these very springs which has done damage to their cause.

One more instance and we have done.

In the central-fire sporting crutch-gun a short spiral has been generally used to retract the plungers which are driven by the hammers to explode the cap. These have frequently failed in their action, or broken, and you hear loud complaints against spiral-springs generally in consequence. But what is the fact? For half the year these little springs have to stand the constant jar of the falling hammer, and for the other half-year it is the fact that they are jammed hard up by the relentless pressure of the same tormentor; and then when the 12th or the 1st comes round, the poor little creatures are expected to be found as elastic and lively as ever. If this is not a case of whipping the horse that will not go (till he does "go"), we assert ourselves natives of Holland.

Finally, to cull from our rambles through the breech-loading question what may seem to have bearing on its future.

We have seen that the early mechanisms failed to afford a joint sealed against the escape of the insidious gas,—that in consequence the science languished,—that no real progress was made till, by permitting the insertion of igniting power in the cartridge, a case could be given the latter, which would seal the joints for itself. But with this unconsumable case, which presented advantages over all other attempted expedients, came the disadvantages of cost, of weight, and additional machinery in the weapon. Finally, that there has come upon the scene an invention proposing to overcome these, and promising, moreover, to *smooth* all difficulties in the barrel, but has remained almost in *statu quo* for fourteen years, apparently from inherent drawbacks peculiarly its own.

If, on the retrospect of these salient points in the history, we should hazard a conjecture that the mechanics of to-day might construct the weapon that should fire a dozen different cartridges, instead of being one of a dozen that can fire but one cartridge, and that might, in addition, remove the special difficulties under which the tubular projectile labours,—we should doubtless be told we were beginning over again at the wrong end, and had failed to read the lesson which past history inculcates. The "knowing ones" would pity our ignorance, and assure us such speculations belonged only to the childhood of breech-loaders. Well, then, with the meekness which becomes us, we will only say they may be right, and they *may* be wrong.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

APRIL 1871.

THE HON. SECRETARY'S REPORT.

MY task upon the present occasion is at once easy and brief, for as there has been no meeting since the publication of the last number of the Journal, it follows of necessity that there is but little to report. That little, however, is of a highly satisfactory nature, inasmuch as it relates to the steady if not rapid increase of the Society. The January ballot added six, and that of last month seven, new names to our list, so that now we have 90 members, of whom 11 are honorary. Satisfactory as this progress is, it falls far short of what we might reasonably look for, were all to exhibit an orthodox amount of zeal; and I trust I am displaying no reprehensible impatience, if I seek anxiously to impress on the members the very obvious fact, that the more rapidly we increase, the sooner we shall arrive at the goal of our ambition; meantime the influence and usefulness, which we trust the Society will one day possess, must necessarily be lamentably curtailed. The workshop and library, so essential if our institution is to assume the attractiveness and importance requisite for its lasting establishment, and the educational influence we desire for it, is simply hopeless, until our advancing numbers put us in possession of funds to enable us to call them into existence. Let each member then make it a point of honour to introduce at least one other. Surely this will be possible. Some, indeed, have done this much, and others far more, but there still remain a very large number, I will not say the majority, whose resources in this respect we are yet unacquainted with. Guided by this principle, the Society would soon become conterminous only with the existing body of amateurs, which we have good reason to believe to be exceedingly large, and the continuous growth of which would unquestionably be stimulated by our own increase.

I endeavoured, in the January number of this Journal, to give a slight outline of what I conceived to be necessary to the complete development of the idea which led to the formation of this Society, and when I have conversed with others, I have generally found their opinions on this subject to coincide in the main with my own. If, therefore, we are to a certain extent agreed as to what is to be done, the question naturally remains—how to do it? Now, as the answer to this question will doubtless eventually involve a considerable outlay, and bearing in mind that when once fairly embarked in the more costly part of our enterprise we cannot draw back without heavy loss and much disappointment, it behoves us not to approach the consideration of a subject so materially affecting our permanent foundation without due deliberation. Until the Society had attained certain dimensions, it was neither prudent nor quite feasible to take any action; but I think the time has now arrived when we may safely endeavour to make some preliminary arrangements, with a view to carrying into execution our ultimate objects. The annual dinner, which is to take place on the 13th of this month, appears to offer a fitting opportunity, and it therefore remains only to determine the direction of our efforts. I have good reason to think that there will be a large attendance, and I trust every member present will have given the subject some attention, and that many will come prepared with practical suggestions. Among the more important themes for discussion, I would suggest the following:—

1. The formation of a council, or committee, for the management of the affairs of the Society, including the ballot.

2. The future rate of subscription and entrance fee (if any).

3. The appointment of a treasurer.

I think a council might with advantage be formed on the model of that of one of the learned societies. The existence of such a body would do away with the present imperfect and troublesome system of balloting, and, on the principle that "two heads are better than one," would in many ways conduce to the good management and general welfare of the society. With the prospect of increased expenses, it will probably be considered desirable to increase the present small subscription, and I think the entrance fee might reasonably be charged, so soon as the Society is able to offer any corresponding advantage. The appointment of a treasurer would be but a natural consequence of the preceding suggestion, and therefore calls for no special comment.

Our members will be aware that, under existing arrangements, there should be a coversazione and exhibition this spring as well as the dinner; and I must here express my regret that we have failed in our efforts to find a place altogether suitable for the exhibition, which, it was hoped, would have been inaugurated this year as the first of an annual series. It was in contemplation to exhibit not merely the work of amateurs, but also the productions of lathe-makers and others who might choose to take the advantage of the opportunity, and the exhibition was to remain open an entire week, within which the dinner and conversazione were to take place. The selection of a fit place for the accommodation of lathes and other heavy articles, and such as would at the same time serve for the conversazione, was, however, found to be attended with so many, for the moment, insuperable difficulties, that the idea was abandoned; and, in the absence of any suggestion at the approaching dinner, I am afraid we shall, this season, at any rate, be obliged to forego so much of our programme as relates thereto, though I have little doubt that we shall be more fortunate next year, particularly if we should succeed in the choice and appointment of a committee composed of men who have both time and energy to place at the disposal of the Society.

The steady and encouraging success which has hitherto attended the attempt to establish the Amateur Mechanical Society, has demonstrated beyond liability to question the fact, that the supposed necessity for such a Society was no visionary idea, but founded on a want, real and felt among amateurs, and one that was recognised as soon as pointed out. Here, then, we have the most propitious omen for the future, only requiring energy and co-operation to render our work, so well begun, a complete success.

T. W. Boord.

SUGGESTIONS AS TO TASTE AND FORM IN AMATEUR WORK.

THE values of *taste* and *form* in the work of an amateur will vary with the object of his work. In much work that amateurs take in hand, *form* is the chief thing to be considered, and there is no room for *taste*. Such work I venture to call "constructive," to distinguish it from what is generally understood by "ornamental" work. For instance, in turning a metal screw, *form* alone may be said to be considered, and *taste* has very little indeed to do with the matter. But in the work of the boxwood ornaments on page 31 of this journal, the *forms* are evidently little more than vehicles for ornament,—and both form and ornament in this instance may be matters of *taste*.

The following suggestions are therefore made chiefly with reference to the ornamental, as distinguished from the simply constructive, work of the amateur.

1. TASTE.—Of course tastes will differ, and it is with much diffidence, and in the hope of bringing out friendly criticisms, that these suggestions are made. But though tastes may differ, yet many people may be found to agree about some simple principles even in matters of taste.

For the present I will mention only one such principle; and, as I certainly should not describe as a principle any original idea of my own, I suggest the adoption by amateurs, in their ornamental work, of the following *dictum* of (I believe) one of our greatest architects:—

Decorate constructions rather than construct decorations.

I may, perhaps, illustrate the bearing of this suggestion, by an experience of my younger days. After inspecting the lathes and specimens of turning in the Great Exhibition of 1851, I set to work to imitate some of the specimens. By the help of some wood-engraving tools (which, by the way, I recommend for delicate handiwork, to those who have never tried them), I produced in ivory some small imitations of the elaborate pinnacles made up of balls, discs, and rings, connected by slender stems, which I had seen exhibited; and the construction of these decorations was approved by competent judges. However, I one day came upon a case of turned work by some artizan, who, among other things, exhibited a cup of ivory turned to such transparency, that a piece of newspaper in the cup could be read from the outside. But the beauty of the transparency, and of the grain of the ivory which it showed, was almost entirely spoiled to the eye by the bareness and ugliness of the cup, which took the character and form of the plainest and most unshapely of crockery egg-cups. In fact, even to my young eyes, the construction clearly wanted decoration and a better form. Partly to economise ivory, and partly with a view to form, the transparent cup I made took the shape of the tall glass ornaments with slender stems, shown in the next Exhibition, 1862,—except that my cup had a broad foot, instead of a shallow basin below. The decoration was confined to the extremities of the slender stem, and consisted of small mouldings worked with wood-engraving tools. In comparing this work with the ivory pinnacle before mentioned, there were not two opinions to be found on the question of *taste*.

It will be seen that the tendency of this suggestion is to make decoration subordinate to construction; and that, in carrying it out, we must give considerable attention to—

2. Form.—A criticism in the first number of this journal on the amateur work exhibited at a Conversazione of the Amateur Mechanical Society, November 24, 1870, says, "We feel convinced that too little attention is given to the study of 'form.'"

There may be two causes (among others) for such inattention to form among amateurs. In the first place, many amateurs have had lessons in "ornamental" turning from professional turners. The professional turner brings to his "ornamental" work the habits he has gained in, and which are very necessary to, his "constructive" work—such as strict attention to a pattern set him by others, and the habit of repetition. Originality and variety would be to him the exception, not the rule. So that the amateur learning "ornamental" turning would learn rather to construct decorations than to decorate constructions, and would so far be led to disregard *form*. The interchange of ideas and of forms and patterns for work, through the medium of the society and its journal, may help much to modify this tendency.

In the second place, the multiplication of special "engines" for special "patterns" may have a tendency to lead amateurs to disregard *form*.

As the possessor of but very modest apparatus, I write with caution and under correction on this point, but I think I am not wrong in supposing that the majority of the special engines are for the purpose of ornamenting *surfaces*—in some cases *flat* surfaces only, and are not adapted for producing, or intended to produce, *form* in the work. I have but once seen a rose engine used to produce the *form* of a rosette (as distinguished from rose *patterns*)—I do not remember ever to have seen an oval box or cup,* and a spiral is far less common than I should like to see it. The tendency of special engines for special "patterns" is, I think, to construct decorations rather than to decorate constructions, and so far to cause a disregard of *form.*

In another letter I may hope to make some suggestions as to the adaptibility of apparatus to production of forms as distinct from "patterns."

In the meantime, I would suggest to amateurs: *Combine handiwork when possible with machine work.*

This I suggest because of the wide scope it gives to *form.* The most variable machine sets its limits to the path of the tool:—the hand is not so limited. As a simple illustration of the bearing of this suggestion, compare the machine-made patriarch of the toy-shop "Noah's Ark" with the carved Swiss boy loaded with his machine-made churn, barrels, and platters.

Attention to handiwork will, I think, lead to attention to *form;* while its combination with machine-work will commend itself also as a matter of *taste.*

C. R. H.

OBSERVATIONS ON TASTE AND FORM.

By Honorary Editor.

HAVING read with much gratification the MS. of the last article, I venture to quote from another MS. lying before me in my own handwriting, which bears strongly upon the case in point. The remarks form a part of a supplementary chapter in course of addition to "The Lathe and its Uses," and which, when complete, may be had separately from the publisher, together with an index to the whole volume. The two will in the forthcoming edition be bound up with the book itself. The chapter

* A very beautifully carved oval vase, with cover and stem of oval (elliptic) section, was shown me by Rev. T. Holditch, made by himself.—*Hon. Ed.*

is chiefly devoted to "Tunbridge ware, and the combination of variously coloured woods in turned work."

"When it is considered that the slide-rest, chucks, and appliances for eccentric and geometric work are of the most costly description, and require that delicacy and accuracy of workmanship which place them beyond the reach of any who are not provided with handsome incomes, it is plain that by far the greater number of turners are debarred from their use, and are driven either to substitute cheap or home-made inefficient substitutes, or are compelled to confine their attention to turned works of a more ordinary and less decorative character. The writer has elsewhere recorded his opinion, that in the present day mere geometric engraving receives too much attention, and that the study of *form* and *outline* is far too little attended to. The use of even the most complicated chuck (such as that of Hartley) can be practically learned in a few weeks, and then little else is required of the turner than patience in elaborating (or rather, *allowing the chuck to elaborate*) designs, whose name is legion, but which, being mere machine work, cannot but become, sooner or later, tedious and unsatisfactory."

Respecting the capabilities of the Rose Engine, of which the work is not necessarily confined to engraving or surface patterns—although very generally this is the only work attempted by its means—I have added the following :—

"Exception is to be made to the above strictures in the case of the Rose Engine, for this, although a carving machine, admits of such extended application, that it deserves the very highest place in the estimation of all true lovers of the art; because, we are here no longer confined to mere tracery of surface patterns, but can exercise both taste and skill *ad infinitum* in hewing and shaping highly decorative articles out of the solid."

Such is the opinion I have recorded in the supplementary chapter alluded to, which I may call a *consolatory* chapter for those whom circumstances debar from the possession of costly lathe apparatus. By combining well-selected (as to colour) sections of various woods, and attending to *form*, there is ample scope for work of a highly ornamental character, and of great beauty, without the use of fly cutters, geometric chucks, or any of that costly and complicated apparatus, in which amateur turners delight, and in which, *unfortunately, they have learned to trust.*

The following principle must certainly be recognised, viz.: "that if the outline of any article is not beautiful, no amount of ornamentation can make it so." Decorations, in such a case, merely show the resources at the turner's disposal, and his skill and patience in availing himself of such resources; but the result is still an ugly specimen, with elaborate decorations *wasted upon it.*

In the *Saturday Magazine* for May 5, 1838, page 176, a short chapter was dedicated to the subject of "The Oval as the Elementary Form of Beauty." By oval, however, is evidently meant the ellipse, but the question nevertheless arises, whether, after all, the egg, whose outline is the *former* of these curves, should not be received as the elementary type rather than the ellipse. The specimens, indeed, given in the above magazine are badly drawn, and do not afford any criterion one way or the other; but inquiry in this direction is well worth the attention of the reader. The outline of a well-formed female face, we must remember, is more likely to be essentially lovely than a form which can be drawn mechanically by the help of mathematical instruments. Referring to Ruskin, to whom, somehow, we do refer in these cases, because probably he evinces deep thought and most unwearied study in all that relates to the true and beautiful in art, we read as follows :—

"Graceful curvature is distinguished from ungraceful by two characters—first, in its moderation, that is to say, in its close approach to straightness in some part of its course; and secondly, by its variation, that is to say, its never remaining equal in degree at different parts of its course."

"This variation is itself twofold in all good curves—

"(*a.*) There is, first, a steady change through the whole line from less to more curvature, or more to less; so that *no* part of the line is a segment of a circle, or can be drawn by compasses in any way whatever. . . . .

"(*b.*) Not only does every good curve vary in general tendency, but it is modulated as it proceeds by myriads of subordinate curves. . . . . Thus, another essential difference between good and bad drawing, or good and bad sculpture,* depends on the quantity and refinement of minor curvatures carried by good work into the great lines."

The latter dictum must be understood, in the case in point, to signify, that, what I may term the *general outline* of the design, such as would be traced by a thread stretched tightly round it touching

* This last applies to the special work on which we are engaged.—J. L.

the several projections, must itself form a good curve; and that the subsidiary curves of the several individual mouldings must melt into such general outline, so as to form parts of it. No doubt, there are several minor considerations, of greater or less importance, upon which beauty of form in designs for the lathe will be found to depend.

The above remarks will, it is hoped, lead to a full description of this important subject, in the next and succeeding numbers of our Journal; and here it may be noted, that such discussions may take the form of letters, or of leading articles, according to the fancy of the writer, as it is desirous to make the magazine acceptable alike to all as a means of inter-communication, and sometimes a short letter may suffice an individual writer for giving expression to his views. Fancied incapability of wielding the pen, is, it is to be feared, the cause of many really valuable suggestions being withheld; but, it must ever be remembered, that ours is to be a useful rather than ornamental publication, and the remarks now made on form may be extended to pen and ink composition. *Decoration* is a secondary matter; let us have the fairly moulded information, and we can afford to neglect in a great degree the non-essentials of neat phraseology, and carefully rounded periods. We amateur mechanics are seldom *well up* in these matters.

We now come to the practical question of how such works are to be turned. A good eye, and capability of free-hand drawing, will *generally* be found more or less requisite in order to lay down on paper the outline of the article to be turned. I say "generally," because some may be able with hand-tools to work out a design without such plan.

After it *is* sketched, it would seem that the best way of accurately transferring to the work the variously curved outline will be the application of a template attached to the slide-rest (cut from sheet-metal by means of a tracing from the original drawing glued thereon as a guide). In "The Lathe and its Uses," the templates are not represented in the best position; they should be attached to two short pillars screwed into the *top* of the main frame of the slide-rest, at each end of the same, so that the template lies altogether above, and spans the tool receptacle. The guide-pin is then to be screwed into the *top* of the receptacle, or of the tool-holder. This arrangement permits the deepest curves of the pattern plate to be followed, without the possibility of the guide-pin coming in contact with any part of the rest—a difficulty always experienced when the templates are affixed underneath the frame, as they were in the lathe to which I then had access; the owner of which, nevertheless, used them very extensively. I am glad of this opportunity of again directing attention to their extensive usefulness, enabling a turner accurately to reproduce any figure in any required number.

As I do not wish to occupy ground which many of our members are better qualified than myself to make use of, I shall leave to others the further development of this most interesting and essential question of "form," which a kind contributor has introduced for our mutual benefit.

J. L., *Hon. Ed.*

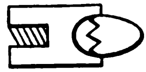
METHOD OF DRILLING AND MOUNTING A COMMON EGG SHELL.

OBSERVE—1. The body and cover of the vase are made of two separate shells, the mode of proceeding for each part being the same.

If you please, boil your egg, and, making not too large a hole at one end, *eat it*. There seems to be a little preference for *boiling* over *blowing* (though this is doubtful), as the inner skin sometimes seems to me to separate more easily from the shell, and it is necessary to remove this, or it leaves a *ragged* look about the shell, when perforated, which cannot easily be got rid of. The skin may be removed, with care, by a little management of the fingers, or perhaps better, by the help of a pair of bent pliars. Should any portion of it be left in, it may be rubbed out by the tip of the finger, with cold water. The next process is to *pack* it, which may be done with the ordinary mastic* glue and lamp black, used for turning ivory very thin: it will not bear the tool without. The fixing in the lathe is a very simple operation. Turn a common wood cup chuck,  with cup to fit so much of the broken end of the shell as may be necessary to hold it: screw the chuck on the

* The mastic, and its use, is described in the "Handbook of Turning," 133 (Saunders & Ottley), and in Campion's "Practice of Turning," 233, and I have found it most useful. Can any one suggest a *white*, instead of a *black*, mastic, which would be more proper for the egg shell? I tried whitening and glue, but did not make it answer.—J. H. H. [Would hard white wax answer for this?—*Hon. Ed.*]

mandrel, and glue the inside with hot thinnish glue. As the mandrel revolves, apply your fingers delicately to the shell, and you will find little difficulty in centering it with great exactness, keeping the shell wet with thin glue, or water, that it may slip easily through your fingers.

It will then be presented thus  With a fine point cut a hole at the end for the stand, and then proceed to drill, with the overhead and slide rest, according to fancy. When done, a fine point will cut it off, when it must be washed, etc., in hot water, to get off the mastic. Should any of this remain, after all your care, a little French white inside the shell will put all to rights. The mounting will also require some delicate manipulation, but I need not describe this—only take care not to make *it clumsy*. Such is the way in which I have managed the egg shell: the whole process requires very great care,—the material being so extremely brittle. If any one can suggest a shorter or easier method, I shall be very glad to hear of it.

JOHN H. HOLDICH.

BULWICK RECTORY, WANSFORD,
January 19, 1871.

SPIRAL FLUTING ON WORK OF ELLIPTICAL SECTION.

THE spiral apparatus, as usually made by Holtzapffel and others for ornamental turning, is mounted in front of the lathe-head, in which position it is inconveniently situated, requires to be completely removed when not in use, and does not admit of the employment of the oval chuck in combination with it. In lathes with traversing mandrels for screw-cutting, it is a better arrangement to have the spiral apparatus connected with the *left-hand* end of the mandrel, as it is equally suitable for the work it is intended to do, is completely out of the way, and, as the greater part of it may be left constantly standing, there is little loss of time in preparing it for use. Mine, which was originally made according to the old plan, was shifted for use to the back of the lathe-head some years ago by Messrs Kennan of Dublin, and does its work most satisfactorily. The alteration involved the removal of the brass slide which carried the scolloped plate for working into the steel guides for screw-cutting, but a simple and equally efficient contrivance was substituted for it by Messrs Kennan.

Moreover, when the spiral apparatus is thus placed, the nozzle of the mandrel being unencumbered, the oval chuck can be mounted in its usual place, and spiral fluting can be executed on work that has been previously brought to an elliptical form while remaining on the chuck.

Though, however, it is easy to cut a single spiral flute in this manner, it is not quite so simple a matter to form a series of parallel spiral flutings round, we will say, an elliptical box, as, of course, the box cannot be turned round on its own centre by means of a divided plate *in front* of the oval chuck, as in the case of circular work, for that would alter the angular position of the ellipse at every division ; the dividing must, therefore, come in some way from *behind* the oval chuck.

The best way to effect this would undoubtedly be to have the first wheel, instead of being attached firmly to the mandrel itself, placed on a kind of chuck fixed on the left-hand end of the mandrel, with a divided plate and spring click, so that the mandrel might be turned round by hand any number of degrees, without disturbing the wheel it carries; but, in the absence of such a chuck, I have found the following plan answer sufficiently well.

I will suppose that this train of wheels consists of one of 144 teeth on the mandrel, working into a pinion of 18 teeth on the radial arm of the apparatus, on the same spindle with a wheel of 120 teeth, in gear with a small one of 16 teeth on the rod that connects the apparatus with the slide-rest and screw, of which it is a prolongation. I will call the wheel and pinion in the radial arm No. 2. Having every part in proper position for commencing the flutes, and the elliptical box in its place on the oval chuck, the cutter or drill is to be brought a short distance, say half an inch, to the right of the work, and a stop is to be placed on the slide-rest, to prevent the cutter from being at any time moved to the right of that point. The nut which binds No. 2 on its spindle must now be slackened, which will allow the mandrel to be shifted round, without moving the train of wheels. The index point of the dividing plate of the lathe is now to be dropped into one of the divisions; the nut of No. 2 is tightened ; the *index is now removed from the hole in which it was placed*, and the cutter traversed from right to left until the first flute is complete. The cutter being withdrawn is run back carefully towards the right, until brought up by the fixed stop at the point from which it originally started. The nut of No. 2 is again slackened, the mandrel shifted round any required number of divisions, the index dropped into the proper hole, the nut again tightened, the index again removed, and the second flute cut, and so on for the remainder.

It is most important not to forget to remove the index before commencing each flute, as, if it remains in a hole of the dividing plate, *something must* give way or slip when the train of wheels is put in motion, and the work is nearly sure to be spoiled.

ON USEFUL CHUCKS, AND OTHER APPLIANCES.

By Virion Nighton.

AN old hand would gladly smooth the path of the less experienced amateur, by advising him what to get and what to avoid. Much time and money is often wasted by those who feel an aptitude for mechanical work, unaided by experience. They are tempted to supply themselves at once with a complexity of apparatus that no ordinary life-time would suffice to use thoroughly, and which, even at second-hand, must be a very costly purchase. To waste of money succeeds the waste of time; these tools, once in a man's possession, must be used; besides, it is no doubt exceedingly interesting to turn over a quantity of beautiful and ingenious mechanism, and see what can be done with it. And so it comes to pass that much wood and ivory is cut up, and the result, after many months of toil, is—a very marvel of complicated ornament and bad taste. Perhaps our amateur does not even get so far as this, but, after the loss of much time, money, and patience, and the distribution of two or three "snuff-boxes" among admiring friends, he gradually gets tired of his toy, or some other employment supplants it, and in two or three years it finds its way to the broker or the auctioneer.

Much risk of this kind of failure would be avoided, if a beginner would be content to procure at first but few adjuncts to his lathe. The lathe itself, however, should be a first-rate one, or it will not be worth while to spend money upon it afterwards. Should our amateur be tempted to have any expensive apparatus adapted to a cheap lathe, he will find his hands disagreeably tied, for the imperfection of his lathe will not permit him to advance beyond a certain style of work, nor can he transfer his costly chucks and slides to a first-rate machine; the whole thing must go together at a great sacrifice, and a fresh start must be made.

Our advice would therefore be—Get your *lathe*, at all events, *from one of the best makers;* the extra money spent on the foundation will not be regretted afterwards. Let the bed be of iron; the fly-wheel heavy and accurately turned; the mandrel a traversing one, with screw guides; the popit-head, or back-centre, with cylinder and internal screw. If a first-rate slide-rest cannot be at once afforded, get a plain and strong but well-made one, which will always be useful afterwards for rough work. Two points should be noted, which are not always attended to by lathe-makers. The first is, that the increase of diameter in the grooves of the mandrel pulley should be exactly proportioned to the decrease of diameter in those of the fly-wheel, so that one driving-band can be used for all but the *very* slow speeds without any tension apparatus; the second is, that the interval between the bearers should be sufficiently great—say $1\frac{1}{2}$ to 2 inches—to permit any rest or head to be withdrawn without the removal of its clamping screw. The writer has a lathe which possesses both these arrangements, and he finds the consequent saving of time and trouble very great.

But it was proposed to write about chucks, and all this time they have not been mentioned.

For plain work, or for preparing materials for ornamental work, the first and foremost place should be given to the AMERICAN SCROLL CHUCK, good engravings of which will be found at page 71 of "The Lathe and its Uses." London tool-makers may affect to despise these chucks, but any amateur who has the good fortune to possess one accurately mounted must pronounce it indispensible. The writer was induced to procure one three or four years ago, and has since increased the number to four, all mounted by himself, and though he uses a considerable variety of material—iron, brass, horn, ivory, hardwood, and softwood—he has no chucks in such constant use as these.

For the benefit of those who cannot refer to the above-named work, the principle of the scroll chuck may be stated in a few words. By a rotary movement, which is variously arranged by different makers, a concealed spiral groove is made to act simultaneously on three equidistant jaws, which are thus caused to converge and hold very firmly the substance to be turned. The most useful size for a 5 inch centre lathe is 4 inches * in diameter, which costs £2, 15s to £3—a very moderate price certainly for a really efficient self-centering chuck. There would of course be an extra charge for mounting it, if done by a lathe-maker. The greatest disadvantage attending the use of these chucks is, that they are heavy and require care in screwing on and off the mandrel nose.

It has been said that these chucks are in very constant use with the writer; let us then consider what others they supersede. First, they entirely do away with that most useless range of brass cup-chucks which lathe-makers insist upon providing. The writer has no less than 12 of these cup-chucks, and *not one of them has ever been used since the possession of his first scroll chuck.*† The cup-chuck being quite unyielding and unaccommodating, some time must be spent in fitting the material to it, especially if hardwood or ivory; indeed, a *double* fitting is often necessary, viz., a plug of softwood first driven in, which has then to be hollowed out to receive the substance you intend to work upon. Conceive then what a saving of time in merely paring down the material into *shape*, without regard to *size*, and then seizing it at once in the firm grip of your scroll chuck.

Scroll chucks will also be found to supersede entirely the die-chuck (itself costing as much as a scroll chuck) in which small bolts of brass or iron are held between two unconnected screws; and the massive six screw-chuck, intended to hold longer cylindrical pieces. For most purposes they will also be found more convenient than carrier chucks and that form of face chuck in which either three or four jaws or dogs are moved towards the centre by separate and unconnected screws; the last kind will, however, still be necessary for objects of irregular shape, or those which must be chucked eccentrically.

Self-centering chucks are by no means new, but those formerly made in England were extremely costly and not always true, whereas the American scroll chuck is both cheap and accurate.

Our amateur will require a supply of plain box-wood chucks, intended to be cut to any shape as need requires, for receiving work

* A small and very handy kind of scroll chuck is made for holding drills.

† Brass cup-chucks, *if substantial enough*, may be utilised as follows:—Cut off the cylindrical part, which may be made into rings for wooden spring chucks; you can then mount a scroll chuck on the remaining flange.

either externally or internally; these he can make for himself very readily with the assistance of a scroll chuck and a traversing mandrel. But far more useful than these are wooden spring chucks, the manufacture of which should also be quite within his capacity. They are usually made of boxwood, and in the larger sizes the length is about equal to the diameter; in the smaller sizes rather greater. They should be hollowed out from the centre to about two-thirds of the radius, and the outside coned to an angle of 3°. According to size, six, eight, or twelve equidistant fine saw cuts are made from the mouth of the chuck towards the mandrel, and a strong brass ring is so fitted to the outside that it will slide up about one-fourth of the coned surface, the inside of the ring being also coned to a *slightly* greater angle than the outside of the chuck.

The use of these chucks is to hold work in a nearly finished state, for completion. The spring chuck being turned out, so that the article will enter it easily but without perceptible shake, the ring is driven up by a few taps of the mallet, which closes together the divided edge quite sufficiently to hold fast; by a tap or two in the opposite direction, the ring is at once loosened and the work released. At least six of these spring chucks should be kept in various sizes, from four inches to an inch and a half diameter.

An *outside* spring chuck, in which the several parts are made to *diverge* by a conical screw, will be found useful for chucking rings. It will be necessary to strengthen this by a metallic ring driven on tight at the end nearest the mandrel; but for the usual form of spring chuck this precaution is not needed.

In addition to scroll and spring chucks, our amateur should possess the following—

A flange or face chuck, with four screws (already alluded to).
A drill chuck, with at least a dozen drills of various sizes.
A prong chuck.

If to these he is able to add an eccentric chuck (costing £8 to £10), he will find scope for much interesting practice, and the power of making a great variety of beautiful objects.

Other appliances, such as—

A compound slide-rest,
An eccentric cutting frame, and cutters,
A drill-slide, with ornamental drills,
An oval chuck,
A dome chuck,

An elliptical cutting frame,
A spherical slide-rest,
A spiral apparatus,
etc. etc. (*ad infinitum*), can be added from time to time, according to the fancy of our amateur, or the depth of his purse.

DIRECTIONS FOR EXECUTING FANCY-TURNED ORNAMENTS IN BOX-WOOD.

BY ELIAS TAYLOR, HARTFORD VILLA, PATCHAM, NEAR BRIGHTON.

(*Continued from page* 33.)

IT should have been stated in the foot-note at page 26 that the working drawings at page 27 had been reduced to one-fourth their full size.

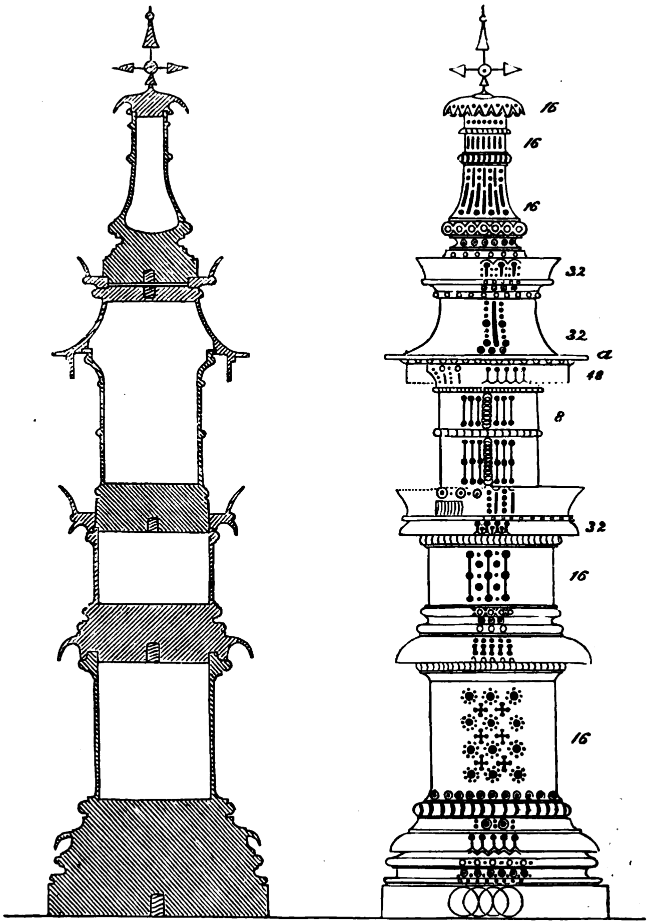
The accompanying working drawings for the other ornament are drawn to the same scale (three inches to a foot), so that the ornaments are four times the size of the working drawings. Both ornaments are the same size, 19 inches high; although the engraver has made a difference at page 31, there is none in reality as to size.

I have gone so much into detail with the directions for the other ornament, that it will only be necessary for me to allude to such parts of this one as differ in workmanship from the other, more particularly the *undercut mouldings*, which add very much to the effect of the work. These ornaments being turned out so thin, they appear light and elegant in themselves, which cannot from engravings be fully realised.

The sectional drawing shows the shape of the undercut moulding to be formed on the bottom piece of this ornament. To undercut it requires light tools. I will say what I do myself. I send my old saw-files to the blacksmith for him to draw them out in long slender pieces of steel, some one size, some another.

I select one of these slender pieces of steel, and put one end into the fire and make red-hot, hammer it out to a point, and to the curve required. I spread the point flat and thin *heart-shaped;* the shank part behind the point is very made narrow, but deep in proportion, to give it strength, which allows the point of the tool to move about in the side opening you make, and to get the hollow parts enlarged.

In making these small tools you must be careful not to over-heat the points, which is called blistering the steel, destroying the goodness, and to be avoided; however, you must be careful to keep it a red heat all the time you are hammering it, otherwise you will find it



snap off. When sufficiently hammered into shape, nicely finish it with a file ready for hardening.

There is a great deal to be said about hardening, but I think the following the most simple way, and easiest understood by a beginner. Make the point a dull red heat, and dip it instantly into water, having the water close to you all ready to do so. Then try it with a saw-file; if you find the file will just make an impression upon it, it will do, but if the file cannot cut it, the tool is too hard and will snap off in using, and you must try again. If too soft, you must make it a brighter red before quenching. You will soon get to understand after you have tried a few times. The tools require to be sufficiently hard to keep a good clean edge, and cut well after rubbing on the oil-stone.

I use for handles what is called a saw pad, that is, handles made to hold key-hole saws with affixing screws, in the brass end of which there are usually two pieces of brass. I take out one piece to make room for the extra thickness of my small tools, and then I have a shifting handle ; of course, the tools can be pointed both ends.

When you have hollowed out underneath the moulding, you have to drill the holes, and either with small circular cutters (which I use), or with taper and square drills, form the divisions into the necessary shapes, as leaves or otherwise.

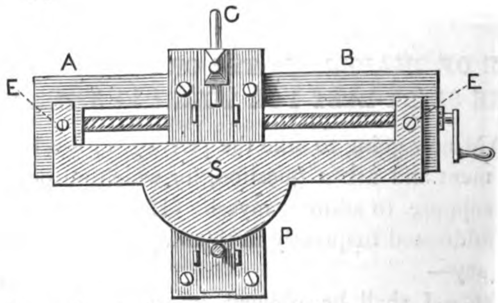
The piece of this ornament next the top requires some care to hollow out, as you have to introduce a hooked tool into the small end to enlarge the lower part as per drawing, having first drilled out to the bottom the full size for the smaller upper part; but all these things only require patience and perseverance.

The numbers on the side of the elevation, indicate the number of patterns round the respective parts. The roof marked *a*, drilled round as detail drawing marked *a*, page 27.

THE USE OF SHAPER PLATES OR TEMPLATES WITH THE SLIDE-REST FOR TURNING SPHERES.

I AM now going to take the privilege of the Letter Department and ask a question, for which purpose I ought, I suppose, to address myself. However, as I hope to be addressed frequently in this way, I shall return the compliment and say—

Gentlemen,—I shall be obliged by your kind attention to a query upon the subject above-named. In advocating the use of shaper plates with the slide-rest in "The Lathe and its Uses," a rather warm opposition was raised by a professional, who asserted that a ball or sphere could not be turned by means of a semicircular template. I ask, "If not, why not?" I here give a small diagram of the arrangement, so far modified, that the shaper plate is, as suggested in my other article of to-day, placed above instead of below the frame of the rest, being attached to two pillars at E, E, sufficiently high to clear the receptacle slide. The exact shape of the plate would depend on that of the slide-rest, and is immaterial so long as the tool C and guide-pin P, which traverses the edge of the plate, are in one right line; *the diameter of the semicircular tool must also be the same as that of this guide-pin*, and the curve of the plate must rather exceed the semicircle. It appears to me that if such plates suffice for the tracing other curves, they must suffice for the semicircle also. I am sorry to say that the amateur who originally showed me his stock of shaper-plates is dead, but I know that he turned and elaborately decorated spheres, and he certainly had no spherical rest, or other appliances than the one in question. The spherical-rest is so costly, and to *my* mind these shaper-plates are of such very extensive application, that I am anxious to call more general attention to them. I have myself no slide-rest at present to which I can attach such plates, so that I am unable to experimentalise in this way. I only wish I had, for I think the system has not been worked out as it deserves. Does any reader know whether there exists such a spherical slide-rest as that described in Hebert's Cyclopædia, of which I wrote a description in No. 21 of the defunct *British and Foreign Mechanic.* The system or principle is clear, the *details are not*, but the arrangement is curious, and theoretically perfect.* I append sketch alluded to above.



A B is the frame of rest; C the tool with half circular end, sharp at end and sides; P the guide-pin that traverses the outline of the shaper-plate S, as the upper part of the rest with the tool-slide traverses horizontally, the pin being kept in contact with the plate by the left hand or by a spring. The pillars on the summit of which the plate is fixed are at E, E.

J. L., *Hon. Ed.*

* See paper on this subject.

MECHANICAL GOSSIP.

LOOKING over the pages of the *Scientific American*, since the commencement of the year, we find, among other curiosities peculiar to that Journal, a series of articles describing some of the various machines which have from time to time been invented by those in search of perpetual motion. Many of them unquestionably exhibit great ingenuity and perseverance, but one fault is common to all—they will not work, and it does appear to us rather like a waste of money to illustrate afresh and so elaborately the chimerical hobbies of bygone days, unless indeed it be to prevent others from becoming the victims of a similar craze. It is, however, somewhat amusing to notice in the same journal, in a column headed "Business and Personal," the entrée to which may be purchased at the rate of "one dollar per line," an advertisement of which the following is a copy :—

"Eureka! A water wheel perpetual motion invented. It supplies itself and drives machinery. One fourth interest for sale.—Address," &c.

Here is indeed a valuable machine! We wonder whether it undertakes its own repairs? One is almost led to fear that the words of warning just referred to, fall like rain on a duck's back!

Hardly, perhaps, to be classed with the foregoing is a project which it appears has been formed for supplying the city of Buffalo with compressed air. Our readers will probably be aware that for the perforation of the Mont Cenis tunnel, commenced in 1857, and just completed, the boring apparatus employed was so driven, hence probably the idea. In this gigantic undertaking the advantage of such a motor was evident, for, instead of the life-sustaining properties of the atmosphere of the tunnel being destroyed, as would have been the case if steam had been used, the air, after performing its mechanical functions, on being released from the machines, served to replace that which had been exhausted by the respiration of the workmen, and burning of lights; but we take leave to doubt whether such a power could be laid on like gas or water, especially when, as in the case before us, it has to be conducted through twenty miles of piping, for the Falls of Niagara (about that distance from the city) are suggested as the source of power; the air, compressed to the extent of about seven atmospheres being stored in reservoirs ready for use. The projectors of this scheme estimate that the cost will be about one twelfth that of steam, and they add that ordinary steam engines will take kindly to the new diet. As already stated, *we* do not, for the present at all events, believe in the feasibility of any such plan, and certainly not in that of this particular one, but we do think that the question of accumulating and profitably applying existing power is one pre-eminently deserving of notice. Take for example the rise and fall of the tides on the shores of this island; what vast power is there here of which at present but little use is made! However, when the good time comes, and we have but to turn a tap or move a lever in order to set our lathes in motion (and the giant strides of the last half century make us loth to be too sceptical), let us hope that the energy thus economised may be judiciously, and at the same time artistically, applied to something besides those pagodas and snuff-boxes, which tradition affirms to be the *ultima Thule* of an amateur's ambition.

In the *Engineer* is a return of rolling stock, dated 30th June 1870, specifying the number of every description of engine, carriage, and waggon, owned by the various railway companies in Great Britain, from which it appears there were altogether 8740 engines at work at that date, of which 1559 belonged to the London and North Western; 912 to the Great Western; 850 to the Midland; 694 to the North Eastern; 535 to the Caledonian; 493 to the Great Northern; 483 to the Lancashire and Yorkshire; 413 to the Great Eastern; 396 to the North British; 280 to the London and South Western; 248 to the South Eastern; and 239 to the London, Brighton, and South Coast. It is curious that out of this large number a total of only 71 tank engines is given.*

The transmission of the Queen's speech to the provinces, at the opening of Parliament, on the 9th of February last, afforded the usual opportunity for a display of telegraphic dexterity. The highest speed attained, was nearly 41 words per minute, between London and Brighton, on a Morse printing instrument, the operator being a woman. For most of the country towns, Wheatstone's automatic transmitter was employed, with which between London and Bradford a speed of 94 words per minute was reached, but as the message for this instrument is first punched out in a separate machine, on a riband of paper, and then passed through the transmitter by a clock movement, it is obviously unfair to compare it with other instruments whose speed depends on manual dexterity alone.

* The total thus made is 7102, not 8740.—ED.

Each of the ribands referred to (containing the 1780 words of the speech), was about 111 yards in length. The delivery commenced at 2.19 P.M., and copies were sold in Edinburgh at 3.45 P.M. It would appear therefore, that, at any rate as far as public messages are concerned, telegraphy has not suffered in the hands of the Post Office authorities.

No doubt many of our readers have tried a material now called Xylonite, formerly Parkesine, after its inventor, for the purposes of turning, etc. A paper was read before the London Photographic Society in December last, describing its manufacture, which is briefly as follows :—Vegetable fibre of various kinds is immersed in a bath of sulphuric and nitric acids, whereby it is converted into a substance resembling gun cotton (xyloidine), which after due treatment is dissolved in woodspirit, naphtha, camphorated oil, or other suitable solvent. A species of collodion is thus obtained, of any desired degree of plasticity, which may be coloured, rolled into sheets, or moulded to any required form. It is said to be a good substitute for ivory, bone, horn, tortoise-shell, and even marble, and to be suitable, amongst a variety of other uses, for friction and gear wheels, bearings for machinery, billiard-balls, &c. We find it turn well and easily. Perhaps some of our readers will communicate their experience.

Reverting to the *Scientific American*, we notice the description of a contrivance for utilising the waste-heat from steam-engines and boilers, which manifests considerable ingenuity on the part of the inventor, and, therefore, if for no other reason, merits a passing notice. The exhaust-steam from an ordinary engine is led through a coil of pipe fixed in a boiler containing bisulphide of carbon, (boiling point about 110° Fahrenheit), the vapour of which is made to drive another engine of similar construction ; and, after being condensed as it escapes from the engine, is pumped back into its boiler. In the experiment described as having been actually made, the average pressure in the steam-boiler was found to be about forty-five pounds to the square inch, and the same in the bisulphide boiler, while the increase of power obtained with a given weight of fuel, was equivalent to 115 per cent. The theory of the experiment, of course, depends on the use of a liquid in the secondary boiler, with a boiling point much lower than that of water. There would be but little waste, since the vapour of the bisulphide was condensed in a coil passing through cold water immediately on its escape from the exhaust-pipe ; but even that little, if our chemical recollections are to be relied on, would be sufficient to spread a most nauseous, not to say unhealthy odour.

We must not dismiss the *Scientific American* without mention of an amusing contrivance designated an "Anti-snoring Device," which, in the illustration, resembles a dog's muzzle, but probably only needs a trial to appreciate its efficacy.

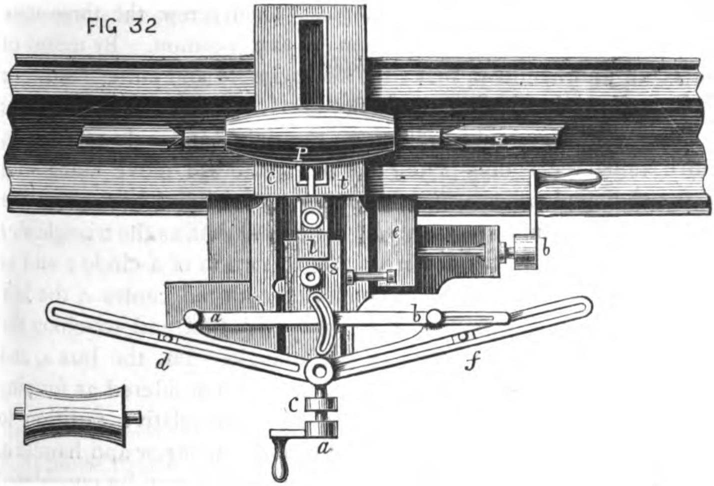
"Our Gossip" would hardly be complete were we to omit the interesting fact mentioned by the *Times* in its notice of the late Dean Alford, from which we discover that that learned and accomplished scholar was also an amateur workman, having with his own hands constructed an organ for his own use.

ANDERSON'S SLIDE-REST FOR SPHERICAL WORK.

I HAD already, in a short paper of *Notes and Queries*, alluded to the above, when it struck me that the majority of our readers, in all probability, do not possess the few numbers of the *British and Foreign Mechanic* which were published last year. I have therefore appended the whole paper which I contributed to that magazine, as this mode of arranging a spherical-rest is very curious, and is sure to interest those accustomed to manipulations with the lathe:—

"There is yet one other slide-rest deserving mention, also designated for turning spheres, and which should by right have been described before the more modern one already sketched. It is of an entirely different form, and acts on a different principle to those in common use, and displays considerable ingenuity in its arrangement. The drawing and description are from "Herbert's Cyclopædia," bearing date 1836. The invention is that of a Mr John Anderson, a member of the London Mechanics' Institution, to whom was awarded, in 1830, the annual prize "for the best machine or improvement of a machine." In the improved slide-rest for turning curved or spherical objects with accuracy, either concave or convex, or for the fashioning of lenses of given radius, the following are the principles upon which it is made to depend:—First, that all angles in the same segment of a circle are equal; and second, that a straight line of any length being made to move always parallel to itself, with one end touching a circle, the other end will describe a circle equal in every respect to the first. "In the improved slide-rest, shown in the annexed figure, fig. 32, the triangle *d c f* is made

FIG 32

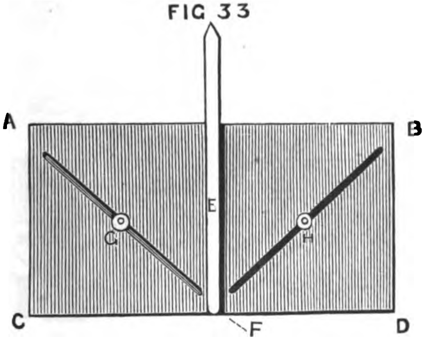


to slide against fixed pins at *d* and *f*, whence the vertex *c* will describe a portion of a circle, greater or less in diameter, according as the angle *d c f* is made more or less obtuse; and further, the centre of the circle thus described will be on the one side or the other of a straight line joining *d f*, according as the vertex *c* of the triangle is on this or the opposite side of such line. The sliding-triangle *d c f* consists of three pieces, namely, of two sides, *d c* and *c f*, with a slit or opening in each for the pins, *d* and *f*, to slide in, and they are moveable round a centre at *c*, by which means they can be made to form any angle with each other. The third piece or base of the triangle is the connecting-bar *a b*, by means of which the two sides are held fast in any required position. The sliding-plate *e e* is similar to that of a common slide-rest, and it is moved backward or forward by a screw and handle, *b*, in the same manner. Upon this plate, and at right angles to the direction in which it moves, a box, *s*, is made to slide, within which box is another sliding-piece, *l*, carrying the tool or cutter, *t*. The interior sliding-piece *l* is made to move within the box by means of a screw turned by the handle *a*; and by this means the cutter *t* can be made to advance or recede as in a common slide-rest. The sliding-box *s* is connected with, and moveable round the centre *c*, at the vertex of the sliding-triangle; and hence, if the box *s* move in any direction, the vertex *c* of the triangle must move along with it in the same direction. Now suppose it were required to turn a body of the form *p* in the figure. Set the sides *d c* and *c f* to the proper angle. Then screw the three nuts *a*, *c*, *b*, tight, which will retain them in that position. By means of the screw and handle *a*, make the sliding-piece and cutter *t* advance as near the body *p* as is necessary to turn it of the required diameter; then, by the screw and handle *d*, on the right-hand side of the rest, move along the sliding-plate *e e*, which plate will move along with it, the sliding-piece carrying the cutter *t*, the sliding-box *s*, and the triangle *d c f*. But it will be readily perceived that, as the triangle *d c f* moves along, the vertex *c* will describe a portion of a circle; and as the end of the sliding-box *s* is connected with the centre *c*, the box will move along always parallel to itself, with that end touching the circle described by the vertex of the triangle. But the box *s*, and the sliding-piece carrying the cutter, may be considered as forming only one piece, as they always retain the same relative position to one another, except when altered by turning the screw and handle *a*, and hence the joint of the cutter *t*, and centre *c*, may be considered as two ends of a straight line, which always moves parallel to itself; and as the one end *c* always touches the circle described by the vertex of the sliding triangle, the other end will (according to the geometrical proposition) describe the portion of a circle equal to it in every respect, and will then, by the revolution of the body *p*, turn it of the form desired. The separate figure *w* represents a concave roller, formed by shifting the vertex of the triangle to the further side of the line (or connecting-bar) *a b*."

The above drawing is copied with care from the original; but although the principle of this rest is quite clear, its actual construction is not so readily understood—the stationary pin *f*, for instance, is isolated, and has no *locus standi;* and just below the letter *e* is a projecting bar, which has the appearance of a spindle, of which the use is not clear. The pins, however, must evidently be screwed into the lower fixed plate of the rest, while the upper part, which traverses in a direction parallel to the lathe-bed, carries the triangle with its attachments, and the tool-slide. The following simple apparatus will show the principle of this curious and ingeniously-planned rest. Cut slots G H in a visiting-card, or stiffer card, which will be better, fig. 33, wide enough to admit drawing-pins easily, and by such pins fix the card down to the drawing-board, but so as to permit its movement upon the same.

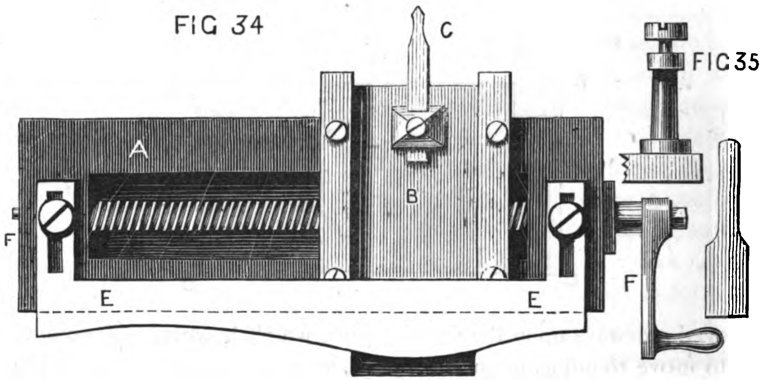
E is a strip of card representing the tool. This is to be attached to the card A D, by passing a pin from below through both, so that the head is below. If this pin is now laid hold of, the card may be

FIG 33



moved sideways upon the drawing-pins, which however will compel it to move round as upon a centre, carrying with it the end F of the tool. The latter, *b*, must be made to keep parallel to its original position by the application of the finger as the card moves round, and it will be seen that the curve in which the end F travels will be followed by the point, here representing the cutting edge of the tool. The triangle is here fixed, which in the rest is adjustable, and the arrangement of slides in the latter provides for the parallelism of the tool. It would not be difficult to apply the principle to a common slide-rest.

It somewhat curiously happens that the *principle* (number two) upon which the action of the above rest depends is practically that which comes into play in the use of templates or shaper-plates, sometimes applied to the ordinary slide-rest for ornamental turning; for such principle establishes the fact stated by the author of "The Lathe and its Uses," that by such templates spheres may be correctly turned, an assertion which at that time was disputed. The shaper-plates in question are thus arranged:—Fig. 34, A A, is the lower frame of the rest as usual, B the tool-slide, C the tool, the point of which is in a right line with the centre of the pin D, fixed in the top of the tool-slide, and standing up from its surface. At F F, two pillars are screwed into the slide-rest frame, of which one is seen at fig. 35. On the top of these is fixed the steel shaper-plate E, of any required pattern, the pin D coming in contact with its outer edge. The top or tool-slide into which this pin is inserted may be kept up to position either with a spring or by the application of the hand, while, by means of the handle attached to the leading screw, the whole upper part is made to traverse the long frame. The tool thus carried along horizontally will then follow the precise curves of the



template, and if the latter be semicircular, the outline of a sphere will be traced. There is nevertheless one thing essential to the correctness of the latter process, which will be understood upon consideration. If such a tool is used as represented, *i.e.*, a tool with a central point and two angular edges, it will follow that sometimes the latter and sometimes the former will be in contact with and cutting the material, which will not be thus accurately shaped thereby; the only tool that will exactly answer is one like fig. 35, the end of which (semicircular) and two sides are alike sharpened, and *the total diameter of which is exactly that of the pin* D, which works in contact with the template, and which should be of hardened steel. In this arrangement of template it will be observed that the tool and pin are in one and the same right line, and this line continues always parallel to its first position; therefore, by the rule or principle laid down, whatever curve the near end of such line follows is also traced by the other end, *i.e.*, by the cutting edge of the tool. The templates are often placed *below* the main frame of the rest, but the pin D then comes in contact with it, if the recesses of the shaper-plate are very deep. By mounting the templates upon pillars, and placing the guide pin above instead of below the tool-slide, the latter can follow all the curves, however deeply cut, and thus an entire semicircle can be traced as is necessary in turning a sphere. It may here be mentioned that these shaper-plates are exceedingly useful in turning a number of articles exactly alike, as handles for tools, chessmen, etc. This exact method, however, belongs to a later page."

SCREW-CHASING BY HAND.

IN a previous paper I have alluded casually to the fact, that the softwood turners in Northamptonshire trace a screw where needed, without the help of any guide whatever, with a V tool of one point. They work the lathe very slowly for this purpose with the left hand, or, if such help "meet" for the work is at hand, they get a wife to pull round the mandrel, while they complete the operation in a single turn of the same for each thread, no second cut being made to deepen it. On visiting the lathe manufactory of Mr Hines, at Norwich, a short time since, I was speaking to him about this free hand-chasing of a screw, and he very kindly showed me his own mode of doing the same with a single point tool; and certainly, in his hands, nothing could be more simple or easy. Having turned down a piece of metal (a steel-lathe mandrel, I believe), he took a sharp-point tool, and making a fulcrum of the rest, swept the point at a greater or less speed, in a semicircular curve, from the right to the left hand, leaving an even thread or tracery of a thread, of coarse or fine pitch, according to the speed of the tool's point in relation to that of the lathe. Let it be understood that the tool was not slid along the rest, which was made the centre of motion or pivot—the point only tracing the required semicircular sweep upon the bar, as the thread of the screw was cut. There is no doubt that it is easier to work in this way than it is to slide the tool bodily along the rest, nor do any chance irregularities upon the edge of the latter interfere in this case with the progress of the work. The workman, in this case alluded to, traced several pitches in succession, from about twenty or twenty-five to the inch, to six or eight; and all appeared wonderfully regular—showing, at any rate, what may be done by practice; and Mr Hines stated that he cut large numbers of screws thus. Mr Northcott in his "Lathes and Turning," appears to have had a similar plan in view where he writes, "The best way for beginners is to take a graver, and first make a deep scratch with the point on the work, and *at about the inclination of the thread.* This scratch then acts as a guide for the chasing-tool, and makes it far easier to catch the thread of the screw." Mr Northcott's practice as an engineer makes his opinion reliable; yet, I confess, I marked a query against this paragraph, because, though in such a tracery one short part of the spiral *may* by chance be of the pitch required, it is quite as likely that the chasing-tool point may take the lead in some other part of such spiral. Having, however, seen the possibility of tracing with a single point, with a fair degree of certainty, a certain number of threads to the inch, I think it not impossible that the method may prove an assistance in making a path for the ordinary chasing-tool; but, in any case, the inside or female screw cannot be formed in this way. At the same place alluded to, I saw one of the guides called by the name of "East Norfolk Amateur," but which was summarily claimed by Mr Hines, as a *chance hit* of his own, when using a milling-tool at an angle to produce an ornamental surface on a cylinder. The tool run along in a spiral path, and as the pitch of such spiral was regulated by the inclination of the tool, its use as an originator of a screw thread was at once perceived. Whoever designed it, it is satisfactory so far as it effectually *marks* a screw thread, and thus forms a guide for the tool; but here again, as the female screw cannot be so traced, and the one is useless without the other, the instrument cannot be deemed perfect. Hence, there is still ample scope for the inventive faculties of the members of the A. M. S. I think most turners are agreed that the traversing mandrel is not exactly a good arrangement, although in default of a better it still holds its own. Its drawback, even in the matter of screwing, is, that one cannot use it when the work is supported by the back centre without some alteration of the latter. A friend asked me a short time ago, for instance, to cut a screw on the end of a table by this means, and to do so entailed the following arrangement:—I withdrew the leading screw of the back centre, placed a coiled spring behind it, and again screwed on the trap cap of the poppit, so as to allow the point to recede under the influence of the guide screw on the mandrel, and to follow up the work as it again receded. This did not practically answer in the above case, because the spring was not sufficiently strong, and the *action of the tool* pressing against the work was sufficient to force it out of the lathe, the cone-shaped point acting as an inclined plane, causing the cylinder to recede under pressure. Not having a stronger spring, nor caring to have one specially made for a single job of the kind, I do not certainly know whether such a plan is really practicable, but it appears the only method unless the work is cylindrical, so as to work in a boring collar, in which case the prong-chuck must be replaced by one to grip the work. The screw mandrel is confessedly not so good for general purposes as the ordinary one, running in collars and against a back centre, to say nothing of its cost in proportion to its use. The tool should traverse in preference to the work.

Some will doubtless say, "Learn, then, to chase screws flying." I can do this myself, and so can hundreds, *but not always certainly*, which is, I believe, a very general "dictum" even of professed turners; and for the most part it will be found that the art will fail when some very special work is to be done, simply from nervous anxiety *not* to fail. You may cut threads on scores of chucks, and then you will probably fail on some precious bit of ivory or choice wood. I should like to say a word more on screws and twists, but my limit is now reached. J. L.

LETTER FROM THE EDITOR.

To the Members of the A. M. S.

GENTLEMEN,—I have to remind you that one of the earliest suggestions made by the founders of our Society was the establishment of a Journal, in which, as a ready means of intercommunication, we might ventilate our several opinions upon matters mechanical—make known to one another any new inventions which might come under our notice—suggest improved methods of work—and, in various ways, assist one another in those captivating pursuits in which we are all alike interested.

The first number of such Journal was published in January last, containing forty-eight pages, not wholly contributed by members. The second number is now in the press, and is being issued under great difficulties, simply because the members display very unpardonable apathy in lending their assistance. The Society now consists of ninety members, of whom, excluding our indefatigable Secretary and myself, *three only* have answered the appeal which had been more than once made for their sympathy and co-operation. Two or three non-members have again kindly contributed to these pages, without whose assistance this second number could by no possibility have seen the light. Is this kind of thing, I ask, to continue? and am I, your most humble and obedient servant, to conclude, either that the

Society does not desire the existence of the Journal, or that only some half-dozen members are able to handle the pen? Of this I am morally certain, that a great many of the members know more of turning and mechanical manipulation than I do myself; and to any or all such I shall be personally obliged for information; and, in addition, I know that, from local advantages, some could give valuable and interesting accounts of work to which the majority are strangers.

As an instance of this, I was myself taken by a kind friend to King's Cliff, the other day, in Northamptonshire, and there I saw a great deal that was quite new to me, and would doubtless be new to a great many members of the A. M. S.—viz., soft-wood turning, including the *cutting screws with a V tool with no guide whatever*, and the making of wooden spoons, butter-prints, and similar articles, the formation and carving of which displayed a considerable amount of ingenuity, novel apparatus, and undeniable skill. I have not communicated the above to our Journal for two reasons—first, it is destined to appear in "The Lathe and its Uses;" secondly, I have already contributed more than my share to the Journal aforesaid, of which I can hardly be expected to become the writer as well as the editor, seeing that my pen is required to minister to certain domestic requisites, of which bread and cheese and small shoes are two important items.

Such being the present state of affairs, I have to appeal to my brother members to respond with greater unanimity to my request that contributions may be sent to me as early as possible for Number 3, to be published in July. Considering that the Journal is a quarterly and not a monthly publication, a considerable quantity of MS. ought to remain in my hands after the issue of any one number; whereas, I have as yet been absolutely unable to exercise the editorial privilege of selection and rejection, owing to the paucity of materials supplied by the members. Hardly a week ought to pass without the receipt on my part of a good bundle of MSS., so that I might have, as a general rule, sufficient matter in hand *for one whole number in advance of that actually in the press.* Until this is the case, our Journal cannot possibly be considered in a flourishing condition. It appears to me that many members shrink from communicating topics of which they are perfectly qualified to treat, because they think it a matter of course that they are not alone in their knowledge. Let such remember that if fifty members share the knowledge in question, there are still forty capable and desirous of instruction; and that a "mutual improvement society," as ours ought to be, contains exactly the same number of learners as teachers. I have myself, in the present number, set the example of "Queries and Letters to the Editor," and by this means alone much desirable information ought to be drawn out from among the members. All want to *know* something—let them ask; all can *tell* us something—let them write.

J. L.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

JULY 1871.

ON DESIGN AND TASTE.

AMATEUR turners frequently feel the want of good designs for their work. They may have the best and most complicated machinery and tools that can be turned out, and may possess a sufficient knowledge of the various modes in which they can be applied, but very often, unless they happen to be artists as well as turners, and are gifted with a taste for design, their labours end in an elaborate display of those snuff-boxes, and those pagodas, which recently excited the just wrath of a writer in the *English Mechanic*, simply because they do not know what else to make.

Some of the various works on turning, that have been published in this country and abroad, have given a few designs for vases, temples, &c., but I have rarely seen one that I felt the least inclined to copy. And being myself one of those turners who are not artists, I have often been at a loss to know how to *devise* some piece of work that would do justice to the instruments my workshop contains, and at the same time please the eye by its form and outline, instead of being a mere tasteless mass of complex and unmeaning ornamentation.

Though, however, I am no draughtsman, I can, and so can anybody, with a pencil and a piece of transparent tracing paper, take the outline of any vase or other object, of which I meet with an engraving; and for many years I have never missed an opportunity of taking such a tracing, whenever I have seen in illustrated papers, books, &c., representations of any article that I have thought could, by any possibility, be made available for the lathe. Of course in most cases many details have to be altered, but the main point is to have a good outline to work upon; and when this is once obtained, a turner, who knows the capabilities of his machinery, will readily see how to produce a sufficiency of ornament.

The vase, of which an engraving is given here, seemed to meet with the approbation of many of the members of our society who were present at the last annual dinner; and perhaps some details connected with it, may be useful to those who have not yet had much experience in turning.

The general outline is taken from an engraving of a cup in possession of the Corporation of Lynn, said by tradition, though no doubt erroneously, to have been presented to the town by King John. The engraving may be found in a work published in 1851, by Cundall and Addey, Old Bond Street, called, "Choice Examples of Art Workmanship." My ivory vase, with its mere formal geometric ornamentation, is of course a very humble imitation of this beautiful cup, with its rich enamels and its form moulded and chiselled by a skilful goldsmith; but still it bears some resemblance, though less than I could have wished, to the general shape of the original.

Having taken a tracing from the engraving, I examined my stock of ivory, to see on how large a scale I could attempt to produce my vase; for no doubt the larger such things can be made, the more effective is the result. Having ascertained the largest diameter I could give to the widest part of the vase, namely, the vase or foot, I arranged a pair of proportional compasses in such a manner that, while the larger opening of the compasses gave me that diameter, the smaller opening agreed with the diameter of the corresponding part on my tracing. I then made on paper a kind of sectional elevation of the vase, to serve as a working drawing,—measuring the diameter and height of each portion on the tracing with the smaller opening of the compasses, and by means of the larger opening, transferring the measurements on an enlarged scale to my working drawing. It mattered little that my working drawing had nothing artistic about it—all I wanted was such an outline as would enable me to see exactly the size of each portion of my work, and then by using callipers for the diameter and a turning square or compasses

for the length (making due allowance for the additional length required for the male screws to connect the various pieces), I could be sure of having everything in right proportion. And here I may remark how necessary it is, in executing any work composed of many pieces, to make a drawing, however rough, before commencing the work, and then to measure with instruments each piece while on the lathe, and not to trust to the eye, or the result will never be satisfactory. In this vase, as I made it, there are 27 pieces,—22 in the cup, stem, foot, &c., and 5 in the cover. The various parts all screw into one another.

A few remarks about certain portions of the work may not be out of place. The foot is formed by cutting away circular discs, or portions of discs, from the ivory, which has been previously brought to shape and polished on the lathe, by means of the Eccentric Cutting Frame, with a tool of this shape, which may be easily filed up

from a suitable piece of flat bar steel, and tempered in the fire, or in a spirit-lamp. It is sharpened on the sides *a* and *b*, which meet at the point *c*, and it is important, in making this tool, to let the point *c* project well beyond the left side of the shank *d* of the tool, to allow for the wear of the side *a* in sharpening. With such a tool, firmly fixed in a strong Eccentric Cutting Frame, it is easy to cut through ivory of a quarter of an inch in thickness, but of course the tool must be advanced with care and not too rapidly, and must be allowed to penetrate until the point comes right through to the underside of the ivory, when the waste piece will drop quietly out.

The upper and lower portions of the enlarged bulb on the stem were both formed with a female screw, so that each in turn might take its place on the same chuck, in order that both might be cut with the same setting of the slide-rest, so as to be precisely similar. They were then connected by a short piece of boxwood, having a male screw cut on the whole of its length, the flat disc with projecting teeth being inserted between them. Of course the disc has a hole in its centre, through which the piece of boxwood passes.

The body of the cup itself was shaped and fluted by means of the "Curvilinear Apparatus," that is, a template, or shaper plate of stout sheet brass, fixed on standards above the slide-rest, against the edge of which a rubber, rising from the movable slide of the slide-rest, is forcibly pressed by means of the lever, while the tool or cutter is traversed along by a handle on the slide-rest screw. The tool or cutter moves in a path corresponding to the particular curve given to the edge of the template, instead of in a straight line, as in ordinary fluting.

One important point must be attended to in forming these templates. The rubber, or at least that portion of it which presses against the template, is the rounded edge of a piece of steel, perhaps the tenth of an inch, or less, in thickness, and may be considered as a mere point; and if the cutting portion of the tool is of the same shape, it will reproduce on the profile of the work the same curve as that of the template; but, in fluting with a flying cutter, working horizontally, it must be remembered that the revolving tool describes a circle of perhaps an inch in diameter, and, though the centre of that circle follows the same path as the rubbing point, its circumference is moving in a different curve altogether, as may be seen in the diagrams

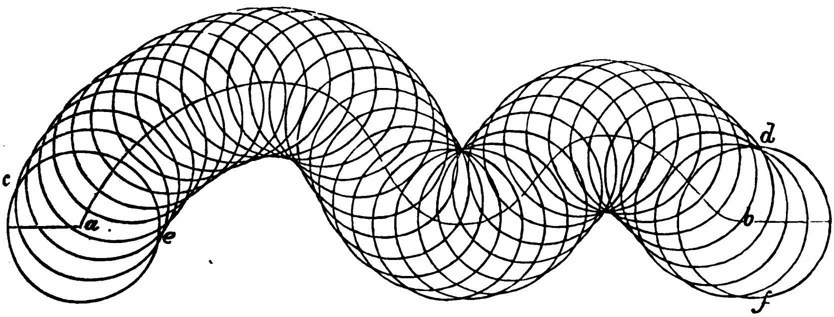


Fig. 1.

where the curved line *a*, *b*, may represent the pattern of the template, while the series of circles, whose centres are points along the template, shew the various positions of the flying cutter, as its centre is guided along the curve *a*, *b*. It is evident that the point of the tool, when in contact with the work, will describe the curve *c*, *d*, which, though parallel to *a*, *b*, differs from it materially in its proportions.

Probably the best way to overcome this difficulty, is to use as a rubber, instead of a mere point, a small revolving horizontal wheel, of the same diameter as the circle described by the flying cutter, but if this cannot be conveniently had, the form of the template must be modified, and if it be filed to the shape of the *outer curve*, *e*, *f*, the point of the cutter will then move in the path of *a*, *b*.

There is, however, still another point to be attended to. In my vase, the portion we are now considering is first brought nearly to the

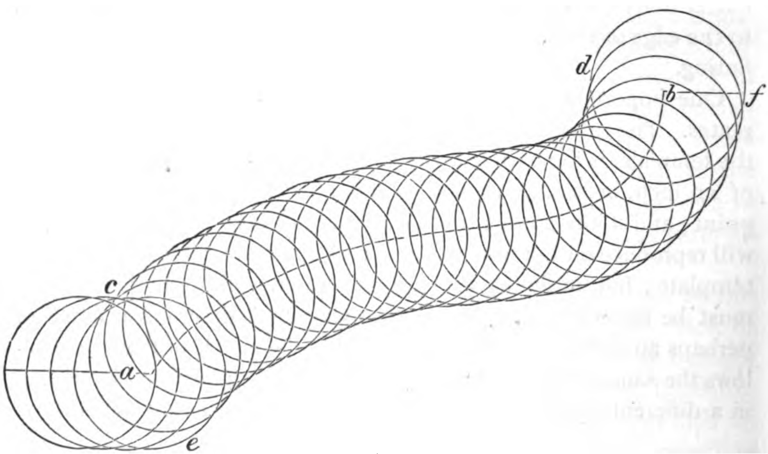


Fig. 2.

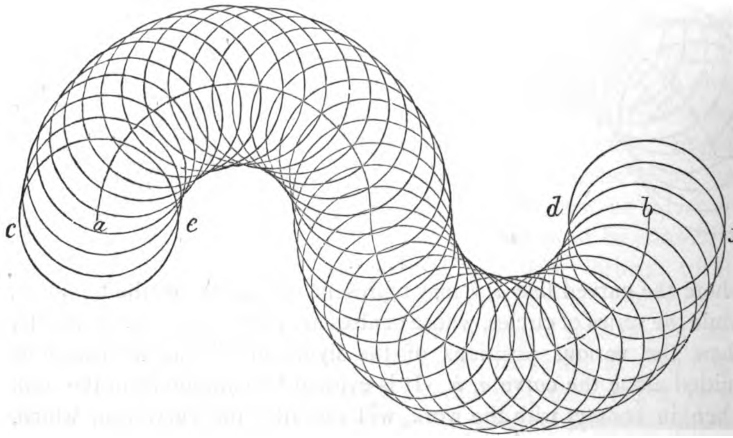
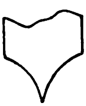
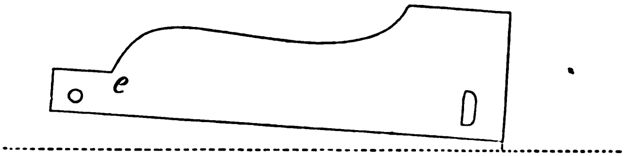


Fig. 3.

required form on the lathe, and finally shaped by a series of deep cuts or flutes produced by the flying cutter, whose point is of this pattern,



these cuts being placed, by the dividing plate of the mandrel, at such a distance apart, that, at the widest portion of the work, that corresponding with the end *e* of the template, they will just cut away the original surface of the material operated upon; but these cuts, as they approach the small end of the work, will be closer together, and cut away more of the material than required, and so cause the outline of the work, when completed, to be smaller than it should be towards its lower extremity. This, in fact, has been the case with



my vase, in which the lower extremity of the cup itself is smaller in proportion than in the original drawing. This may be avoided by placing the template at an angle, with its right-hand end brought more forward towards the operator than the left, as in above diagram. This will gradually withdraw the point of the cutter as it proceeds from left to right, and cause it to cut less deeply.

George Calvert Clarke.

GOSSIP—THE INTERNATIONAL EXHIBITION.

THE Exhibition appears to have come upon us unawares. Early in the year, comparatively few people realised the fact that an International Exhibition was to be opened on the 1st of May, and to judge from the arrangements, or rather want of arrangements, on the opening day, the South Kensington officials would certainly seem not to have been of the number of those who did. The bare mention of an Exhibition carries us back in imagination to the departed glories of 1851 and 1862—those fairy palaces, with their gorgeous *coup d'œil*, a very *olla podrida* of all that was beautiful, once seen never to be forgotten—alas! these are of the past and appear unlikely to recur. But regrets for the past are useless, and may perhaps be out of place; let us rather occupy ourselves with the present. The existing Exhibition being the first of an annual series at each of which some particular branch of industry will be selected for illustration in detail, it is to be hoped that greater practical benefit will result than was possible when nearly every trade under the sun was represented at the same time and place, so that memory and judgment were alike confused. Without going into the question, we may assume that the arrangement of the buildings is the best that could be made, though, to a jaded sight-seer from the country, the galleries and arcades (names suggestive of length) must seem well-nigh interminable, and this drawback is enhanced by their situation round the Horticultural Gardens, which render short cuts from one part to another impossible to all but those who have the *entrée* to the gardens, or are disposed to pay sixpence for that privilege. The Albert Hall, the Exhibition, and the Horticultural Gardens are so cunningly interlaced (not to mention a *soupçon* of Woolwich Arsenal and the South Kensington Museum, which is apparent at the south-eastern corner), that we feel sure a bumpkin must be sorely puzzled to understand his whereabouts at any given moment without previous consideration.

Excluding the Scientific Inventions, the machinery in motion is, with one exception, limited to the illustration of Woollen and Worsted Manufactures, and appears to be very complete. Apart from their special uses, many of the machines exhibited are worth attention, as examples of ingenuity in communicating and applying motion of all kinds. Amongst these may be mentioned, besides the various looms, &c., a small, but rather complex, machine for making the "cards" for carding engines, a grinding apparatus for the same, and a small circular knitting machine, to the capabilities of which we can personally testify. The exception above referred to is a group of machinery connected with the Pottery Department, which should certainly be visited, inasmuch as it contains, *inter alia*, a machine which should command the respect of all turners, as the progenitor of our ornamental lathes—the Potter's wheel. The few and simple tools required, and the consummate skill shown in the management of them, should surely teach a lesson to many who, with elaborate machinery at command, are yet barely able to shape with gouge and chisel the object they propose to decorate. There is likewise in this shed a steam-engine (Tangye's patent), which for simplicity and effectiveness seems to commend itself to those among us who are sufficiently lazy to wish for, or for other and sufficient reasons may require, a motive power for their machinery other than their own muscles. Its chief feature is that the bed-plate, front cylinder cover, guides and plummer-block for the crank-shaft bearing, are all cast in one piece. It is made from 1 H. P. upwards, and the price is moderate. The *Scientific American* for April 1st contains an engraving of an engine said to have been designed by a Mr Holmes, which bears a very remarkable resemblance to it. A walk through the adjacent gallery containing Porcelain (with a sketch book for an occasional outline), should not be destitute of results in the important matter of form. Many of the vases and tazze exhibited are capable of reproduction on a reduced scale in ivory and ornamental woods, and would well repay the trouble of sketching, and adapting to the requirements of lathe-work. On another page will be found some excellent advice, from one who has had considerable experience in such adaptation, and those who have seen specimens of his handiwork will not fail to acknowledge the force of his argument, which may be thus briefly stated :—*For one who is not an artist by nature, it is better to copy a good design than originate a bad one.*

Apropos of this subject, we annex an outline drawing of a porce-

lain vase, recently sold at Christie's, which appears capable of good use in the manner suggested. In carrying out such work, great care should be taken to preserve the exact proportions ; ornament should be sparingly applied, leaving a sufficiency of plain but highly-polished surface to relieve and throw up the rest, and the pattern, though well "cut up," should not be so deep as to interfere with the original curves of the design. In the eastern Arcade, among the Pottery and Terra Cotta, may be found numerous architectural examples, containing mouldings of great beauty, many of which are also well worth jotting down for future use. Notable among these is a beautifully-executed model in brickwork, representing a window of an Italian Cathedral. Who has not seen the ivory thermometer stands, and other similar articles, to be found in most opticians' windows, *ornamented* with a hideous jumble of beads and quirks, the disposition of which has apparently only been guided by the order in which the tools came to hand? Than this what can be more inartistic? To avoid the perpetration of such outrages on good taste, a workman should endeavour to make himself acquainted with the first principles of ornamentation, wherein, among other things, he will learn what a moulding is. Without pretending to treat the subject scientifically, we may describe a moulding as either simple or compound, consisting of one or more members, each of which should not only be kept separate and distinct, but should be in proportion to and in harmony with the rest—and, having a correct idea of its value as an ornament, he will find it useful to preserve a few sketches of the best examples he meets with, especially when, besides being capable of adaptation to his purposes, they are the work of a master, and, therefore, carry with them an undeniable stamp of authority. We must risk being thought pedantic in insisting on such minute attention to detail, but our experience certifies that inattention to such matters is the rock most workmen, and especially Amateurs, split upon, and we further most emphatically assert that real excellence of design can never be attained unless the workman bears constantly in mind what is almost habitually forgotten—the essential difference between "ornamented construction" and "constructed ornament."

Among the Scientific Inventions, the first object of any importance which strikes the eye, is a ten inch equatorial telescope by Cooke & Sons of York, who are known to more than one of our members for their lathes, planing machines, and the excellence of their work generally. They have also an electric motor clock, driving eight dials in different parts of the building. Signor F. Tommasi exhibits the model of an invention for utilising the power produced by the use and fall of the tides, a subject to which we referred in our last number. The apparatus consists of a reservoir communicating with the sea, situated so as to lie below the average level of high-water mark, and divided into two compartments, the air from one of which, compressed by the rising tide, is made to drive a machine similar in construction to an ordinary steam engine, while with a falling tide the engine works by exhaustion. By this means the inventor calculates that the engine would alternately work and rest three hours at a time, and for those branches of industry to which such intermitted work is not adapted, he proposes to add air pumps, and by their means to utilise the power which would otherwise be wasted during the night, and on Sundays, by compressing air in a suitable reservoir, for driving the engine during the intervals of rest in the day-time. At the end of the gallery is Mr Cunningham's Carving Machine, with some excellent samples of its work. We regret that Mr Jordan's is absent, for it would have been interesting to compare them side by side, though, perhaps, difficult to decide on their relative merits. For amateurs they would both be rather cumbersome, and are neither of them capable of being driven by the feet of the operator, excepting the small machine Mr Cunningham has adapted to fit the bed of a lathe. This we have not seen; but, we must confess to a dislike for all such adjuncts to the lathe. They are a great trouble to mount when required, and must, of course, be taken down again before the lathe can be used for its legitimate purposes, besides which such changes can certainly do a valuable lathe no good, and may do it a great deal of harm by bruising or straining the bed. The latter objection will not apply where a common lathe is kept for such purposes; but even then the economy is but questionable when time and trouble are taken into consideration. Above all things, we would caution beginners against mounting a grindstone or emery wheel to run between the centres of a lathe, unless it be one of the commonest kind and fit for little else. Emery wheels are especially detrimental, the fine grit from them being certain to work into the bearings of the lathe and eventually ruin it. Mr Cunningham also exhibits a remarkably well-finished specimen of his combined fret-cutting, moulding, and sawing machines, which has been purchased by one of our members. Such a machine, mounted as this is, on a strong wooden frame, is a very desirable addition to an amateur's workshop, and, in our opinion, far preferable to those on iron frames, there being less vibration, though the latter possess the undeniable merit of cheapness. Warsop's Aero Steam-engine, which drives the Printing Machine close by, is worth a visit. The novelty consists simply in the addition of an air-pump to an ordinary steam-engine, by which air is forced into the boiler; the cylinder of the engine is consequently supplied with a mixture of air and steam, by which it is claimed to effect a considerable saving in fuel, to preserve the boiler from scaling and incrustation, and to prevent priming, all advantages which will not fail to be appreciated by employers of steam power. Further on the gallery assumes the aspect of a fishmonger's shop on a large scale, albeit the contents are not particularly appetising in appearance, models of nearly everything in the way of fish from whales to whitebait; but as we have no intention of poaching in Mr Frank Buckland's domain, we will retrace our steps as far as Cooke's telescope, and go out into the open ground. Here we find a model of Hodgson's Wire Tramway constantly at work, carrying buckets to and fro, in a manner similar to that in which children usually suppose messages to be carried by the telegraph wires. This contrivance is eminently adapted for the conveyance of minerals from the mine to the ship, and, bearing in mind its small cost as compared with that of ordinary tramways and their appurtenances, we think it likely to be favourably received. Close at hand is Thomson's Road Steamer, a monster weighing about six tons, which might be recommended to the Indian Juggernaut devotees, supposing they wished to avail themselves of the advantages of steam-power. The upright boiler and funnel, shaped like those of the American wood-burning locomotives, gives it rather the effect of being top-heavy; but a glance at the ponderous wheels and framing soon dispels the idea. The funnel is designed to prevent the escape of sparks, and, as far as possible, to deaden the sound of the exhaust steam. The fuel is a mixture of coke and coal; and the working pressure 120 lbs. The speed at which it is capable of travelling, the very small space required for turning (the square of its own length), the ease with which it is steered, and the absence of damage to the ground over which it passes, are certainly remarkable. The sight of it at work reminded us of that mythical machine mentioned in Macrae's amusing book called "The Americans at Home," which, when properly wound up and set in motion, was warranted by its inventor to chase a pig over a ten-acre lot, convert him into pork, manufacture his bristles into blackening-brushes and his tail into a corkscrew!

ELEMENTARY PAPER.

GLUEING, VENEERING, POLISHING.

Glueing.

THE right sort of glue to use for ordinary work is "best Scotch" (inferior kinds are often adulterated with lime). This glue is sold at all good tool shops; but if it cannot be obtained, choose the most transparent cakes. For fine work in light-coloured woods, Salisbury glue may be used; this is made in thin cakes, and is of a clear amber colour.

Preparation of the glue. Break it into small pieces with the hammer, and soak for at least twelve hours in sufficient water to keep it covered even when swollen by the water it absorbs: this water *must* be cold. It is no use attempting to melt glue by putting it into hot water; it will always be stringy, and give endless trouble. Put the pieces of soaked glue without any superfluous water into the glue pot, taking care that the outer vessel is kept full of water, which will prevent the glue in the inner vessel from burning; this is very important.

The glue will now soon dissolve; it will be thin at first, but quite strong enough; subsequent boilings will, however, improve it, so long as it is never allowed to burn; indeed, as water is driven off by evaporation, more will have to be added. If stronger glue is required, it may be made with beer instead of water, and stronger still, if linseed oil is added to it instead of water, as the original water in which it was dissolved is evaporated by boiling.

Cleanliness is very essential to the well-being of glue; a wooden cover should therefore be provided for the pot, and if any dust or dirt is on the cold glue, it should be just washed off before putting the pot on the fire. A scum always rises as the glue boils; carpenters generally stir this in with the brush, I prefer to skim it off, and put it in a gallipot, where it accumulates and settles with waste scrapings, and much of it may be utilised afterwards.

A wire stretched across the pot is very useful to remove superfluous glue from the brushes; this is much better than pressing them against the edge of the pot, where quite enough glue is sure to accumulate and burn.

Never use any of that old dried up and burnt glue, which may be generally found in the bottom of a glue pot kept in a kitchen; have the whole concern boiled out in a saucepan, before you put your nice fresh clean glue into the pot.

How to use the glue. It must not be supposed that the strength of a glue-joint depends upon the quantity used; those joints hold the best in which the pieces of wood are brought closest together. The following is a brief description of the process to be pursued:—Have the glue as hot as possible, the glue pot within easy reach, a basin of hot water, and a bit of sponge on the bench. Cover quickly with hot glue both the surfaces to be united, and rub them together, pressing out all the glue that can be got rid of; let the motion of the one piece on the other be but slight; for instance, in a three foot joint the top piece need never have more than an inch or two beyond the other, which is fixed, it is supposed, in the bench screw; it will soon be felt that they are inclined to stick together, then they must be brought at once to that which is to be their final position, and *not moved again.* Superfluous glue may now be wiped off with the sponge when necessary, as when it is in an angle or an awkward place to get at afterwards; but as a general rule, and particularly in a long joint, it should be left on till cold, for it excludes the air, and goes a long way towards making a good, permanent joint.

If the edges of two long boards have to be glued together, the job will require two hands. One board having been fixed in the bench-screw, the other is rested against it, so that the edges meet obliquely, making a very blunt V. While one workman steadies this second board (with the help of a weight, or the jack planes on the bench, to keep it from slipping), the other holding the glue pot in his left hand, passes the brush, well loaded with glue, rapidly along the edges; he must not mind wasting his glue, there is no time now to be careful about not spilling a drop or two. When the edges are quite covered, he takes one end of the loose board, his assistant the other, and they rub it up and down a time or two, till it sticks, as with shorter pieces.

And here note, that if you are not skilful enough to shoot a perfectly true edge on your board, make it slightly concave rather than convex; for the ends always have a tendency to rise.

In glueing flat pieces of wood together, such as two or three thin pieces to make one thick, with the grain running different ways, screw-clamps are required: these are wonderfully useful things for many purposes, very cheap, and not half enough used by amateurs.

Veneering.

The softest woods should be chosen for veneering upon—such as common cedar or yellow-pine;—perhaps the best of all for the purpose is "arrow board," twelve foot lengths of which can be had of perfectly straight grain, and without a knot; of course no one ever veneers over a knot. Hard wood can be veneered, boxwood with ivory, for instance; but wood that will warp and twist, such as nasty cross-grained mahogany, must be avoided.

The veneer, and the wood on which it is to be laid, must both be carefully prepared, the former by taking out all marks of the saw on both sides with a fine toothing plane, the latter with a coarser toothing plane. If the veneer happen to be broken in doing this, it may be repaired at once with a bit of stiff paper glued upon it on the upper side. The veneer should be cut rather larger than the surface to be covered; if much twisted, it may be damped and placed under a board and weight over night. This saves much trouble; but veneers are so cheap, about 1d. a foot, that it is not worth while taking much trouble about refractory pieces. The wood to be veneered must now be sized with thin glue; the ordinary glue pot will supply this by dipping the brush first into the glue, then into the boiling water in the outer vessel. This size must be allowed to dry before the veneer is laid.

We will suppose now that the veneering process is about to commence. The glue in good condition, and boiling hot, the bench cleared, a basin of hot water with the veneering hammer and a sponge in it, a cloth or two, and everything in such position that one will not interfere with, or be in the way of, another.

First, Damp with hot water that side of the veneer which is not to be glued, then glue the other side. Second, Glue over as quickly as possible the wood itself, previously toothed and sized. Third, Bring the veneer rapidly to it, pressing it down with the outspread hands, and taking care that the edges of the veneer overlap a little all round. Fourth, Grasp the veneering hammer close to the pane (shaking off the hot water from it) and the handle pointing away from you; wriggle it about, pressing down stoutly, and squeezing the glue from the centre out at the edges. If it is a large piece of stuff which is to be veneered, the assistance of a hot flat iron from the kitchen will be wanted to make the glue liquid again after it has set; but don't let it dry the wood underneath it, or it will burn the glue and scorch the veneer, and ruin the work. Fifth, Having got out all the glue possible, search the surface for blisters, which will be at once betrayed by the sound they give when tapped with the handle of the hammer; the hot iron (or the inner vessel of the glue pot itself, which often answers the purpose) must be applied, and the squeezing process with the hammer repeated.

When the hammer is not in the hand, it should be in the hot water.

The whole may now be sponged over with hot water, and wiped as dry as can be. And observe, throughout the above process never have any slop and wet about the work that you can avoid. Whenever you use the sponge, squeeze it well first. Damp and heat is wanted, not wet and heat. It is a good thing to have the sponge in the left hand nearly all the time, ready to take up any moisture or squeezed-out glue from the front of the hammer.

So much for laying veneers with the hammer, which, though a valuable tool for an amateur, is not much used in the best cabinet-makers' shops; cauls are adopted instead. They are made of wood, the shape and size of the surface to be veneered, or better still, of rolled zinc plate, and being made very hot before a good blaze of shavings, they are clamped down on the work when the veneer is got into its place: they must be previously soaped, to prevent them sticking to the veneer. The whole is then left to dry together. The hammer is quite sufficient for most amateurs. I have laid veneers with it 5 feet long by 18 inches wide, without assistance, and without leaving a blister. Cauls, however, are very necessary if a double curved surface has to be veneered, or a concave surface; they need not be used for a simple convex surface. By wetting well one side of the veneer it will curl up, and can easily be laid on such a surface; but it will be well to bind the whole round with some soft string to assist it in keeping down while drying.

POLISHING.

No attempt at scraping, sand-papering, or polishing veneered work must be made till the glue is perfectly dry and hard. It should be left twenty-four hours in a warm room at least, and better still if left two or three times as long.

The processes for French polishing vary somewhat according to the nature of the wood. For common work in deal, the wood may be well sized first, then papered with fine glass-paper, and polished.

For mahogany, walnut, and similar porous woods, the pores must be filled by rubbing in, on a roller of old carpet, a mixture of Russian tallow (that is, tallow free from salt) and plaster-of-Paris, well amalgamated—before the fire in cold weather. Russian tallow may be had at most oil shops generally pure enough; but if the presence of salt is suspected, refine it by boiling it in plenty of water, stirring it well, and skimming it. Set it by to cool, and use the cake of tallow which will be at the top.

The more this filling-up process is persevered in, the less will be the subsequent labour in polishing: quite a bright surface should be got up by this alone. The mixture of tallow and plaster may be darkened with red lead for mahogany, or other colouring matter, according to fancy.

This filling is not necessary for boxwood, ebony, or others of the hard woods.

To polish a surface thus prepared, not being hard wood and not in the lathe, take a ball of cotton wool saturated with methylated French polish; cover it with a fold of linen cloth; on the linen cover put with the tip of the finger a drop or two of raw refined linseed oil (not "boiled oil"); get on a good body of varnish by rubbing always one way with circular strokes; be very careful to go over all the ground each time you work round the surface; and do not go over the same spot twice before you have gone over all. The longer this is done the better. Never mind the smears, which, though they look queer, are the very appearance you want at this stage. Having got on a good body, leave your work and take to another piece. It is good to leave it, if convenient, even for a day or two. By the way, shut all doors and windows before you begin. You can't do French polishing in a draft or in a very cold room.

When you resume work, use a mixture of half methylated French polish, and half methylated spirit, or less than half of the spirit when you commence, and put now as little as possible on the wool, covering it with more than one fold of fine linen or cambric. Very little oil, as before—only just enough to prevent the rubber from sticking to the work; go over it lightly, with an easy gentle touch, in circular strokes, all one way. Never mind the smears. When it comes to look something like a good result, which it soon will, you may take out the smears by rubbing up and down with a mere trace of spirit on wool well covered with the linen, but avoid going over the same place twice, and be very light and gentle, or you will remove your polish. Finally, rub it well with a clean wash leather (carefully folded, so as to have no hard crease which will scratch), or an old silk handkerchief, breathing on the work occasionally.

Boxwood, ebony, cocus, &c., may be rapidly polished in the lathe. At first get a body on of polish, and this can be done without using any oil. The work must not be turned round rapidly, but the pulley of the lathe moved slowly by hand; then use your rubber with a drop of oil, and finally, the polish thinned with spirit.

If either on flat or turned work you require a very superior polish, you may remove nearly all the first coat with fine glass-paper, and put it on again, which will not take long, the pores being all filled. Remember that throughout the oil is only used to prevent the rubber from sticking, and it has to be got out afterwards with the spirit; so never use more than necessary.

In the lathe, when you come to the wash leathers, the work may be driven rapidly. A bit of ebony can be polished in five or six minutes to such a surface that small print can be easily read in it as in a mirror. Don't use your rubbers when they get hard and dry, but nevertheless stick to an old one as long as you can, and if you have to put them by, keep them in a tin box tightly covered.

SHERRARD B. BARNABY.

LATHE WORK—TEMPLATES, &c.

VIRION NIGHTON has given some very useful hints to young turners as to purchasing apparatus, though every one should commence on a common lathe, and not go in for a traversing mandrel, until he has, at all events, mastered the rudiments of the art of plain turning; but as soon as ornamental turning is begun, the foundation of a really good mandrel and popit head is indispensable. But there is one part of his paper to which, as an old turner, I must take exception. American scroll chucks are most useful in their way, and superior to the old two jawed universal, except for large and heavy work, but they by no means supersede cup chucks, and a well-sized assortment of them is not to be despised. In my opinion, the little time spent in turning down one end of a rough piece of hard wood or ivory, held maybe in a universal, to fit nicely into a cup chuck, is well bestowed, for your work is thus held so much more pleasantly and securely. Cup chucks are often made too deep; $\frac{1}{2}$ in. to $\frac{5}{8}$ in. is ample depth, save for very large-sized ones. Let no one, therefore, cut up cup to mount scroll chucks on their backs, but take the not very much additional trouble to make a fresh back on purpose. I mounted mine (a 3 in. one) on an iron back, but am just about mounting a small one for drills on gun metal. Can any of our readers say if a well-proportioned gun metal back could not carry even a 4 in. one perfectly firmly. While on the subject of chucks, I may add, that I have found a small cup chuck, about 1¼ in. diameter, with a screw cut inside (about 16 to inch is a good thread), most useful for screwing small ends of boxwood into, to serve as wood chuck. You thus get a metal chuck which can be left on the lathe without fear of shifting; and the ends of box, being themselves pretty sure to be well-seasoned, stand far better than a plain boxwood chuck; moreover, by this means a wood chuck is obtained, which will, by a transfer cup, pass to the oval or eccentric chuck.

With reference to the question started by our honorary Editor, of turning a ball by means of a template,* or curvilinear apparatus, if he means a plain ball, such as a billiard ball, it cannot be finished by it at both poles; and from the trouble, if not the almost impossibility, of adjusting with any certainty to the right distance from the axis, no advantage would be gained from the use of it for even shaping out any part of a true sphere. A perfectly true plain ball may easily be turned by hand, but if he wishes to apply it to the ornamenting of a ball it can be done, only, unless the patterns be cut very shallow, the chances are the ball will not come out a true one. The curvilinear apparatus is most useful, and not used by amateurs generally, as it might be; it is simply made, and any fair workman who has it not may add it to his slide-rest, and would find it a most valuable adjunct. I always keep rough plates of brass, which I file out to any curve or shape required, and thus it comes in continually for ornamenting either with drill or vertical cutter. If you confine yourself to the few beautifully mottled steel templates supplied by Holtzappfel, very possibly, unless work is made to the shape, you may not once a year find a curve to suit; but by filing the shape to suit your work, it may be made use of continually. The guide pin, as it is called, both in the query and in a following article of our last number, is generally a simple screw with a rounded point. It cannot be a fixture, as the

* Since writing the above, a ball has been successfully turned by a correspondent, by the aid of a semicircular template and tool with a semicircular edge.—ED.

adjustment of the depth of cut must be regulated by it; in very highly-finished and expensive apparatus, it is sometimes a small miniature cylinder popit, with round nose, which is of course superior. If you turn down any work to shape by means of a template, with the view of ornamenting it after, care must be taken to leave a little margin for going in deeper, or you may perchance find the ornamenting tool scarcely touching, or not cutting its pattern up, in some hollow or corner, exaggerated from the form of the template by the side of the turning tool; and unless the tool and point of stop exactly correspond (a thing in practice almost impossible to carry out), the shape produced will not be precisely similar to the template. The fixed direction of the tool, although moving along in a curve, is of course the drawback to the curvilinear apparatus. Were it not for this, it would do all the work of the spherical rest, and more also; but still, notwithstanding, I feel sure no one will regret adding it to his lathe, and investigating to what uses it might be applied, though turning a true ball may not be among them. M. Y.

HONORARY SECRETARY'S REPORT.

THE Second Annual Dinner took place on Thursday the 13th of April last, at Willis's Rooms. As announced, a room was opened for the reception of members at three o'clock, who from that time until five, the dinner hour, were occupied in conversation and in examining the specimens of work brought for exhibition. These were not so numerous as might have been desired, yet sufficiently varied to afford food for discussion. There were a number of black-wood boxes with medallions executed by Lowe's machine, one being an excellent portrait of Mr Forshaw, whose work they were; a back-geared lathe-head of peculiar construction, contrived by Mr Beckford; several elegant pieces in ivory, by Colonel Clarke, Mr Chatto, Mr Rivington, and Mr Yeatman; and a model of an ingenious letter-box, invented by Mr Hodgson, which, although it admits a letter easily enough, renders the abstraction of one by improper means next to an impossibility; besides a number of other objects which time and space prevent me from particularising. At five o'clock, the company, to the number of twenty-five, including two or three visitors, sat down to an excellent dinner, which having been satisfactorily disposed of, and the health of the Queen given and cordially responded to, the business was proceeded with, which on this occasion was of a more important nature than any that has yet occupied the attention of the members at previous meetings, involving, as it did, an almost entire re-construction of the system of management. In the April Number, I endeavoured to point out the necessity for this change, and at the same time suggested the formation of a Council, and an increase in the subscription. A considerable time was occupied in the discussion of these questions, in which most of the members present took part. It is unnecessary to reproduce in detail the different suggestions made and opinions expressed: it will be sufficient to say, that they were, without exception, practical, and to the point, and resulted in the following motion made by the Rev. S. B. Burnaby, seconded by F. Blake, Esq., and carried unanimously:—

"That a Council, consisting of all Honorary Officers and seven Lay Members of the Society, be forthwith appointed, by whom all the affairs of the Society be managed. They to appoint a Chairman. Election of new members to rest with them (one black ball excluding); to meet when they consider necessary."

Several members were then nominated to serve on the proposed Council, and out of these the following seven were elected by show of hands:—

F. W. BLAKE, ESQ.
REV. S. B. BURNABY.
COLONEL CLARKE.
H. W. ELPHINSTONE, ESQ.
HENRY PERIGAL, ESQ., F.R.A.S.
MAJOR SANDEMAN, AND
MORGAN YEATMAN, ESQ.

It will be seen from the wording of Mr Burnaby's motion, that the Council is invested with the fullest powers, an arrangement which cannot but be regarded as most judicious, since having selected those who are both able and willing to put their shoulders to the wheel, it is of the last importance that they should be allowed to pursue their labours with unfettered hands. It was unanimously decided to postpone the increase of subscription and the entrance fee. This is therefore now a question which it will be the province of the Council to deal with when they consider that the proper time has arrived. The appointment of a governing body having rendered unnecessary for that evening any further attention to business, the members gave themselves up to the discussion and solution of those numberless intricate questions which are certain to arise when two or more workmen meet, and separated shortly before ten o'clock.

Hitherto I have embodied an account of all meetings in my Report; this, as far as the Annual Dinner, Conversazione, &c., are concerned, I shall continue to do, in the absence of any reason to the contrary; but the business transacted at the meetings of the Council will in future be noticed under a separate head, so that members may be able readily to refer to the proceedings, unencumbered by any expressions of my own personal opinion which I may occasionally permit myself to introduce into my General Report. It only remains for me to congratulate the Amateur Mechanical Society most cordially, upon having secured the services of a Council composed of gentlemen, whose character and attainments offer the fullest guarantee that its affairs will in future be most conscientiously and ably administered, and who will not permit the loss of any opportunity for furthering the interests of the undertaking.

T. W. Boord.

Postscript.—The visit of the Society to the Government Small-arms Factory at Enfield took place on the 27th of June, as announced. Owing, doubtless, to the same cause which has hitherto prevented large musters, the wide dispersion of our members, there was, notwithstanding the fineness of the weather, a comparatively small attendance—to be regretted, perhaps, on behalf of the absentees, but decidedly advantageous to those present, inasmuch as they were the better able to follow the explanations afforded them by the attendants without crowding; and to further this object, the members were divided into two parties, which were conducted through the factory independently of each other.

The first part shown was the Stock Department, containing the machinery employed for shaping the stocks of long and short rifles and carbines. The wood—walnut—is obtained almost exclusively from contractors in Italy and Spain, and arrives in roughly-shaped pieces, sawn from the plank apparently by a hand-saw. These pieces, after being examined as to size and soundness, are successively passed through a series of machines constructed on the principle of the copying-lathe, wherein steel templates govern the penetration of the tool, and cause the wood to assume the required shape. The cutters of the first machines for roughing-out are formed as circular discs, with gouge-shaped blades attached to the periphery, the rubber being a wheel of the same diameter and section as the cutter. Perhaps the most compact and cleverly arranged is the machine for excavating the recess for the lock: it consists of a revolving frame, furnished with five or six vertical spindles, carrying drill-shaped cutters of various diameters and their corresponding rubbers, which are successively brought over the work as it lies fixed on the bed of the machine in front of the workman, with a template by its side representing the cavity to be formed. There is but one driving-band, and this works each spindle in succession, as the tool is brought into cut by its lever, the depression of which shifts the band from a loose pulley on which it runs when not in use to the driving-pulley of the spindle required. Space will not admit of a detailed description of the innumerable processes required in the preparation of the various parts of a rifle; besides which, it would be invidious to select any particular portion for description, so great is the accuracy and precision of the whole manufacture. In the smithy, swages, presses, steam-hammers, and Ryder's excellent machines, are largely employed; for shaping, the preference appears to be given to circular mills, the work being securely clamped on a self-acting slide-rest. Some pieces are smoothed by grinding on large Bilston stones, as bayonets, sword-bayonet blades, barrels, ramrods, &c., others by hand-filing, as sword-hilts, heel-plates, and portions of the lock. After being ground, the outside of the barrels is finished with fine emery and water in a machine, which gives each barrel a reciprocating circular as well as an endlong motion. The spiral groove in the interior of the barrel is produced by a cutter fixed in a traversing-bar, carrying on its extremity a pinion which is driven by a rack half a turn, or more as required, in the length of the barrel—the motion of the rack being controlled by a guide-bar fixed at a given angle to the bed of the rifling-bench. Before being finally put together, the whole of the parts are carefully tested, gauged, and, if found correct, marked by the "Viewer." The barrels are twice proved, once before and once after being stocked, the former being a very severe test, with nearly three times the service charge of powder and two balls; which, however, only proves fatal to about one barrel in every thousand. The factory employs about two thousand hands, all of whom are on "piece-work," and is capable of turning out four thousand rifles per week.

After visiting a large manufactory such as that of which the above is but an incomplete sketch, one cannot but be struck by the vast number of special machines employed, each one calculated to perform its allotted task with an accuracy well nigh marvellous, nor can one help observing, that however skilful a man may be in the management of the machine under his control, still to a certain extent he loses his individuality and becomes merely a part of the machine; if this assumption be to any extent correct, it is to be feared that such employment must in the long run lower the standard of individual skill, a circumstance to be regretted though apparently unavoidable if we are to keep pace with other nations. It is also rather mortifying to one's national pride, to observe that a large proportion of the machinery is of American origin, a circumstance which may possibly be explained by a comparison of the Patent Laws of the two countries: in America, every encouragement is offered to inventors—here, to put it mildly, such is not the case. In conclusion, our warmest thanks are due to the authorities for their reception of us, nothing could exceed the politeness and attention we experienced at the hands of those whose task it was to conduct us.

T. W. BOORD.

PROCEEDINGS OF THE COUNCIL.

THE first meeting of the newly-appointed Council took place on Thursday, the 20th of April—eight members present. The business transacted was chiefly of a preliminary character, with a view to ascertain the time and place most convenient for future meetings, and, although there were some candidates for election, yet, as they had offered themselves previously to the annual dinner, it was decided not to proceed to their election under the powers conferred by Mr Burnaby's resolution, but to place their names before the members for ballot in the usual way on the 1st of May following, and the said resolution was ordered to be given, *in extenso*, in the circular of that date, for the information of such members as were not present at the dinner.

A second meeting was held on the 18th of May—seven members present—when a thorough revision of the bye-laws was commenced, in order the better to adapt them to the altered constitution of the Society. A letter from Mr Northcott, containing suggestions for the improvement of the Journal, having been read, the subject was considered, and thanks ordered to be returned for the communication.

It was decided that the members of the Society should this year visit the Government Small-arms Factory at Enfield, towards the end of June, and the Hon. Secretary was directed to make inquiries with that view. The following candidates were duly elected :—

Harry Bridson, Esq. John Tomes, Esq., F.R.S.

Another meeting took place on the 8th of June—five members present—when the revision of the bye-laws was completed. They now stand as follows :—

1.—That this Society be called "The Amateur Mechanical Society," and shall have for its object the promotion of Mechanical Art and Science, especially by establishing communication between amateur workmen.

2.—That any gentleman interested in Mechanical or Scientific pursuits be eligible for election. For this purpose the Candidate must be proposed by one member *on his own personal knowledge*, and seconded by another, the proposer being held responsible for the eligibility of the Candidate. The election of members (by Ballot) is vested solely in the Council—one black ball to exclude.

3.—That any Civil Engineer, or other person of known mechanical or scientific ability, be eligible for election as an Honorary Member, without the power of voting.

4.—That a copy of the Bye-Laws be given to each member on his election, and that by its acceptance he be considered as signifying his assent to them.

5.—That the Subscription, at present, be One Guinea per annum, payable in advance on the 1st January in each year. Members elected on or after 1st October in any year, not to be liable for that year. Any member more than twelve months in arrear, to be considered as having dissolved his connection with the Society.

6.—That the entire management of the affairs of the Society be entrusted to a Council composed of Seven lay members, in addition to the Honorary Officers of the Society. Two members of the Council to retire on the 1st January in each year, and not to be eligible for re-election until after the expiration of twelve months from the date of their retirement.

7.—That the council shall meet at such times and places as shall be determined by the chairman. The summons for each meeting, containing a note of the principal business to be transacted, together with a list of the names and addresses of the Candidates to be balloted for, to be sent to each member of the Council one clear week before the meeting.

8.—That all the Honorary Officers of the Society retire on the 1st of January in each year, but be eligible for re-election immediately.

9.—That a Ballot for the Officers of the Society, and for two members to supply the places of those retiring from the Council, shall take place annually in January, for which purpose balloting papers shall be sent to each member, containing the names of those nominated by the Council, with space for any alterations or additions that the voters may think requisite, such papers to be completed and returned by post to the Secretary.

10.—That the Council shall have the power of filling up any vacancy occurring after the annual election.

11.—In the event of a candidate being black-balled, it shall be competent for any two of the Council, or five lay members, to call for a re-consideration of the grounds of rejection, which shall take place at the next meeting of the Council, and shall be final.

12.—That the meetings of the Society consist of an Annual Dinner and other gatherings, at such times and places as shall from time to time appear expedient to the Council.

13.—That for all practical purposes the Annual Dinner shall be considered to be the Annual General Meeting of the Society, but a special general meeting may be convened at any time by the Council, or on a requisition signed by not less than twelve members.

14.—That a list of the names and addresses of the members be printed as occasion may require.

A day was fixed for the visit of the Society to the Ordnance Factory at Enfield. There were no Candidates for the election.

T. W. Boord.

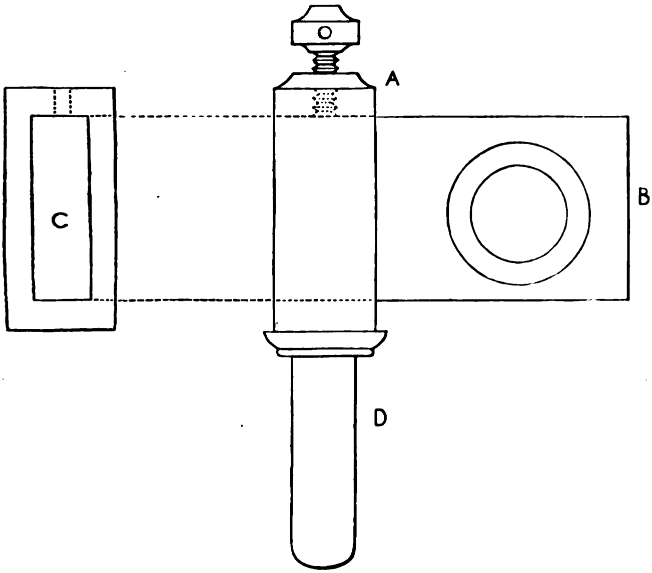
"DE QUIBUSDAM REBUS."

THE Queries addressed in the last Number to members and non-members, as to the possibility of turning spheres by means of templates, has been answered by both, and for these answers I am grateful, both being, so far as they go, satisfactory. A difficulty evidently exists; but it appears to me that this relates to the mode of holding the work, and not to the special contrivance used for shaping it,—a difficulty equally evident in the use of the Spherical Rest. As yet, I have no reply to my question as to the other curious Slide Rest which I took from Heberts' "Cyclopædia," so I may conclude that none of our readers have seen one of this form. The *principle*, however, is, I think, by no means undeserving of study and further development. I notice that in the present Number objection is made to mounting apparatus for planing, grinding, fret-work, and such like, on the bed of the

Lathe. I quite agree with those remarks; and the more experience one has of the drawbacks to such wholesale adaptation of the Lathe proper, the more fully will they be acknowledged. The best Lathe-room I ever saw, was, I think, that of an amateur, who, if now alive, would have been a great acquisition to our Society. I refer to the late Rev. Thos. Meyler of Marlborough, my own worthy schoolmaster, and a turner and mechanic of great skill, to whom one of our members, I know, would acknowledge his indebtedness as well as myself. I well remember that room, with the excellent Lathe of the owner, fitted with Rose engine, and most of the ornamental apparatus then known. There was a second Lathe, made by himself for the use of a pupil, of which, I remember, there was a peculiarity in the connection (I can't call it *link*) between the crank and treddle, which, I regret, I cannot now exactly "get right" in my mind. The axle of the *best* Lathe ran on friction wheels. There were in addition two separate stands, one for grinding, with an oilstone revolving horizontally, fitted with a guide for angular adjustment; the other for circular saws, each distinct and complete, with its own special apparatus;—a cabinet of screwing gear, with a table suspended above of the various pitches for bolts of given size; a separate cabinet of chucks and Lathe apparatus; tool racks, stores of wood and ivory, and various other matters, all well arranged, in good working order, and of the best construction. Below, in another part of the premises, was a forge and its appliances; and in a cellar, flasks and sand for casting. I believe the owner could use his tools as well as his cane,—the skill with which the latter was handled, my own hands and shoulders have often been made to testify. I only regret that, as a man, I never knew the wielder; but only as a boy, whose dread of "the master" prevented such conversation on matters mechanical as I should have subsequently valued most highly. I feel even now, that the possession of that well-lighted large workshop, erected for the special purpose, would render me superlatively happy. It appeared to contain everything, from an electrical cylinder to a patent corkscrew. Alas! it is now a thing of the past, as all our mortal workshops are destined to be, yet we and they ought to leave an influence for good. If I were to allow myself one sigh more, by way of epitaph on the departed, I should have to claim for him the merits of a worthy man, a good scholar, a first-rate Turner, Mechanic, Archer, and Angler; may I be no less, and no worse.

Apropos of the exhibition, at the contents and object of which our worthy secretary has glanced in his paper, I fear amateurs will be disappointed in the apparent absence of Lathes, and mechanical appliances connected therewith. I suppose, however, that machinery of this class will take its turn with the rest, and that any of us who may be alive on such happy occasions will then be able to feast our eyes unrestrainedly. How many things there are in the mechanical world to which we are strangers! We know something I think about planing, turning, slotting, grooving, and such like, and may know how to erect miniature pagodas, or to design, turn, and decorate more useful and more graceful articles; but from the joint of a pair of pliers to the little brass clips for papers, made of three pieces, and sold at 1s. per gross, we are generally less informed; and as to Dutch dolls at a farthing, jointed and painted, what speed, ingenious adaptation of resources, and division of labour, must be manifested in their production. Has no member visited the Swiss valleys, from which emanate our exquisite watches, automatic birds, and jewelled toys fit for fairyland; or the shops in which the sturdy Dutchmen cut and carve to patterns which were not new to our grandfathers; or the villages in that now military Germany, in which sundry and divers boxes of soldiers, and, wondrous clocks and organs, and et ceteras, are yearly produced? Surely, for works of this class, made and sold at so cheap a rate, there must be used appliances, and methods new to most of us, and well worthy of being made known by papers in our Journal.

A very useful and easily adjustable support for slender turning, or for use as a coneplate or boring collar, was sent me the other day by Hines of Norwich, which may, I think, be serviceable to some of our readers;—I have therefore given a reduced drawing of the same. A D is a casting of iron, or other metal, turned to fit an ordinary rest socket at D; the flat side of the upper part is shown at C with the slot in which slides the plate B, which may be of wood or metal, wood answering very well for most purposes. This is bored with a conical hole, on the line of centres, and when in position, is clamped by the capstan-headed screw on the top. If the slide is of wood, it will be necessary to have a small metal plate to take the pressure of the screw point, which would otherwise indent and injure the slide. This is certainly an arrangement which can be cheaply constructed, and is as good a pattern, probably, as can be made. The possibility of using wood slides enables one to make the actual support for any particular work with great ease, to bore to fit any special object, and generally to arrange matters easily and satisfactorily. These boring collars should be adjusted by withdrawing the back centre, so as to allow the coneplate to be slipped over the work, and then replacing it as before; and when the article passing



through the plate is found to run smoothly and evenly, the screws of the boring plate are to be tightened, and the back poppit removed. The rest can be brought quite close to the apparatus shown here, which is a great advantage in hollowing out work. It will generally be found worth while to bore tool handles with a coneplate, instead of effecting this in the usual uncertain way with a gimlet, and (which is not at all a good plan), burning out the hole to shape, by heating the tang of the tool that is to be fitted into it. If the hole is bored in the Lathe with a nose bit, centrally and truly, the tang may be fitted into it accurately by a few strokes of a narrow chisel, or drift, or small file, and a tool so fitted will have its axis in a line with that of the handle, and will work satisfactorily, without getting loose and falling out perpetually, as it is sure to do if the tang has been fitted by heating it. Where such heating and burning is practised at all, it should be done by a large nail or other article of convenient size, never with the tool itself, the temper of which is sure to be injured.

LETTER FROM THE EDITOR TO THE MEMBERS.

GENTLEMEN,—It is with much regret that I feel obliged to vacate the Editorial chair, unanimously, I believe, conferred upon me at the commencement of the Publication of the Journal. The post of Editor is at once an honourable and an anxious one; it has its pleasures and its drawbacks, among the latter of which are the circumstances which compel me to resign, after the issue of the present Number. *I find it impossible to obtain that support so necessary to the very existence of the Journal.* It is now the 16th of June, the number is due July 1st; but although in my last I spoke strongly upon this subject, and hoped long ere this to have plenty of MS. for at least one number, I have not sufficient for *half* of it, and shall have again to supplement these by papers from kind friends outside the pale of the Society, and by extracts from other sources. Much of this, therefore, will again fall upon myself, and my time is too much engaged to allow of this extra work, which confessedly ought not to be asked from the Editor. I can only hope that my successor will meet with better support, or the Journal will inevitably fail.—Yours faithfully,

J. LUKIN.

LETTERS TO THE EDITOR.

SIR,—I beg to call attention to the mode of spelling the technical term indicating circles not concentric with each other. This term, I think, should be written *ex-centric*, meaning *out of the centre*, not *eccentric*, or odd or irregular.

There is nothing eccentric or odd in a circle, it being the most perfect form in nature. But groups of circles, judiciously arranged ex-centrically, form very agreeable combinations, and produce many beautiful patterns for ornamental turning. They may also be arranged eccentrically or irregularly, so that the effect produced might not inaptly be termed eccentric or grotesque; but only an eccentric turner would do so.

As we do not affect to be either literary or classical, but would rather hope to rank among scientific societies, I think we had better follow the custom of scientific men, who usually write the term as a compound word, and style our art "Ex-centric Circular Turning;" repudiating the idea of turning being eccentric, although some of its votaries may occasionally be deemed so.

When I mean a definite point, such as the centre of a circle or other curve, or the centre of motion, or of the mandrel, &c., I write *center;* using the word *centre* indefinitely when writing of the centre of the universe, the centre of a room or of a crowd, and the like; but I should not object if the printer preferred (er) center in all cases as an English word with an English termination.

I also protest against the absurdity of calling the Ellipse-Cutter an "Elliptical Cutting Frame;" the *frame* is not elliptical! The "Eccentric Cutting Frame" also would be better called an Ex-centric Cutter. HENRY PERIGAL.

9 NORTH CRESCENT, BEDFORD SQUARE,
8th June 1871.

17th May 1871.

DEAR SIR,—You have not yet fathomed the mystery of ball-turning by template. The diagram of your arrangement for that purpose, given on page 58 of your *Quarterly Journal*, would turn a ball with points resembling the annexed Fig. 1; and, when your cutter had arrived at those points, the work would fall from the centres.

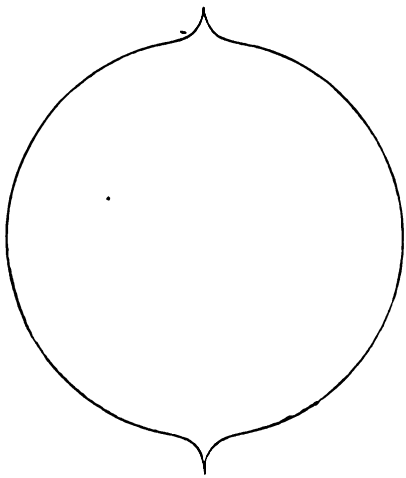


Fig. 1.

To turn a true sphere, your template must be shaped as in Fig. 2, to allow the tool to proceed at least half a diameter of the stop past the centre of the ball; and how could you chuck your work to accomplish this?

I believe the nearest approach to turning an accurate sphere is made by supporting your work on the mandrel alone, and mounting

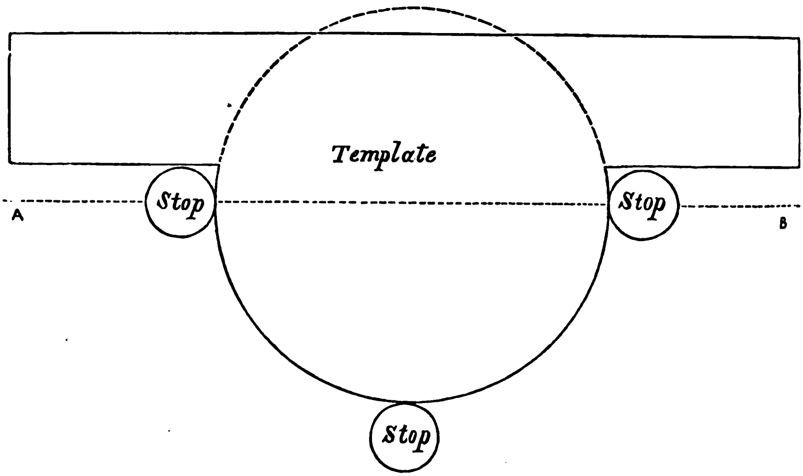


Fig. 2.

your cutting tool similarly to old Bergeron's plan, described on page 143 of "The Lathe and its Uses."—Yours truly,

SAM. CARTWRIGHT.

REVIEW.

A COPY of "A Few Notes and Queries about Newcomen," who made the first steam-engine, has been put into our hands for review. It is a small pamphlet or tract, with one or two nice engravings, by Thomas Lidstone, Architect of Dartmouth, in which town this great inventor carried on his labours. The object of the writer is to give and obtain all the information possible about Newcomen and his family, and to stir up the nation to raise a statue or memorial of the great man in his native town. The interest that has so long centred in Watt, the great *improver* of the steam-engine, has certainly not hitherto been shown, as it ought to have been, towards the subject of this interesting little treatise. We commend this little pamphlet, therefore, to the attention of our readers, hoping that some of them may be able to answer the Notes and Queries of the writer, and thus help him to a more complete biography of this great and worthy man.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

OCTOBER, 1871.

HON. SECRETARY'S REPORT.

SINCE my last report our Society may be said to have been almost dormant, the members having apparently, during the last three months, devoted themselves more to travelling, shooting, and yachting, than to mechanical and scientific pursuits. There has, therefore, been but one meeting of the Council, the minutes of which are appended. Since the foundation of the Society, in 1869, we have only lost one member by resignation,

Major ROBERT POORE,

who resigned on the 3rd January last. Notice of the fact should have appeared in my report for April, but it was accidentally omitted, and is now only brought to remembrance by the loss of another member, one of the founders of the Society, in the person of

EDWARD J. BOOTH, Esq.,

who died at his residence on the 1st inst., and will, I feel sure, be deeply regretted by all who had the pleasure of his acquaintance. Mr. Booth spent some years of his life in India, and it was there chiefly that he developed his abilities as an amateur mechanic. On his return to this country, some years since, one of his first cares was to provide himself with a complete workshop; how complete it was all who have seen it know, and not a few will be ready to testify to its owner's skill and unvarying courtesy in not only smoothing the tyro's rugged path with sound advice, but even allowing him the use of his machinery, a trait in his character which, I think, will be regarded as an excess of good nature. As such workshops are not to be met with every day it may not be inopportune to glance at the contents of the one in question. The *pièce de resistance* was a 6-inch Rose-engine Lathe by Bower, made originally for the late Lord Harborough at a cost of about £1500. When this lathe came into its late owner's possession it had not only almost every contrivance which an amateur could possibly desire but a great deal besides, and Mr. Booth afterwards added to it all the more modern appliances. There were two geometric chucks, one with a flange movement, by Holtzapffel, and the other with the more convenient right-line movement, by Cooke, the latter of unusually massive construction and capable of being used as a "first part" to the former. It had also a medallion-copying contrivance, of rather limited capability, in comparison with those which have more recently appeared, and a more than ample assortment of all the usual and unusual ornamental and other chucks and cutters. There were besides an excellent 5-inch screw-cutting lathe by Ledger, with overhead motion and slide-rest (of which latter both the main and cross-slides were self-acting), a planing machine with a 2 ft. 6 in. stroke, a forge, drilling machine, carpenter's bench, very complete cabinet of screwing tackle, small tools of all sorts and sizes in profusion, and a large Leroy gas engine to supply power. I understand that the whole of this really splendid collection of tools has been left to a nephew of Mr. Booth's, at present resident in India.

Members will be aware, from the letter which appeared in the last number, that Mr. Lukin has resigned the Editorship, and a glance at the wrapper of this number will inform them that I hold the office, temporarily; for, however pleasant it may be to be constantly in the midst of one's hobbies, I regret that my other engagements will not admit of my devoting that time, care, and attention, which is indispensable to the success of our Journal. My interest in the Society induced me to undertake the office for the present rather than allow the publication of the Journal to be suspended, and I can only say that, with the co-operation of the members, I will do my best to perform the duties efficiently so long as I hold it; though I do not reckon the pen among those tools which adapt themselves most readily to my hand. I may, perhaps, here be permitted to observe that an editor's troubles can be lightened by at least one half if contributors will only be prompt in their response to his appeal, and send their articles and drawings in a condition fit for the printer and engraver. The latter, for example, sometimes require reducing; to do this oneself costs time, and if left to the engraver, money, which with the limited means at present at our disposal is an important consideration.

No arrangements have yet been made for the next Conversazione, but I anticipate that it will take place about the third week in November, the same time as last year. So soon as the exact date is fixed due notice will be given. I merely mention this now in order that members may not forget to prepare specimens of their work for exhibition.

The Council and Journal Committee.

A meeting of the Council took place on the 2nd September—three members present—when the following gentlemen were duly elected members of the Society:—

Sir Charles Watkin Shakerley, Bart.
Frederick John Smith, Esq.
The Rev. Thomas Clarke Brettingham, B.A.

A meeting of the Journal Committee was held after the business of the Council was concluded—four members present—to consider the course that should be taken in consequence of Mr. Lukin's resignation. No one having been proposed to fill the vacancy, the Hon. Secretary undertook to perform the duties of Editor temporarily. MSS. for the October number were examined.

T. W. Boord.

CHUCKS, CEMENT, SCREWS, &c.

MANY of the following remarks may appear to experienced turners trivial and almost needless, but as among the members of the Amateur Mechanical Society there must be some who, though taking a general interest in such matters, have had little or no practical experience in turning, and as we hope that many may join our ranks who have not yet held a turning tool in their hands, but who may feel some desire to follow a pursuit that is certainly a very fascinating one, I trust that what follows may be considered solely as intended to afford a few hints to beginners who may not have had an opportunity of obtaining that which is better than anything they can read, some practical lessons from an experienced workman. Many books on turning have been published, and in all or most of these descriptions are given of the various kinds of chucks used with the lathe, but so far as I see, these books do not give sufficient instructions for mounting rough and irregularly shaped pieces of material; and many a young hand, who is ready enough to begin upon a piece of wood or ivory that has been previously shaped and prepared for him, is perhaps disheartened when he has to cut his material from the log or tusk, and finds it full of projecting lumps and corners which do not readily allow of its being fixed in any of his chucks. It is for such that I have noted down a few remarks, which I hope may prove useful.

I think most turners will admit that, among all the contrivances for holding work in the lathe, nothing excels the American "scroll-chuck," two or three of which, of different sizes, should form part of the equipment of every lathe. If the material to be operated upon is anything approaching a circular form, it may be held in one of these chucks with sufficient firmness without further preparation, but it will generally be found a safer plan, after placing it in the chuck, to support the right-hand end of the work with the back-centre, to receive the point of which a small hole should be formed with a point-tool in the centre of the work as it revolves on the lathe. The end may then be turned off square to within a short distance of the centre, and a portion of the length—say an inch—from the end towards the right turned true and cylindrical. The work may now be reversed, the portion already turned true being placed in the chuck, the jaws of which, when tightened, will act with a more even pressure than they could when an irregular surface was presented to them.

In the above case, the wood or other substance to be turned is supposed to have been sawn from the log quite or nearly at right angles to the length of the piece. If, however, as often occurs, the saw-cut has been made at a considerable deviation from the right angle, it may be difficult or impossible to use the scroll-chuck for holding the work at first. In this case, the common "prong-chuck" (Fig. 1) is very useful. Its centre point, *a*, enters a hole previously drilled in the end of the wood, while a saw-kerf across the face, in line with the central hole, receives the knife edges, *b c*. Let *d e f g* (Fig. 2) represent the piece of wood to be chucked. It is evident that if the face, *d f*, be presented to the chuck in the position here shown, the lower corner of the knife-edge will be caught by the projecting slope of the wood before the upper corner can touch the receding portion. If, however, the chuck be turned round about a quarter of a circle, a position will be easily found in which the knife-edge will touch the wood equally on both sides of the central hole, and it is in this line that

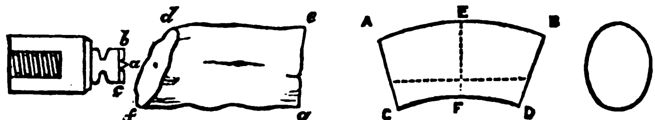


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

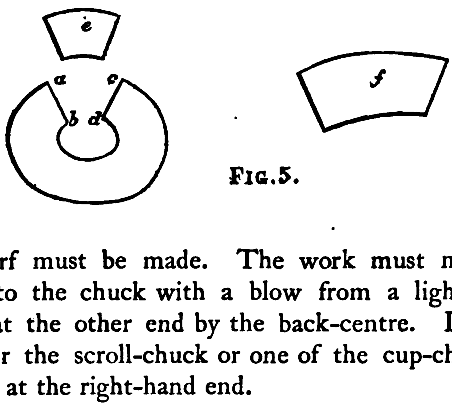


FIG. 5.

the saw-kerf must be made. The work must now be driven tightly on to the chuck with a blow from a light mallet, and supported at the other end by the back-centre. It can then be prepared for the scroll-chuck or one of the cup-chucks by being turned true at the right-hand end.

Somewhat more difficult to prepare for the lathe is a rough piece of ivory sawn from the tusk or *tooth*, as it is called in the trade. Owing to the natural formation of the elephant's tusk, which is usually considerably curved in its length, and is of more or less elliptical section, a piece taken out of any portion of its length, if the saw-cuts have been made, as they should be, at right angles to the curve of the tooth, will have its ends far from parallel and its section not sufficiently circular to be grasped conveniently by the three jaws of the scroll-chuck. Let A B C D (Fig. 3) represent such a piece, measuring in a straight line from A to B 4 inches, from C to D 3½ inches, and from E to F, being the greatest diameter in the centre of the piece, 2 inches. Fig. 4 is a section on the line E F. Let it be required to form the largest possible cylinder from such a piece. It is evident that, if a hole be drilled midway between A and C, and another at the opposite end of the piece, midway between B and D, an imaginary line, connecting these holes, will not pass through the centre of the piece, and consequently, if the piece were so chucked as to place these two points in the axis of rotation, there would be a waste of material, and the resulting cylinder would be smaller than necessary. The holes should therefore be placed higher up on the lines A C and B D, at such points as will cause the imaginary line to pass through the centre of E F. The ivory may now be mounted on the prong-chuck, as described above, or it may be placed in a vice and rasped or filed at the left-hand end until its elliptical section approaches a circular one, taking care to remove more of the material from the lower than from the upper side, so as to keep the hole as nearly as possible in the centre. Then a wooden chuck may be hollowed out to receive the prepared end of the ivory, the other end being supported by the back-centre while the work is being adapted for the scroll- or cup-chuck. If one end of the ivory be at right angles to the length of the piece, or if the piece be a thin disc or slice, or even a slab of an inch or two in thickness, the "cement-chuck" will be found very convenient for holding it until the circumference and outer face are turned true. A cement-chuck may be made from any old, nearly worn-out chuck of box or other wood, turned flat on the face, and smeared over with turner's cement, for making which there are several recipes to be found in books on turning. Most of the cements, however, sold for this purpose are, in my opinion, too hard and brittle, so that the work attached by their means to the chuck is too easily knocked off by any sudden jar. I have found a mixture of pitch, marine glue, and gutta percha, in nearly equal proportions, form a very strong and tenacious cement. These may be melted together in a pipkin, poured out upon an oiled slab of marble or iron, and when sufficiently cool rolled with the fingers (also oiled to prevent the cement from adhering to them) into sticks for use. It is best to remove the central portion of the face of the wooden chuck, leaving only a flat ring of from half an inch to an inch in breadth, according to the size of the chuck, to receive the cement, a stick of which can be heated over a spirit lamp, and smeared upon the face of the chuck till the latter is well covered. If the spirit lamp is then placed on the lathe below the face of the chuck, while the latter is made to revolve slowly, the cement will be evenly warmed all over, and rendered sufficiently soft to receive one face of the ivory, which should be pressed firmly against it, and if found to run much out of truth, may be moved into a better position before the cement has had time to harden. In a few minutes it will be sufficiently hard and firm to resist almost any jar which it is likely to receive while the ivory is being turned true, though it is always safer to use the support of the back-centre if possible. A smart blow with the mallet will generally remove the work from the chuck, though I have sometimes found this cement hold the ivory so firmly that it has been necessary to drive a chisel between the chuck and the work to remove the latter. If a portion of the hollow part of the tooth should require to be mounted on the cement-chuck, and its length be such as to render the support of the back-centre desirable, a piece of any soft wood may be roughly rasped into shape and driven firmly into the hollow of the ivory. The back-centre point when forced up by its screw will find its own position in the wood, and give support to the work.

If the ivory has been cut from a portion only of the circumference of such a hollow part of the tooth, as in Fig. 5, which represents the end of the portion of the tooth from which the piece E has been removed by the saw-cuts, *a b* and *c d* (*f* being a side view of *e*), the ends of the piece will present a figure roughly approaching a rectangle. A convenient chuck for holding such pieces is supplied in sets of various sizes by Holtzapffel and other makers. It is called the "square-hole chuck," and consists of a strong cup-chuck filled with gun-metal, having a square opening, as large as the chuck will admit, tapering inwards to the back of the chuck, so that, by selecting a chuck of proper size, any material of nearly square section at the end will be caught in some part of the taper square hole, while the other end of the piece is supported by the back-centre. A few strokes of a rasp will readily make one end of a piece like the above fit such a chuck. If the ivory does not exceed an inch or so in diameter it may be mounted, holes having been previously drilled at each end, between the points of a "driver-chuck" and of the back-centre. Some form of this chuck is usually supplied with every lathe.

In articles such as vases, temples, pagodas, boxes, &c., the parts of which are usually screwed together, the various portions frequently require to be chucked by their screws for finishing or ornamenting. In order to save time and material, it is as well, when possible, to let the material which is to form one portion of the finished article serve as a chuck for that which is to be attached to it. If the portion which is to be formed into a screw be very short it is much more difficult to cut the screw upon it than if there were a greater length of material to operate on. Sometimes in small and delicate pieces the form makes it necessary that the screws should be very short, leaving perhaps room for only two or three very fine threads. In such cases it is best to sacrifice a small quantity of material, and make the screw at first two or three times as long as it is required to be, afterwards cutting off whatever may be necessary to reduce it to the requisite length. This applies both to the male and female screw. It is much easier to cut a screw, even with the traversing mandrel, when the work revolves at a moderate rate than when the motion is very rapid; therefore, especially in making short screws, the lathe-band should be shifted, before commencing, to a smaller groove on the large wheel, and a larger one on the mandrel pulley than it occupied while shaping the material, thus causing the mandrel to make fewer revolutions for each turn of the wheel. Although, in using so expensive a substance as ivory, it is desirable to waste as little as possible, yet, when small pieces of it, having a fine screw upon them, require to be chucked by their screws, it will be found more economical to make the chuck itself, at least that part of it which receives the screw, of ivory embedded in a wooden chuck, than to risk spoiling the work by the use of a less hard material which might give way under the pressure of the tool.

G. C. C.

GEOMETRIC, EXCENTRIC, AND ENGINE TURNING, WITH BACK-GEARED APPARATUS AND THE CONTINUOUS MOTION OF THE LATHE.

IN the appendix to *The Lathe and its Uses* I illustrated and described a method of rose-engine turning by the addition of an extra mandrel to the lathe, and in the preface to my description I stated that I originally placed the extra mandrel by the side of the principal mandrel, but afterwards found it best to place it over instead of by the side. Some correspondents are anxious to know how I contrived to do engine-turning with the extra mandrel by the side of the principal mandrel, or in other words, with a back-geared apparatus. To answer these inquiries, and for general information, I will describe how I have one of my head-stocks fitted up in this way at the present time, and will give specimens of the work done with it.

I have two methods of using the apparatus; one, by driving the excentric cutter with connecting and change wheels, and the continuous motion of the lathe, thereby producing geometric and excentric patterns; the other, by substituting instead of the excentric cutter, a cutting tool sliding in a holder (Fig. 5), fixed in the slide-rest. The slide with the tool is attached to an excentric chuck on the projecting part of the back spindle, which by a lever, adjusted proportionately to the throw of the chuck, causes the tool to slide backwards and forwards, as the mandrel with the work goes round, producing a great variety of engine-turned patterns. Mr. Northcott's lathe for irregular turning is of this kind, but his *slide-rest* works backwards and forwards, whereas my *tool* only does so. Instead of the excentric chuck, a chuck to receive templates can be substituted. I have given a full description and drawings in my article on *Rose-Engine Turning* in the appendix to *The Lathe and its Uses*, showing how patterns are thus produced, and with the back-geared apparatus they are formed in a similar manner.

The head-stock (Fig. 1), with its appendages for this description of turning, is drawn to $1\frac{1}{2}$-inch scale. It is a strong 7-inch centre lathe, with traversing mandrel for screw cutting, and other apparatus for ornamental turning, but only so much is given as is necessary for the purpose of describing this particular style of turning, so that the drawing may not be confused. On the edge of the division plate in front of the mandrel pulley (Fig. 2) is a cog-wheel, which gears with the change wheels on the back-spindle; and the cog-wheel, A, on the outside projection drives,

FIG. 1.

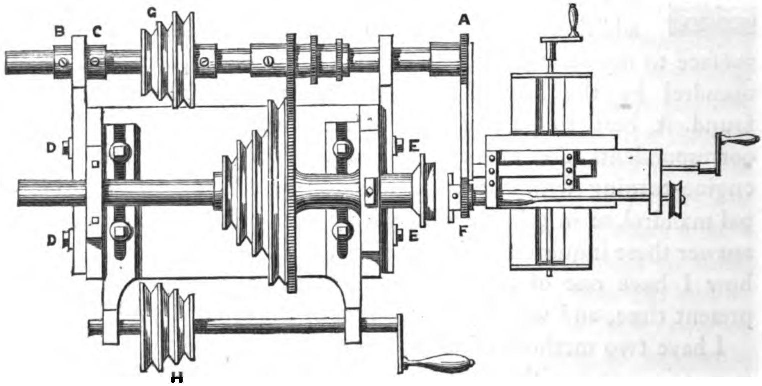


FIG. 2.

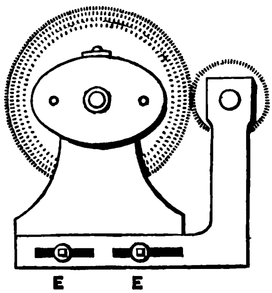


FIG. 3.

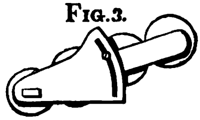


FIG. 4.

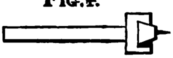
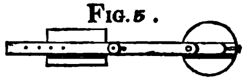


FIG. 5.



with the assistance of a train of wheels, the excentric cutter, which has also a cog-wheel, F, attached to it for the purpose. The excentric cutter is screwed into the drilling frame attached to and by the side of the tool-holder of the slide-rest. The stem carrying the frame with the train of wheels (Fig. 3) is held in the tool-slide of the slide-rest, and, with the assistance of the quadrant, adjusted to the required height to gear with the other wheel, A. The back spindle is turned the same size in diameter the whole length to enable it to slide in its bearings. The front projecting wheel, A, is brought opposite the excentric cutter in the slide-rest, and then the adjusting collars, B and C, are used to fix it in the necessary position. In like manner the change wheel on the back spindle intended to be used is brought opposite the mandrel wheel, and the adjusting screws, D D, E E, are loosened so that the wheels may be brought into gear when the four screws are tightened again. The apparatus is either worked with the overhead motion driving the excentric cutter, by the hand motion connecting the two pulleys, G and H, or with the slow motion of the lathe wheel, according to circumstances.

The specimen, Fig. 1, was executed with the excentric cutter, and Fig. 2 with the tool sliding in the tool-holder. It was my

FIG 1.

FIG. 2.

intention to give one or two more elaborate patterns, but ill health prevents my doing so at present.

ELIAS TAYLOR.

MOTIVE POWER FOR AMATEURS.

AN amateur having only a light ornamental lathe, and confining himself to the production of delicate work, can obtain all the power he requires for driving his lathe and instruments by the treadle and crank, and without much exertion, as the force necessary for such work is but slight.

Unless, therefore, he be of a rather lazy disposition, he will scarcely wish for any external motive power. But for heavier work, ornamental or otherwise, for performing which the cutters have to be driven at a high velocity against a fair sized cut, for metal turning, wheel cutting, planing, and other operations absorbing more force, treadle-driving is not such a lazy amusement; and an amateur devoted to these classes of work may, I think, be pardoned if his enthusiasm becomes somewhat damped under the combined influence of a heavy cut and warm weather. Under such circumstances it often becomes a matter for consideration what kind of engine can be most advantageously and conveniently used to obtain the necessary motion, and to render the work less fatiguing. It may, therefore, be of some use to state the chief requirements of the case and the conditions under which the power has generally to be applied.

Firstly, as to the force required. It may be assumed that in ordinary treading, the amateur will probably exert a force equal to raising from 2000 to 3000 pounds one foot high in the minute, or, say from one tenth to one sixteenth of a horse-power, a horse-power being taken as equivalent to 33,000 pounds raised one foot high per minute. This estimate of 2000 to 3000 foot-pounds as the power exerted in treading, is probably a fair one for ordinary, moderately heavy work, but for very light work it is certainly excessive, and for very heavy cuts it may be somewhat low. In few cases, however, need an amateur's motive-power engine develop more force than, say 16,000 foot-pounds per minute, or half a horse-power, although in every case it is advisable to have an engine powerful enough to overcome the greatest resistance that legitimate lathe-work ever opposes to it. The power necessary for driving a lathe where moderately light work only is performed being estimated at from one tenth of a horse-power to one sixteenth, an engine capable of exerting one eighth of a horse-power is the lightest that ought to be provided. For light metal turning and such work the average power requisite may be taken at one tenth of a horse-power, but the engine should be capable of exerting at least one fourth of a horse-power; and when, in addition to a lathe, a planing machine, second lathe, or grindstone has to be driven at the same time, the engine should be capable of developing one half of a horse-power. It is desirable that the engine should be capable of adapting itself to sudden variations in the resistance opposed to it; but this quality is not an essential one, as, for most kinds of light work, the power requisite to drive the lathe mechanism forms a large proportion of the total power required.

Secondly, as to speed. In ordinary treading, an amateur drives his lathe fly-wheel from 50 to 100 revolutions per minute, and frequently would drive it much faster if his leg were capable of such rapidity of motion, which it is not. Of course, if the motor is capable of exerting sufficient power, it may run very slow or very fast, and its speed can be increased or diminished by suitable means, but there are several reasons why it is advisable that the engine should run faster instead of slower than the lathe wheel; the principal of which are, that the faster an engine runs the smaller it need be to develop any given power (a slow-running engine of any kind being generally heavy and clumsy), and the faster an engine runs the less is it affected by slight variations of resistance. Of two engines, therefore, in other respects equally good, the one running the faster is to be preferred.

Thirdly. As the amateur cannot usually spare much time for his pursuits, he can ill afford to lose time in getting ready and attending to his motive power. It is therefore essential that the engine should be easily and readily set in motion, and as easily and readily stopped when no longer wanted. It must be capable of running some time without requiring much attention, and a little want of attention should have no graver result than a stoppage of its working.

Fourthly. It must be as little dangerous as possible. It should occupy little space, be of small weight, and not unsightly. It must not be noisy in running, nor must it cause any unpleasant smell. First cost is not a very great object, nor is cost of working, but the latter is of the more importance. Simplicity is, of course, a desideratum, but a little complexity need not be a great fault.

These being the chief requirements, it remains to be seen how they are fulfilled by the various motive-power machines we have at our disposal, and which may be classed as follows:

The windmill, by which the pressure of the wind is utilised.

The turbine and the hydraulic engine, using the pressure of falling water.

The steam engine, worked by the expansive force of heated water, &c.

The gas engine, deriving its power from the expansion of highly heated gases.

The air engine is much too bulky, and need not be considered.

The magnetic engine is too much of a toy, far too costly in working, and, notwithstanding the wonderful accounts lately current here of an American motor of this sort, will, I fear, scarcely answer our purpose, although in some respects it would be very well adapted to it.

The solar engine of Ericsson, which in all probability has a future, is as yet a philosophical instrument only, and far too dignified to drive an amateur's lathe. Falling weights and coiled springs of any reasonable size are not sufficiently powerful, and although various other agencies could be enumerated, the choice practically lies amongst those first mentioned. Each of these is more or less adapted to the purpose, but the machine best suited to one case is not so to all. In another paper I shall show the circumstances under which each can be most advantageously adopted by the amateur.

W. H. N.

GOSSIP.

"... bald, unjointed chat ..."

King Henry IV, Pt. I.

A FEW lines will suffice to complete our passing notice of the International Exhibition. Mackie's Steam Type-Composing Machine (which seems rather out of place among the woollen machinery) deserves our first attention as a marvel of ingenuity which has already been practically tested, and, so far as we can learn, not been found wanting. The machine exhibited in the Exhibition of 1862 will be in the recollection of most of our readers. There the depression of a number of keys, arranged similarly to the keys of a piano, caused corresponding types to fall from their boxes on an inclined plane from whence they were conveyed by an endless band to the hands of the person whose duty it was to "justify" or make them up into lines of the requisite length, so that each compositor required a separate machine, an arrangement alike costly and cumbersome. Mr. Mackie's invention consists of two parts; first, the small instrument for perforating the paper riband with which the composer is fed; and second, the composing machine itself. The first of these, occupying about as much space as a sewing machine, may be easily worked by women, or by an author himself, at his own residence if he please. It is provided with sixteen keys, each producing a perforation in the paper, and by the combinations obtainable with these sixteen, not only are all the single letters, capitals, small capitals, figures, and points set, but about six hundred words and parts of words in frequent use. The composing machine itself is quaintly described in Mr. Mackie's circular as having the appearance "of a railway carriage wheel placed horizontally on the top of a sugar loaf four feet high, with twenty-nine sentry boxes round the rim at equal distances." The sentry boxes are the type-pockets, each containing eight different sorts of type, fixed over the edge of a revolving wheel furnished with "pickpockets," which, after being properly set, abstract the required type, each from its particular pocket, while passing beneath it. The machine is fed at one point of the circumference with the paper riband from the perforator, which is made to pass over a drum containing sixteen holes representing the sixteen possible perforations of the paper. As many levers, provided with pegs capable of entering the holes in the drum, rest lightly on the paper as it travels forward, with an intermittent motion, and each time a perforation in the paper coincides with one of the holes, the corresponding peg falls in carrying with it, of course, its own lever, and this slight motion is contrived to set the proper "pickpocket." After being taken from the pocket in the manner described, the type remains on the edge of the wheel until, in the course of its revolution, it encounters a "pusher" by which it is transferred to a travelling band and finally collected on a "rule" ready for being justified. The machine is guaranteed to compose 12,000 per hour, rather more than a *Times* column, say ten hours work for one man; but apart from its speed it has other advantages, among the foremost of which are the following: it will set any sized type with equal rapidity; the perforated paper may be used many times, and, if required, each time for different sized type;

and it is said to wear the type less than any other machine which has yet been tried.

At the time of our last visit to the Exhibition, with a view to the paper under this head in the preceding number of the Journal, the French Annexe was untenanted, a silent but significant commentary on recent events. Now all is changed, their galleries teem with life; bronzes, marbles, silks, and glittering trifles of all descriptions appear to jostle one another in a tasteful medley such as a Frenchman only can devise, and in which the national warlike spirit (the Prussians notwithstanding) peeps out even in the toys. Among the latter there appear to be some clever automata, but, as far as we could see, nothing very new. The scientific instruments exhibited are but few in number—microscopes, telescopes, and the like—and, to our thinking, seem to be rather overdone with deep-coloured lacquer. There is an apparently clever autographic telegraph, the details of which, in the absence of the attendant, we were unable to examine, and it was guarded besides by a placard bearing the words "*Not to touch.*" In the corridor we find a remarkably well constructed set of models of mechanical movements which do great credit to the workman who made them. Our readers will be familiar with most of them as being identical with those published in a collective form in Brown's 507 *Mechanical Movements*,* a compilation, with additions, from Johnson, Willcock, Willis, Goodeve and other writers on mechanics.

Every one must surely at one time or other have been struck by the number and variety, to say nothing of the artistic merit, of the inmates of the Noah's arks sold at our toy shops. After allowing for the advantages of subdivision of labour, and for the most part children's labour, it has always been a wonder to us how so much can be sold for so little. We recollect buying one containing 400 animals, besides the usual long-coated family, for little over a pound. The perseverance of Mr. Cremer, for we understand he met with some difficulty in obtaining the specimens, has, however, at length solved the riddle, and we are now fairly let into the secret. It appears that a ring of wood, from twelve to fifteen inches in diameter, is turned, we suppose with some kind of "profile" tools, and then cut up into radial slices, each slice showing the exact

* London: Trübner & Co.

profile of the animal to be represented, and is afterwards finished by hand, fitted with a tail, &c., and finally painted. The tails and other appendages are in like manner cut out of profile-rings. Specimens of such rings are to be found among the "Appliances for Physical Training, including Toys and Games;" the title of this class might, we think, have been reversed, for Mr. Cremer certainly monopolises two thirds of the whole. We wish he had favoured us with a sight of the tools employed. The process in itself is no novelty; we remember seeing in Holtzapffel's showroom years ago, and doubtless it is there now, a profile-ring in ivory representing the Duke of Wellington, whose prominent features probably procured for him this distinction. The tools for executing such a ring are sold by Messrs. Holtzapffel in sets, and, we need scarcely add, are expensive, so that we should recommend any one having further curiosity in the matter to pause before purchasing a number of tools which he would most likely tire of after once using, and content himself with a slice of the duke. Since writing the above we observe that a correspondent of the *English Mechanic* states that specimens, in all respects similar to those above mentioned, may be seen in the museum in Kew Gardens.

Whilst on the subject of Tommasi's Flux-Motor in our last number we intended to have mentioned Admiral Inglefield's admirable Hydrostatic Steering Engine, (which, according to the laconic description of the Official Catalogue is "to enable one man to steer the largest ship,") as an instance where, on shipboard at least, the ever present power of the ocean is not overlooked. We believe that some of our iron-clads—the Achilles among others—are already provided with such water-power machinery for starting the screw propeller, rotating the turrets, moving heavy guns, &c., and that it has been found thoroughly effective. As most of our large war steamers draw from twenty to thirty feet of water it will be readily understood that there is a constantly available hydrostatic power equal to a column of water of that height. For the purpose of utilising this force the water is admitted to a cylinder of about thirty inches diameter, situated on the keel of the ship, the length of stroke of the piston is about twelve inches, and the speed about twenty revolutions per minute. To the piston-rod is attached the plunger of a force-pump, three inches in-diameter, by which means a pressure of nearly 1000 lbs. on the square inch is obtained, and through the intervention of a hydraulic ram, made serviceable for the purposes before enumerated. The comparatively small quantity of water required is afterwards discharged into the bilge to be pumped out as usual. Widely differing from this invention is that of an American gentleman, a Mr. Hamilton, who is, or lately was, constructing a vessel which he expected to move bodily through the water by a turbine driven on the same principle. *Query*, what is to become of the discharged water in this case?

In the Exhibition of 1851, according to the *Mining Journal*, was to be seen a letter written on a sheet of steel measuring 8 in. by $5\frac{1}{2}$ in., or a surface of 44 square inches, and weighing 69 grains, about one thousandth of an inch in thickness. The appearance of this letter, from Pittsburg, U. S., caused considerable excitement among our iron manufacturers, who were not long in finding that they could produce as thin and thinner sheets than that in question. The last and most successful attempt yet made, (by Messrs. W. Hallam and Co., Swansea,) has for result a sheet measuring 10 in. by $5\frac{1}{2}$ in., or 55 in. surface, and weighing only 20 grains, less than one fourth of the weight, in proportion to its size, of the original and less than ·00025 inch in thickness.

The exhibition has taken up so much of our space in this number and the last, that we have had no opportunity of commenting on the contents of the *Scientific American*. We now turn to its amusing and, at the same time, instructive columns, but are sorry to observe that there is not the usual amount of matter specially interesting to our readers. The following is selected from the American Railway Carriage Builder's Standard Table for Screw Bolts and Nuts; the original is much longer, but the intermediate and larger sizes can be easily calculated.

Diameter of bolt in inches.	Number of threads per inch.
$\frac{1}{4}$	20
$\frac{3}{8}$	6
$\frac{1}{2}$	13
$\frac{5}{8}$	11
$\frac{3}{4}$	10
$\frac{7}{8}$	9
1	8
$1\frac{1}{2}$	6
2	$4\frac{1}{2}$

Distance between parallel sides of finished bolt-heads and nuts to equal $1\frac{1}{2}$ diameters of bolt $+ \frac{1}{16}$ in.

Thickness of bolt-heads and nuts to equal diameter of bolt.

Some time back there appeared a notice in the *Scientific American* of a new magneto-electric engine, invented by a Mr. Paine, by which we learnt that he already had one such engine at work cutting wood, exerting a power equal to that of two horses at a cost of 5*d*. *per diem*, and that, having assigned his patent right to a joint-stock company composed of "gentlemen of wealth," they were engaged in building a 500 horse-power engine to be worked by *four cells* at a daily outlay of 10*d*. for acid and zinc. A correspondent of the same paper, after commenting on a flying machine which had been illustrated in its pages, and which, by-the-by, he claims as his own invention, notwithstanding its having been patented, apparently surreptitiously, by some one else, suggests that, as he was brought to a standstill for want of a suitable motive power for his flying machine, Mr. Paine and he should now coalesce, the former supplying the requisite motor and he the propeller, with a view to their seeking in company a planet more suitable to their advanced ideas. The Mr. Paine above referred to asserts that the force developed by the action of a single Bunsen quart cell, if utilised and converted into power, would drive the largest ship afloat with a velocity only limited by the strength of the ship's frame!

The Americans are deservedly famed for their ingenuity, but we occasionally meet with contrivances which seem to indicate that they are sometimes gifted with a superabundance of that excellent quality. Among their patents for the last six months we find a machine for parting ladies' hair, a ditto for dyeing ditto, an artificial leech (the natural article is disagreeable enough), an "oyster shucker," which, being interpreted, means a machine for opening oysters, and lastly, emanating from that earthly paradise, Salt Lake City, a machine, drawn by two horses, for killing grasshoppers!

In the last number we made some observations on *form* (page 89), in the course of which, as well as on former occasions, we have thought it necessary to protest against the want of artistic feeling and overcrowding of ornament which too frequently mark the work of an amateur. Time, however, works wonders, and as amateurs enlarge their observation and acquire experience, it may be confidently predicted that these defects will gradually disappear. How reasonable our hope in this respect is, a glance at the accompanying drawings will serve to satisfy our readers. It is always so much pleasanter to praise than to blame, that we cannot disguise our pleasure at being able to place before our readers such gratifying results of amateur work. The object represented on this page is a flower vase in ivory by Major-General Yorke, C.B. Its form is

derived from that of an ancient charter horn found at Borris Idrone, Co. Carlow. It is supported by a dolphin and two demon-fish; the carving on the body of the vase illustrates the adage in Izaak Walton:—

> "Hops, turkeys, carp, pike, and beer,
> Came over to England all in a year."

The hops ascend a stem in front, the turkeys are four in number, the fish in duplicate, and beer is represented by barley (beare) and a barrel. The vandyked border contains emblems of antiquity from the remotest times down to the middle ages, including, among others, the Scarabæus of Egypt, the Keys of St. Peter, and the Fleur-de-lis.

The next illustration represents an egg-shell vase by the Rev.

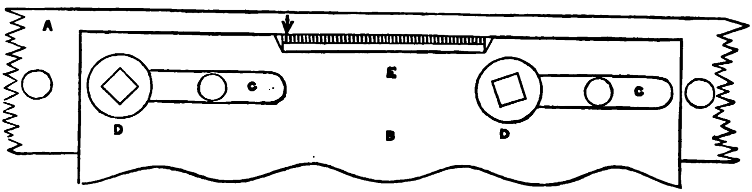
Mr. Holdich, who in the April number gave a very brief description of his method of executing this kind of work, and at the same time asked for any suggestions which might offer themselves on the subject, a request which does not appear to have been yet answered by any one. The material has the advantage of being inexpensive, and, in the hands of a skilful workman, is capable of being turned to good account, as the example in question testifies. We therefore hope that Mr. Holdich will amplify his directions for working in this material for the benefit and instruction of those who have not yet made trial of it.

A NEW USE OF THE CURVILINEAR APPARATUS.

NOT the least useful paper in the last number of the Journal was that of Colonel Clarke, in which the use of the curvilinear apparatus is so well described. I have heard that this was originally devised by an ingenious amateur, who, for some special object, wished to produce quickly a considerable number of articles of exactly the same shape and size. Others have since found it of the greatest use in applying ornamental cutting to curved surfaces, and it is now a very usual adjunct to first-class lathes, though it is to be feared that some who possess it have never used it at all. My present object is to suggest its application to the cutting of spirals, by those who have not a spiral apparatus.

In the following diagram, let A represent the long steel bar which is supported on two standards bolted to the slide-rest; B, a piece of stout sheet brass, the edge of which is filed into equal undulations, the curve of which will depend upon the form which it is desired to give to the thread of the spiral. Instead of a pair of holes, two slots, C C, must be cut in the brass plate, exactly in the same line, parallel with the edge of the plate, and each somewhat longer than two complete undulations. A corresponding length, E, of the edge of the plate must be filed to a feather edge, and graduated as will be shown. The slots must allow longitudinal motion only, there must be no lateral play. Or, if that be found too difficult, the nearer side of each slot must at all events be filed very accurately straight and parallel, and the binding screws, D D, always kept in contact with that side.

Now, I will suppose that a double-threaded spiral is required, having a thread $\frac{3}{4}$ of an inch wide. Cut the edge of the brass plate into undulations measuring exactly $\frac{3}{4}$ of an inch from crest to crest, make slots that will allow a range of rather more than $1\frac{1}{2}$ inch, and file down, say $1\frac{3}{4}$ inch of the straight side of the plate for graduation, as near the centre as may be. Having determined (according to the diameter of the prepared material) how many cuts will be necessary to complete the shape, which we will suppose to be 32, mark off exactly $1\frac{1}{2}$ inch on the feather edge E, and divide into 32 equal parts. Then, having pushed



the brass plate nearly as far as it will go to the left, clamp it down, and engrave an index point on the steel bar opposite to zero of your scale. I say advisedly *nearly* as far, to allow of adjustment if the index point should not happen exactly to correspond.

Having prepared the material of the desired diameter, insert a drilling instrument in the receptacle of the slide-rest, set the index of the dividing-plate (on the mandrel) at zero in a circle which will divide by 32, and make one cut of the length of the intended spiral, as deep as it is safe to go. Shift the index $\frac{1}{32}$ of a circle, unclamp the brass plate, and move it one degree to the right, clamp it down again, and make another cut of the same depth, and so on till the work is cut all round. If the full depth of cut has not been attained, slide the brass plate back to zero and repeat the process, and in due time a double-threaded spiral of the required dimensions ought to be the result. The best drills for this process are the common pointed drill and the half-round. The drilling instrument is the best tool for small spirals, but for those of large diameter the horizontal cutting frame will be found to answer well, with a round-ended or angular cutter. The double-threaded spiral is the form best adapted to this process, but the number of threads may be readily varied by any person conversant with lathe work. Whether a right or a left-handed spiral be obtained will simply depend upon whether the dividing-plate be worked upwards or downwards. I have spoken of this plan as a *substitute* for the usual spiral apparatus with change wheels; but it will be found that twisted forms may be accomplished by the former, which are scarcely possible with the latter. Thus it may be looked upon as an additional means of ornamentation.

While on the subject of templates, I may perhaps be permitted to express my belief (for I have not tried it) that a sphere *can* be turned by such means. Mr. Cartwright has only shown that it cannot be accomplished *with a round-ended tool*, and he, at the same time, assumes that the sphere must be supported on *both* sides. Imagine the work to be firmly chucked so as to dispense with the poppit-head, and a tool of this shape, viz. widest at the extremity and very slightly bevelled, would surely accomplish it, *provided that the width of the tool was exactly that of the rubber.* The side *a* of the tool will finish the right-hand end (if I may so speak) of the sphere, and the side *b* will cut it off quite clean.

VIRION NIGHTON.

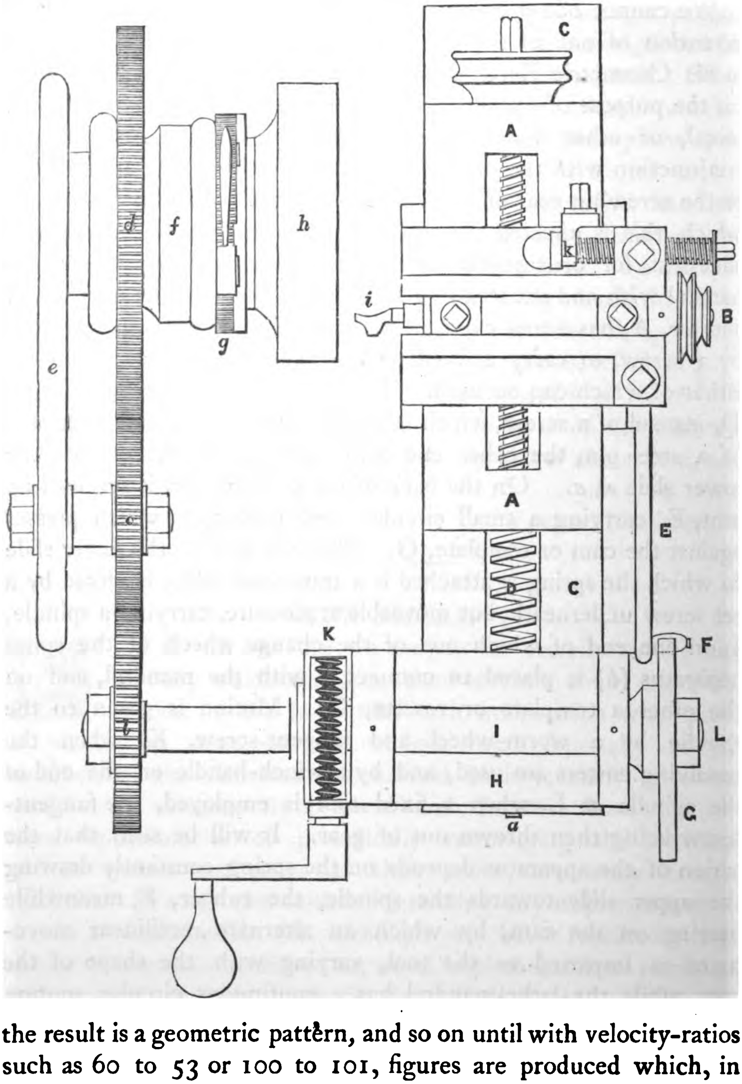
NEW TOOLS.

UNDER this heading we propose to describe briefly any novelty which may from time to time come under our notice, in the hope that such information may prove of service to some of our readers, more especially to the members of the Amateur Mechanical Society, many of whom reside at a distance from town, and therefore have not the same opportunities of periodically rummaging the contents of the various tool-shops as their more fortunately situated brethren. We say this without intending any disparagement of the local Holtzapffels, for, although we have repeatedly purchased very excellent, and, to us, novel implements from provincial tool makers, still, we submit, for so-called *ornamental* apparatus, London stands alone. It is, however, not exclusively with this class of tools that we wish to deal, our taste in respect of work (should we not rather write *play*?) is cosmopolitan, and we shall, therefore, consider all as fish which comes to our net, provided only that we can discover sufficient merit and novelty in each individual tool or machine to enable us to recommend it, and that it be fairly within the scope of an amateur's requirements.

We cannot better commence our labours than by noticing an invention of one of our members, Captain Dawson. We refer to his Geometric Rest, which, as its name implies, is designed for the purpose of executing geometric patterns on ivory, wood, metal, or other material by the use of cams or templates in conjunction with the ordinary spiral apparatus of the ornamental, or the screwing gear of the engineers' lathe. The instrument by which this is effected is similar in construction to an ordinary slide-rest for ornamental turning, except that it has two slides parallel with and situated one above the other. The upper and shorter, A, has a tool carriage of the usual construction, traversed by a screw, to carry a fixed tool, excentric cutter or drill (B), either of which can be used. The lower slide, C, has a spring, D, instead of a screw, which is attached to the top slide by means of a steel pin, the other end being fastened to the end of the lower slide at *a*. On the back of the tool-carriage is screwed an arm, E, carrying a small circular steel rubber, F, which presses against the cam or template, G. On that end of the lower slide to which the spring is attached is a transverse slide, H, fixed by a set screw underneath, but moveable at pleasure, carrying a spindle, I, on one end of which one of the change wheels of the spiral apparatus (*b*) is placed to connect it with the mandrel, and on the other a template or rosette, G. Motion is given to the spindle by a worm-wheel and tangent-screw, K, when the revolving cutters are used, and by a winch-handle on the end of the spindle at L, when a fixed tool is employed, the tangent-screw being then thrown out of gear. It will be seen that the action of the apparatus depends on the spring constantly drawing the upper slide towards the spindle, the rubber, F, meanwhile bearing on the cam, by which an alternate rectilinear movement is imparted to the tool, varying with the shape of the cam, while the lathe-mandrel has a continuous circular motion imparted to it through the change wheels. The cams may be of any shape, regular or irregular, the pattern being dependent on the relative velocities of the mandrel and the spindle; thus, 1 to

1 with, say, a heart-shaped cam, produces an exact counterpart of the cam. With other ratios, though the original shape is lost,

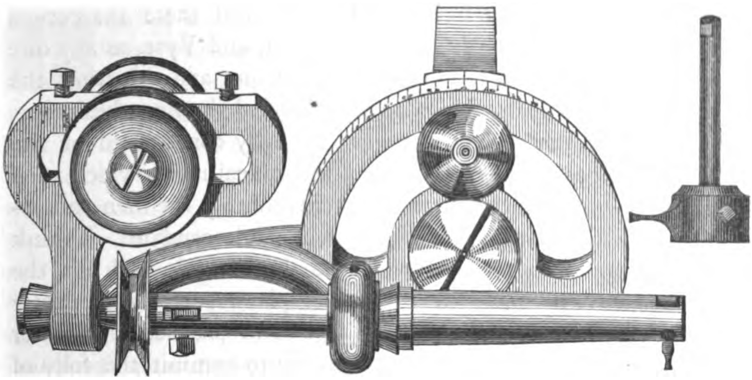
FIG. 1.



the result is a geometric pattern, and so on until with velocity-ratios such as 60 to 53 or 100 to 101, figures are produced which, in intricacy, rival those of the geometric chuck, and, as they can be cut to any reasonable depth with the drill—half an inch, for instance—they are, in our opinion, far more serviceable for ornamental purposes. In order to avoid confusion we have omitted all but necessary details in our illustration. *b*, *c*, *d*, are change wheels, *e* the radial arm, *f* the spiral chuck, *g* its dividing wheel with detent, *h* the work, *i* the cutting tool (in this case a drill), and *k* a collar to avoid the necessity for using the lever in bringing the tool up to its work. The apparatus forms the subject of a patent.

Our next illustration represents a form of universal cutter made by E. F. Baker, the novelty of which consists in the manner of mounting the spindle and guide-pulleys. The square stem, seen at the back of the instrument (Fig. 2), fits into the tool-

Fig. 2.



holder of the slide-rest; to this is attached a frame, of German silver, in the specimen before us, carrying the pulleys and spindle. The former, two only in number, are carried on a small block secured by a set screw in a slot in the frame about 1½ inch in length. This apparently limited power of adjustment, Mr. Baker states, he has found sufficient for all purposes. The spindle has the form of a mandrel working in double bearings, with a socket to receive tool-holders of various lengths according to the requirements of the work in hand. A long tool-holder, with its cutter, is represented *in situ*, and another of different shape is shown by the side of the instrument.

THE COFFER IN THE GREAT PYRAMID.

THE following are the original dimensions:

$$\begin{array}{lcccccccc} & \text{Length.} & & \text{Breadth.} & & \text{Depth.} & & \text{Volume.} & \\ \text{Interior} = & 78 & \times & 27 & \times & 35 & = & 73710 & \\ \text{Exterior} = & 90 & \times & 39 & \times & 42 & = & 147420 & \end{array} \qquad \frac{73710}{147420} = \frac{1}{2}$$

$\therefore$ Thickness of walls $= 6$, and of bottom $= 7$

$$\begin{array}{lcccccccc} \text{Bottom} = & 90 & \times & 39 & \times & 7 & = & 24570 \\ \text{Walls} = & 2(90+27) & \times & 35 & \times & 6 & = & 49140 \end{array} \qquad \frac{24570}{49140} = \frac{1}{2}$$

The exterior volume being thus exactly double the interior capacity, a solid accurately filling the inner space might be formed of the walls and bottom, which are likewise in the same ratio (2 : 1) to each other. Also the interior length was made double the exterior breadth, in order to evade the difficulties of solid geometry by reducing the duplication to a simple problem of plane geometry. Perhaps the duplication of the cube itself may be effected by some such artifice? I derived these theoretical units from the measure of Greaves, Jomard, and Vyse, as any one else might have done, by taking their means and adopting the nearest whole numbers, which at once verified the hypothesis.

My belief is that the coffer was originally constructed of the exact dimensions represented by my theoretical units, which may be called "pyramid inches," as they were probably the then equivalents from which our present inch is a lineal descendant. I think the coffer was very accurately finished, both inside and out, the sides and bottom made true parallel plane surfaces, perfectly smoothed, but not polished. The sage who planned the coffer was doubtless much too wise and scientific to commit the folly of polishing even the outside, as it was intended for scientific purposes, not for show. Ages afterwards, when the use and intention of the coffer may have been forgotten, probably some *un*scientific Pharaoh desecrated the coffer by ordering it to be converted into a sarcophagus for his own sepulture. It was most likely at this epoch that attempts were made to polish it, when its former accuracy was destroyed by the hollows which usually result from polishing plane surfaces by unskilled hands, more or less of all its surfaces being worn away, and the walls of the coffer rendered somewhat thinner than originally constructed. Thus the hollowed portions and inequalities recorded by Smyth are mere unintentional defects of workmanship.

Among Smyth's measures of the length and breadth of the coffer are numbers *greater* as well as *less* than my theoretic units, which are thereby confirmed. But his numbers for the outside height and inside depth are all *less* by about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch only. Assuming his measures to be correct, the upper edges may have been worn away by unskilful polishing.

Considering the Duplication Theory established, I now claim that it be recognised, on behalf of its advocates, Röber, Taylor, Jopling, Willich, Drach, Creedy, and

HENRY PERIGAL.

NOTES.

"The earth hath bubbles, as the water has,
And these are of them."—*Macbeth.*

THERE are many useful scraps of information, acquired by experience, reading or tradition, which are either forgotten when needed or totally lost for want of some suitable receptacle where they may be pigeon-holed for future reference and use. Some such already exist—the *English Mechanic* is in itself a perfect encyclopædia—but there can hardly be too many nets spread to catch such valuable waifs and strays, and this especially in the interest of the amateur mechanic, who, we know alas! is frequently of indolent habit, and unwilling to be at the trouble of setting such traps on his own account. No practical mechanic can be without special experience of some kind, and many will have discovered that there are generally at least two ways of doing a thing, one of them being easier and better than the other. It is the results of such casual experience, together with what are popularly known as "dodges" and "wrinkles," with other useful and interesting matter, that it will be the object of this portion of our Journal to collect and chronicle, and it is hoped that they will prove a source of interest to our members, and that we shall soon be amply supplied with their varied experiences.

GLUEING.—French cabinet-makers use a gluepot with an inside pan made of glazed earthenware and divided radially into three divisions, in one of which is kept strong glue, in another weaker, and in the third water only, with a brush or piece of sponge for cleaning off superfluous glue from the work.

Chalking the joints in glueing end-wood is not to be recommended; a better plan is to size the end-grain with thin glue first, and then make a smooth face before glueing permanently.

The addition of a little bichromate of potash is said to render glue impervious to moisture after exposing the articles to which it is applied to the light, and a small quantity of methylated spirit will greatly improve its keeping qualities.

A few holes bored near the top of the inner vessel of a gluepot, by admitting steam from the outer vessel will prevent the glue from solidifying on the side. They need not be bored round the whole circumference of the pot, to allow of pouring out the glue if necessary.

TIMBER.—*It is said* that if planks are sawn in the same direction, east and west, as the tree stood before cutting, they will not warp.

RASPS.—A farrier's rasp is an excellent tool for preparing a rough piece of wood or ivory for the lathe. Where only a small quantity of the material is required to be removed it will be found to be more convenient than the axe or paring-knife. There is also a somewhat similar tool used by shoemakers which, for smaller jobs, will be found equally efficient.

SOFT FILES.—Small single-cut files or "floats" of various shapes not hardened, may be met with at some of the dealers in watchmaker's tools, which are useful in finishing small articles in hardwood, ivory, and also gold and silver; they are used sometimes by jewellers for finishing, on account of their leaving a smooth surface behind them instead of a rough one, as a cross-cut file does.

CORRESPONDENCE.

To the Editor.

SIR,—I noticed in the second number of the *Amateur Mechanical Society's Journal* an article on "Screw Cutting by Hand," in which the writer quotes the Northamptonshire soft wood turners as customarily tracing and cutting a screw with a V tool without any guide whatever. This appears at first sight to be a most difficult operation, but it is not so in reality, for cutting a screw with a single V tool is almost as simple and easy as with the usual chaser, when the manipulator knows how to handle his instrument and has had a little practice. In cutting a short thread, which is more difficult to execute correctly than a long one, it is requisite that the foot and hand should keep pace the one with the other. The V tool should traverse the entire length of the intended screw from right to left during the downward stroke of the treadle, and should be withdrawn from the work whilst the treadle is making the upward or back stroke, the tool being held as nearly as possible at right angles to the axis of the mandrel. Thus, with a little practice, the amateur would acquire the facility of cutting threads or screws of any pitch on wood or ivory with the requisite exactness in half the time or less that he would expend in arranging his apparatus on a lathe fitted with a traversing mandrel.

Mention has been made in one or two of the numbers of the *Amateur Mechanical Society's Journal* of the want of cordiality which occasionally betrays itself between professional and amateur turners, and I surmise that the cause of this apparent estrangement is the propensity among amateurs of providing themselves, or allowing themselves to be furnished with, a needless variety of appliances, instead of endeavouring to make shift with a few of the most useful tools and acquiring the art of using them with dexterity and ingenuity. Consequently, when an amateur finds himself in a workshop devoid of those appliances to which he has been accustomed, and is asked his opinion as to the best method of producing a given form with the tools at hand, he is all afloat, and subjects himself to an amount of ridicule from the professional which is hard to bear and not altogether undeserved.

I quite coincide with "Virion Nighton," that every beginner should commence turning on a simple lathe, and also that, as soon as ornamental turning is begun, a superior mandrel and poppit-head, as well as a slide-rest, are indispensable; but I cannot see what greater efficiency a traversing mandrel affords to an amateur who can chase threads or screws by hand, which all ought to be able to accomplish, while its double bearing causes more friction and therefore makes the lathe run heavier. I would rather see amateurs depend more upon themselves and less on their tools than at present seems to be their habit or inclination; then their ingenuity would be called to the front, whereas now, I fear, amateur turning is too much like the simple imitation practised by a child in his copybook. And this is a pity, because much more may be done with a little ingenuity on even the common lathe than many imagine possible. For example, in the manufacture of perambulator wheels the spokes are often, if not usually, made oval in shape, larger near the wheel's centre than at the circumference, and are made oval by the exercise of a little ingenuity. A chuck is made of boxwood, and fixed on the mandrel in the ordinary manner. In the face of this two square holes are cut parallel with each other, sometimes without any division being left between them. Into these holes, which are perhaps half an inch in depth, are inserted the ends of two square bars of wood, whose opposite ends are united firmly together either by an iron band, a piece of twine, or a pair of clamps, the latter being the best to withstand the pressure of the poppit-head centre, which must now be brought up and fixed in the usual manner. Having turned off the rough edges, and reduced the two bars to circular arcs, the band, twine, or clamp is removed, and the bars reversed in the chuck, so as to bring the inner edges outwards, when the same operation is repeated and the spokes completed. The object of the holes is to make the ovals at one end larger than at the other, the spokes when finished being slightly conical lengthwise, and oval in breadth. This plan is found to answer well where a number are required, as not only two but four spokes can be cut at the same time, all consequently of the same size.

I enclose my card, although I do not wish my name to appear in your Journal should you deem this letter worthy of insertion, and must apologise for having written you at this length—not being a member, though desirous of becoming one—but having seen the first three numbers of the Journal, and taking a great interest in anything mechanical, I could not refrain from giving my opinion on these points of, I may say, vital importance, believing that the welfare of such a Society as the Amateur Mechanical Society depends more upon the members devising and executing new ideas rather than continually copying old ones.

J. H.

[No apology is needed; on the contrary, we thank J. H. for his contribution, and hope to see him speedily enrolled a member of the Amateur Mechanical Society.—Ed.]

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

JANUARY, 1872.

A RETROSPECT.

THE close of the year affords a fitting opportunity for a review of our past labours, and for an attempt to estimate the amount done as well as left undone. Let us hope that our successes have exceeded our failures. As regards the general progress of the Society, it may be said, we hope without incurring a charge of exaggeration, that it exhibits an unequivocal success. If it be considered somewhat slow (the increase in our numbers during the year having amounted to about twenty-five per cent. only), this seems readily accounted for by our By-Laws, which very properly allow of admission only on personal knowledge and recommendation; and, on the other hand, we are justified in indulging in some natural satisfaction when we look at the quality and social status (matters of the utmost importance in such a Society as ours) of those who have joined our ranks.

Our Journal is just entering on the second year of its existence; we have given four numbers to the world, they might have been thicker, they might, perhaps, have been published in a more popular form; these defects, if such they are, are susceptible of future and easy remedy. As respects the value of the contents, our readers will have formed their own conclusions, but we may safely give expression to our gratification at the progress made (notwithstanding limited resources and many difficulties), and to some pride at the more than average ability of many of the articles which have appeared. Still, we cannot but regret that the exhibition of so much skill and enterprise has failed to stimulate to exertion a larger number of our members, being well persuaded that the contributors to the Journal bear no proportion to the number of those who possess the requisite talent to enable them to write if they had the will. We can quite understand that many may reasonably shrink from the production of a complete article on any subject, which to be perfect should be as far as possible exhaustive, but this excuse does not apply to *Notes* or suggestions upon any of the multifarious questions ot interest which must continually occupy the mind of every amateur.

We conclude with the agreeable task of calling attention to the circumstance that the first number for 1872 shows a considerable increase in size over its immediate predecessors, and includes an array of articles replete with varied, useful, and entertaining matter. This we must regard as a good omen of future success, and we trust it will have the effect of stimulating our contributors to increased efforts, and that the "appetite" for contributing will "grow by what it feeds on."

HON. SECRETARY'S REPORT.

THE Second Annual Conversazione took place on the 24th November last, at the Architectural Union Company's Gallery, 9, Conduit Street, W., when; in addition to the work exhibited, visitors again had the advantage of inspecting the collection of photographs forming the Annual Exhibition of the London Photographic Society, all of which were good—many deserving the highest praise, not merely as photographs, but as works of art. The success of the evening was in a measure hindered by the exceedingly dense fog which hung over a large portion of the metropolis, but, notwithstanding this drawback, there was a fair muster of members and their friends—the latter including quite as many ladies as gentlemen. I mention this because I have been frequently asked if ladies are admissible. Certainly they are, and I make bold to say that there will not be found one among the members of the Amateur

Mechanical Society who would deny that their presence "lends enchantment to the view." Besides, who but ladies are competent to pronounce an opinion on the relative practical merits of the hosts of worsted and silk winders, needle cases, and other objects of (more or less) beauty which are daily being elaborated by amateurs for their special behoof. Pagodas and snuff-boxes I of course, leave out of the question, the former being matters which "no fellow," other than a Chinaman, can understand, and the latter, let us hope, unnecessary. Prominent among the specimens of work, of which there was no lack, was a collection of objects carved in ivory by Major-General Yorke, C.B., some twelve pieces in all, including the beautiful flower vase illustrated on page 132 of the last number, most of which were of considerable size, and all remarkable for artistic feeling and freedom of execution. Colonel Lloyd exhibited a large number of excentric turned specimens both in wood and ivory, many of which he stated were produced with the assistance of special contrivances of his own, which I trust he may some day find time to describe fully in our columns for the benefit of his brother workmen. Lathes, owing to the absence of accommodation for them, were again conspicuous by their absence, and even if the room were suitable, it is a question whether makers would care to incur the expense and risk ot exhibiting such heavy machinery for one night only. This is a subject which it will be well for the Council to consider before the next Conversazione takes place, for I cannot but think that if it were arranged to keep the exhibition open—say for one week—it would not only prove an inducement for members and lathe-makers to exhibit, but would also tempt many country members to come up for the occasion.

I regret to have to conclude my report by recording the death, on the 20th ult., of a member and contributor to these pages in the person of

ELIAS TAYLOR, Esq.,

who had for many years turned his attention to mechanical pursuits, but latterly, owing to failing health, was compelled almost entirely to relinquish the practical portion of his favourite amusement. I have also to announce the resignation of

JOHN PENWARNE, Esq., and
FRANCIS BACON, Esq.

Meetings of the Council.

Owing to an oversight, no mention has hitherto been made of the Meeting which took place on 27th June last. There were six members present, and the following candidates were duly elected:

Captain Thomas Cowper Hincks,
Major-General John Yorke, C.B., and
Lord Lindsay.

On the 30th October—six members present—the following gentlemen were admitted:

James Hutchinson, Esq.,
William L. Merry, Esq.,
Colonel H. Hughes Lloyd;

and, as an Honorary Member,

William Henry Beaumont, Esq.

Arrangements were made for the November Conversazione.

On the 11th December—six members present—the following gentlemen were duly elected members:

John B. Fletcher, Esq.
Arthur Lucas, Esq., C.E., and
Francis B. Cunningham, Esq.

The order of retirement of the present members of the Council was considered, and it was determined to decide it by lot, by which means the following order was arrived at:—

H. Perigal, Esq. M. Yeatman, Esq.	1871.
F. W. Blake, Esq. Rev. S. B. Burnaby.	1872.
Col. Clarke. Major Sandeman.	1873.
H. W. Elphinstone, Esq.	1874.

It will be seen on reference to By-Law 6 that, of the lay-members of the Council, two retire at the close of each year. The present members having been elected simultaneously at the last General Meeting, it became necessary to decide this point once for all. The two new members elected this month, and those in succeeding years, will of course retire in rotation.

Messrs. W. H. Northcott and J. Rivington were nominated to serve on the Council in place of those retiring, and T. W. Boord as Hon. Secretary for the ensuing year. No one was nominated for the Editorship, which therefore remains in the Hon. Secretary's hands until some member comes forward who is able and willing to undertake it.

On the motion of Mr. Yeatman, seconded by Mr. Elphinstone, it was unanimously resolved that the names of the Journal Committee should no longer be published.

Mr. Burnaby suggested that, in order to induce contributions to the Journal, an annual prize should be offered for the best paper or set of papers on any one subject. A draft of the proposed conditions was read and discussed, and the subject was then ordered to stand over for further consideration at the next meeting.

On the 30th December—seven members present—the discussion on Mr. Burnaby's proposal was resumed, and it was at length resolved to recommend its adoption to the next General Meeting somewhat in the following form :—

1. That an Annual Prize be given for the best paper or set of papers, by a member of the Society, on any one suitable subject published in the Journal during each year. In the case of a series of papers the date of publication of the last of the series to determine the year in which it is to be held to compete.
2. That the prize for the year 1872 be of the value of £20, to be received by the winner in the shape of an addition to his lathe or workshop, or in any other form most agreeable to himself.
3. That the award shall rest with the whole body of the Society, each member being supplied with a suitable voting paper, together with the last number of the Journal in each year, provided always that not less than 20 votes are recorded (not necessarily for the same paper). In case of equality of votes the Editor to have a casting vote.

There were no Candidates for election.

T. W. Boord.

SPIRAL GRAILING.

THE operation called "grailing," by which a flat surface of wood or ivory is prepared, previously to being ornamented with the excentric cutter, drill, or other instrument, is usually performed by cutting a series of fine concentric circles from the circumference to the centre of the work, produced by moving a pointed tool in the slide-rest, say the 150th or 200th of an inch for each cut, until it forms a mere dot in the centre. This is a slow and tedious operation, especially on a piece of work of any size, such, for instance, as the lid of a box four inches in diameter, and unless the greatest care be taken to move the tool the exact distance for each cut, certain circles will catch the eye more than others, and the surface will not have that even, "dead" look, which contrasts so well with the ornamented portions. Moreover, the point of the tool is apt to lose something of its sharpness before the grailing is completed, and thus, again, the surface may lack that evenness of appearance which is its greatest beauty. Many turners are of course aware that grailing may be effected by means of a single fine spiral line, running from the circumference to the centre of the work, and some lathes are fitted with the necessary apparatus for doing this; but I think the practice ought to be more generally known than it seems to be, for the trifling addition to the lathe which it requires is within the power of any amateur to make for himself, while there can be no question about the saving of time which it effects, in spite of the minute or two required for putting the bands in position; and the result is in every way satisfactory, the surface presenting a perfectly even, uniform appearance, fully equal, if not superior, to ordinary grailing when performed in the most careful manner, and, like it, showing a beautiful play of light as it is moved about in different positions. It is of course requisite that the surface should be perfectly flat and even before commencing the cut, and that the tool should be as sharp as possible. This sharpness will be found to be much better maintained during the cutting of one spiral line than when the tool has to cut a considerable number of separate circles. All that is necessary is to connect the screw of the slide-rest with the mandrel by a series of bands, in such a manner that the point of the tool will move slowly across the face of the work, while the latter revolves rapidly on the lathe. This may be effected in the following manner.

The usual lathe-band, from the largest groove of the driving wheel of the lathe to the smallest groove of the mandrel pulley, gives a rapid motion to the work. A second band passes from the smallest groove of the double-bevelled wheel to the largest on the left-hand pulley of the overhead gear. A third band descends from a *very small* pulley on the overhead spindle to a large one fixed upon one end of the slide-rest screw. This wooden pulley or wheel, as well as the smaller one from which it is driven, any turner may make for himself of box or other wood. It should have a square hole through its centre if it is to be slipped on the square end of the slide-rest screw, which may be done if the overhead gear admits of being pushed sufficiently far back over the bed of the lathe to bring it directly over the right-hand end of the rest as it stands across the lathe-bearers; or, if the slide-rest is adapted for the spiral apparatus, and has a projecting piece at the left-hand end of its screw, the wooden pulley or wheel may be placed on that. In my own case, in consequence of the limited range backwards and forwards of my overhead spindle, which is supported by two uprights rising from either end of the lathe-bed, I was unable to place it directly over either end of my slide-rest, and therefore had to make my large pulley on the larger end of a conical piece of boxwood, hollowed out so as to admit within the hollow about three inches of the left-hand end of the rest. In this manner I was able to bring the groove of the wooden wheel beneath the overhead spindle. Of course, a simple stout disc of wood with a groove formed on its edge is sufficient, if the end of the rest can be placed immediately below the spindle. Any desired degree of fineness can be given to the grailing by altering the position of the lathe-band. The following are the diameters of the various wheels and pulleys that I use, and find to answer.

Large wheel	about 27 in. diameter.
Mandrel pulley	" $3\frac{3}{4}$ "

'Slow motion' of driving wheel .	about	14	in.	diameter.
Large pulley overhead	,,	4		,,
Small ditto	,,	$1\frac{1}{4}$		,,
Wooden do. on slide-rest . .	,,	$5\frac{1}{2}$		,,

These proportions produce grailing as fine as can possibly be required—almost too fine, as it takes good eyes to distinguish the lines at all. By shifting the lathe band to about the centre of the large bevel of the driving wheel and of the mandrel pulley, grailing is produced of about the usual degree of fineness. As, from the smallness of the lesser pulley on the overhead spindle, the band might possibly slip upon it should the slide-rest screw work at all stiffly, or the work offer too much resistance to the tool, it is as well, instead of forming its groove of the usual V shape, to leave it of sufficient width to allow of the band, which should be of small catgut, being passed twice round it.

In grailing by the means here described, the tool should be so set as to penetrate no deeper than will suffice just to remove the original surface of the work from between two adjoining coils of the spiral line. If it be set to cut too deeply, the work is apt to be torn by it. The progress of the tool, which must always be from the outer edge or circumference of the work towards the centre, must be carefully watched, and the moment the centre is reached, the tool must be withdrawn quickly.

G. C. C.

ENCAUSTIC TILES.

ENCAUSTIC tiles were much used by the architects of the middle ages, and the art of manufacturing them was revived about the year 1833 by a Mr. Wright, of the Staffordshire Potteries, and soon after that time the method was improved by Minton.

A good buff colour and a warm red are produced by firing certain clays in their natural state. Black is produced by staining with manganese, blue with cobalt. The clays after having been well washed and purified, are passed first through wire and then lawn sieves in the liquid state (technically termed "slip") into large cisterns, where they consolidate, and are then dug out and pulverised by machinery. Having been thus brought to the proper consistency, the clay intended to form the body of the tile was formerly pressed into an iron mould, the bottom of which was formed of plaster of Paris, bearing the design to be impressed on the tile. The pattern being removed, the indentations were filled with the coloured clays according to the intended design, and the surface was then shaved off so as to remove all superfluities and ruggedness, leaving the pattern intact. The tile was then dried for two or three weeks, and finally fired by exposure to an intense heat for sixty hours. It has, however, been recently discovered that the red or brown clays of which the body of the tile is usually formed, stain the surface of the one next beneath, when being fired. To obviate this, a small portion of white clay is thrown into the mould first, and compressed tightly before the coloured clay, of which the body of the tile is still formed, is added, and this simple expedient completely prevents their staining each other. But a great improvement has taken place, not only in the arrangement of the clays, but also in the machinery employed for their manipulation. The iron mould which, as before stated, had its bottom formed of plaster of Paris, bearing the design to be impressed on the tile, is now made entirely of iron, whilst the bottom, which formerly was stationary, now works easily, by means of a lever and treadle, up and down the inside of the mould, which is a fixture.

In forming the Tile, the base of the mould is raised to within a short distance of the surface, and a small quantity of white clay thrown in and distributed equally over the bottom by means of a straight edge. A thin, smooth, copper plate of the exact size is then placed on the clay, and the whole lowered into the mould and tightly compressed by a screw and ram. The pressure being removed, the compressed clay is raised to the surface, and the copper plate having been withdrawn, another, perforated to represent a portion of the pattern, is substituted, on which some clay of the required colour is sprinkled, and the superfluous amount removed, leaving only the perforations filled. A smooth copper plate, similar to the previous one, is then added, and the whole again lowered into the mould and tightly compressed, as before mentioned. On again being raised to the surface, both plates are cautiously removed, the small portions of coloured clay (whose positions may have been slightly altered by the removal of the plates) carefully rearranged, a plate, perforated to represent a different portion of the pattern, is adjusted, and the same process of filling in, lowering, and compressing is repeated until the whole is finished, a different plate being used for each portion of the pattern.

The tiles, now presenting a hard dusky appearance, are filled in earthen pans placed in rows round the inside of the kiln one above another. These pans are made of a commoner sort of red clay than that which forms the body of the tiles, and are usually manufactured on the premises. They are about two feet six inches long by one foot six inches broad, and eight to ten inches deep, oval in shape, with sides about two inches thick; but massive as these pans are, they will only serve for about three firings. Their purpose is to permit a large number of tiles to be fired at the same time, by preventing their being crushed or amalgamated with each other, by the weight of those above them. The tiles now remain in the kiln for six clear days and nights, when the fires (which by that time have consumed sixty tons of coals) are allowed to die out, and an opening having been made in the kiln, it is allowed to cool until the eighth day, when the pans are removed, and the tiles, being turned out roughly in order to disconnect any that may be adhering to each other, are placed separately a few inches apart on shelves, where they remain until quite cold. They are then glazed by being smeared with a solution of the white clay, in its "slip" state, mixed with some chemicals, which, on being applied, causes it to dry instantaneously, and, after the tiles have again been baked, to become hard, and give a bright and glossy appearance to them when finished.

J. H.

RECTILINEAR, CIRCULAR, AND ELLIPTIC DRILLING.

PART I.—*Definitions.—Laws which govern the position of lines drilled.—Illustrations of these laws.—Application to drilling* (1) *angular letters* **A K M N V W X Y Z**, (2) *square leters* **E F H I L T.**

INSTRUMENTS REQUIRED.—*Excentric chuck, slide-rest, drill, division-plate and fluting stops.*

THE special object of the following paper is to show the method of cutting the letters of the alphabet, either singly or in combination with others, on the surface of work in the lathe by means of the ordinary ornamental drill. But inasmuch as the varied shapes and positions of such letters involve the application of most of the laws which govern the position of lines drilled, it has been thought well to treat of those laws and to give illustrations of them, more in detail than would have been necessary if the object in view had been the cutting of letters only. The whole paper will probably be comprised in four parts; the second being devoted to circular drilling, and letters with circular loops; the third to elliptic drilling, and letters with elliptic loops; and the fourth part will contain some examples of ornamental drilling, and of letters drilled in combination forming names and initials.

DEFINITIONS.

1. *Center* and *All at center.*—The words "All at center," or "Center" used alone, refer to the center of rotation of the lathe, and not to the center of the work, which will be frequently removed by the excentric chuck from the true center. When the work is "all at center," the axis of rotation of the lathe passes through the center of the work, the chuck being in its concentric position, accurately vertical, with the head of its screw upwards, and ready to be turned downwards without "loss of time." Its toothed wheel is stopped at 96, the lathe pulley at 96, and the point of the tool or drill is accurately at the center of the lathe, both vertically and horizontally.

2. *Chuck vertical.*—To adjust the excentric or ellipse chuck

vertically, place a T square with its arm across the bed of the lathe and its blade against the side of the chuck, which has its screw-head up. Standing at the back of the pulley, adjust the index so that the chuck may be vertical when the pulley is stopped at 96, if 96 be the number of teeth in the chuck wheel, or at such other number as the chuck may have divisions.

3. *Chuck horizontal.*—Do not, in adjusting the chuck horizontally, trust to a level, unless you are certain that the bed of the lathe and the slide-rest are level, but adjust vertically in 96, and then bring the pulley to 24 or 72. The great thing is to have the chuck vertical or horizontal with respect to the bed of the lathe, and not with respect to the true horizon. Nevertheless, let it not be supposed that there is no advantage in having the bed of the lathe accurately level.

4. *Drill at center.*—To adjust the drill, place in the tool box a fine-pointed tool which has not been bent by rough usage, and, having elevated or depressed the rest by means of the capstan-head till the point of the tool appears to be vertically at center when tested by the ordinary "standard," fix the pulley in 96 and the excentric chuck wheel in 96, and trace a line across the face of the work; bring the pulley to 48, and trace again; if these two lines are coincident the tool is correctly adjusted vertically. Now remove the index and bring the point of the tool to the apparent center of the lathe; rotate the pulley; if the point of the tool describe a dot it is rightly adjusted horizontally, if it describe a small circle it is not. In making these two adjustments it does not matter whether there be any excentricity on the chuck or not. Of course the drill itself may be used instead of another tool; but in good lathes if one tool is "at center," all the tools will be "at center."

5. *Excentricity nothing.*—Having adjusted the tool at center, with, perhaps, some excentricity on the chuck, screw the chuck up to what is believed to be its concentric position. Fix the pulley at 96 and the chuck wheel at 96 and trace a line across the face of the work; bring the chuck wheel to 48 and trace again; if the two lines coincide the chuck is adjusted. Note what division is indicated on the nut of the screw, probably it may not be that marked 0.

6. *Central horizontal line.*—An imaginary line across the face

of the work and through its center, horizontal when the chuck wheel is stopped at 96, and the pulley at 96. This line is sometimes called the axis of x, and is marked x in the figures which accompany this paper. From it all excentricity is measured vertically.

7. *Central vertical line.*—An imaginary line across the face of the work and through its center, vertical when the chuck wheel is stopped at 96, pulley at 96, horizontal with pulley at 24 or 72. It is called the axis of y, and is marked y in the figures.

8. *Upper and lower horizontal lines.*—In drilling angular letters such as **A**, assuming that the angle F H E and the height A E have been determined (see Fig. **A** *in loco*), the length of the line H F can be calculated and drilled accurately to $\frac{1}{200}$ of an inch by the marked divisions of slide-rest—

$$F\,H = \frac{H\,E}{\cos\frac{H}{2}} \therefore \log F\,H = \log H\,E - \log\cos\frac{H}{2}$$

or, by the tables

$$\log F\,H = \log H\,E - \log\cos\frac{H}{2} + 10$$

but such extreme accuracy as to the height of the letter can rarely be necessary. H E may be made to depend upon H F, instead of H F upon H E.

Suppose then it be desired to drill a letter $\frac{1}{2}$ inch high, make the excentricity $\frac{1}{4}$ inch, *i. e.* two turns and a half of the excentric chuck screw, and, with a pencil in tool box, draw a line across the face of the work. Bring the chuck wheel to 48 and draw another line; they will be $\frac{1}{2}$ inch apart and will be guides for the drilling of the letter, sufficient, with due care, for all practical purposes. Or, if there be no pencil which can be relied upon as "all at center," a dot may be made on the face of the work with a fine tool, first with pulley 96, chuck 96, then with pulley 96, chuck 48. Then, by bringing the pulley to 24 or 72, vertical lines may be drawn, by the T square and a hard pencil, through the dots, which will be the *upper and lower horizontal lines* when the pulley is brought back to 96.*

*** When the letters of a name, or initials, are to be drilled on the face of work which is to be ornamented, it will be well to drill the letters first, and do**

Laws which Govern the Position of Lines drilled on the Face of the Work.

I. If it be required to drill a line A, Fig. 1, which shall lie on the axis of x and be bisected by the axis of y, it is best to drill one half of the line first and fix the left hand or outside fluting stop; then turn the pulley half way round and drill the other half to the same stop. To do this the drill must be accurately at center vertically.

II. If it be required to drill a line B, Fig. 1, which is bisected by the axis of y, but which does not lie upon the axis of x, make the excentricity = O B, and drill the first half with pulley in 96, chuck 96; fix the left-hand stop and drill the second half with pulley in 48, chuck in 96, to the same stop.

III. If it be required to drill two equal lines, B and C, Fig. 1, symmetrically situated on opposite sides of the axis of x, and bisected by the axis of y, having first drilled one of the pair by Law II, the other may be drilled to the same stop by bringing the pulley to 96, chuck to 48, for the first half, and the pulley to 48, chuck to 48, for the second half.

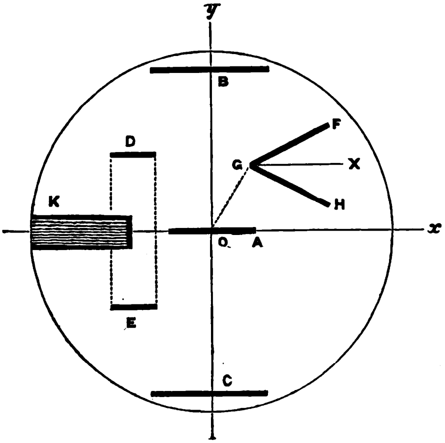
IV. If it be required to drill lines symmetrically above and below the axis of x, but both on the same side of the axis of y, as D and E, Fig. 1, then, one of them having been drilled between stops with pulley in 96, chuck 96, the other may be drilled between the same stops by bringing pulley to 48 and chuck wheel to 48. Hence it follows that if it be required to drill out a slot having its sides parallel to the axis of y, but wider than the drill itself, K, Fig. 1, the greater portion of the material having been first removed by a series of cylindrically drilled holes, the top of the slot can be finished by a straight-sided drill, used as for drilling the line D, and the lower side by drilling as for line E.

V. If it be required to drill lines at a given inclination to each other, the apex of the angle not being at the center of the work, as

the ornamenting afterwards. For, the letters being cut with a plain round-nosed drill, no great harm will be done if the work be polished, and any accidental dots or scratches removed after they are cut. If, however, the work is already ornamented, it will be well to make trial on a piece of boxwood first. *Experimentum fiat in corpore vili.*

F G H, Fig. 1, the apex must be first brought vertically over the center by moving the excentric chuck wheel through *n* teeth, and then the chuck screwed down till the apex is at the center,

FIG. 1.



making the excentricity = G O. The pulley must then be moved through as many divisions (*n*) as the chuck wheel was moved, but in the opposite direction. This will bring the line G X, bisecting the angle, on to the axis of X. The lines F G, H G may now be drilled by moving the pulley first through half as many divisions forwards from *n*, the horizontal position of G X, and then half as many backwards from the same position, as will include the angle F G H.

For example.—Let it be necessary to bring excentric chuck wheel from 96 to 12 in order to make G O vertical. Then the pulley must be moved from 96 to 84 to make G X horizontal. Let the angle F G H = 45°, that is, 12 divisions on 96 row, then F G must be drilled with the pulley in 84 + 6 or 90, and H G with pulley in 84-6 or 78.

VI. Since there are 360° in a circle, every tooth of the excentric chuck wheel and every division on the 96 row of division plate, includes 3·75°. Subjoined is a table showing the degrees answering to the divisions on 96 row.

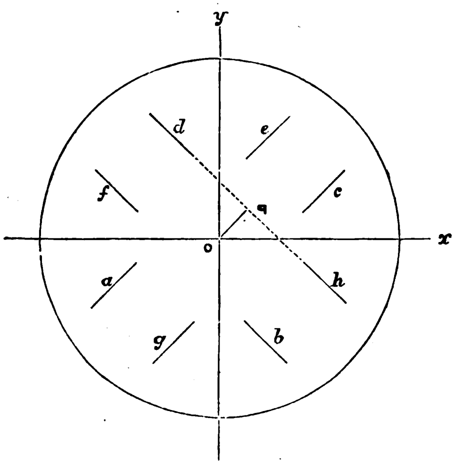
Degrees	360	225	180	105	120	112½	90	52½	60	56¼	52½	48¾
Div. on 96...	96	60	48	36	32	30	24	18	16	15	14	13
Degrees	30	41¼	37½	33¾	30	26¼	22½	18¾	15	11¼	7½	3¾
Div. on 96 ...	12	11	10	9	8	7	6	5	4	3	2	1

If n be number of divisions moved on 96 row, then $3\frac{3}{4}\, n$ is the number of degrees moved through.

Illustrations of the Preceding Laws.

Fig. 2.—o *x* and o *y* are the horizontal and vertical axes when pulley in 96, chuck in 96. The excentricity equals the perpen-

Fig. 2.



dicular distance o P from the center to the straight line joining any two of the lines, as *d*, *h*.

a. Pulley in 96; chuck 84	*e.* Pulley in 48; chuck 84.
b. " " " 60	*f.* " " " 60.
c. " " " 36	*g.* " " " 36.
d. " " " 12	*h.* " " " 12

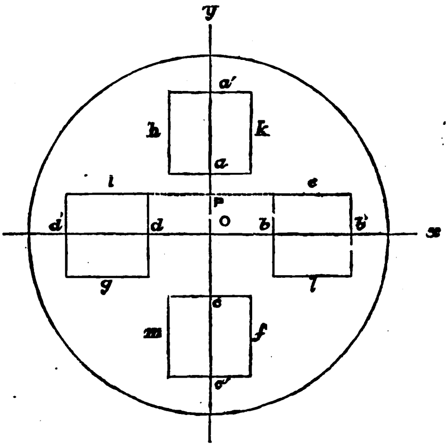
The lines are all drilled between the same stops.

Fig. 3.—With excentricity $= a\,O$.				With excentricity $= d'O$.			
a.	Pulley 96;	chuck	96	*a'.*	Pulley 96;	chuck	96
b.	,, ,,	,,	24	*b'.*	,, ,,	,,	24
c.	,, ,,	,,	48	*c'.*	,, ,,	,,	48
d.	,, ,,	,,	72	*d'.*	,, ,,	,,	72

These lines are all drilled between the same stops.

For the remaining 8 lines the excentricity $=$ O P $= \frac{1}{2}$ side of square, the stops must be shifted from their former position,

Fig. 3.



the same distance as before being retained between them, and all the 8 lines drilled to same stops.

e.	Pulley 96;	chuck	96	*i.*	Pulley 48;	chuck	96
f.	,, ,,	,,	24	*k.*	,, ,,	,,	24
g.	,, ,,	,,	48	*l.*	,, ,,	,,	48
h.	,, ,,	,,	72	*m.*	,, ,,	,,	72

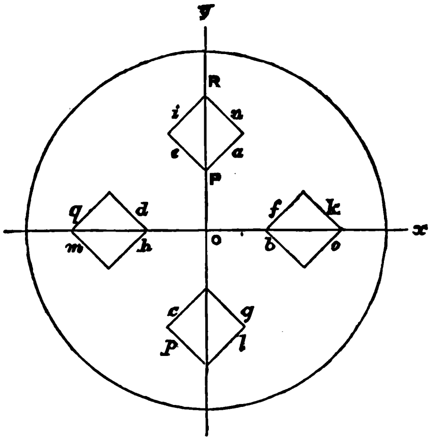
Fig. 4.—With excentricity $=$ O P.

a.	Pulley 84;	chuck	96	*e.*	Pulley 60;	chuck	96
b.	,, ,,	,,	24	*f.*	,, ,,	,,	24
c.	,, ,,	,,	48	*g.*	,, ,,	,,	48
d.	,, ,,	,,	72	*h.*	,, ,,	,,	72

Between same stops.

The position of the stops must now be altered, great care being exercised to keep the same distance between them as before. It will be well to drill the line marked *i* (the first of second set) not quite to the point R; but having drilled it nearly to R, drill *n*, and fix the stops when these two meet each other. It will be an additional guard if the vertical and horizontal axes be traced before commencing to drill at all.

FIG. 4.



With excentricity = OR.

i.	Pulley 84;	chuck 96			*n.*	Pulley 60;	chuck 96		
k.	,,	,,	,,	24	*o.*	,,	,,	,,	24
l.	,,	,,	,,	48	*p.*	,,	,,	,,	48
m.	,,	,,	,,	72	*q.*	,,	,,	,,	72

Fig. 5. Excentricity O A = $\frac{3}{10}$ inch. Length of each side = $\frac{7}{10}$ inch. Angles = 60° and 120°.

Having all at center, fix left-hand stop, the tool being ready to move to the right without loss of time.

1. Move excentric chuck down 3 whole turns. Move tool 7 turns to right, and fix right-hand stop.

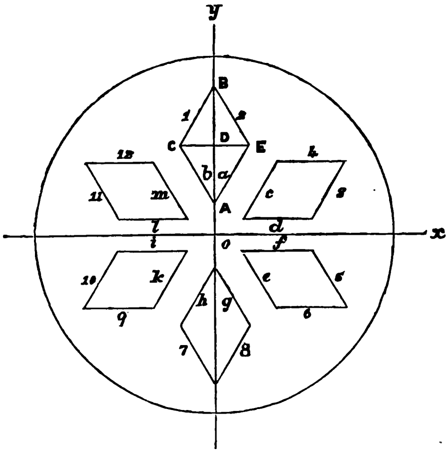
a.	Pulley	80;	chuck	96	*g.*	Pulley	64;	chuck	48
b.	,,	64;	,,	96	*h.*	,,	80;	,,	48
c.	,,	64;	,,	16	*i.*	,,	80;	,,	64
d.	,,	80;	,,	16	*k.*	,,	64;	,,	64
e.	,,	80;	,,	32	*l.*	,,	64;	,,	80
f.	,,	64;	,,	32	*m.*	,,	80;	,,	80

The pulley is here fixed in 80, *i. e.* 96 — 16, because the angle

D E A = 60°, and 16 divisions of 96 = 60°, and in 64, *i. e.* 96 — 32, because B E A = 120°.

2. The excentricity must now be made = O B, which can be calculated, for $BD = CB \cos. 30° = CB \frac{\sqrt{3}}{2} \therefore AB = CB\sqrt{3}$, and $OB = OA + AB = \frac{3}{10}$ in. $+ \frac{7}{10}\sqrt{3}$ in. $= \frac{15 \cdot 11}{10}$ in., that is, 15 whole turns and 1 division from concentric position, or

FIG. 5.



12 and a trifle from present position. It will, however, be sufficient to unfix the fluting stops, and the pulley being in 80, chuck in 96, increase the excentricity and traverse the tool till its point comes to C; then drill B C nearly to B, and E D nearly to meet it, finishing the two as they approach each other; fix stops.

1.	Pulley 80; chuck 96		7.	Pulley 64; chuck 48	
2.	„ 64;	„ 96	8.	„ 80;	„ 48
3.	„ 64;	„ 16	9.	„ 80;	„ 64
4.	„ 80;	„ 16	10.	„ 64;	„ 64
5.	„ 80;	„ 32	11.	„ 64;	„ 80
6.	„ 64;	„ 32	12.	„ 80;	„ 80

NOTE.—The figure is reduced in size.

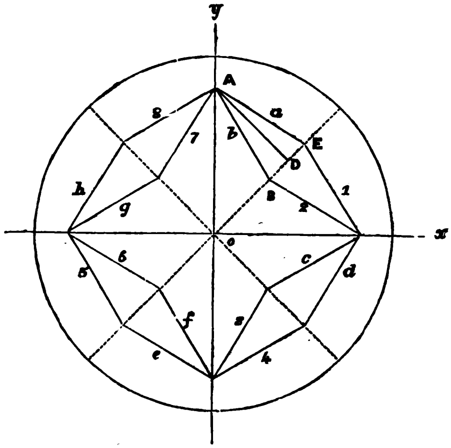
Fig. 6.—In this figure, if the excentricity O A and the angle B A E be given, the length of the side A B can be calculated to as many places of decimals as may be thought desirable.

For $\quad \sin.\ ABD = \frac{AD}{AB} \therefore AB = \frac{AD}{\sin.\ ABD}$

And $\quad \sin.\ AOD = \frac{AD}{OA} \therefore AD = OA \sin.\ AOD$

Whence $\quad AB = \frac{OA \sin.\ AOD}{\sin.\ ABD}$

FIG. 6.



Both these angles are known, for

$$ABD = 90 - \frac{BAE}{2} \text{ and } AOD = \frac{90}{2} = 45^\circ$$

Example.—Let the angle $BAE = 30^\circ \therefore ABD = 75^\circ$, and the excentricity $OA = \frac{23}{20}$ in.

So that $AB = \dfrac{\frac{23}{20} \sin.\ 45^\circ}{\sin.\ 75^\circ} = \dfrac{\frac{23}{20}\ \frac{1}{\sqrt{2}}}{\frac{1+\sqrt{3}}{2\sqrt{2}}} = \dfrac{23}{10\,(1+\sqrt{3})} = .84$

And, again, if the length of the side AB be given, and the angle ABE, the excentricity OA can be calculated.

For $\quad OA^2 = 2\,AD^2 \therefore \frac{OA}{\sqrt{2}} = AB \sin.\ ABD$

$$\therefore OA = AB \sin.\ ABD \,.\, \sqrt{2}$$

whence, in the figure, assuming that A B is given ·84 inches, we have $O A = .84 \times \sin. (90^\circ - 15^\circ) \sqrt{2}$

$$= .84 \frac{1 + \sqrt{3}}{2\sqrt{2}} \sqrt{2} = .42 \times 2.73 = 1.14$$

or one inch and one tenth and 4 hundredths, which is very near what it ought to be, namely, $\frac{23}{20}$ inch; and by extending the decimal places we might have arrived at any degree of accuracy.

But, as a general rule, these calculations are unnecessary. The form of this and of similar figures will depend upon the excentricity, which, being given by the chuck, we leave the length of the sides of the rhombi to determine themselves.

Thus, with pulley in 24 and 60, draw with T-square the dotted diagonal lines. Having all at center, left-hand stop fixed and tool ready to move to right, screw excentric chuck down till excentricity = O A.

Now drill (*a*) with pulley in 8, chuck 96; (*b*) with pulley in 16, chuck 96; nearly to the diagonal line O E.

Unfix left-hand stop, and drill (1) with pulley in 88, chuck 24; (2) with pulley in 80, chuck 24; nearly to diagonal line O E.

Go back to position for *a* and *b*, and advance them a little. Do the same for 1 and 2 till the sets meet; then fix the stops foı the *a b* set and proceed.

a.	Pulley 8;	chuck 96.		*e*.	Pulley 8;	chuck 48.
b.	„ 16;	„ 96.		*f*.	„ 16;	„ 48.
c.	„ 16;	„ 24.		*g*.	„ 16;	„ 72.
d.	„ 8;	„ 24.		*h*.	„ 8;	„ 72.

Now move to position (1), viz. pulley 88; chuck 24. Bring tool box against left-hand stop; unfix right-hand stop and fix it against tool box in its present position. Unfix left-hand stop, traverse tool along (1), already drilled, till it reaches end of (*a*), and there fix left-hand stop.

1.	Pulley 88;	chuck 24.		5.	Pulley 88;	chuck 72.
2.	„ 80;	„ 24.		6.	„ 80;	„ 72.
3.	„ 80;	„ 48.		7.	„ 80;	„ 96.
4.	„ 88;	„ 48.		8.	„ 88;	„ 96.

Application of Laws to Drilling (1) Angular Letters **A K M N V W X Y Z**; (2) Square Letters **E F H I L T.**

A at center.

1. Excentric chuck vertical, stopped in 96, screw head up. Pulley stopped in 96. Slide-rest tool at center. Draw top and bottom horizontal lines.

2. Screw excentric chuck down half the height determined for the letter, which will bring the apex to the tool.

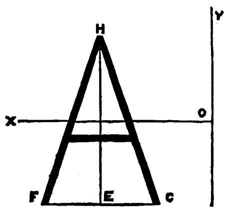
3. Shift pulley backwards to 72, and drill 5 (five) divisions from 72 on each side of 72; *i. e.* in 77 and 67, between stops.

4. For the horizontal stroke. Come back to pulley 96, and set excentric chuck in 48. Screw the handle down a trifle to bring the stroke just below the central horizontal line, and drill.

A on the left of center.

1. Bring the apex H vertically over the center by excentric chuck wheel, noticing how many teeth it takes; let the number be n. Screw chuck down till H comes to the center. (See Law V.)

2. Now, if we had started with pulley in 96, and excentric chuck in 96, it would have taken 24 divisions of pulley or of chuck to bring H E horizontal. We have, however, already moved n divisions on chuck, which has the same effect here as n divisions on pulley. We must, therefore, now act as though we had moved n on pulley and instead of moving it 24 divisions, move it $24 - n$ backwards, to make H E



Example.

1. Let it take 15 divisions on excentric chuck to make H O vertical. Move pulley backwards 24 — 15, or 9 divisions, *i. e.* to 87.

2. Pulley stopped 5 divisions on each side of 87, viz. in 82 and 92. The angle F H G being $\frac{10}{96}$ of 360°, is $37\frac{1}{2}$°. This angle can, of course, be varied; 4 divisions of pulley on each side of H O horizontal will give 30°, and 6 divisions on each side will give 40°.

horizontal. This setting gives the starting-point; now move pulley, first forwards 5 divisions, and then backwards 5 divisions from this starting-point, drilling between upper and lower horizontal lines, with stops fixed.

3. The horizontal stroke. Same as § 4 of **A** at center.

A on right of center.

1. Make H E vertical, as in last case, by moving excentric chuck *n* teeth forwards, and screw chuck down till H is at center.

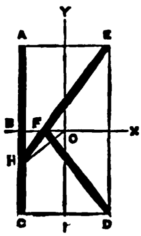
2. Move pulley through 24 — *n* divisions forwards, and drill with pulley stopped in 5 divisions on each side of 24 — *n*.

3. Horizontal line same as in the other two cases.

K at center.

Proportions.

Height	A C	=	12
Width	A E	=	6
	H C	=	4
	O B	=	3
Angle	A H É	=	$37\frac{1}{2}°$
	E F D	=	$105°$



Example.

1. Having determined the height the letter is to be, draw the horizontal lines A E and C D, and the vertical lines A C and E D, bring excentric chuck to 72 and turn it down one quarter of height so determined. This brings A C on to horizontal central line.

1. Let height required be $\frac{1}{2}$ inch or $\frac{5}{10}$, turn chuck down $\frac{5}{40}$ or $\frac{25}{200}$, *i. e*, one whole turn and five *small* divisions.

2. Drill half the determined height of the letter on each side of center (see Law II).

2. Height being $\frac{1}{2}$ in., drill $2\frac{1}{2}$ turns of slide-rest on each side center.

3. Mark on the line thus drilled the point H one third of the height up, and bring this point vertically over center by moving excentric chuck wheel through *n*

3. Eight teeth moved from 72, *i. e.*, to 64 to bring H O vertical.

	Example.
teeth. Screw chuck down till H lies at center.	
4. Move pulley forwards sufficient to bring H E horizontal, and drill.	4. 18 divisions, *i. e.*, to 18 on pulley.
5. Screw chuck up and move pulley backwards till F D is horizontal and drill.	5. 4 divisions below 96, *i.e.* to 92 on pulley.

K on left of center.

1. Having determined the height of the letter and the position of A C, the pulley being in 96, bring chuck to 72, and screw handle down till A C lies along central horizontal line; drill it one half on each side of center.	1. Height to be ½ inch.
2. Now screw the chuck up one half of the height of the letter, which will bring the line D E on the central horizontal line, mark the points D E and draw D E with pencil.	2. Chuck screwed up 2½ turns.
3. Mark the point H and bring it vertically over center by moving excentric chuck wheel backwards. Screw chuck down till point H is at center.	3. 2 teeth from 72, *i. e.*, to 70 on chuck to make H O vertical.
4. Move pulley forwards sufficient to make H E horizontal: if it cannot be done exactly, the excentricity may be slightly altered to make it so, then drill.	4. Pulley moved 11 divisions from 96, *i. e.*, to 11.
5. Move pulley backwards, and screw chuck up till F D is horizontal, and drill.	5. Pulley moved 9 divisions from 96, *i. e.* to 87.

K on right of center.

1. Bring chuck to 24, pulley 96, and having marked the position of A C, screw chuck down and drill A C.	
2. Screw chuck down one half the height of the letter, and draw D E as in last case.	2. Chuck screwed down 2½ turns more.
3. Mark the point H, and bring it vertically over center by moving excentric	3. Chuck moved 2 teeth from 24, *i. e.*

	Example.
chuck forwards. Screw up till H is at center.	to 26.
4. Move pulley forwards till H E is horizontal; if it cannot be made exact, &c., as above § 4, and drill.	4. Pulley moved 6 divisions from 96, *i. e.*, to 6.
5. Move pulley backwards and screw chuck down till F D becomes horizontal, and drill.	5. Pulley moved 13 divisions from 96.

M at center.

Central angle$=37\frac{1}{2}°$, or 10 divisions on 96. Having determined the height of the letter draw the upper and lower horizontal lines.

1. Bring the apex of the central angle vertically over center by moving chuck to 48, and screw the chuck down one half of the height determined for the letter. This will bring the apex of the central angle to the center.	1. Height $\frac{1}{2}$ inch, screw chuck down $2\frac{1}{2}$ turns.
2. Bring the pulley to 72, and drill the two central lines of the letter, five divisions above and below 72 respectively, with slide-rest stops fixed.	2. Pulley in 77 and 67.
3. Bring pulley back to 96, chuck to 24, and screw chuck up till the right-hand line of the letter lies on the central horizontal line, and drill, fixing the stops.	
4. Bring the chuck to 72, and drill between the same stops.	

M on left of center.

Pulley in 96, chuck in 72. Draw the horizontal lines.

1. Bring the apex of the central angle vertically over center by moving excentric chuck through *n* teeth, and screw chuck down till this apex lies at the center.	1. Chuck moved 7 teeth from 72.
2. Now if we had commenced with the chuck in 72 and pulley 96, we should have had to move pulley five divisions on each	

side of 96, to drill the two lines of the central angle, but having already moved excentric chuck wheel *n* teeth, we must only move pulley the difference between *n* and 5 for the first line of the angle, and then ten divisions forwards for the second half. Therefore move pulley *n*—5 divisions and drill between stops.

Example.

2. Move pulley 2 forwards, because 7 — 5 = 2.

Move pulley 10 more in same direction and drill again between same stops.

Move pulley to 2+10 or 12.

3. Now bring pulley back to 96, and chuck to 72. Screw the chuck down till the side line of the letter is on horizontal central line and drill it, between stops.

4. Screw up again till the other side line is on central horizontal line, and drill it between same stops.

M on right of center.

Pulley 96, chuck 24.

1. Bring central apex vertical as before by *n* teeth of excentric chuck, and screw down as before till this apex is at center.

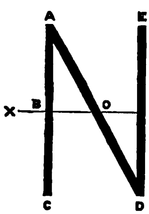
2. Move pulley *n*—5 divisions backwards from 96 and drill between stops. Then ten more in same direction and drill between same stops.

3. Bring pulley back to 96, chuck to 24 and continue as §3 and §4 of M on left of center.

1. Excentric chuck moved 7 teeth forwards to 31.

2. Pulley moved 7—5 or 2 divisions, *i. e.*, to 94. Then to 84.

at center.



Draw upper and lower horizontal lines.

1. Bring pulley to 16, chuck 96, and drill the central line half on each side of center, this gives 60° for angle A O *x* and consequently O A B = 30°.

2. Come back to pulley 96, chuck 24, and screw down one half the width of the letter. A C ought now to be on the central horizontal line, and may be drilled between stops.

3. Bring chuck to 72, and drill E D between same stops.

N on left of center. Draw upper and lower horizontal lines. Pulley 96; chuck 72.

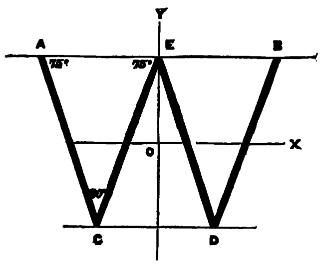
1. Tool being accurately at center, screw chuck down till the point where center (O) of letter is to be, is at exact center of lathe. Move pulley backwards through 8 divisions to 88; because having moved from 96 to 72 on excentric chuck, which we have moved through 24, and only wanting 16 divisions to make A O B = 60°, we must move pulley 8 backwards; (24 — 16 = 8). Drill the central line half on each side center, between stops.

2. Come back to pulley 96. Screw chuck down till D E comes to central horizontal line, and drill between same stops.

3. Screw up till A C comes on central horizontal line, and drill between same stops.

N on right of center. Pulley 96; chuck 24. Then proceed as for **N** on left.

V same as **A** upside down.



W at center. Draw the top and bottom horizontal lines; and, the tool being accurately at center, fix right-hand stop.

1. Turn excentric chuck down one half as much as the height required for letter, this brings the point E to the center.

2. E O will be horizontal with pulley in 72. Therefore drill E C and E D each four divisions from 72 on opposite sides, that is, in 76 and 68, between the same stops.

3. Come back to pulley 96; and, in order to drill A C parallel to E D, shift excentric chuck wheel the same number of teeth as pulley was moved divisions for E D, namely 24 + 4, or 28. That is, shift excentric chuck wheel to 96 — 28, or 68; also, the chuck must be screwed up till A C comes on to central horizontal line, and the stops shifted and refixed.

4. Come back to pulley 96; and, to drill B D parallel to E C, shift excentric chuck wheel 20 teeth (because pulley was shifted $24-4$ or 20 divisions for E C), and also 48 more to bring B D to the top side of center, *i. e.* to $96-48-20$, or to 28.

W on left of center. Draw top and bottom horizontal lines; fix right-hand stop; pulley 96; chuck 96.

	Example.
1. Bring the apex E vertically over center by excentric chuck wheel, moved n teeth backwards.	1. E over center, with chuck in 77, or moved 19 teeth.
2. Screw chuck down till E comes to the center.	
3. E O will be horizontal with pulley in $72+$ the number of teeth just shifted on excentric chuck wheel. That is in $72+n$, or $96-(24-n)$.	
4. Drill E C and E D each four divisions on opposite sides of $72+n$, that is, in $72+n+4$, and $72+n-4$. E C is drilled from the right-hand stop (already fixed) to lower horizontal line, and left-hand stop must be then fixed for E D.	4. Shift pulley to $72+19+4$ or 95, and to 87.
5. Bring pulley back to the starting point in which E C was drilled, namely, $72+n+4$, and move excentric chuck wheel 8 teeth backwards, which brings A C parallel to E D. Screw chuck down till A C comes on to central horizontal line, shift the stops, and drill A C.	5. Pulley to 95, and chuck from 77 to 69.
6. Move fully 8 divisions forwards from $72+n+4$, and screw the chuck up till B D comes on to central horizontal line, and drill.	6. Pulley to 7.

W on right of center. Draw top and bottom horizontal lines; tool at center; fix left-hand stop; pulley 96; chuck 96.

1. Bring apex E vertically over center by excentric chuck wheel moved forwards	1. E O vertical by chuck moved 19

	Example.
n teeth, and screw chuck down until E is at center.	teeth, *i. e.* to 19.
2. E O will become horizontal by shifting pulley forwards through 24 divisions, less the number of teeth just moved on excentric chuck wheel, *i. e.* to 96 + 24—*n*, or 24—*n*. Drill E D and E C each four divisions on opposite sides of 24—*n*, *i. e.* E D in 20—*n*, and E C in 28—*n*, from left-hand stop already fixed to horizontal line, fixing the right-hand stop.	2. E O horizontal with pulley in 5. E D drilled with pulley in 5 — 4 or 1, and E C in 5 + 4 or 9.
3. Bring pulley back to starting point in which E D was drilled, viz. 20—*n*, which makes A C parallel to E D. Screw chuck up to bring A C to central horizontal line, and drill between the lines.	3. Pulley back to 1.
Shift chuck 8 teeth forwards, which makes B D parallel to E C, screw chuck down till B D is on central horizontal line, and drill.	4. Chuck to 27.

X at center. Pulley 96; chuck 96. Draw top and bottom horizontal lines.

1. Move pulley 16 divisions backwards to 96—16, *i. e.* to 80, and drill, fix stops. This makes the angle of the letter 60°.

2. Now move pulley through 16 more divisions (or 60°), *i. e.* to 64, and drill between same stops.

X on left. Pulley 96; chuck 72. Screw down until center of letter is at center of lathe.

1. Move pulley through 8 divisions backwards to 88, and drill to the upper and lower horizontal lines; fix stops.

2. Move pulley 16 divisions forwards, *i. e.* to 8, and drill between same stops.

X on right. Pulley 96; chuck 24. Screw down as above for **X** on left.

1. Move pulley through 8 divisions forwards to 8, and drill; fix stops.

2. Then 16 backwards to 88, and drill between same stops.

Y at center. Pulley 96; chuck 96. Draw top and bottom horizontal lines.

1. Bring excentric chuck wheel to 48 to get apex of angle vertically over center, and screw down a trifle to bring the apex just below center. Move pulley through 17 divisions forwards, *i. e.* to 17, and drill, being careful not to go too far; fix stops.

2. Move pulley 14 divisions more, and drill between same stops.

3. Bring pulley now to 24 and keep chuck in 48, to bring tail of the letter horizontal, and drill.

Y on left. Pulley 96; chuck 72. Tool at center.

1. The apex of the angle must now be thrown a trifle below center by moving excentric chuck wheel backwards, say one tooth, and pulley forwards one tooth to 1, and chuck screwed down till the apex is at center.

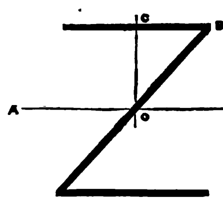
2. Move pulley 7 divisions backwards, *i. e.* to 90, and drill between stops, being careful not to go beyond the apex.

3. Move pulley forwards 14 divisions, *i. e.* to 8 and drill between same stops.

4. Come back to pulley 96, and chuck 72, and drill the tail of the letter.

Y on right. Pulley 96; chuck 24. Tool at center.

1. To throw the apex a trifle below center the chuck wheel is now moved forwards, say one tooth, then proceed as above; but in § 4 the chuck is in 24 instead of 72.



Z at center. Pulley 96; chuck 96. Draw upper and lower horizontal lines.

1. Bring pulley to 34; this makes the angle A O B $= 90^\circ + 37\frac{1}{2}$, being 24 div. for 90°, and 10 for $37\frac{1}{2}^\circ$. Drill the long stroke of the letter.

2. Come back to pulley 96, screw chuck down one half of height determined, and drill upper horizontal stroke; fix stops.

3. Bring pulley to 48, and drill lower line between same stops.

Z on left of center. Pulley 96; chuck 72. Draw upper and lower horizontal lines.

1. Bring pulley to 10, (CoB = $37\frac{1}{2}°$) and screw chuck down till center of letter comes to center of lathe, and drill long stroke.

2. Pulley back to 96, chuck 96; proceed as above.

Z on right of center. Pulley 96; chuck 24. Then proceed as with **Z** on left.

(2). Square Letters E F H I L M T.

E at center.

1. Pulley 96; chuck 72. Screw chuck down half the width of the letter, and drill the long line, half on each side of the center.

2. Bring chuck back to 96. Screw down enough more to make the height required, and drill the top line, half of it on each side of the center, between stops.

3. Bring chuck to 48, and drill bottom line between same stops.

4. Screw chuck up till excentricity = 0, and drill center line to just beyond center of work.

Example.

1. Height $\frac{1}{2}$ inch; width $\frac{60}{200}$, screw down one turn and a half. Drill two and a half turns of slide-rest on each side of center.

2. Screw down till $2\frac{1}{2}$ turns in all are made, drill top line $1\frac{1}{2}$ turn of slide-rest on each side center, or 3 in all.

E on left of center.

1. Pulley 96; chuck 72. Screw chuck down till the position determined for the long stroke of letter comes on to central horizontal line; drill the long stroke, half on each side center.

2. Bring chuck back to 96, and screw up again till no more is left than gives the required height; drill from last line to width of letter, between stops.

3. Chuck to 48, and pulley to 48; drill bottom line with same stops.

E on right of center.

1. Pulley 96; chuck 24. Then same as § 1 of E on left.
2. Same as § 2 of E on left, but screw chuck down instead of up.
3. Same as § 3 of E on left.

F same as E, but without the bottom stroke.

H at center.

1. Pulley 96; chuck 72. Screw chuck down one half the proposed width of the letter, and drill half the height on each side center, between stops.
2. Bring chuck to 24 and drill between same stops.
3. Bring chuck to 96; make excentricity = 0, and drill between the lines already drilled.

H on left of center.

1. Pulley 96; chuck 72. Screw chuck down till the long stroke on right side of letter comes to the central horizontal line, and drill half proposed height on each side center, between stops.
2. Screw chuck further down till other stroke comes to central horizontal line, and drill between same stops.
3. Same as § 3 of H at center.

H on right.

1. Pulley 96; chuck 24. Then proceed as for H on left.

I at center.

1. Pulley 96; chuck 72. Drill half height proposed on each side of center.

I on left.

1. Pulley 96; chuck 72. Screw down till the position for letter comes on central horizontal line, and drill as before.

I on right.

1. Pulley 96; chuck 24. Proceed as before.

T at center.

1. Upright stroke same as I.

2. Come back to excentric chuck 96; screw down one half the height required, and drill half width on each side of center.

T on left of center.
1. Pulley 96; chuck 72. For upright stroke.
2. Same as T at center.

T on right of center.
1. Pulley 96; chuck 24, and then as for T on left.

SHERRARD B. BURNABY.

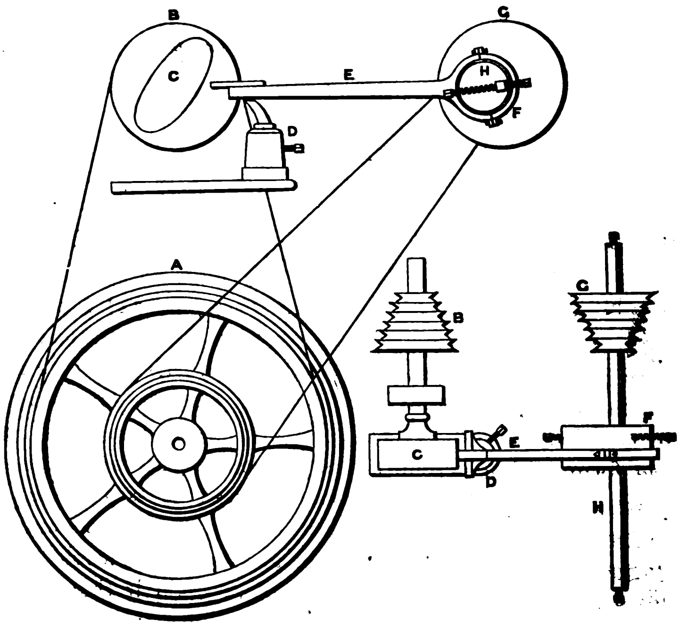
(*To be continued.*)

A SUGGESTION FOR OVAL AND ROSE ENGINE-TURNING APPARATUS.

IN a former paper (*Taste and Form*, p. 52) I proposed making some suggestions for adapting apparatus for the production of *form* as distinct from *pattern*. Since I last wrote, the inventions of Mr. Taylor and Captain Dawson have been described in this Journal; both seem capable of producing form within certain limits, as well as patterns unlimited. The simpler apparatus I am about to describe is intended for turning ovals and rosettes. I give it in its original shape, and call it a suggestion only, as there may be amateurs who would like to try the experiment without spending more upon it than did the schoolboy who first tried it twenty years ago. In this arrangement it will be seen that the nature of the work varies with the relative velocities given to the mandrel and the tool.

An oval is turned by using equal velocities; the shape of the oval varying with the length of stroke given to the excentric, and its size with the distance of the tool from the centre of the work. Rosettes are turned by giving a slow motion to the work, and a rapid motion to the tool; the depth of the indentations varying with the length of stroke given by the excentric, and their number with the respective velocities of the work and the tool. By shifting the tool to the face of the work oval and rose-engine *patterns* can be cut in considerable variety, and by shifting the rest from beneath the tool more or less towards the excentric, the tool itself will describe circular or oval patterns on the face of the work, which must, for these, be held and moved by the dividing plate. If the work is made to revolve, cycloidal and geometric patterns can be cut by the combined circular and oval movements.

For turning ovals and rosettes, the chuck must be tightly screwed



A is the driving-wheel of the lathe (the framework is omitted from the drawings); B, the mandrel pulley; C, the work, an oval; D, the T rest; E, arm of the excentric; the excentric F and the pulley G, similar to the mandrel pulley, are carried on a square axle H, at the back of the lathe, parallel with the mandrel, so that the pulley G can be worked by the driving-wheel at the same time with B. The cutting-tool is clamped upon the lever E, supported by the rest, and is moved to and from the work by the action of the excentric.

or keyed to the mandrel, as in this arrangement its usual direction is reversed. The tool may be steadied by the hand, care being taken that as few jars as possible occur, lest the lathe-bands slip and the work be spoiled. Some patience is required for adjusting the bands for the several velocities, and they must be well stretched upon the wheels.

The most obvious improvements upon this apparatus are (1) the use of change wheels to connect the excentric with the mandrel; (2) fixing the tool in the slide-rest, and working one of the slides by the connecting-rod of the excentric. It should also be contrived that the tool should work on the side next the workman.

I have no experience of their full capabilities, but I think that, with some such apparatus as I have suggested, most of the work of the oval chuck, and of the cumbersome and expensive rose-engine, could be accomplished at a smaller cost, so that the *forms* of ovals and rosettes might be more frequently used, which is my chief object in writing now; and as the same apparatus, with slight modification, would probably produce oval, rose, excentric, and geömetric patterns in sufficient variety for most amateurs, it would save the cost of additional apparatus for surface patterns.

C. R. H.

P.S.—I have just read, in the *English Mechanic* for January 12th, 1872, a letter, signed "H. S. Savory," in which the writer speaks of "having cut out a six outer-looped box more than one inch deep" with the geometric chuck, and I infer from the letter that the cutting tool was a drill carried by the slide-rest.

The geometric chuck is only known to me by some of the patterns produced by it, therefore I do not quite understand the above description of the box, but suppose its shape would be more or less hexagonal, or a hexagon with round corners and curved sides, if such a description may be allowed me. Such a shape would be cut by the apparatus I have been describing if the velocities of the mandrel and of the excentric were as 1 to 3; with velocities as 1 to 2 the shape cut would be nearly a square, which form could also, I believe, be cut in the geometric chuck.

Mr. Savory's box, however, is an instance of the use of apparatus for the production of *form* as distinct from *pattern*, and I am the more anxious to draw attention to it because, as he speaks of it as being a somewhat novel use of the geometric chuck, it may interest amateurs who possess the apparatus, but have only used it for the production of patterns.

C. R. H.

MOTIVE POWER FOR AMATEURS.

(*Concluded from p.* 126.)

THE *Windmill*, one of the most ancient of the motive-power engines, is now very little used, and nearly forgotten. It is not at all impossible, however, that its assistance may at some future day rise in comparative value, and, in that case, the windmill will be reintroduced perhaps as a new invention and subject of a patent, for which the Attorney General of the period may have the pleasure of receiving the usual big fee, and appending his name as a warrant for future litigation. A small windmill, such as an amateur would require, would cost, say about £40 erected, and something more for bringing the power from the windmill to the lathe-room. Once erected, it gives out its power free of cost, and an occasional oiling is almost the only attention it requires. It is somewhat bulky for the power obtained through its agency, and it is not at all times desirable to have such an apparatus on the roof of one's house, nor is it to every place that the wind can get access. The chief disadvantage attending its use is the uncertainty of its power both as to time and intensity. It is not generally convenient for an amateur to work only when the wind blows, nor is it always convenient for him to work when the wind does blow, so that by itself, the windmill is useful only for such purposes as pumping. But by employing a heavy weight in conjunction with a windmill, an equable force could be obtained when required, except, perhaps, in seasons of long-continued calm. With the weight suggested, the arrangement would be such that the windmill, whenever going, would be employed in winding up the weight, and simple mechanism should be added, so that when the weight was lifted as high as it was arranged to go, the windmill should be thrown out of gear or stopped. In this manner the amateur would derive his power only indirectly from the mill, but directly from the energy due to the weight falling from the height to which it had been previously lifted by the windmill, and I believe that this motive power would then be obtained in as convenient a manner and as inexpensively as by any means I am acquainted with.

In cities and other places where water may be drawn from the mains at a considerable pressure, the *Turbine Water-wheel* is a very convenient, and in every respect an eligible motor. In some places the water can be obtained at a pressure of from 50 to 100 pounds per square inch, and, in such instances, the turbine wheel would need to be but a very small instrument, so small that an enthusiastic amateur might use it also as an appendage to his watch chain. These instruments fulfil all the conditions laid down in my previous paper; and they are, I consider, preferable to any kind of reciprocating water-pressure engine.

The *Steam Engine* may, on the whole, be considered the motive power most generally applicable to the purposes of the amateur mechanic, but it has its disadvantages, and rather serious ones. A steam engine for an amateur's workshop should work at very high pressure, say 100 to 150 pounds to the inch, for high pressures are really no more dangerous than low pressures, and the higher the pressure the smaller is the quantity of water required to produce a given power. The cylinder of the engine would be very small, and its crank shaft would rotate at a high speed. The steam generator for such an engine should be relatively very large, in order that the engine may run some time without lowering the water level so rapidly as to oblige the amateur to be very watchful against explosion from overheating. I see, in my mind's eye, a little steam engine of this sort, that would run even the turbine wheel a very close race for the amateur's patronage.

Gas Engines appear to have many admirers, and no doubt for small powers, they are in many respects advantageous. But a very large and clumsy machine is necessary to produce even the small power an amateur requires. The *Lenoir* engine is perhaps to be preferred to the *Hugon*, and, I think, the *Otto & Langen* to either, although the latter makes an objectionable noise. All these engines emit a more or less disagreeable smell, and, when neither wind nor watermill aid us, I should, on the whole, be inclined to call in the assistance of heat and a steam engine in preference to the same agency and the gas engine.

Examples of the turbine, the water-pressure engine, the steam engine and the gas engine, are all to be found in the workshops of our members, and I think the users of these machines would confer a service upon the Amateur Mechanical Society by publishing in this Journal their several experiences.

W. H. N.

NOTE ON THE EMPLOYMENT OF THE EXCENTRIC CUTTER.

IT occurred some years ago to the writer that, as by means of the motion of the slide-rest and the mandrel, a cutting tool can be placed opposite every point of the surface of work, it is theoretically possible to arrange the cuts made by an Excentric Cutter along *any curve whatsoever.* Unfortunately however, the difficulty of making the calculations will hinder one from adopting this plan in all cases. It also occurred to him that many patterns might be formed by combining the motion of the slide-rest, division plate, and screw of the excentric cutter. He has worked out a great many patterns consisting of looped, waved, and orthoidal figures, cut according to one or other of these methods, in a little book which he hopes shortly to publish. He gives here an example of each method.

Definitions.

I. By the *excentricity* is meant the distance that the slide-rest has been moved to the left, *i. e.* towards the operator, from the position "all at center."

II. By the *radius* is meant the distance that the slide of the excentric cutter is thrown out from the position in which the tool cuts a mere dot.

Before cutting either of the patterns here given the operator must adjust *most carefully* for height of center; he must also particularly guard against any loss of time in the movement of either the slide-rest screw, or of the excentric cutter screw.

Fig. 1.—*A figure of six loops.*

Make cuts with radius ·1 inch and excentricity 1 inch at the following numbers on the 96 circle of the division plate :—8, 24, 40, 56, 72, 88.

Diminish excentricity by ·02 and cut at 7, 9, 23, 25, 39, 41, 55, 57, 71, 73, 87, 89.

Diminish excentricity by ·0575 and cut at 6, 10, 22, 26, 38, 42, 54, 58, 70, 74, 86, 90.

Diminish excentricity by ·0925 and cut at 5, 11, 21, 27, 37, 43, 53, 59, 69, 75, 85, 91.

Diminish excentricity by ·125 and cut at 4, 12, 20, 28, 36, 44, 52, 60, 68, 76, 84, 92.

Diminish excentricity by ·15 and cut at 3, 13, 19, 29, 35, 45, 51, 61, 67, 77, 83, 93.

Fig. 1.

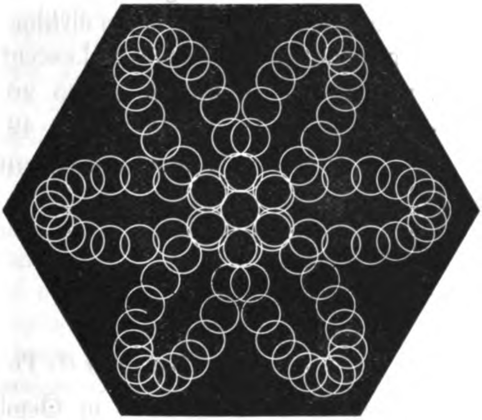
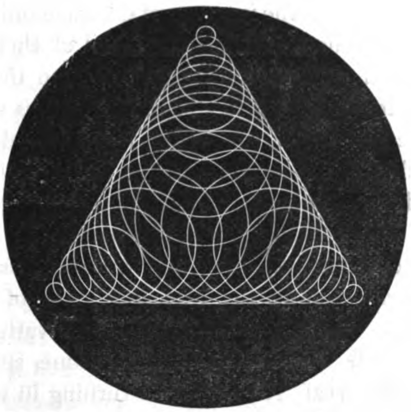


Fig. 2.



Diminish excentricity by ·1725 and cut at 2, 14, 18, 30, 34, 46, 50, 62, 66, 78, 82, 94.

Diminish excentricity by ·1875 and cut at 1, 15, 17, 31, 33, 47, 49, 63, 65, 79, 81, 95.

Diminish excentricity by ·195 and cut at 16, 32, 48, 64, 80, 96.

If the pattern has been cut correctly all the cuts after the last given change of excentricity will be coincident.

FIG. 2.—*A triangle.*

Cut at 96, 32 and 64, on the 96 circle of the division plate, with the following corresponding values of radius and excentricity:

Excentricity .	100	90	80	70	60	50	40	30	20	10	0
Radius .	0	5	10	15	20	25	30	35	40	45	50

HOWARD WARBURTON ELPHINSTONE.

GOSSIP.

"... bald, unjointed chat ..."

King Henry IV, Pt. I.

WE were favoured with an invitation in October last to visit an Exhibition of Turned Work, held towards the end of that month, at the Mansion House, under the auspices of the Worshipful Company of Turners, whose peculiar province it is to watch over the interests of the trade indicated by their title. Judging from the formal notice issued of their intention to hold this Exhibition, we conclude that the step they are taking is comparatively new, and, we feel bound to say, is one which, in our opinion, if persevered in, cannot fail to be attended with satisfactory results, should the ends aimed at in the conditions be in any sufficient degree realised. The Company proposes to give each year their Silver Medal and the Freedom of the Company and of the City of London to any one workman or apprentice in the trade who may send in the best specimens of hand-turning for the year. The material to be used will be varied in different years so as to include wood, ivory, metals, stone, spar, &c. The competition for the year 1871 was in turning in wood with the ordinary lathe, but without special apparatus, and the qualities considered in awarding the prize were the following.

1. *Working to exact dimensions*, illustrated by a cylinder, six

inches long and two inches in diameter, or any other object measuring exact inches without fractions.

2. *Exactness of surface and fit*, such as is shown by a nest of cylindrical boxes with screwed lids, which shall drop out of one another and fit without shake. These qualities may be otherwise illustrated at pleasure.

3. *Exact copying*, so that the two objects produced (such as two cups, vases, boxes, or chessmen) may be fac-similes in every part.

4. *Neatness of design, symmetry of shape and good form of moulding.*

5. *Fitness of the work and design for the purpose proposed.*

6. *Ability to turn in different woods of varied grain and degree of hardness.*

The qualities above detailed are, without exception, excellent, and their presence, individually or collectively, in a piece of work would afford evidence of a master hand. We are surprised that proficiency in screw cutting does not occupy a more prominent place than that accorded to it in No. 2. In Nos. 4 and 5 we are brought back to the theme we have so repeatedly insisted on—*form*—a subject presenting sufficient difficulty to the amateur, who may be supposed to have good opportunities for art education, how much more then, to the professional turner, whose opportunities for such study are very limited, and whose living depends too often on the quantity rather than the quality of his work. Still, the daily-increasing facilities for art study, coupled with efforts such as the one we are speaking of, will go far to raise the standard of excellence in this, to our mind, most essential particular. We must confess our disappointment at the small number of "exhibits," but this is a defect which will doubtless diminish from year to year. The first three and last of the six conditions appeared to offer no material difficulty to the aspirants, if we except one who had apparently understood the cylinder referred to in No. 1 to mean a model of a steam cylinder with piston complete. He also apologised for having made the said model only five inches long, because he had not a piece of mahogany large enough! We should have thought that if the prize was worth the trouble of competing for at all, it was worth the extra inch of wood required. Most of the articles were exceedingly well executed, and bore witness to the dexterity of their makers; but some few, especially those professing to satisfy conditions 4 and 5, we are at a loss to understand how it can have occurred to any man to perpetrate. We noticed a case containing a number of snuff-boxes, the medallion portrait on one of which at once indicated its origin. Our industrious member Mr. Forshaw, whose work they were, it appears not only received permission to exhibit them, but was admitted to the Livery of the Company and the Freedom of the City of London. This was, of course, independent of the Exhibition, for Mr. Forshaw could not possibly claim that his medallions were turned "without special apparatus."

Among the Prince Imperial's belongings, which were sold in Paris last autumn, together with other property of the Imperial family, were to be found a small steam printing press, carpenter's, locksmith's, and ivory-handled turning tools, as well as, says one of the newspaper reports, "some awkwardly turned pegtops, balls and draughtsmen," proving that his mechanical education was not neglected; nor does it appear to be so now, for we see by a paper of a later date, that he is at present, or was, studying mechanics at King's College, under Professor Eldon. The cabinetmaker's and locksmith's tools remind us of Louis XV and Louis XVI, and possibly some such thought was present in the mind of the Emperor when he decided that practical mechanics should form a part of his son's education. Be this as it may, there can be no doubt as to the wisdom of such a decision, and we think that a love of skill in practical mechanics might with advantage be more generally encouraged in the education of our youth. At our public schools, for example, it would take the form of a recreation, and one that would certainly be more conducive to health than playing at foot-ball in a thin jersey, on a pouring day, in the middle of winter. None but those who have experienced it can realise the discomfort, to say nothing of the danger, of "keeping base" under such circumstances for an hour or so. A little time in the course of the week devoted to such pursuits as carpenters' and joiners' work, turning, &c., could scarcely be said to be wasted, for we imagine that to men in most positions in life, manual dexterity would be almost, if not quite, as valuable as much of the knowledge acquired at our schools. Then, again, after his school days are over, a young man, once thoroughly imbued with a love of mechanical pursuits, will most assuredly be provided, not only with a delightful means of recreation for an over-wrought brain, but with a powerful counter-attraction against the allurements of the many questionable places of amusement which exist in large towns and cities. Ours will no doubt be considered by many an interested statement of the case, but we nevertheless deem our position tenable as regards not only mechanics, but all the "liberal arts and sciences."

Our limit being reached, we cannot, as usual, devote any space to the *Scientific American*, and the presence of other, and we trust equally interesting matter, will account for the non-appearance of the articles headed *Notes* and *New Tools* in this number.

THE TURNERS AND TURNERY OF KING'S CLIFFE, NORTHAMPTONSHIRE.

FOR very many years the small town, or rather village, of King's Cliffe, about eight miles from Oundle, has been remarkable for the manufacture of various useful articles in soft wood, chiefly by means of the lathe. Situated in the very heart of what was once Rockingham Forest, it is probable that the abundance of material created the trade, though I can find but little concerning it in the way of history. The place itself seems to have been of more consequence formerly than it is now, for we find that it had a charter for a market; indeed Bridges, who died in 1724, having collected a vast store of materials for the "History of the County," afterwards published, writes, "Here is a weekly market on Tuesday, and a fair for three days, beginning on St. Luke's eve." Both market and fair have been long discontinued, and it now ranks as a large village with a population in 1871 of 1259 souls. It is also said that here was a hunting seat of King John, but no vestige of it remains. Some of the older writers remark upon the want of wood in Northamptonshire; perhaps they referred to the scarcity of hedge-grown timber in the then unenclosed fields, for surely three large forests, Rockingham, Salcey, and Whittlebury, must at all times have rescued it from this reproach. Of Rockingham Forest, with which we have now to do, Bridges informs us that its limits extended from Oxendon Bridge, near Market Harborough, to Stamford Bridge, in length about twenty miles, and in breadth four or five miles, and within its precincts was good corn and pasture, and plenty of wood.

Morton, who was Rector of Oxendon, and published a natural history of Northamptonshire, writes, in 1712, "A large part of the county, along the southern banks of the Welland, or betwixt the rivers of Welland and Nyne (Nen), is taken up with the Forest of Rockingham, which, as it now stands, is dismembered into several smaller parcels, and those, in some places, at considerable distance from each other, by the interposition of fields and towns. In all probability it was one entire or continued tract of wood, and a forest of much larger extent than now it is; yet the present extent, according to the last survey in 1641, is well nigh fourteen miles in length, the breadth of it in the upper part is five miles, and in the lower part very nearly as much; but before that Livedon and other adjacent territories were disforested, it was much broader. Almost encompassed with the forest is a spacious plain called Rockinghamshire, while the Lawn of Benefield, one of the lawns of this forest, is spacious and fair, and a place of excellent grass for the deer. Of the forest in general, it is usually said, and that with great reason, that it is one of the largest and richest in the whole kingdom. In the Westhay Wood, and in several other woods of this forest, by Cliffe and thereabouts, is made a considerable quantity of charcoal of the tops of trees. Many waggon loads of it are sent down yearly to Peterborough."

So wrote Morton and Bridges, years ago, concerning Rockingham Forest, and I shall have to refer to them yet again; but I may here remark, that though there remain considerable tracts of woodland, the forest, as in their time, has almost disappeared. The last fifty years have seen great changes, and still more "room has been made for the plough by stocking up the woods." Touching the trees of the forest I have not much to say. The ash has been called the "staple timber tree, the weed of the county, the ash keys germinating here as freely as the acorn in Warwickshire"—(*Rev. T. James*). Morton, speaking of the western part of the county, tells us, "the smiths of Bromicham do usually, once in the year, make a journey thither for ash timber, for the doors of bellows. At Winwick, in 1703, they gave £1500 for 100 ashes. They were clean and straight, as usually here, which are the ashes fit for their purpose." The ash is still a good tree hereabouts, and we can still boast of good specimens. The Crawford Ash, *e. g.*, which, if not within the bounds of the Forest, must have been close to its borders, is a remarkable tree. It measures, as I am credibly informed, twenty-one feet in circumference at four feet from the ground, and covers with its wide spreading branches thirty-six poles of ground. We have a not very mean specimen in this Parish of Bulwick, belonging to Thomas Tryon, Esq., and I know of others well worth looking at. There are fine specimens, too, of very old oaks, especially I would mention those on Morehay Lawn, close to King's Cliffe, and I will not pass by an elm in Deene Park, near here, which measures twenty-two feet in circumference at four feet from the ground, the branches above spreading over about thirty yards of ground from east to west and the same from north to south. The butt is short (a Wyche elm, I suppose), but the branches are magnificent. There is, again, a rather remarkable maple in Blatherwycke Park, adjoining Cliffe, the property of H. De Stafford, Esq. Usually, about here, the maple does not grow to a large size, and the butt not more than eight or ten feet high. This one measures five feet six inches in circumference at three feet from the ground, and runs up straight without a branch for full twenty feet. I do not know another like it.

But it is time that I should turn to the special subject of this paper—the turners and turnery of King's Cliffe. As already observed, I cannot tell much in the way of history. On making inquiry at Cliffe itself, all I have been able to learn yet is from a man who told me that his grandfather died in 1818, at the age of eighty-eight, that he was brought up a turner, and practised it all his days. This takes us back about 140 years. But I can go back yet a little further, for Morton, already quoted, makes mention of the Cliffe trade in these terms. He had been speaking of the charcoal burners, when he proceeds: "And hither all other arts that respect the wood of trees, and particular that of turning, is to be referred. At King's Cliffe, a town of no great bigness, there were, when I wrote this, above twenty tradesmen, whose employment was the turning of dishes and spoons. The latter is a distinct trade of itself, and tools they have appropriate to it. There is scarce any town in England wherein this sort of handicraft is so much professed, or is managed with so great dexterity as here." This notice shows that the trade was no new trade then, and probably it had been carried on many years previously. There are at this time not less than forty men constantly employed in the trade, so that it has not decreased since the days of Morton. The woods most in request by the turners of King's Cliffe are maple, sycamore, alder, birch, lime, chestnut, beech, ash, and whitethorn. Lime, sycamore, and beech are often cut into boards for trenchers, when of sufficient size, but the woods in most request are poles from two to six inches in diameter. It is usually sold in parcels, each parcel containing a rood, or half rood, the buyer to cut it down and convey it home. So much of the country having been disforested, there is a comparative scarcity of this material, and it has to be sought at greater distances than formerly, while the workmen complain somewhat of the "Leicester folk," who come to them to buy poles for "bobbins" to wind cotton on, for which they commonly give about twenty-five shillings a ton, delivered at the nearest station. When the poles are brought home they are stacked out of doors for twelve months, then put under cover for another twelve months, before they are fit for use. Sometimes green wood is boiled to extract the sap, and is thus used in a very short time after being cut down, but an experienced turner told me he did not consider this to answer; the wood, under such circumstances, being very liable to split; *e.g.* salt-cellars and egg-cups are turned out roughly, and left some time before finishing; but if the wood is boiled, as above, a large proportion of them crack and are useless. The tools employed are simple enough; the lathes—at any rate, by the side of a Holtzapffel—are generally clumsy, heavy-looking, with wooden

HOLTZAPFFEL'S PATTERN.
Shank, 5 inches; handle, 9 inches.

wheels, and wooden chucks ringed with iron. I find the lathe-heads usually come from Birmingham, and cost about twenty-five to thirty-five shillings each, the frames being home made. Common chisels and gouges, with hook tools, are used with great dexterity, the result of practice in one particular line. The "hooks" are commonly made by the village blacksmith, under the turner's direction, for different turners seem to me to have different *twists*, and each prefers his own. I have had a set of six made for me at 1s. 6d. each. They are more substantial than some I have, of Holtzapffel's, and of a different shape, thus:

KING'S CLIFFE PATTERN.
Shank, 8 inches; handle 12 inches.

It is really very interesting to see how cleverly these tools are managed. There is here, as in other places, a division of labour, for though most of the turners can do many things, each one has his own speciality at which he is most expert. Thus, at one shop are made spice boxes, salt-cellars, &c., at another pump buckets, at another water and beer taps, at another spoons, and so on; but how these are made, what "the tools appropriate," and what the demand for the various articles must be left to a future opportunity, when I hope to give a few examples of what is always to myself, and probably to all turners, interesting work.

JOHN H. HOLDICH.

CORRESPONDENCE.

SCREW-CUTTING, &c.

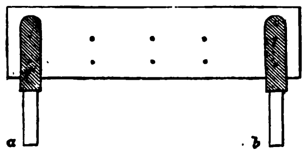
To the Editor.

SIR,—I see in the last number of our Journal that J. H. has expressed his opinion that cutting screws in soft wood, by means of a V-tool, is "simple and easy," and directs that the tool shall traverse the whole length of the intended screw during one downward stroke of the treadle. No doubt mechanical manipulation is more easy to one and less so to another, but I think any one who will try the experiment in question will find quite sufficient difficulty to make success, if achieved, delightful. The Northamptonshire turners evidently pride themselves on the facility gained after long practice, which seems at any rate to premise certain obstacles requiring skill and perseverance to overcome. The Tunbridge turners use a traversing mandrel as a matter of course, thereby acknowledging a difficulty which, for some reason, they decline to be at the pains of conquering. If, therefore, J. H. is himself in this matter an adept, let him congratulate himself. But, as regards the treadle-motion above referred to, I do not see how the thing can be done. Suppose, *e.g.*, an inch is to be cut with a thread of 8 pitch, the work must make eight revolutions exactly while the treadle descends once. Whether or no it will do so must depend *on the relative size of the fly-wheel and pulley*, which is by no means always as sixteen to one (for, observe, we have but a half revolution of the fly-wheel). I think the statement which I fall foul of, is an oversight nevertheless, and (as I know from experience) an oversight of this kind is exceedingly apt to creep into black and white, ready for some one of the hawk and vulture species to prounce upon at the earliest opportunity. If J. H. simply means that a habit should be gained of running the chaser along in exact time with the downward tread of the foot, returning always to the first position of the tool just as the crank is again ready to descend, I quite agree with him; the only difficulty being to strike each time with the point of the chaser in the hollows of the thread. If the length of the required screw is too great for the tool to run it at once, the first few threads become a guide for the rest as soon as they are deep enough to hold the tool securely in cut, and after the length of screw has thus been traced piecemeal, the whole should be chased at one run from end to end a few times, without stopping, to finish off the work, and in this the treadle will be up and down probably a good many times; but if the turner can stand steadily, as he ought to do, upon one leg, using his hand with perfect independence of the motion of his body or legs, this operation will not be one of difficulty. To run a thread with a single point or V-tool, *using the treadle*, is by no means so easy as the same operation with a comb, upon a piece of box or hard wood.

J. H. remarks also upon the inexpediency of a traversing mandrel. If a turner is *perfectly safe* as to screw chasing by hand, I agree with him upon the point, although I myself have a traversing mandrel, and *occasionally* use it for its legitimate purpose. I think screw-chasing is comparable to public speaking, or preaching extempore; fear makes a break down, but a dash *in medias res* very generally insures fair success. Professional turners, whose practice is certainly not to be despised as teaching the *best way* of doing things, presupposing *intelligent* workmen, give one a rather strong hint upon the question of traverse or no traverse. They use, extensively, wooden cup chucks bound at each end with a ring of iron to prevent splitting. Having screwed such a chuck upon the nose of the mandrel, *they drive the work into it by blows of a tolerably heavy hammer.* How about the traversing mandrel standing usage of this character? Yet there can be no doubt that dispensing with the back centre by thus firmly chucking the work has great advantages. A professional would in this manner turn and bore a tool handle of hard wood, without any boring collar, simply because he is thus accustomed to secure his work immovably in the chuck. Amateurs take a great deal of unnecessary trouble in these respects. The truth is, an amateur's lathe is not by any means generally suited for *general* turning. Many have a strong lathe for rough work, and another, with traversing mandrel, for ornamental turning; and when a lathe is intended to be devoted to the latter kind of work only, or chiefly, not only would it be almost impossible to have it strong enough to bear hammering work into a chuck, and similar rough usage, but it should decidedly be made with a traversing mandrel, inasmuch as this is necessary not for screw cutting alone, but also for what is called the pumping action, used with swash-plates. This is beyond question the class of lathe for costly chucks and fittings of the like nature, and then the usual three-foot-six iron bed is also sufficient; but if one lathe only is to be had, and this is to be used generally upon all kinds of work, and only casually upon something of a more elaborate character, I think I should decidedly prefer a plain, strong mandrel, not traversing, and a six foot bed—a lathe to be used without fear; nor is it necessary that such a lathe should run heavily, because strong enough to bear a little hard usage. I could point out more than one or two makers who would give a mandrel, fit for any ordinary work of an amateur, which from excellence of fitting, narrow collar, and first-rate temper would run smoothly and lightly, would not disgrace an excentric or geometric chuck, and yet would not be liable to give way under such heavy inflictions as I have spoken of above. The bed of a *general* lathe should never be less than six feet long, and should have heavy and stiff standards.

I can only say from experience that it is a great nuisance to find that you have a too short lathe bed. The extra cost in the original is not heavy, and it is by no means pleasant, if by chance you wish to turn a table leg or similar article, instead of some wonderfully elaborate work in ivory, to find yourself nonplussed for want of an extra foot or two of bed.

Another item of lathe apparatus is a longer rest, one of metal or hard wood, with *two* tenons to fit into *two* sockets. This, for long work, will be found a great convenience. Chairmakers arrange a rest in a very simple way; they have an iron hook on each wooden poppit, working in a mortice, to allow it to be drawn out according to the diameter of the work, and in these is placed a flat bar of hard wood, so that the rest extends from poppit to poppit; but this cannot be arranged with the ordinary metal lathe-heads, hence two rest-sockets become requisite. The T's for such work can be cheaply made thus:



If the board will clear the poppits when in use, *a* and *b* can be put nearer or further apart, according to the length of the piece to be turned.

The general suggestions of J. H. are but an echo of what I myself have written many a time and often, and I am right glad to see another inclined to run in this same groove—recommending the exercise of ingenuity and home-made shifts and appliances of the true workman, instead of spending needless dollars on apparatus which may possibly not be called into use again for years after that special work is accomplished for which such costly apparatus was deemed necessary. It is far more creditable to do much with few appliances than to be the possessor of expensive fittings and turn out (exquisitely done it may be) only a few *chef-d'œuvres*. If it were not for the dread of calling up an honest blush, I could name an amateur in our ranks whom many would consider very indifferently fitted up with lathe apparatus, over whose tasteful work, nevertheless, we have, many of us, bent with criticising eyes, and been fain to confess that it was in all points well and excellently done, of good taste, and masterly workmanship. In conclusion, I beg to add my hope to that of our Editor, that "J. H." will write us many more pages, not henceforth as an outsider, but as an honoured and valued member of the Amateur Mechanical Society.

J. L.

Egg-Shell Turning.

To the Editor.

Sir,—Interpreting your observations on page 134 of the Journal as a general invitation, I beg to forward, for the information of the members my plan for preparing an egg-shell for mounting in the manner referred to.

Select an egg of regular shape and without cracks, wash it with warm water and soap, using a moderately hard brush for the purpose; when clean and free from stains put it in a saucepan with sufficient cold water to cover it well; heat the water gradually until it simmers, keep it simmering five minutes to make the white hard, but be careful not to let it "gallop," or the shell will in all probability crack; then wrap it in a dry cloth and let it gradually cool. Now drive a piece of willow, alder, or birch into an ordinary cup-chuck, turn it out to fit the large end of the egg accurately, about the middle, damp the inside of the chuck and hold a piece of chalk against it as it rotates. The wood being wet causes it to adhere to the shell, and the chalk prevents the egg from slipping out. Having adjusted the egg very truly, divide the shell into two parts with a fine-pointed tool. The inside being hard, prevents the half out of the chuck from falling when the shell is cut. Now take a very thin knife blade, or anything else which will answer the purpose, wet it, and carefully pass it through the incision in the shell, working the mandrel backwards and forwards with the left hand until the white and yolk are divided in two, having first prepared a cloth for the detached half to drop on. I have cut many shells, and use for the purpose nothing more nor less than a small saw file ground to a very long conical point. These files are usually made harder than ordinary files, and are consequently better adapted for cutting through the enamel of the shell. If holes in the ends are required for the purpose of mounting, the egg must be chucked by the small end first and a hole drilled in the opposite end, then turn a trifle from the face of the chuck, *nearly* down to the shell, to relieve it, taking care to hold one hand to catch it if it should fall out before you are ready; now chuck it by the large end, make the hole opposite, and cut the shell in half as directed above. Shells thus prepared may be mounted effectively as cups, vases, &c., in ivory, African black wood, or cannel coal, according to the taste of the operator, but patience and perseverance are essential to success. Duck's eggs are far more brittle and thinner than common eggs, but when of a dark-green colour look well, mounted in ivory. Deep-coloured cochin china eggs are also very suitable.

E. F. Baker.

Turning Spheres by Templates.

To the Editor.

Sir,—As the correspondent, mentioned on page 99, who supposed he had successfully turned a ball by the aid of a semicircular template and tool with a semicircular edge, I have a confession to make. I was too hasty in my conclusion.

All went well enough with me until near the *final cut*, when, owing to want of foresight, my tool-slide reached the chuck and stopped the work, which has never been completed. A friend was with me, and I suppose this accident led us both away from the real difficulty we should soon have met with; at any rate, we concluded that there would be no more difficulty with one end of the ball than there had been with the other, and that, to all intents and purposes, the thing was done. This was the more readily taken for granted because, as the Editor, who proposed the plan, says, "the principle is clear and theoretically perfect." It is easily solved mathematically, but it seems to be just one of those perfect theories of which it cannot be said, *solvitur ambulando.* If we could work with mathematical points for guide-pin and cutter, the thing could be; unfortunately, such points cannot be fixed in a slide-rest or made to cut, but as we must work with tools of definite size and shape, we have to make allowances for them which the theory does not make. This, I think, is the real reason why it is *practically* impossible to turn a sphere by means of a template.

C. R. H.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

APRIL, 1872.

HON. SECRETARY'S REPORT.

Meetings of the Council.

THE first Council Meeting this year took place on the 3rd February, when six members were present. The Balloting Papers, which had been returned properly filled up, were first examined, and the two gentlemen who had been nominated to serve on the Council, Messrs. Northcott and Rivington, were declared to be duly elected. The Hon. Secretary was re-elected, and the Editorship of the Journal still left in his hands. The following gentlemen were admitted members of the Society:

Sir Charles Taylor, Bart.,
Herbert William Smith, Esq., and
Thomas Sebastian Bazley, Esq., M.A.

Mr. Burnaby's proposal, noticed on p. 149 of the last number, was further considered. Arrangements were made for the Annual Dinner.

The next meeting was on the 7th March—five members present—when the following gentleman was duly elected:

James Stuart Tulk, Esq.

Thursday, the 2nd May, was fixed for the Annual Dinner, which it was decided should take place at Willis's Rooms, the arrangements to be, in every respect, similar to those of last year.

T. W. Boord.

CONSIDERATIONS ON THE USE OF TEMPLATES BY AMATEURS.

SO much has been said lately in this Journal on the use of templates in the lathe, that it may be advantageous to take a broader and more comprehensive view of the whole subject. In a recent number (page 134) I suggested one use of templates, but I shall now attempt to show that, from an amateur's point of view, they are only to be regarded either as imperfect substitutes for more costly mechanism, or as temporary expedients for a special purpose.

Take the latter case first; this will comprise their use as guides for the slide-rest tool in the production of form. A turner wishes to make a vase with ornamental patterns cut upon the outside, and following its shape. He can turn the vase to any required form without the assistance of a template, but he cannot without it apply the ornament accurately and with good effect. He therefore cuts out a template to the required curve, and, when it has been used for this special purpose, it is laid aside, never, in all probability, to be again fixed to the slide-rest. He is justified in having recourse to this temporary expedient for a special object which he could not otherwise accomplish, and the slide-rest remains fully available for all its original uses.

But when we consider the use of templates as substitutes for more perfect mechanism, it will at once be seen how cautious we should be in extending their use. Examples will occur to the reader. Whether we attempt to turn billiard balls, to make spirals (as in the paper alluded to above), or to produce geometric patterns by some such contrivance as Captain Dawson's,* it is evident that the character of the result depends upon the degree of accuracy with which the template is filed out, and, if the intended curve be ever so slightly deviated from, every ornament produced by its means will inevitably show the same fault in the same relative place. But the spherical slide-rest, the spiral apparatus with change wheels, and the geometric chuck, may be constructed with far less microscopic accuracy, and yet do their work perfectly.

* I do not wish to speak disrespectfully of this invention, which is highly ingenious, and is capable of producing endless varieties of pattern *by changes in the connecting train of wheels.*

The latter class of contrivances may be compared to the action of an intelligent mechanic, the former to that of the Chinese who, receiving an order for a dinner service, reproduced upon every plate and dish an imitation of a crack which happened to be in the pattern piece. Therefore I maintain that the application of templates to the production of a single form or pattern is fundamentally wrong in principle, and can only be regarded as a cheap and imperfect substitute where the more perfect and expensive machine cannot be got at. Even the costly and complicated Rose engine, and, by implication, the Rose-cutting frame, underlie the same reproach. They are mere copying machines, and cannot lay claim to any high scientific character.

These considerations are only intended to discourage the use of templates *as applied to the production of a single form or pattern*, and have no reference to their use in manufactures. As copying instruments they were originally used, and in copying will be their greatest use and legitimate employment. The Government factory at Enfield, and Jordan's wood-carving machinery, are two of the best known among many applications of this kind.

VIRION NIGHTON.

P.S.—This paper was written before the publication of the last number, in which the invention of my friend and relative C.R.H. (communicated to me privately twenty years ago) has at last appeared. This seems a move in the right direction, and I may say the same of one of the late Mr. Elias Taylor's methods, which strongly resembles it.

THE DIVISION PLATE.

IN selecting the numbers for the division plate circles, the object will be to obtain the largest assortment of generally useful factors, from the fewest circles, containing the fewest number of holes: and that the factors, in the aggregate, should advance at the beginning of the scale by small amounts, then proceeding by wider intervals. It is also an advantage if the holes can be distributed at about equal distances throughout the circles, not being more crowded or more scattered in one than in another.

The following table represents the various equal parts into which any circumference may be divided by the aid of the circles now recommended, which are suggested as fulfilling the above conditions more perfectly than some lists in more general use. It will be observed that the successive numbers attainable increase by 1 up to 22, and then by 2 (at the most) up to 44, thus affording a large choice in the lower figures.

Equal parts required.	Circles to be used, and holes to be moved, at a time, in each of those which yield the required number.							
No.	192	168	156	144	132	120	114	102
2	96	84	78	72	66	60	57	51
3	64	56	52	48	44	40	38	34
4	48	42	39	36	33	30	—	—
5	—	—	—	—	—	24	—	—
6	32	28	26	24	22	20	19	17
7	—	24	—	—	—	—	—	—
8	24	21	—	18	—	15	—	—
9	—	—	—	16	—	—	—	—
10	—	—	—	—	—	12	—	—
11	—	—	—	—	12	—	—	—
12	16	14	13	12	11	10	—	—
13	—	—	12	—	—	—	—	—
14	—	12	—	—	—	—	—	—
15	—	—	—	—	—	8	—	—
16	12	—	—	9	—	—	—	—
17	—	—	—	—	—	—	—	6
18	—	—	—	8	—	—	—	—
19	—	—	—	—	—	—	6	—
20	—	—	—	—	—	6	—	—
21	—	8	—	—	—	—	—	—
22	—	—	—	—	6	—	—	—
24	8	7	—	6	—	5	—	—
26	—	—	6	—	—	—	—	—
28	—	6	—	—	—	—	—	—
30	—	—	—	—	—	4	—	—
32	6	—	—	—	—	—	—	—
33	—	—	—	—	4	—	—	—
No.	192	168	156	144	132	120	114	102

Equal parts required.	Circles to be used, and holes to be moved, at a time, in each of those which yield the required number.							
No.	192	168	156	144	132	120	114	102
34	—	—	—	—	—	—	—	3
36	—	—	—	4	—	—	—	—
38	—	—	—	—	—	—	3	—
39	—	—	4	—	—	—	—	—
40	—	—	—	—	—	3	—	—
42	—	4	—	—	—	—	—	—
44	—	—	—	—	3	—	—	—
48	4	—	—	3	—	—	—	—
51	—	—	—	—	—	—	—	2
52	—	—	3	—	—	—	—	—
56	—	3	—	—	—	—	—	—
57	—	—	—	—	—	—	2	—
60	—	—	—	—	—	2	—	—
64	3	—	—	—	—	—	—	—
66	—	—	—	—	2	—	—	—
72	—	—	—	2	—	—	—	—
78	—	—	2	—	—	—	—	—
84	—	2	—	—	—	—	—	—
96	2	—	—	—	—	—	—	—
102	—	—	—	—	—	—	—	1
114	—	—	—	—	—	—	1	—
120	—	—	—	—	—	1	—	—
132	—	—	—	—	1	—	—	—
144	—	—	—	1	—	—	—	—
156	—	—	1	—	—	—	—	—
168	—	1	—	—	—	—	—	—
192	1	—	—	—	—	—	—	—
No.	192	168	156	144	132	120	114	102

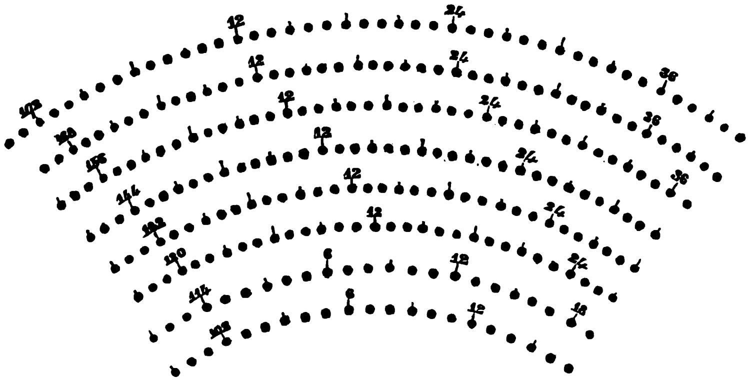
The 360 circle is not included in this list, for all the features which it affords, except 180, 90, and 45, can be obtained from some one or more of the selected circles; and these factors, with many others, can be had when necessary from the large dividing wheel with 180 teeth, and its tangent screw with changeable micrometer heads, generally attached to the mandrel pulley of the best ornamental lathes. (*Lathes and Turning*, Northcott, p. 206.)

Another desirable feature of a division plate is that the circles should be figured and marked in such a manner as to indicate as many numbers as possible *by inspection only*, thus avoiding the liability to error caused by having to count the holes between each insertion of the index point. It is an ordinary practice to figure each circle at intervals agreeing with its characteristic number, placing, for instance, a mark at every fifth, and a figure at every *tenth*, hole of the 100 or 120 circles, whose characteristic is 10, and similarly figuring every *seventh* hole of the 112 or other circle whose characteristic is 7. But in neither of these instances is the use of the special factors thereby facilitated; in the former the process of moving the division plate round with the index applied to the 120 circle, and stopping at every tenth hole, gives twelve equal parts; and in the latter by using the 112 circle, and stopping at every seventh hole, as marked, we obtain 16 equal parts, both 12 and 16 being numbers belonging more properly to other circles. The better way in order to obtain the number 7 and its multiples from the 112 circle would be to figure the latter at every *eighth* hole with a mark at every fourth, thus dividing the circle in a prominent manner into 7, 14, and 28 equal parts, and indicating with much readiness the stopping places of the index in order to obtain equal divisions of these numbers.

In the assemblage of circles now recommended the marks and figures are arranged to correspond with the special characteristic of each, by figuring every twelfth hole (and in the two inner circles every sixth), with marks at every sixth, and subdivisions at every third. Thus:—

Circle.	Diameter.	Holes per inch of circumference.	Characteristic factor.		Equal parts.			
192	6·5 inches	10·6	8	gives by inspection	8	16	32	64
168	6·1 ,,	11·4	7	,, ,,	7	14	28	56
156	5·6 ,,	11·3	13	,, ,,	...	13	26	52
144	5·2 ,,	11·3	12	,, ,,	6	12	24	48
132	4·8 ,,	11·4	11	,, ,,	...	11	22	44
120	4·3 ,,	11·2	10	,, ,,	5	10	20	40
114	3·9 ,,	9·3	19	,, ,,	...	...	19	38
102	3·5 ,,	9·3	17	,, ,,	...	...	17	34

The engraving represents the general appearance of a segment of the division plate, drawn to actual size, but the figures are too small for use. It is assumed that the index is provided



in one way or another with sufficient range in a plane parallel to the pulley, to enable the point to apply to any of the circles: and, to avoid the error of passing inadvertently from one circle to another, it is desirable to have the means of clamping the index stem in suitable positions.

The figures opposite the first holes of each circle are placed not diametrically, but in a circular arc coincident with that which may be described by the index point, (when adjusted vertically) in passing from one circle to another. These figures are intended to be of larger dimensions than any others, to distinguish the commencement of the several circles, and, if practicable, it would be of further advantage to colour the figures red and black throughout the alternate circles.

THOS. SEBASTIAN BAZLEY.

RECTILINEAR, CIRCULAR, AND ELLIPTIC DRILLING.

PART II.—*Circular drilling.—Laws which govern the position of circles and segments of circles drilled.—Illustrations and examples.—Application to drilling letters with circular loops,* **B J P R U.**

CIRCULAR DRILLING.

I. In cutting circles with the drill, their position with reference to the center of the work is determined solely by the excentric chuck, and their radii by the slide rest traversing the drill more or less from the position "all at center." At the commencement, the chuck should be accurately vertical when the pulley is stopped in 96, or in the highest number of that row of divisions which may be used, and the chuck wheel should be stopped at 96. It is most convenient to use the 96 row on the division plate, as answering to the 96 teeth of the chuck; but in some cases where finer adjustments are required, the 360 row is used.

II. Mr. Elphinstone in his paper on "Excentric Turning," published in the first number of this Journal (p. 8), has shown how to calculate the radii of circles in contact, whose centers are the locus of a circle of given radius. The rules laid down in that paper may be adopted here, remembering, however, that the excentricity of the centers of the circles drilled is now given by the chuck, and their radius by the slide-rest which determines the distance of the point of the drill from the center of the lathe.

Mr. Elphinstone's example to his first rule (p. 9) would therefore read as follows:—

Let the excentricity be 50,* or 5 turns of the excentric chuck screw, and the number of circles required be 16; the corresponding modulus is ·195, which is 2 × sin. 5° 37′ 30″ to three places of decimals, or 2 × sine of ½ the angle subtended by the chord, which chord is the modulus required. Then, ·5 × ·195 = ·0975, the value of the radius required, *i. e.* the drill must be traversed from "all at center," 9¾ divisions of slide-rest screw.†

Again, let the excentricity be 1 in., or 10 turns of the excentric chuck screw, and the number of circles 16; the modulus is ·195. Then, 1 × ·195 = ·195, the value of the radius required, *i. e.* the drill must be traversed from all at center, 19½ divisions of slide-rest screw.

These two examples may be sufficient to show how Mr. Elphinstone's valuable rules, and his table of the moduli corresponding to the various numbers of circles, can be applied here.

III. It may be useful to remember, in designing patterns for circular drilling, that if the centers of circles be at the angles of

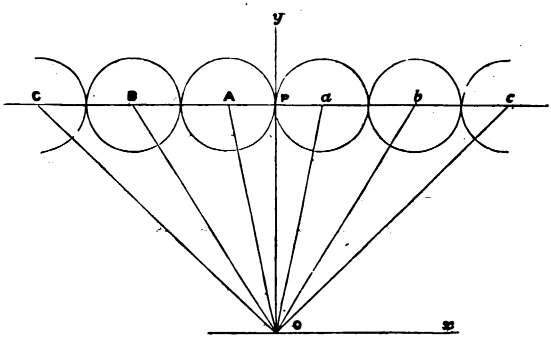
* By 50 is meant fifty hundredths of an inch, or ·5 in.; I venture to think that ·5 is a simpler notation for half an inch than 50, and shall therefore adopt it.

† See Note A, p. 239.

any equilateral rectilinear figure, as the equilateral triangle, the square, or any regular polygon, such circles will be in contact when their radius equals the radius of the circle inscribed in such figure, or, in other words, when their radius is equal to half the side of such figure.

IV. If it be required to cut a series of equal circles in contact, whose centers lie upon a given straight line, either the excentric cutting frame must be used, or, with the drill, the *compound* excentric chuck. For it is not with the drill as with the excentric cutter. With the latter instrument, a circle of any diameter can be placed where we will by means of the slide-rest; with the former, the slide-rest is taken up in determining the size of the circle cut, and is therefore not available for placing the circle in any required position. That is, the work must be brought to the tool when drilling, and not the tool to the work. Moreover, a circle that is to be cut with the drill must be brought into such a position that its center is at the center of rotation of the lathe; this can only be done by the excentric chuck wheel with its limited number of 96 teeth. If the chuck have a tangent wheel instead of a click wheel, its range is increased, and by careful calculation

FIG. 1.



the object in view may be accomplished. A reference to figs. 1 and 2 will make this clear. Let A, B, C, . . . a, b, c, . . . be the centers, on a straight line, of equal circles in contact. O P, the excentricity of the straight line measured on the axis of y, is known, and r, the radius, is known. Then we have—

$$A\,O = a\,O = \text{excentricity of first pair} = \sqrt{O\,P^2 + r^2},$$

$$\text{and tan. } A\,O\,P = \frac{r}{O\,P}, \text{ or}$$

$$\text{log. tan. } A\,O\,P = \text{log. } r - \text{log. } O\,P + 10\,;$$

so that the excentricity A O measured by the chuck itself, and the angle A O P measured by the wheel of the chuck, can both be computed. For the next pair—

$$B\,O = b\,O = \text{excentricity of second pair} = \sqrt{O\,P^2 + 9\,r^2},$$

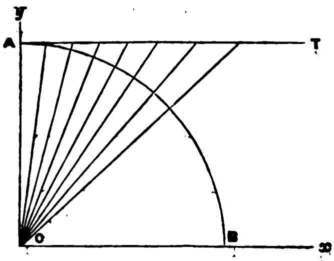
$$\text{and tan. } B\,O\,P = \frac{3\,r}{O\,P}, \text{ or}$$

$$\text{log. tan. } B\,O\,P = 3 \text{ log. } r - \text{log. } O\,P + 10\,;$$

so that the excentricity B O and the angle B O P can both be computed.

By following out the same process, any number of circles may be placed in the required position, but such work as this involves will probably be seldom undertaken; with the chuck wheel divided into 96 teeth only, it is mathematically impossible; for, assume the equal angles in fig. 2, whose apices

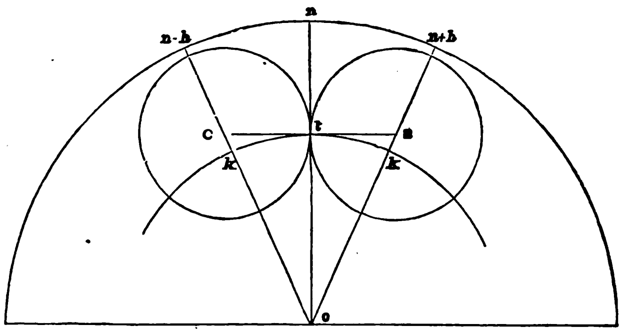
FIG. 2.



are at the center O, to represent each of them one tooth of the wheel, or $3^\circ \cdot 45'$. They are subtended by equal arcs of the circle A B, but by unequal spaces on the line A T. If these spaces had been set off equal to each other on the line A T, the angles would have been unequal, decreasing as they receded from the axis of y, but the teeth of the chuck wheel which determine the angles are constant. Hence, the simple excentric chuck is of no avail for drilling a series of equal circles or segments of circles, having their centers on a given straight line, and in contact with each other.

V. Never more than two such equal circles will be required in drilling letters; and it is possible to drill two such, with this limitation only, that the given straight line be a line at right angles to a radius possible upon the excentric chuck, by which is meant a radius that can be brought into a vertical position by the chuck wheel. There are 96 such radii, so that the range of position for two equal circles in contact is large, though not unlimited. The radii of such circles, however, are not independent. They are functions of the angle included between the vertical line through the center of the work, and the line joining that center with the center of the circle itself, and depend therefore upon that angle and the excentricity *t* O.

FIG. 3.



Let C *t* B be the given straight line with excentricity *t* O on the axis of *y*, *t* being the point at which the circles are to be in contact. Then *t* B, the radius, is the sine of the angle *t* O B, and *t* O B must be some multiple of $3^\circ 45'$, because the angular measure of each tooth of the chuck wheel is $3^\circ 45'$; in other words, *t* B, the radius, can only be O B sin. *n* ($3^\circ 45'$), *n* being any integer from 1 to 96, that is, the radius can only be OB × ·06105, or O B × ·12187, or O B × ·18224, &c. But *t* B, the radius, depends also upon *t* O, the excentricity of the point of contact, for it is evident that as *t* O increases *t* B increases, if the angle be constant; and we have seen that *t* B increases as the angle increases, if *t* O be constant. Hence, in drilling a letter in a given position, whose form involves two similar segments of equal circles, as **B**, the radius of the circles which *can* be drilled in the given position must determine the size of the letter, and of the rest of the letters if there be more to be cut in combination with it. Therefore, as a rule, *the size of a curved letter should always determine the size of other letters in combination with it*, since it is far easier to fit the square and angular to the curved letters, than to fit the curved letters to the size of the square and angular.

VI. The method of drilling two equal circles, whose centers are upon a given straight line at right angles to one of the 96 possible radii, and which are in contact with one another, is as follows :—

Let t (fig. 3) be the known point at which the pair are to be in contact, O t being a radius which can be brought into a vertical position by stopping the chuck wheel at a tooth marked n. B C the straight line joining the centers of the pair, at right angles to O t. Then O B = O C = excentricity of the centers of the circles $= \sqrt{O t^2 + B t^2}$.

(1.) Bring O B vertical by moving the excentric chuck wheel through the angle t O B, or by h teeth, *i.e.* O B vertical, with wheel stopped at $n + h$.

(2.) Make the excentricity = O B, which must now be calculated, either in terms of O t and B t, if B t be known; or, in terms of O t and the angle t O B, if B t be not known: for, it is evident that if the excentricity O t were retained without the increment B k, the centers of the circles would be at k, k, instead of at B, C.

(3.) Bring O C vertical by moving the excentric chuck wheel through the angle t O C, or by $- h$ teeth, *i. e.* O C vertical with wheel stopped at $n - h$.

(4.) The excentricity is the same as for the first circle.

In practice it will probably be found that quite sufficient accuracy is obtained by drawing a line, C B, with the T-square through the point t, when the chuck wheel is stopped in 24, which will make C B vertical; and, when O B is brought to its vertical position by h teeth of the chuck from 96, screwing the chuck down till the point of intersection B, of C B and O B, comes to the center, as indicated by the point of the tool "at center." Then, rotating the lathe, after giving the proper radius to the tool by the slide-rest, slightly increase or diminish the radius, or the excentricity (if it be not an absolutely fixed quantity), till the line

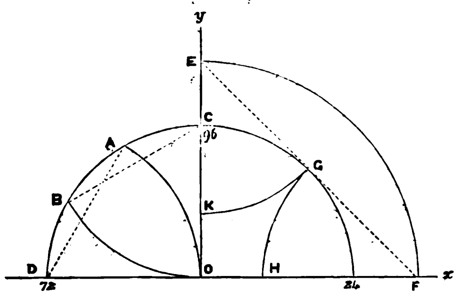
O *t* is a tangent at the point *t* to the circle, which can be cut; O *t* will probably be the axis of *x*. Then bring the chuck wheel to 96 — *h*, and drill the second circle.

VII. In ornamental work the drill will perhaps be more frequently used for cutting segments of circles than for complete circles, which latter, unless the cuts be heavy, can be formed by the excentric cutting frame with facility. The method is simple, and the result, which in certain instances is something like rose-engine work, is effective. The great advantage of the drill is that it can be used for giving form as opposed to mere ornament. A box, for example, whose depth depends only upon the length of the drill, can be formed in any of the shapes delineated in the following figures.

VIII. One important point must be kept in mind. The width of the drill will increase the width of the lines as drawn in the figures. The figures show but an imaginary line traced by the center of an imaginary drill.

IX. If it be required to drill segments such as A O, B O, fig. 4,

FIG. 4.



which intersect each other at the center of the work, and whose radii D A, C B, are equal to O C, the radius of the work, and which are symmetrical in the 4° quadrant with respect to both axes; then, an excentricity must be given by the chuck precisely equal to the radius O C, which is given by the slide-rest traversing the tool from the center towards the left.

For the first segment A O, the chuck wheel is stopped in 72, because D is the center of the segment.

For the second B O, the chuck is stopped in 96, because C is the center.

For the first segment the upper segment stop is placed in position when the pulley is fixed by its proper stop at 72, and the lower segment stop when the pulley is at 72 — 16, or 56, because the segment cut is just $\frac{1}{6}$ of the circumference, and $\frac{96}{6} = 16$.

For the second segment everything is reversed; 48 takes the place of 96 on the division plate; the $+^{ve}$ sign becomes $-^{ve}$, the $-^{ve}$ becomes $+^{ve}$; and the lower segment stop is treated as the upper. Thus, because the upper stop was fixed before when the pulley was at 72, that is, at 96 — 24, the lower is now fixed when the pulley is at 48+24, or 72 again; so that in this instance the lower stop does really occupy the very same position that the upper did. Again, the lower stop was fixed before with the pulley at 72 — 16, therefore the upper is now fixed when the pulley is at 72 + 16, or 88. The segments are drilled, of course, by slowly rotating the pulley through the angle subtended by the arc included between the segment stops.

X. Let such segments as K G, H G, in the 1° quadrant of fig. 4, be required. Their radius is identically the same as in the last case, F G = E G = O C; but their centers E, F, lie outside the work. Also, they are symmetrical with respect to both axes, intersecting each other at a point half way between 96 and 24. The excentricity must now be increased till it equals E O. It can be readily calculated in terms of O C, the known radius, both of the work and of the segments, which call r,

$$E F^2 = 4 r^2 = 2 E O^2,$$

$$\therefore E O = r\sqrt{2} = r \times 1{\cdot}4142,$$

the radius r being still retained as it was on the slide-rest.

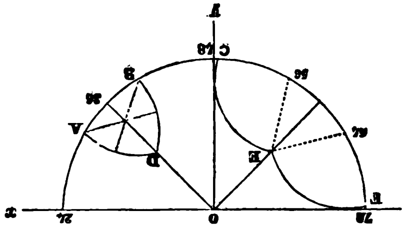
For the first segment K G, inasmuch as its center lies on the axis of y, the chuck must be stopped at 96; and for the second segment H G, whose center lies on the axis of x, the chuck must be stopped at 24.

For the first segment the upper segment stop is fixed with the pulley at 72, because K G reaches the axis of y, which is horizontal when the pulley is at 72 or in the ordinary position of the axis of x; the lower stop is fixed with the pulley at 72 — 12, or 60, because $\frac{1}{8}$ of the circumference is to be cut, and $\frac{96}{8} = 12$.

For the second segment the upper stop is fixed when the pulley is at 72 + 12, or 84, and the lower with pulley at 72, (really 48 + 24, because previously the upper was fixed with pulley at 96 — 24).

XI. In the 2° quadrant, fig. 5, the excentricity O C is the same as before, but the radius for the two segments A D, D B, is decreased; it is exactly one half of O C. The segments are symmetrical in the quadrant with respect to both axes, that is, the

FIG. 5.



line O D, in which lies their point of intersection, bisects the quadrant. Their centers A, B, divide the circumference of the quadrant into three equal portions, being at 32 and 40 respectively. Consequently, for the first segment A D, the chuck is stopped at 40, and for the second, B O, at 32.

For the first segment the upper segment stop is fixed when the pulley is at 92, (96 — 4); the lower when the pulley is at 92 — 16, or 76; $\frac{1}{6}$ of the circumference being cut.

For the second segment the upper stop is fixed with the pulley at 68, that is, 48+4+16, just as above 76 was 96 — 4 — 16; and the lower with pulley at 48+4, or 52.

XII. In the 3° quadrant, fig. 5, the radius is the same as in the last example, viz. one half of the excentricity. Segments of corresponding circles to those in the last case are cut, but they are different segments. They are symmetrical with respect to the axes of x and y; their point of intersection lies on the line O E bisecting the quadrant. The center of E C is at 56, of E F at 64. Consequently for the first, E C, the chuck is stopped at 56, for the second, E F, at 64.

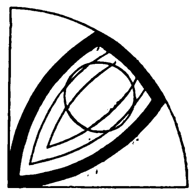
For the first segment the upper segment stop is fixed when the pulley is at 96 — 4, or 92; the lower when the pulley is at 92 — 24, or 68, as $\frac{1}{4}$ of the circumference is cut.

For the second the upper stop is fixed with pulley at 52+24, or 76; the lower with the pulley at 48+4, or 52.

XIII. It is perhaps scarcely necessary to say that, if the drill be intended to cut away the segments from the material altogether, as in the upper portion of fig. 7, the segment stop which gives the exterior limit need not be fixed at all.

XIV. If the interior portions of the material left between two segments be required to be removed, leaving only a thin line as for the partitions in a box, all that need be done is to reduce the radius by the slide-rest gradually. Some portion may conveniently be removed by circular drilling in the ordinary way.

FIG. 6.

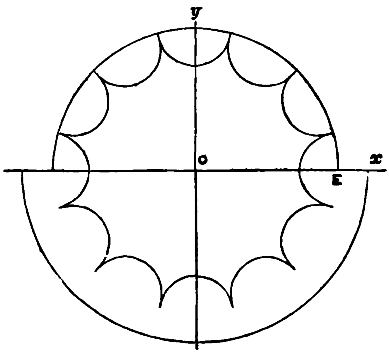


In fig. 6 the thick dark lines represent the material intended to be left; all inside these lines is removed; the course of the drill is indicated by the finer lines, which are segments of circles described with the same centers, but reduced in radius. Care must be taken, in adjusting the segment stops, to allow the rim on the periphery of the work to remain intact—that is, their range must be diminished from what it would be if the segments were to be cut out altogether.

ILLUSTRATIONS AND EXAMPLES.

Fig. 7.—In the upper half of this figure the material is cut away

FIG. 7.



altogether by the segments which intersect each other at the extreme edge of the work. In the lower half the segments do not reach to the edge.

The excentricity O E = $\frac{3}{4}$ in., or seven and a half turns of the slide-rest screw; and as there are twelve circles in contact round the circumference of the generating circle whose radius is ·75 in., the radius of each will be O E × sin. $\frac{360^\circ}{2 \times 12}$ or O E × sin. 15°, which = ·75 × ·25882 = ·194115, say one turn nine divisions of slide-rest towards the left from all at center. (Mr. Elphinstone's table may be used here, where the modulus or sin. $\frac{180^\circ}{12}$ is given as ·259, affording the same result, the high places of decimals not being generally necessary.) Before commencing to drill, the fluting stops should be fixed on both sides of the tool-holder. The segments are cut with the chuck stopped at 96, 8, 16 . . . . . so that the axes of x and y bisect the concaves. If it had been desired that the axes should pass through the points of the figure the cuts would have been at 92, 4, 12 . . . . For the upper half of fig. 7 the segment stops need not be used at all, since each affords only an exterior limit; for the lower half they must be fixed; the upper when the pulley is at 96, the lower when it is at 48.

Had it been intended that in the lower half of fig. 7 the concaves should not have been complete semicircles, a slightly larger radius would have been employed. The upper segment stop being fixed when the pulley was at $96 - n$, the lower when the pulley was at $48 + n$, n being such that the segments would just meet without intersecting. Of course therefore in practice, if the exact radius for the drill be not calculated beforehand, n will be taken too great, and gradually reduced till its right value be found by experiment.

Fig. 8.—In this figure the outer segments of the same circles as in the last case are cut, instead of the inner segments. The only difference is that the upper segment stop is fixed when the pulley is stopped at 48, and the lower with the pulley at 96, or $48 + n$ and $96 - n$, if the radius be increased and less than a semicircle be cut. The axes will bisect two of the curves if the cuts be made with the chuck stopped at 96, 8, 16 . . . . , and pass through the points of contact if at 92, 4, 12 . . .

FIG. 8.

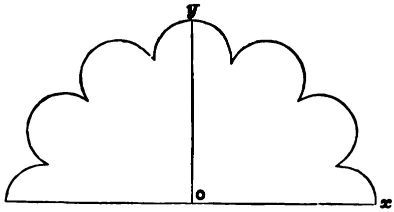
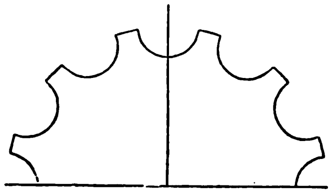


Fig. 9.—By taking a radius for the drill considerably less than would be required for placing circles in contact, the flutes and

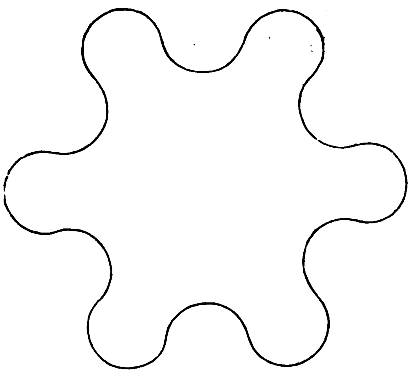
FIG. 9.



fillets of fig. 9 will be obtained. This is a useful pattern for silk-winders in mother-of-pearl, ivory, or tortoiseshell.*

Fig. 10.—Here the inner and outer segments are cut alternately, that is, six are drilled with the chuck wheel stopped at 96, 16,

FIG. 10.



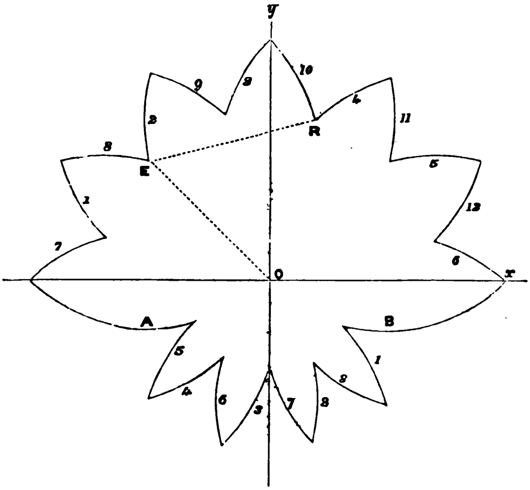
32 . . . , the upper segment stop being fixed when the pulley is

* See Note B, p. 237.

at 96, the lower when the pulley is at 48. The other six are drilled with the chuck stopped at 8, 24, 40 . . . , the upper segment stop being fixed when the pulley is at 48 and the lower when at 96.

Fig. 11.—In this figure, which it will be observed is symmetrical only with respect to the axis of *y*, certain segments of 12 equal circles are used, a circle of radius equal to that of any one of the 12 being the locus of their centers.* Hence the excentricity,

FIG. 11.



O E, determined by the chuck, equals the radius, E R, (determined by traverse of the tool from "all at center"). For the larger rays, in the 1° and 4° quadrants, those segments are used which are more remote from the center than the segments employed for the smaller rays in the 2° and 3° quadrants. The pattern consequently lies more above than below the axis of *x*. It will be well to bear this in mind if the work be completely cut out from valuable material for a silk winder, as waste may then be avoided by careful chucking. This is especially important with mother-of-pearl; the difficulty of obtaining a flat surface increasing rapidly with the area.

* As the geometrical construction of this figure affords a good example of the method that may be adopted in designing such patterns, it is given in Note D at the end of the paper.

The following are the settings:—

1. "All at center;" tool ready for traverse to the left. Screw the excentric chuck down n turns, and slide-rest screw n turns (in fig. 11, $n = 9$). Fix the lower segment stop when the pulley is at 88; the upper when the pulley is at 8, thus including $\frac{1}{6}$ of the circumference, the value of the segment A, which may now be cut, the chuck being stopped at 96.

2. Fix the lower segment stop when the pulley is at 96, keeping the upper one where it now is, viz. with pulley at 8. Cut the segments 1, 2, 3, 4, 5, 6 with the chuck stopped in 88, 96, 8, 16, 24, 32 respectively.

3. Fix the lower segment stop when the pulley is at 40, the upper when it is at 48. Cut the segments 7, 8, 9, 10, 11, 12 with the chuck stopped in 64, 72, 80, 88, 96, 8 respectively.

4. Keep the lower segment stop where it is, viz. with pulley at 40, and fix the upper with the pulley at 56. Cut the segment B with the chuck stopped at 16. This completes the 7 larger rays.

5. Fix the lower segment stop when the pulley is at 88, and the upper when it is at 96, thus including 8 divisions or $\frac{1}{12}$ of a circle. Cut the segments 1, 2, 3, 4, with the chuck stopped in 48, 56, 64, 72.

6. Fix the lower segment stop when the pulley is at 48, and the upper when it is at 56. Cut the segments 5, 6, 7, 8, with the chuck stopped in 48, 40, 32, 24.

Many other very effective forms may be generated in the same manner as the last, viz. by equal circles intersecting each other. In Fig. 12 the excentricity, O D, and the radius, D A, are precisely the same as in Fig. 11 (viz. ·9 in.). Different segments, however, of the circles are employed. The pattern has the advantage of being symmetrical with respect to both axes, its center being at the center of the lathe. The settings are as follows: For the four larger rays:—

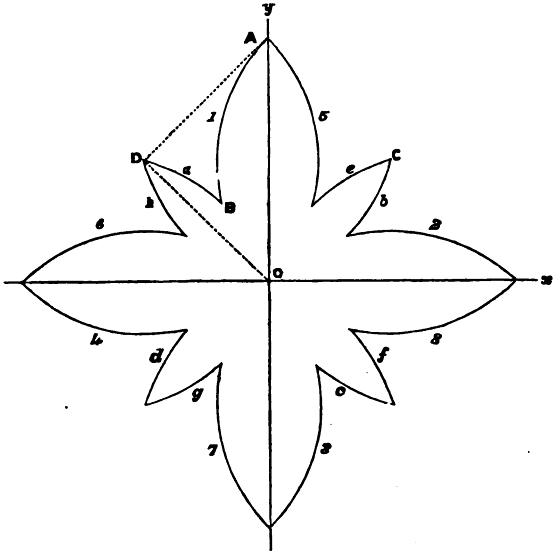
1. Fix the lower segment stop when the pulley is at 80, and the upper when it is at 96, including $\frac{1}{6}$ of a circle. Cut the segments 1, 2, 3, 4, with the chuck stopped in 12, 36, 60, 84.

2. Fix the lower segment stop when the pulley is at 48, and the upper when at 64. Cut the segments 5, 6, 7, 8, with the chuck stopped in 84, 60, 36, 12.

3. For the smaller rays, fix the lower stop when the pulley is

at 56, keeping the upper where it is, viz. at 64, thus including $\frac{1}{12}$ of the circumference. Cut the segments *a*, *b*, *c*, *d*, with the chuck stopped in 68, 92, 20, 44.

FIG. 12.



4. Fix the lower segment stop when the pulley is at 80, and the upper when at 88. Cut the segments *e*, *f*, *g*, *h*, with the chuck stopped at 28, 52, 76, 4.

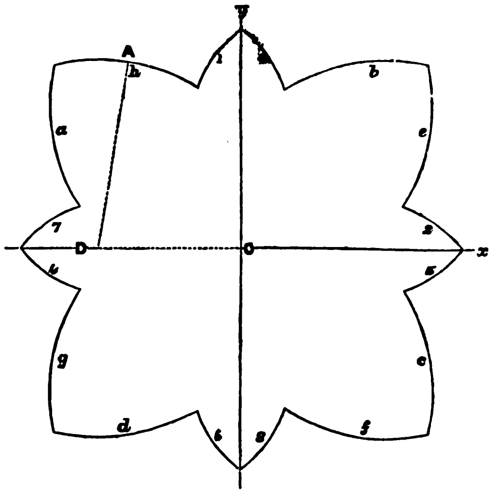
Fig. 13.—By increasing the radius, but retaining the same excentricity, the angles of the pattern become more obtuse. In fig. 13 the excentricity, O D, is ·75 in., and the radius or traverse of tool from center, D A, is 1 in. instead of ·75 in., which, if it had been, the result would have been homogeneous with fig. 12, but smaller. The settings are as follows :—

Screw the chuck down $7\frac{1}{2}$ turns, and traverse the tool to the left 10 turns. The 96 row on the division plate will not give sufficiently fine adjustments; therefore let the chuck be vertical when the pulley is stopped at 360.

1. For the larger rays. Fix the lower segment stop when the pulley is stopped at 330, and the upper when at 13, including 43°. Cut the segments *a*, *b*, *c*, *d*, with the chuck stopped in 96, 24, 48, 72.

2. Fix the lower segment stop with the pulley stopped at 167, and the upper at 210. Cut the segments *e*, *f*, *g*, *h*, with the chuck stopped in 96, 24, 48, 72.

FIG. 13.



3. For the smaller rays. Fix the lower segment stop when the pulley is at 329, and the upper when at 350, including 21°. Cut the segments 1, 2, 3, 4, with the chuck stopped in 16, 40, 64, 88.

4. Fix the lower segment stop with the pulley at 190, and the upper at 211. Cut the segments 5, 6, 7, 8, with the chuck stopped in 8, 32, 56, 80.

Fig. 14.—On the other hand, by increasing the excentricity, but retaining the same radius, quite a different effect is obtained. This figure has the same excentricity (O D = ·75 in.) as fig. 13; the radius, however, C R, is reduced to ·5. The chuck, therefore, is screwed down 7½ turns, and the tool traversed 5 turns from center. The 96 row can be used on the division plate. The settings are:—

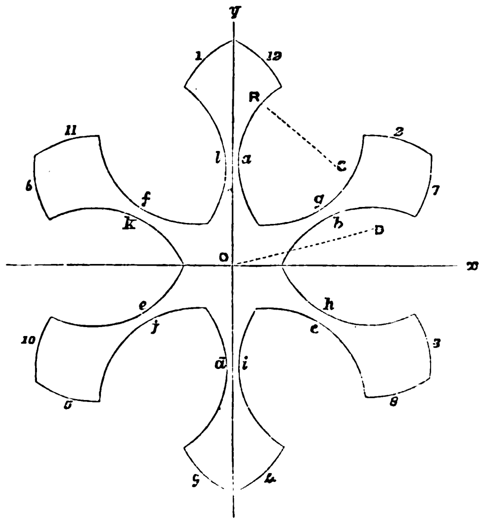
1. Fix the lower segment stop when the pulley is at 74, and the upper when at 3. Cut the segments *a*, *b*, *c*, *d*, *e*, *f*, with the chuck stopped in 12, 28, 44, 60, 76, 92.

2. Fix the lower segment stop when the pulley is at 45, and the upper when at 70. Cut the segments *g*, *h*, *i*, *j*, *k*, *l*, with the chuck stopped at 4, 20, 36, 52, 68, 84.

3. Fix the lower segment stop when the pulley is at 3, and the upper when at 14. Cut the segments 1, 2, 3, 4, 5, 6, with the chuck stopped at 4, 20, 36, 52, 68, 84, as before.

4. Fix the lower segment stop when the pulley is at 34, and

Fig. 14.



the upper when at 45. Cut the segments 7, 8, 9, 10, 11, 12, with the chuck stopped at 12, 28, 44, 60, 76, 92, as in § 1.

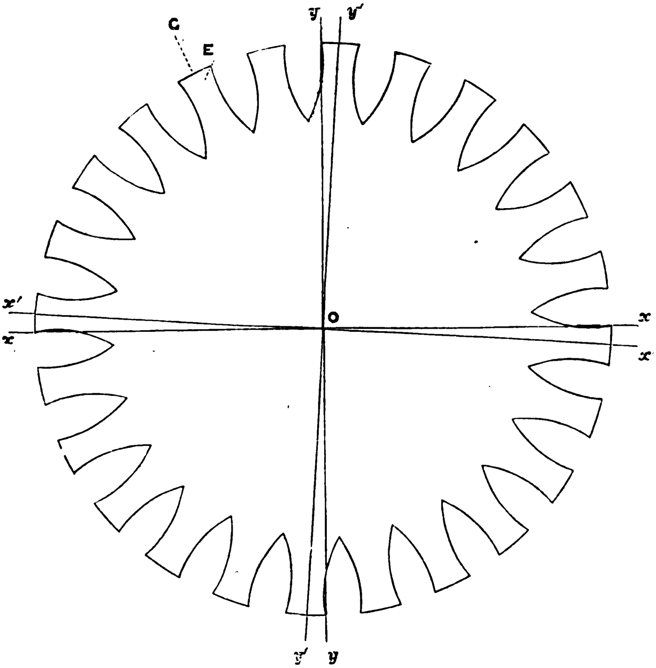
5. If it be thought that the arms are too thin, and it must be remembered that the width of the tool will reduce them yet more, their thickness can be increased by reducing the radius.

Figs. 15, 17, and 18 are each cut with an excentricity of $1\frac{1}{2}$ in., or 15 turns of the excentric chuck screw, and with a radius of ·585 in., or 5 turns $8\frac{1}{2}$ divisions of the slide-rest screw.

In originally designing such patterns as these, assuming the excentricity or radius of the great circle which determines the size of the figure (because the whole work lies within it) to be known, the radius of the circles, segments of which are to be cut, is thus found:—

Let R be the radius of the great circle; its circumference is the locus of the centers of the circles whose radius *r* is required. Let there be *n* such circles. Inasmuch as the circumference is divided into n equal arcs by the centers of the n equal circles, which arcs are occupied alternately by the tops of the rays and the intervening spaces, we have each of these arcs subtending an angle of $\frac{360^\circ}{n}$. Now, each of the equal circles will have for its radius the chord of

FIG. 15.



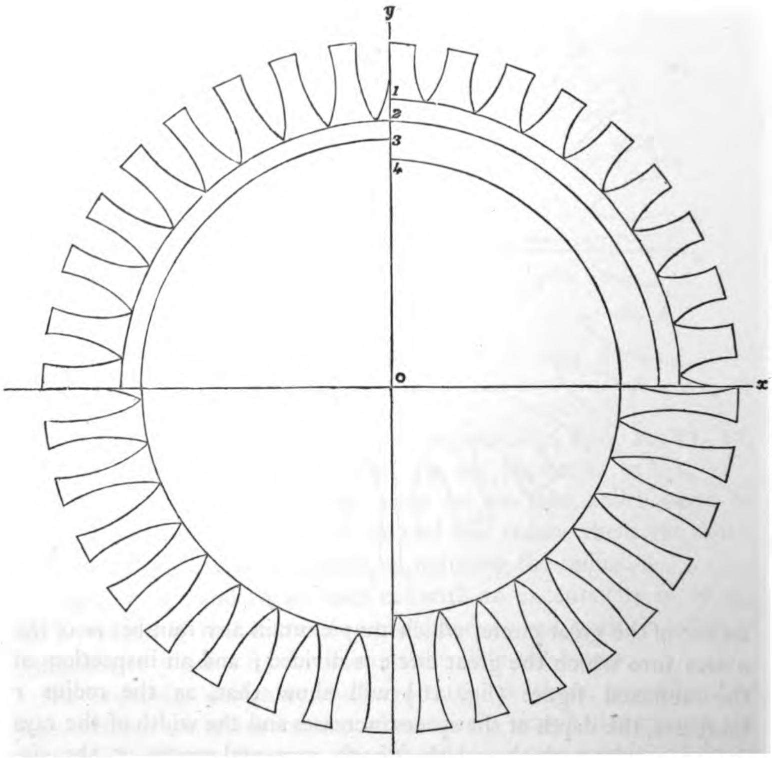
an arc of the great circle, which may contain any number m of the n arcs into which the great circle is divided; and an inspection of the annexed figure (fig. 16) will show that, as the radius r increases, the depth of the spaces increases and the width of the rays decreases, although the width of both rays and spaces at the circumference remains constant. Thus, in the 1° quadrant, the radius is the chord of an arc of 3 divisions, there being 72 in all; in the 2° quadrant it is the chord of an arc of 4 divisions, in the 3° of 5, and in the 4° of 6 divisions. Hence, to find r, the radius required, we have,

m = number of divisions in the arc whose chord $= r$,
n = whole number of divisions in the circle whose radius $=$ R,

$\frac{m}{n} \times 360° =$ the angle subtended by the arc, the chord of which $= r$. And, since the chord of an arc of a circle = twice the radius × sine of ½ the angle subtended by the arc,

$$r = 2\,\text{R} \times \text{sine} \frac{m}{n}\, 180°.$$

FIG. 16.



For example:—

1. Let R $= 1{\cdot}5$, $n = 48$, and $m = 3$; as in fig. 15.

$$\text{Then } r = 2 \times 1{\cdot}5 \times \sin.\frac{3 \times 180°}{48} = 3 \sin.\ 11°\ 15'.$$
$$= 3 \times {\cdot}19509 = {\cdot}58527;$$

or, taking the first three places of decimals, 5 whole turns, $8\frac{1}{2}$ divisions of the slide-rest screw, which is only $\frac{27}{100,000}$ in. too little.

2. Let $R = 2{\cdot}05$, $n = 72$, and $m = 3$; as in the 1° quadrant of fig. 16.

   Then $r = 2 \times 2{\cdot}05 \times \sin. \frac{3 \times 180^\circ}{72} = 4{\cdot}1 \times \sin. 7^\circ 25' 50''$
   $= 4{\cdot}1 \times {\cdot}12932 = {\cdot}530212$;

   or, 5 turns, 3 divisions of the slide-rest, which is too little by 212 millionths of an inch.

3. Let $R = 2{\cdot}05$, $n = 72$, and $m = 4$; as in the 2° quadrant of fig. 16.

   Then $r = 2 \times 2{\cdot}05 \times \sin. \frac{4 \times 180^\circ}{72} = 4{\cdot}1 \times \sin. 10^\circ.$
   $= 4{\cdot}1 \times {\cdot}17365 = {\cdot}711965$;

   or, 7 turns and $2\frac{1}{4}$ small divisions of slide-rest.

4. Let $R = 2{\cdot}05$, $n = 72$, and $m = 5$; as in the 3° quadrant of fig. 16.

   And we have $r = 2 \times {\cdot}2{\cdot}05 \times \sin. \frac{5 \times 180^\circ}{72}$
   $= 4{\cdot}1 \times \sin. 12^\circ 30'. = 4{\cdot}1 \times {\cdot}21644 = {\cdot}887404$;
   or, 8 turns $8\frac{1}{2}$ divisions.

5. In the same way, if, as in the 4° quadrant, $m = 6$, we find that $r = 1{\cdot}061162$, or 10 whole turns, 6 divisions, and $\frac{1}{4}$ of a small division.

We may now proceed to the settings of figs. 15, 17, and 18; but first let it be remembered, as was said in § 5 under fig. 14, that the width of the tool will diminish the width of the rays, and consequently increase that of the spaces. The effect may perhaps be thought more pleasing. Moreover the depth of the spaces will be increased by half the width of the tool.

Fig. 15.—The 360 row on the division plate is used.

1. All at center. Chuck vertical, with pulley stopped at 360. Screw the chuck down 15 turns. Traverse the tool to the left 5 turns, $8\frac{1}{2}$ divisions. Fix the tool box by the fluting stops on each side. Now notice that fig. 15, as drawn, is not symmetrical with respect to the axes of x and y, though it is with respect to x', y'.

This is intentional; it is so drawn that the error, easily fallen into, may be noted and the method of correcting it—that is, of shifting the figure till it comes into the position with respect to x, y, in which it is drawn with respect to x', y'.

2. Fix the upper segment stop when the pulley is at 347. This brings the point marked E, in fig. 15, opposite the tool ready to cut E F, (the chuck being in 96), and consequently the figure, if now cut, will not be symmetrical with respect to the axes of x, y. This is of no consequence if it be intended as an independent form, but if it be in combination with other work the error must be rectified. To do so, shift the chuck wheel one tooth backwards to 95, the point marked G will be brought opposite to the tool, and x', y', will occupy the places of the true axes of the work.

Having, then, the upper segment stop fixed with the pulley at 347, fix the lower with the pulley at 307. Drill with the chuck stopped at 95, 3, 7, 11 . . . 91, or at every fourth tooth: observe that the cut at 7 is the one nearest to the axis of y, being that immediately on the right of y'.

3. Fix the upper segment stop when the pulley is at 233, and the lower when at 193. In § 2 the position for the segment stops was found experimentally; here, however, we have 193 determined, because $347 = 360 - 13$, and $180 + 13$ is 193. Also we have 233, because $193 + 40 = 233$, just as $347 - 40 = 307$.

Drill now with the chuck stopped at 89, 93, 1, 5 . . . . 85, or at every fourth tooth: observe that the cut at 89 is that nearest to y', being that through which y passes in the figure.

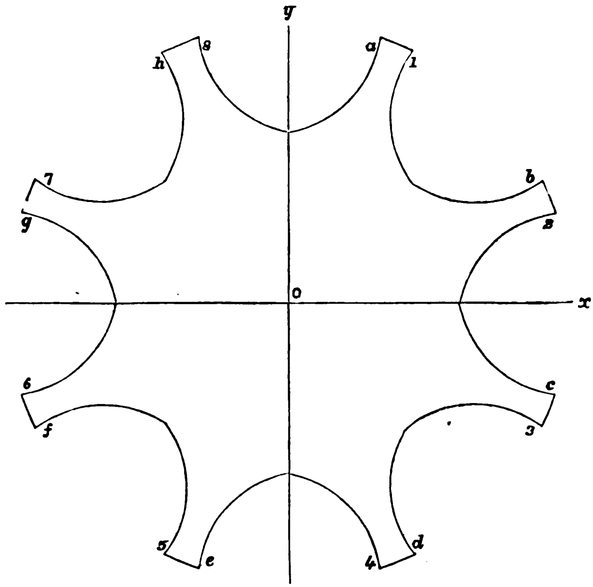
4. If the lines at the top of the rays (on the circumference) be to be drilled, the figure being a pattern on a surface, and not cut out, as for a silk winder, from a disc of the exact size of the great circle, then bring the chuck back to its concentric position, and traverse the tool as much more to the left as will make a total of 15 turns, so that the radius equals the original excentricity.

By now stopping the pulley at 270, the axis of y will be horizontal, and therefore the upper and lower segment stops must be placed when the pulley is stopped at divisions equidistant from 270 above and below it; 3° on each side is too little, 4° is too much; the pattern requires 3° 45′, because $\frac{360^\circ}{48} = 7^\circ\ 30'$. Therefore, for preference take the 3°, because of the width of the drill.

However, 3° 45′ can be obtained—(1) by the adjusting stop; (2) by the screws of the segment stops; (3) by using one division on each side of 24 in the 96 row, first altering the adjusting nuts of the pulley-stop if necessary, so that it may hold the chuck vertical when at 96 on the pulley. Having settled this matter according to convenience, drill with the chuck stopped at 96, 4, 8, 12 . . . 92.

Fig. 17.—Larger segments of the same circles as in the last pattern are employed.

Fig. 17.



1. The first settings are precisely the same as § 1 of fig. 15.

2. The upper segment stop is fixed when the pulley is at 347, as in the last case (§ 2, fig. 15), but the lower when the pulley is at 275, thus including 72°. Cut the segments 1, 2, 3, 4, 5, 6, 7, 8, with the chuck stopped at 13, 25, 37, 49, 61, 73, 85, 1 (the twelves + 1).

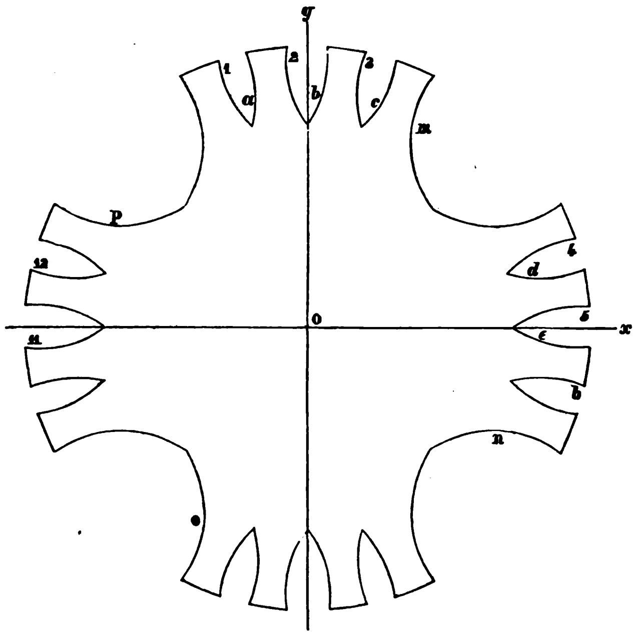
3. Fix the upper segment stop when the pulley is at 193, and the lower when at 265 (because 347=360 — 13, and 180+13 is 193; also 193+72=265). Cut the segments *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*,

with the chuck stopped in 95, 11, 23, 35, 47, 59, 71, 83, (the twelves—1).

4. If the lines at the top of the rays be to be drilled, then with the same settings of chuck, slide-rest, and segment stops as in § 4, fig. 15, drill with the chuck stopped at 6, 18, 30, 42, 54, 66, 78, and 90.

Fig. 18.—This is a combination of figs. 15 and 17, the same excentricity and radius being employed as for those patterns;

Fig. 18.



but, in order that it may be symmetrical with respect to both axes, it is arranged in such a way that they shall bisect spaces instead of rays. The settings are:

1. Fix the lower segment stop when the pulley is at 307, and the upper when at 347, as in fig. 15.

Drill ...... 1, 2, 3; 4, 5, 6; 7, 8, 9; 10, 11, 12; with the chuck stopped at 1, 5, 9; 25, 29, 33; 49, 53, 57; 73, 77, 81.

2. Fix the lower segment stop when the pulley is at 193, and the upper when at 233.

Drill ...... *a, b, c*; *d, e, f*; *g, h, i*; *j, k, l*; with the chuck stopped at 87, 91, 95; 15, 19, 23; 39, 43, 47; 63, 67, 71;

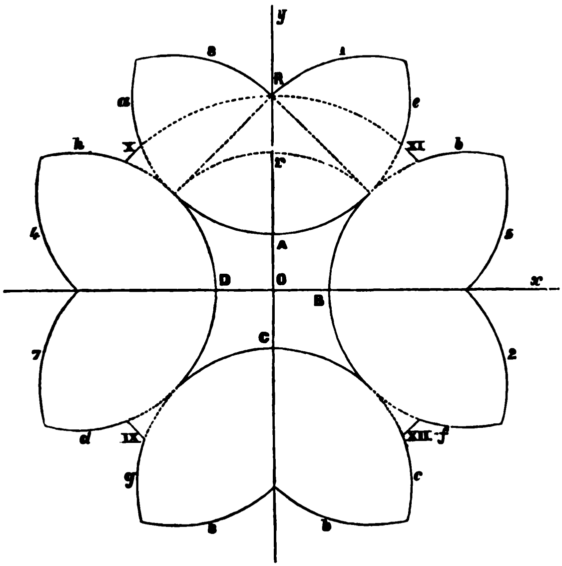
3. Fix the lower segment stop with the pulley at 275, and the upper when it is at 347 again, as in fig. 17. Drill *m*, *n*, *o*, *p*, with the chuck stopped at 13, 37, 61, 85.

4. Fix the lower segment stop when the pulley is again at 193, and the upper when it is at 265. Drill the other four segments to complete the spaces with the chuck stopped at 83, 11, 35, 59.

5. To drill the top lines, as in fig. 15, fix the upper segment stop with the pulley at 3° 45′ (or say 3°), more than 270, *i. e.* at 273, and the lower with the pulley at 3° 45′ (or say 3°), less than 270, *i. e.* at 267. Drill with the chuck stopped at 90, 94, 2, 6; 18, 22, 26, 30; 42, 46, 50, 54; and 66, 70, 74, 78.

Fig. 19.—The centers in this figure are determined by the

FIG. 19.



points of contact which a square has with the circles inscribed in it, and described about it. The square and the circles are indicated by the dotted lines. If for the circumscribed circle a radius = R be taken, then that of the inscribed circle will be $\sqrt{\frac{R}{2}}$ which call *r*. Hence if R = 1 in., *r* = ·707108 ; or say 7 turns 1½ small divisions of slide-rest. Now R and *r* determine the excentricities in this figure; and the radius of the small circles, segments of which form the pattern, is taken exactly equal to *r*, in order that the four wings may be in contact without intersecting. The following are the settings, starting from "all at center," and with the chuck vertical when the pulley is at 360 :—

1. With excentricity 1 in., or 10 turns of the chuck-screw, and radius ·707, or say 7 turns 1 small division of the slide-rest screw, the segments A, B, C, D are to be cut. That is, they are to be cut as segments if it be intended to cut right through the thickness of the material, removing the central portion. If, however, the figure be cut merely as a pattern upon a surface, the arcs need not stop short where they meet the inscribed circle, but may be carried on as indicated by the dotted lines in the fig., where it will be seen that the segments marked *a*, *e*; *b*, *f*; *c*, *g*; *d*, *h*; are respectively portions of the circles A ; B ; C ; D. Assuming, however, that it be intended to remove the central portion, the settings will be given accordingly.

2. Fix the upper segment stop when the pulley is at 315, and the lower when it is at 315 — 90, or 225. Cut the segments A, B, C, D, with the chuck stopped at 96, 24, 48, 72.

3. Fix the upper segment stop with the pulley at 15, and the lower at 340, for an arc of 35°. Cut the segments *a*, *b*, *c*, *d*, with the chuck stopped at 96, 24, 48, 72, as before, these being arcs of the same circles as those just cut.

4. Fix the upper segment stop when the pulley is at 200, and the lower when it is at 165 (because 15 in. § 3 = 360 + 15, and 165 = 180 — 15 ; also 200 — 165 = 35, just as 15 — 340 = 360 + 15 — 340 = 35). Cut the segments *e*, *f*, *g*, *h*, with the chuck stopped at 96, 24, 48, 72, as before.

5. And now for the remaining eight segments, the excentricity has to be reduced to the radius of the inscribed circle, still retaining the same radius for the tool, as given upon the slide-rest, at present. Decrease, therefore, the excentricity on the chuck by

2 turns $9\frac{1}{2}$ divisions, thus making it 7 turns 1 small division, or ·707.

6. The segments are those of circles cut intermediate to the preceding. For the first four fix the lower segment stop when the chuck is vertical, *i. e.* when the pulley is at 360, and the upper when the pulley is at 60, including $\frac{1}{6}$ of the circumference. Drill the segments 1, 2, 3, 4 with the chuck stopped in 12, 36, 60, 84.

7. Fix the lower segment stop with the pulley at 120, and the upper when it is at 180. Drill the segments 5, 6, 7, 8, with the chuck stopped at 12, 36, 60, 84, as before.

8. If the small arcs marked x, xi, xii, xiii, be to be drilled, bring the chuck back to its concentric position. Increase the radius by the slide-rest to 10 turns, *i. e.*, 2 turns $9\frac{1}{2}$ divisions more than at present. Fix the lower segment stop when the pulley is at something less than 315, the upper when it is at the same amount more than 315, say at 313 and 317, according to the width of the drill, taking great care to go the same distance both above and below 315. Cut with the chuck stopped at 96, 24, 48, and 72.

Application of Laws to Drilling Letters with Circular Loops **B J P R U.**

B at center.	*Example.*
1. Excentric chuck vertical, screw head up, stopped in 96. Pulley at 96. Having in the slide-rest a sharp-pointed tool or pencil, fix the right hand fluting stop, taking care that the tool is accurately at center, and ready to move to the left without loss of time.	
2. Traverse the tool to the left sufficient to form a circle, when the pulley is rotated, the diameter of which is one half of the whole height proposed, *i. e.*, traverse the tool through one fourth of such height.	2. Height $\frac{1}{2}$ in. Tool traversed to left $\frac{1}{8}$ in., or 1 turn 5 small divisions.
3. Screw the excentric chuck down precisely the same amount.	3. Chuck down 1 turn 5 small divisions.

4. Bring the pulley to 24 and fix the lower segment stop, then to 72 and fix the upper. Take out the point tool, and put the drilling frame in its place. Drill between these stops a semicircle, and remove them.

5. Shift the chuck wheel to 48. Bring the pulley to 72, and fix the lower segment stop; to 24, and fix the upper. Drill between these stops and remove them.

6. Bring the pulley to 96, and the chuck wheel to 72. Traverse the drill back to center against the right hand fluting stop, which is still fixed. Remember that the drill is now ready to move to the right without loss of time and therefore not ready to move to the left.* Drill half the long line of the letter on each side of the center (*v.* Law I, Rectilinear Drilling, p. 158), or drill to the upper and lower horizontal lines (*v.* Definitions § 8, p. 157), which it is always well to draw, being very careful not to go beyond the height of the letter. Indeed if there be any doubt on the subject it will be better not to drill the whole length of the line now, but to wait till the top and bottom lines are drilled, the meeting of these with the long line at F and E will be a guide (fig. B on the right of center).

7. The pulley being still at 96, bring the chuck wheel also to 96, restoring the letter to its vertical position, and add to the present excentricity as much more, viz., one fourth part of the height of the letter, making in all one half from the concentric position of the chuck.

Example.

4. Pulley to 24 and 72 for lower and upper segment stops.

5. Chuck to 48; pulley to 72 and 24 for lower and upper segment stops.

6. Pulley to 96; chuck to 72. Tool traversed to center, and 2 turns 5 divisions drilled on each side of center.

7. Chuck to 96. Chuck down 1 turn 5 small divisions more, making in all $2\frac{1}{2}$ turns.

* See Note C, p. 238.

Drill E D (fig. **B** on right) to meet the long line E F just completed, or to be completed now.

Example.

8. Bring the chuck wheel to 48, and the pulley to 48; drill the bottom line F G the same as the top (*v.* Law IV, p. 158).

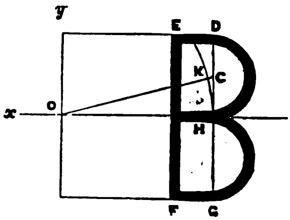
8. Chuck to 48; pulley to 48.

9. Bring the chuck back to its concentric position and drill A H.

9. Chuck concentric for central line.

B on the right of center.

1. Draw the central horizontal line, and having determined the position of the letter,



that is, the excentricity of the point H which is its center, and at which the two circular portions are in contact, mark this point. To do this bring the chuck wheel to 24, screw down as many turns as will bring H to the center, making the excentricity of H = O H; then dot the point H, and with the T-square draw the vertical line D G through this point, the chuck being brought back to 96.

1. O H = $\frac{1}{2}$ in. Chuck down 5 turns to mark H, being stopped at 24.

Having in the slide-rest a sharp-pointed tool accurately at center, and ready to move to the left without loss of time, fix the right hand fluting stop.

2. Same as § 2 of **B** at center.

2. Same as 2 of **B** at center.

3. The excentric chuck wheel being now stopped at 24, stop it at 24 — *n*, *n* being such that the circle which can be cut has O H for a tangent at the point H.

3. Chuck to 24 — 4 or 20.

It is possible that the click wheel will not give sufficiently fine adjustment here; n degrees are required, but n may not be an integral multiple of $3{\cdot}75^\circ$, the value of each tooth. For instance, in the example in the margin, $n = 3$ is too little, $n = 4$ is very near, but it brings the top of the curve slightly above the upper horizontal line. Moreover the increase in the excentricity for C K makes matters worse. The remedy is either to increase the whole size of the letter, and that of others in combination with it (*v.* Rule, end of § 5, p 206), or to diminish the radius very slightly. Generally it will be found so trifling that the width of the tool used will compensate it unless the most extreme accuracy be required.

4. When the chuck wheel is stopped at 24, and the pulley at 96, H O is vertical; now that it is stopped at $24 - n$, C O is vertical. If, therefore, a circle be drilled now, its center will be at K instead of C, because O K = O H. The excentricity must therefore be increased by the amount C K, an amount certainly very trifling in a letter whose height is, *e.g.*, $\frac{1}{2}$ in., but still worth calculating. K C = O C − O H and

$$OC = \sqrt{OH^2 + HC^2},$$

$$\therefore KC = \sqrt{OH^2 + HC^2} - OH.$$

Increase, therefore, the excentricity by this amount. Bring now A O vertical again by stopping the pulley at $96 + n$; *i.e.*, n divisions in the opposite direction to that in which the chuck wheel was moved n from 24, and fix the lower segment stop. Move the pulley through 48 divisions to $48 + n$, and fix the upper stop. Drill between these stops and remove them.

Example.

4. O H = ·5,
H C = ·125,
K C =
$\sqrt{{\cdot}25 + {\cdot}015625} - {\cdot}5$
$= {\cdot}015$ or $\frac{3}{200}$.

Excentricity 3 small divisions more. Pulley to 96 + 4, or 4 for lower segment stop. To 48 + 4, or 52, for upper.

5. Here remember that in this and all similar cases, whatever number from 24 the chuck is now stopped at, so many from 24 on the other side must it be at when the second loop of the letter is drilled. Bring, therefore, the chuck wheel to 24 + n, the pulley to 96 − n, that A O may again be vertical, and fix the lower segment stop; to 48 − n, and fix the upper stop. Drill between these stops and remove them.

Example.

5. Chuck to 24 + 4 or 28. Pulley to 96 − 4, or 92, for lower, and to 48 − 4, or 44, for upper stop.

6. Now screw the chuck up by an amount equal to one fourth part of the height of the letter, less the increment made in § 4; and with the pulley at 96, the chuck at 24, drill E F, which will now be horizontal, one half on each side of the axis of y.

6. Chuck up 1 turn 5 small divisions—3 small divisions, or 1 turn 2 small divisions; stopped in 24; pulley in 96.

7. The pulley being kept at 96, bring the chuck also to 96, and screw the chuck up one fourth part of the height of the letter more. Join E D, which will now be horizontal.

7. Chuck up 1 turn 5 small divisions.

8. Bring the pulley to 48, and the chuck to 48. Join F G.

8. Pulley to 48, chuck to 48.

9. Screw the chuck up till it is concentric, and join A H.

9. Chuck concentric.

B on the left of center.

1. The same as § 1 of **B** on the right of center, but the chuck wheel is brought to 72 instead of to 24.

1. O H = 1 in. Chuck down 10 turns to mark H, being at 72.

2. The same as § 2 of **B** at the center, or on the right.

2. Height = 1 in. Traverse tool to the left ·25 in., or $2\frac{1}{2}$ turns.

3. The chuck being now at 72, bring it to 72 − n, n being such, &c., as in § 3 of **B** on the right.

3. Chuck to 72 − 4, or 68.

4. The same as § 4 of **B** on the right. A O is vertical with the pulley in $96 + n$ as in that §, but now the upper segment stop is to be fixed when the pulley is at $96 + n$, and the lower when it is at $48 + n$.

Example.

4. O H = 1 in. H C = ·25 K C = $\sqrt{1 + \cdot 0625} - 1$ = ·0307, or, excentricity is to be increased 3 large divisions. Pulley to 96 + 4, or 4 for upper, and to 48 + 4, or 52 for lower stop.

5. The same as § 5 of **B** on the right; but the chuck is to be at $72 + n$ instead of $24 + n$; and the pulley at $96 - n$ for the upper stop, $48 - n$ for the lower.

5. Chuck to 72 + 4, or 76. Pulley to 96 − 4, or 92 for upper stop, and 48 − 4, or 44 for the lower.

6. Screw the chuck down one fourth part of the height of the letter, less the increment K C; and the pulley being at 96, the chuck at 72, drill the long line E F, which will be horizontal.

6. Chuck down 2½ turns less 3 divisions, or two turns 2 divisions. Pulley at 96. Chuck at 72.

7. Bring the chuck to 96, the pulley to 48. Screw the chuck up till no more than one half the height of the letter is left, and join E D.

7. Chuck up till excentricity = 5 turns. Chuck to 96, pulley to 48.

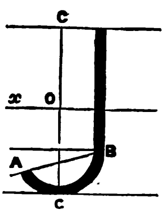
8. Bring the chuck to 48, the pulley to 96, and join F G.

8. Chuck to 48, and pulley to 96.

9. Make the chuck concentric, and join A H.

9. Chuck concentric.

J at the center.



Draw the top and bottom, and the central vertical lines; the latter will pass through the center of the circular portion of the letter, the upright stroke being on its right. Fix the right hand fluting stop.

1. Having determined the height of the letter, traverse the tool one fourth part of such

1. Height = ½ in., tool 1 turn 5 small div., to left.

height to the left. Bring the chuck to 48, and turn it down exactly the same amount.

2. Fix the lower segment stop with the pulley at 96, and the upper with pulley at 44, thus including 44 × $3\frac{3}{4}$°, or 15° less than a semicircle. Drill between these stops, and remove them.

3. Bring the pulley back to 96. If more letters be to be drilled in combination with the present work, bring the tool back to center against the right hand fluting stop, which is still fixed; turn the excentric chuck down as much more as at first, making now an excentricity equal to one half of the height of the letter. This will bring the point C (the highest point as the work stands on the chuck) to the center. Shift the excentric chuck wheel to 96, bringing the letter to its proper position, and the point C′ will be at the center. If the upper horizontal line were not drawn at first, or if it be thought unsafe to trust to it, this point C′ may now be marked, and a line drawn through it with the T-square (the chuck being made horizontal for the purpose). This line is the upper horizontal line for all the rest of the letters, and C′ is its center.

5. The pulley being in 96, bring the chuck wheel to 24. If the process of § 3 has not been gone through the excentricity is now correct. If, however, § 3 has been worked, the excentricity must be reduced again from one half to one fourth of the height. Unfix the right hand fluting stop, and drill the long line from B to the upper horizontal line, $\frac{3}{4}$ of the whole height.

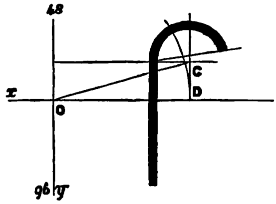
Example.

Chuck in 48, and screwed down 1 turn 5 small div.

2. Pulley to 96 for lower, and 44 for upper stop.

5. Chuck to 24 and pulley to 96. Long line drilled from end of arc to a length of ·375, or 3 turns $7\frac{1}{2}$ divisions.

J on the left of the center.



Having determined the height and position of the letter, that is, the excentricity of its central point D, draw the upper and lower horizontal lines and the vertical line D C through D, according to the method described in § 1 of B on the right, but the chuck wheel must be brought to 72, since this letter is to be on the left.

There is now an excentricity on the chuck equal to O D, and C D is horizontal. In order to mark the point C, which is the center of the arc to be drilled, and which is in C D, bring the chuck to 48, thus turning the letter upside down. Screw the chuck up till no more excentricity is left than one fourth part of the height, and mark the point C, which will be at the center vertically, though not horizontally.

2. Having now all the lines drawn, or the points marked, it will be safest to come back to "all at center." Traverse the tool through one fourth part of the height of the letter. Make O D vertical by bringing the chuck to 72, and screw down through O D till D comes to the center. Make O C vertical by shifting the chuck wheel through n teeth to $72 - n$. Now the excentricity must be increased by O C – O D or $\sqrt{OD^2 + DC^2} - OD$. Now make O C horizontal by bringing the pulley to $72 + n$, and fix the lower segment stop; and to $(24 - 4) + n$, or $20 + n$, for the upper stop, thus including 15° less than a semicircle.

3. Before drilling between these lines examine whether the lower horizontal line will be a tangent to the circle that can be

Example.

1. OD = ·45 in., ∴ $4\frac{1}{2}$ turns of chuck down to mark D.

Height = $\frac{1}{2}$ in. ∴ chuck up till no more than 1 turn 5 small div. is left, to mark C; and chuck stopped in 48.

2. "All at center."

Tool 1 turn 5 small div. to left. Chuck in 72, and down $4\frac{1}{2}$ turns.

Chuck to 72 – 4 or 68. Increment = $\sqrt{\cdot45^2 + \cdot125^2} - \cdot45 = \cdot017$, or $1\frac{1}{2}$ small divisions.

Pulley to 72 + 4, or 76 for lower, and to 20 + 4, or 24 for upper segment stop.

cut with the present settings; also make sure that the line C D passes through C, the center of the circle. If not, either the traverse of the tool by the slide-rest is incorrect, or the excentricity requires a slight alteration. Having done this, drill between the stops and remove them.

4. Bring the pulley to 96, and the chuck to 72. Screw the chuck up through the increment and also through one fourth part of the height of the letter, so that the long line may come to the horizontal central line. Notice carefully whether the drill meet the end of the arc, and drill three fourths of the height of the letter measuring from the arc, that is, to the upper horizontal line.

4. Pulley 96; chuck 72.

Chuck concentric and down again through $\frac{3}{4}$ of the height, or $\frac{3}{4}$ of ·45 = ·3375 = 3 turns $7\frac{1}{2}$ small divisions.

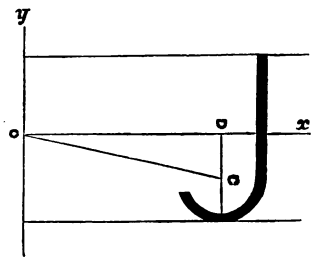
J on the right of the center.

1. Draw the upper and lower horizontal and the central vertical lines. Having determined the position of the point D bring the chuck wheel to 24, and screw down through O D to draw D C.

1. Height = $\frac{1}{2}$ in and O D = 1 in.

Chuck down 10 turns to mark D.

2. Traverse the tool to the right through one fourth part of the height of the letter,



and mark C. The tool is now in the right place for drilling the arc, and the letter is in the position indicated by the figure.

2. Tool 1 turn 5 small divisions to the right to mark C.

3. Make O C vertical by bringing the chuck wheel to 24 + *n*, and increase the

3. Chuck to 24 + 2, or 26. Ex-

excentricity by O C—O D, *i.e.*, by $\sqrt{OD^2 + DC^2} - OD$.

Example. centricity increased by $\sqrt{1 + \cdot125^2} - 1 = \cdot007$ or $1\frac{2}{5}$ small divisions.

4. Bring the pulley to 72 — n, when the axis of y will be horizontal, and fix the lower segment stop; to 72 — n + 44, which is 20 — n, and fix the upper stop. Having made the examination directed in § 3 of **J** on the left, drill between these stops, and remove them.

4. Pulley to 72—2 or 70 for lower stop, and to 20—2, or 18 for upper.

5. Bring the pulley to 96 and the chuck to 24. Screw down through one fourth part of the height of the letter, less the increment made in § 3, and drill the long line of the letter to the upper horizontal line.

5. Pulley to 96; chuck to 24. Chuck screwed down 1 turn 5 small div. — $1\frac{1}{4}$ small div. = 1 turn $3\frac{3}{4}$ small div.

P at the center.

The same as **B** at the center, omitting §§ 5 and 8.

P on the right and on the left of center.

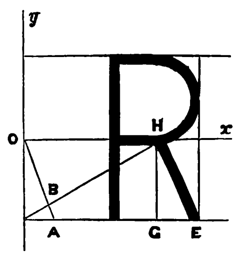
The same as **B** on the right and left, omitting §§ 5 and 8.

R at the center.

The same as **P** at the center, with an addition for the tail.

Make the chuck concentric, and bring the tool to the center. Fix the pulley at 16, the chuck being at 96, and drill from the centre towards the right to meet the lower horizontal line.

R on the right of the center.



The same as **P** on the right with the addition.

Make the chuck concentric, and bring the tool to the center. The angle E H G =30°. Bring H E to a horizontal position, therefore, by shifting the chuck wheel to 16. Screw the chuck down through H B, and traverse the tool along H E to meet the lower horizontal line. To find the value of H B we have O A parallel to H E, ∴ H O B = 90° − E H G = 60°; and, O B H being a right angle, H B = O H sin. 60° = O H × ·866.

R on the left of center.

The same as **P** on the left, with the addition, which is as for **R** on the right, but the chuck must be shifted to 96—16, or 80, in order to make H E horizontal.

U at the center.

The same as **J** at the center, but the whole semicircle must be drilled instead of 15° short, and the addition be made for the left hand stroke. Bring the chuck wheel to 72, keeping the pulley in 96, and drill the line.

U on the left of center.

The same as **J** on the left, but the whole semicircle, &c., as above. Screw the chuck down through one half the height of the letter, and drill the line.

U on the right of center.

The same as **J** on the right, but the whole semicircle, &c., as above. Screw the chuck up through one half the height of the letter, and drill the line.

NOTES.

(A)

To reduce decimals of an inch to the graduations of the chuck and slide rest.— The first figure after the decimal point indicates the number of whole turns of the screw, the second the number of whole (numbered) divisions. If there be more than two places of decimals, take the first for the number of whole turns, and the quotient of the next three divided by 50, or the next four by 500, &c., for the number of small (half) divisions, e.g.,

2·1075 in. would require 20 whole turns for the 2 on the left;
1 " " 1 " right,

and $1\frac{1}{2}$ small divisions for the 075, because $\frac{075}{50} = \frac{75}{50} = 1\frac{1}{2}$.

The reason for this is evident, if it be remembered that ·1075 means $\frac{1}{10} + \frac{75}{10,000}$, or $\frac{1}{10} + \frac{75}{50 \times 200}$, or $\frac{1}{10} + \frac{1\frac{1}{2}}{200}$.

(B)

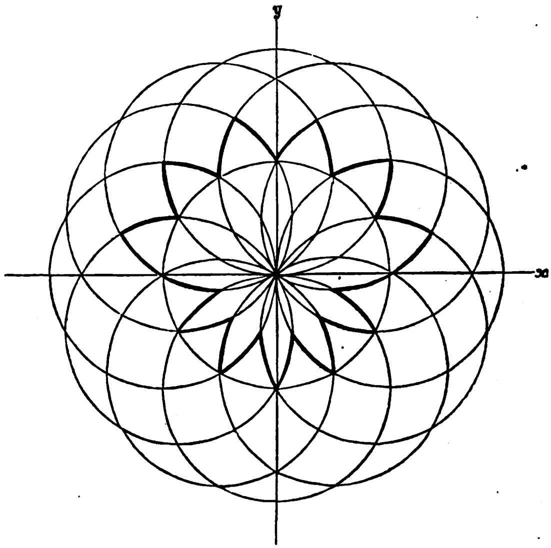
Patterns for silk winders.—If such patterns be cut out from blocks of wood or ivory, it is not necessary to turn off a disc of the right thickness first, indeed, it is better not to do so, on account of the difficulty of chucking it firmly afterwards. Let the parting-tool in first to such a depth that sufficient material only may be left to hold the work at the center, going deeper than any of the sharp angles of the figure. When the drilling is finished the work may have a circular hole turned out of its center, if desired, by which it can be rechucked, after cutting it off with a fine saw or parting tool, and the back finished. As it cannot be chucked very tightly, for fear of splitting, a pin may be driven into the face of the chuck against which some portion of the work will bear.

(C)

Traverse of tool, and loss of time.—The tool box being traversed from the left to the right against the right hand fluting stop, is not ready to move to the left again without loss of time. To remedy this, after bringing the tool to the right hand stop, fix the left hand stop tight against the tool box; unfix the right hand stop, traverse the tool still more to the right, and then back to the left hand stop; fix the right hand stop again, and unfix the left. The tool is now ready to move to the left without loss of time, and yet is in the position it was in after first traversing to right hand stop.

(D)

Geometrical construction of the figure for generating figs. 11 *and* 12.—x and y, being the rectangular axes, their point of intersection is taken for the center of a circle of any radius, and starting from its point of intersection with x as a center, six circles of the same radius are described around it, their centers being



successively the points of intersection of the one immediately preceding each of them with the first or central circle. Starting again from the point of intersection of the central circle with y, six more are described in the same way. This divides the circumference of the first circle into 12 equal arcs, and any segments of any of the circles can be drilled.

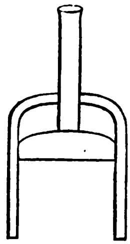
SHERRARD B. BURNABY.

(*To be continued.*)

THE TURNERS AND TURNERY OF KING'S CLIFFE, NORTHAMPTONSHIRE.

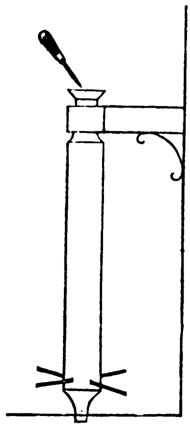
HAVING committed myself by promising a *tail* to my tale about the turners and turnery of King's Cliffe (p. 191), I must now try to redeem my promise by a few remarks on the articles made, the manner of making, price and demand which exists for the Cliffe ware.

FIG. 1.



The articles made are very numerous. I have before me the price list of a man who, with his son, carries on a fair business; it comprises about sixty different articles; and these again divided into different sizes, though, it must be observed, he does not himself make all the articles mentioned, but supplies them. However, he and his son make a great many of them. It would be needless to name them all—let me rather select a few. First on the list we have "butter prints" of four kinds; 1, in cases (Fig. 1); 2, single prints; 3, oval prints; and, 4, mould prints. Those in cases are divided into six sizes, viz. 1 lb., ¾ lb., ½ lb., ¼ lb., 2 oz., and common size. The simple prints are divided in like manner, and with the others there are different sizes and prices. The turner will readily understand how the ordinary prints and cases are turned, but there is an ingenious device (Fig. 2) in connection with the carving which calls for notice. They are, of course, carved with chisels, gouges, &c., the contrivance in question is for holding them, and very handy it is for the purpose. It consists of an upright post, the bottom formed as a pivot, turning in a hole in the floor usually, the upper part in a wooden collar carried by a bracket projecting from the wall. Near the lower extremity are two bars of iron, running through the post at right angles, on which the workman keeps his feet and so steadies

FIG. 2.

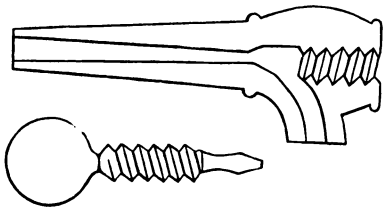


the work or turns it as may suit his purpose. The butter print is fixed by a thumbscrew in a socket in the upper part of the post; napkin rings are first fixed in a holder fitting into the socket. There is no turning about the butter moulds—they consist of two pieces of wood, three or four inches square and about an inch thick, on each of which one half of the device is carved (a wheat-sheaf, swan, &c.), the butter being pressed between them.

The spice box is another article of which many are made. These are divided into small, middle, large, and large with five lifts, each *lift* being, in fact, a separate box, the bottom of which forms the top of the one immediately beneath it. There is a screw for each division, which is cut with a simple V-tool by hand, without any guide. The lathe head is turned with the left hand and the tool held in the right, and it is curious to see with what facility and accuracy this is done. The insides of the divisions, like the insides of all other boxes, are cut out very quickly with the hook tool (p. 190), and the bottoms squared with a similar tool of rectangular shape.

Taps are made of various sizes—large ones for water-butts and

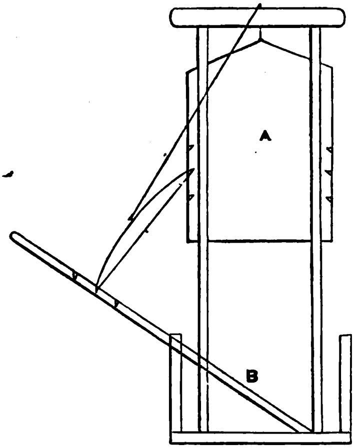
FIG. 3.



smaller ones for beer and other purposes. Fig. 3 represents a tap in section. The screw is cut by hand with the V-tool. To cut the female screw the tap is chucked on a taper iron mandrel which holds it sufficiently firm for the purpose. The outside is turned as far as the projection for the spout which is shaped with the paring knife.

The mouse-trap (Fig. 4) is also made in considerable quantities and is very effectual for its purpose. It will be seen that there are seven pieces besides the string, five of these being turned, and all put together for one shilling—less if sold wholesale. The

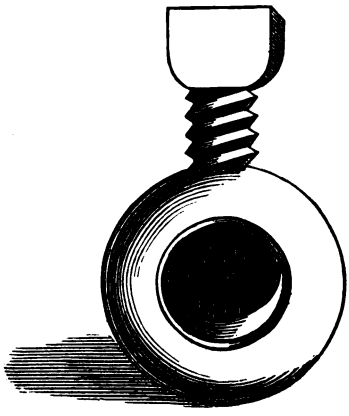
FIG. 4.



principle is very simple, the wooden block A falls on the mouse when, to secure the bait, he ventures his foot on the treadle B.

The turned nutcracker (Fig. 5) may be seen on many stalls at

FIG. 5.



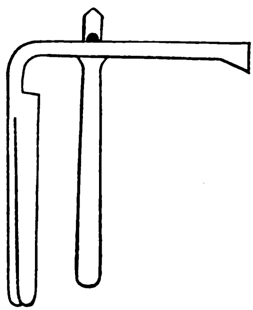
fairs where nuts are sold. It is simple enough, consisting of two pieces only, a wooden box and a screw. The figure will sufficiently show what it is and, I should suppose, the manner of its use.

Salt-cellars and egg-cups are made in large quantities; the wood is cut into proper lengths and roughly pared with the knife. A taper screw, or worm chuck, is fixed on the mandrel and the piece of wood screwed on with a few turns and cut out most expeditiously with the hook tool and gouge.

The words "puzzle boxes" and "chartist whistles," which occur in the list, may excite curiosity; they are, however, very simple articles. The puzzle box is in the form of a ball, ornamented with sets of concentric circles, two of which, on opposite sides, serve to conceal the ends of a cylindrical box which is fitted in diametrically and capable of being pushed out with the finger, when the proper place is found. We have no chartists about here that I am aware of, and why the whistle, which, by the bye, is *not* a whistle, should be named after them, I cannot tell. It is a small box with a perforated top, standing on a foot, something like a pepper box in shape, with a cylindrical piece projecting from the top, made to represent a whistle, but whoever attempts to sound it receives a puff of flour in the face, through the holes, to the discomfiture of the performer and amusement of the lookers-on.

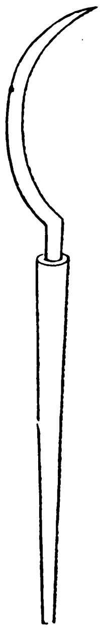
And now let me turn to the manufacture of spoons, which is

FIG. 6.



peculiar and has peculiar and appropriate tools. They are made of poplar, alder, and, it may be, other woods—of poplar by preference. The first process is to cut them into lengths and give them the rough shape of the article with the saw and paring knife. The bowl is then cut out with a curious instrument called a "fixel" (Fig. 6), if that be the right word, for I have not yet been able to find it. The blade is in the form of a gouge, about six inches long. The spoon is held by the left hand on a block and the fixel in the right, when the bowl is chopped out with ease and considerable precision. It is then finished with the "smeething"* (Fig. 7), the bowl being held in the left hand, with a bit of rag to guard the hand, and the tool in the right, the long handle going under the arm to steady it and give power. The spoon is then put into the lathe (commonly the simplest form of pole or spring-lathe) where, in a few turns, the handle is completed with a gouge. The whole is then finished off on the block with a knife of peculiar shape, with a long handle like the smeething, and used in the same fashion. All these tools are made by the village blacksmith.

Fig. 7.



Some few toys are also made here, as humming tops, small churns, rattles, &c. The humming tops are made of four pieces, painted, varnished, and sold at 6*d.* and 4*d.* each, which seems but little money. Some rather ornamental watch-stands, cotton-stands, pin-cushions, and spill-cups, also deserve a passing notice, but probably I have already become sufficiently tedious, so will pass on to a few words about the demand for, and the price of, the various articles of which I have spoken. Bearing in mind that not less than forty men are constantly employed in these works, it will be seen at once that the demand is considerable. Wooden spoons are not yet out of fashion, and notwithstanding the great increase of metal spoons and dishes, and the cheap and cleanly crockeryware, there are places where wooden ware is still preferred, and where it holds its head aloft. Large quantities are sent to Liverpool for exportation, mostly, I am told, to America; and the manufacturing districts of England, Yorkshire, Lancashire, &c., are ready markets. I was in a shop the other day where a man was turning tobacco boxes, in the form of little barrels. He had an order for a gross from Lancashire; these are sold at 4*s.*

* Though I have not yet found the word "fixel," I find the word "smeeth (to)" thus defined in Todd's Johnson, 1829:—"*v. a.*, the Saxon form of *smooth*, and still used in some parts of the north."

the dozen (wholesale). An order was once given for fifty pounds' worth of *butter prints alone* for America, which was considered a large one. As another sample of an order I may give the following (it was from Westmoreland):

5 gross of salt-cellars.
4 „ money boxes.
1 „ cotton-stands.
6 „ nutcrackers.

No less than 2304 separate articles! Touching the price at which the Cliffe ware is sold it seems marvellously small, and yet an industrious workman will make a very fair living out of it. It is not very easy work, but a man will turn six dozen salt-cellars in a day, which being sold (wholesale) at 1*s.* 6*d.* per dozen will produce 9*s.*; but then something must be allowed for wood, wear of tools, &c., so that probably he will not earn more than 7*s.* 6*d.* Egg-cups again are sold at 10*d.* a dozen, and I was somewhat surprised when a boy about 17 told me, perhaps a year ago, that he had, by way of trial, turned 16 dozen in a day, no less than 192, but that it was a very hard day's work, lasting from 3 a.m. till dark. He has, however, now outdone himself; I was in his shop a week or two ago, and he told me he had turned 19 dozen in a day, from 7 a.m to 7 p.m., allowing one hour only for meals, and that he intended the day after my visit to turn 21 dozen, for he had an order for 2 gross, of which he had turned 3 dozen only, and he wanted to complete the order next day. Probably he did it, but it seems to me a marvellous quantity,—252 separate articles! The wood, I should observe, was cut into lengths of about two inches, and roughly pared, and each piece had to be screwed on to a taper screw and turned, the inside with a hook tool, the outside with a gouge. Another man told me he had once begun and finished 13 dozen spoons in a day, which, if sold at 10*d.* a dozen, would produce 10*s.* 10*d.*, but these are unusual quantities, and could not be produced for any length of time in like proportion. Butter prints are variously priced according to the size. Those in cases for 1 lb. are sold at 14*s.* per dozen, for ½ lb. at 10*s.*, and so on. Spice boxes with five lifts are sold at 18*s.* per dozen, with four lifts at 15*s.*, &c., which, taking the many pieces into account, seems very little. Nutcrackers are sold at 8*s.* per gross. Puzzle boxes at 1*s.* each, retail; considerably less, probably 8*s.*

per dozen, wholesale, and so on. Croquet sets are also made here, but not many of them, at from £1 to £3 the set, and very well made too. The balls are of crab tree, which is getting somewhat scarce.

There is a pretty method of ornamenting small boxes and other ware by transferring small pictures from paper to the wood. I did not know how this was done till lately, nor do I know now where to procure the small pictures for the purpose. It seems that travellers come round with them. They appear somewhat dim, as though you saw them through from the back. They merely require to be put in warm water, and laid face downward on the wood, when the back paper comes off and leaves the impression. It is then varnished over and the ornamentation is complete. A word also about the varnish. It is usually home-made. One very useful one is composed of—

6 ounces of gum sandarach;
1 pint of methylated spirit of wine;
4 ounces of black resin.

Perhaps a quart is made at a time, mixed in a tin can, and set near the fire to melt. The can should be large, as it is liable to boil over if care be not taken, and care *must* be taken in this matter. When thoroughly mixed it is strained into bottles for use. It is simply laid on with a camel hair brush, in a warm room. Another kind, somewhat harder, is made with shell-lac, but I have not the exact receipt by me. And now methinks I have said enough, perhaps far too much. What will be the future of the King's Cliffe trade it is impossible to say, for the giant steam engine is even now threatening to swallow up the old foot lathe. One of the principal turners—and a very excellent one too—is about to set up a steam-engine to drive his lathes. The other turners do not seem to think he can undersell them, and, indeed, the price at which the Cliffe ware is sold appears to me already reduced to a minimum. So let us hope there will be room for all, and that all the lathes in King's Cliffe will work harmoniously together, as I believe they ever have done, holding a generous rivalry one with another, as members not only of an interesting and most useful trade, but of the great Christian family, considering one another and provoking unto love and good works.

JOHN H. HOLDICH.

GOSSIP.

"... bald, unjointed chat ..."

King Henry IV, Pt. I.

WE were much interested and edified by the perusal of an article which appeared in the *Times* early in February headed "The Walter Press." At the time of our last visit to the *Times* office, in 1869, we were told that there were four machines in use, two of which were open to inspection, whilst the other two performed their task in secret, and from the tenor of the article in question we conclude that it refers to the latter, though why the *Times* should have copied it from the *Scotsman*, as stated beneath the heading, and not itself given a description of its own machines, we are at loss to conceive, unless it be a result of that innate modesty which is, or should be, one of the attributes of greatness. We will endeavour briefly to epitomise the article referred to for the benefit of our readers. On the 29th of November, 1814, the *Times* was first printed by steam-power at the rate of 1100 sheets per hour, a speed which was at the time considered very extraordinary, and was duly commented on in the issue of that date. But little further appears to have been done until 1856, when the pressure of business resulting from the Russian war proved an incentive to increased exertion. The then recently invented *papier-mâché* stereotype process engaged the attention of Mr. Walter with a view to the multiplication of forms from which to print, and by this means and the employment of extra presses the speed was raised from 5000, at which it then stood, to 10,000 per hour. From that time experiments were commenced with the object of constructing a machine which should at the same time throw off a larger number of impressions per hour, perform its work with increased accuracy, and economise labour. These conditions appear to be satisfactorily fulfilled for the present, at least, by the machine under notice, though how long it will continue in favour in this age of progress is of course an open question. The Walter press is capable of delivering 17,000 copies per hour with one fifth of the number of hands required by its immediate predecessor. A thin sheet of dry *papier-mâché* is applied to the type in a suitable press so as to produce a matrix from which, when bent round to suit the curve of the drum of the machine in an apparatus constructed for the purpose, a cast is taken in stereotype metal. This process occupies something less than a quarter of an hour, the plates are then rapidly fitted and bolted to the drum of the machine, and printing commences from a reel of paper specially made in one continuous piece about four miles in length, which is cut to the required size in the machine. This arrangement obviates the necessity of hand feeding, which in the American perfecting machines until lately (and perhaps still occasionally) in use, occupied ten hands, and ten more at the delivery tables. The average daily issue of the *Times* is 60,000 copies, for which about nine tons of paper are required ; half a ton weight of water is absorbed in damping, which is effected by winding the paper from one reel to another, passing it on the way between two wet rollers. A page of the second edition is kept open daily for the latest news until a quarter past 12, when it is stereotyped, and publishing commences at a quarter to 1. Motive power is supplied from a 24 horse-power beam engine.

In the *Leisure Hour* for February we find a paper "On Snow Crystals," by James Glaisher, Esq., F.R.S., which is perhaps worthy of the attention of the ornamental turner. It is most profusely illustrated, and some of the figures given, if not actually capable of reproduction in the lathe, may at any rate suggest designs for surface patterns such as are produced with the excentric chuck and cutter. Seeing that water crystallises at an angle of 60°, and that consequently the patterns afforded by snow crystals are all based on the hexagon, it is wonderful to contemplate the variety of combinations illustrated by Mr. Glaisher, and our wonder increases when we consider that these illustrations (eighty or more in number) represent but a small proportion of the geometrical figures actually produced during every snow storm.

A sale was held on the 1st March of the contents of the late Mr. Babbage's workshop, but for some cause best known to the auctioneers many of those who would have attended, if only to purchase a memento, were in ignorance of the fact. Many of our readers will have observed with regret an obituary notice in October last relating to this gentleman, who was chiefly known in the scientific world as one of the introducers, in conjunction with the late Sir John Herschel and Dean Peacock, of the analytical method of mathematical reasoning which now obtains at Cambridge. He was thus led to the invention of his calculating machine or "Difference Engine," which, although incomplete, bears witness to the great ability and untiring perseverance of its inventor, whose intention it was to construct an analytical engine, of which the first machine would have only formed a part. On the construction and uses of such an instrument it is fortunately not our province to dilate; we say fortunately, for we apprehend it would tax the skill of an able mathematician to write a description which should be intelligible to any but those well versed in mathematical science. The machine tools disposed of at the sale, consisting of lathes, planing, punching, slotting, and wheel-cutting machines, were mostly adapted to special purposes, and all suggested the idea that in their selection quality had been considered before cost, notwithstanding which the prices obtained were in most instances very small—in some we should imagine not above half the second-hand value.

CORRESPONDENCE.

TURNING SPHERES BY TEMPLATE.

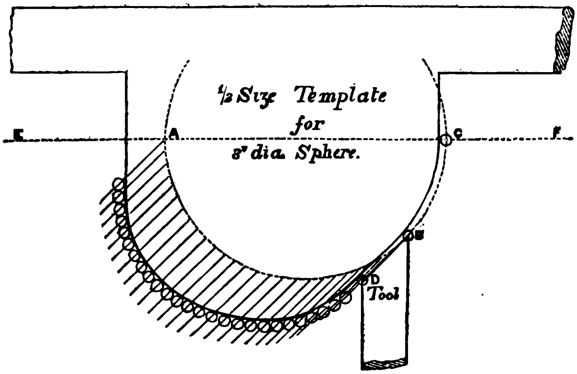
To the Editor.

SIR,—"Virion Nighton" suggests, on p. 136 of our Journal, a form of tool for turning spheres by means of a template. Now, that tool will undoubtedly both turn and *cut off* a sphere when under the guidance of a properly shaped template, the construction of which, according to my views, is the object of my present letter. For my own part, I should not think of making a template except for the production of a number of balls; had I only one to make, I should turn it by hand, testing it by means of a semicircle. The tool I am about to describe is of the same shape as that shown by "V. N.," above mentioned, ground at an angle of 45° precisely, and having the cutting edge $\frac{1}{16}$ths of an inch in length. With these conditions of angle and length of edge the template for a 3″ diameter sphere is made as in the diagram.*

The semicircle A B C represents, in plan, half the circum-

* The diagram is half the full size.

ference of the proposed sphere, A being next the mandrel. It is evident that, on starting at C, the tool will cut at its corner D,



and will continue to do so until it arrives at the point B, at which place it is out of cut. This portion of the circumference can, therefore, be cut by means of a template composed of an arc of a circle whose radius = radius of sphere — radius of rubber (the diameter of which I have taken at $\frac{1}{4}''$) therefore the radius of this part $= 1\frac{3}{8}''$. Beyond the point B the template assumes the shape of a curve, which is found by dividing the remainder of the circumference A B into a number of points (say $\frac{1}{8}''$ apart), and from each of these drawing a line at 45° (the same angle as the tool) to the axis E F, and on these lines marking off the length of the cutting edge of tool, viz. to $\frac{11}{16}''$; these points, joined by a curve, will give the path of the *centre* of the rubber-pin. To find the shape of the template from this, proceed to describe at each of these points a circle (or portion of one) with $\frac{1}{8}''$ radius, then the inner edges of their circumference joined by a curve will give the shape of the template. The part comprised between B and D is a straight line at an angle of 45° (same angle as tool) to E F. Having laid the curve down on paper to full size, I should make the template by gumming a tracing of the curve upon the iron, and then with a sharp-pointed centre-punch mark the iron by following the line on the paper, which can then be cut out to the dots. The template should be carried beyond the axis, say $\frac{3}{4}''$, according to the size of the tool used. Care must be taken to set the tool square with the work, or else an oval (more or less) will be the result.

G. W. A.

P.S.—If any of our Members succeed with this plan, will they kindly communicate their experiences to the Journal?

A Suggestion.

To the Editor.

Sir,—I have been much struck by a paragraph that appears in an article entitled *Gossip* in the January number of your Journal (p. 186), and which seems to me most pregnant and suggestive. May I be allowed a word or two on the subject of it? Let me say at once that I am not a practical mechanic, and have with regret to disclaim any pretension to belong in any sense, other than admiration justifies, to the most honorable guild of Amateur Mechanics. That I am not a practical mechanic is owing, I believe, solely to the fact that in early manhood circumstances were adverse, or rather, I should say, absolutely antagonistic to the development of a faculty that had made itself partially apparent in youth; and this latent love of the subject will account for the interest with which your *Gossip* has inspired me, and must be my justification for addressing you.

The paragraph I refer to is that in which you speculate upon the advantages that would accrue were practical mechanics made generally a part of the education of our youth: "A little time," you say, "in the course of the week devoted to such pursuits as carpenters and joiners' work, turning, &c., could scarcely be said to be wasted, for we imagine that to men in most positions of life manual dexterity would be almost, if not quite, as valuable as much of the knowledge acquired at our schools." These words will I venture to think at once find a ready and sympathetic response, not in the minds only of those of kindred tastes and pursuits with yourself, but also of most of those who have reached a period of life that enables them to form some just estimate of the faults and defects of their own education, and the serious disadvantage they have been at in the race of life in consequence of them. As a mere *pastime*, applying the term in its primitive sense, and amusement, what occupation can be more attractive than that at the lathe or the carpenter's bench? To a young man released from the labours of his office, wearied, it may be, and exhausted by long hours of close occupation or intellectual drudgery, and unwilling or unable to turn at once to reading or study, what relief is afforded by a resort to healthy and invigorating occupations that bring into play some of the best powers of brain and body, and stimulate both without excessive fatigue. To those, again, who by birth or fortune are happily exempted from the hard necessity of daily toil, while offering all the gratification and relaxation that they derive whose lot it is to have to fight the battle of existence, such pursuits supply in addition what is of still greater importance, "a counter-attraction," as you observe, "against the allurements of many questionable places of amusement;" and who can tell but with some might be found sufficiently powerful to eclipse and cast into shadow even the apparently fascinating, if cruel, glories of Hurlingham itself.

In other ways, too, the art of carpentering will prove itself of great utility to many classes of persons. How many shillings and half-crowns, for example, *paterfamilias* might be saved were he able, by a little "manual dexterity," to dispense with the services of the carpenter, &c., upon the innumerable occasions they are required, they know best who are sufficiently observant of their expenditure to note the large sums that even poor householders are compelled to disburse in such matters yearly. And if a competent knowledge of mechanics is of no insignificant moment to those whose lives are spent at home, how truly invaluable must it be to such as are called upon to emigrate and create for themselves homes in wild and uncultivated countries where skilled labour cannot be had, or only at a prohibitory cost? The difference between the home that would arise, (say in the backwoods of Canada or the plains of Australia), under the hands of an intelligent and practised mechanic, albeit an amateur only, and such as would result where this qualification was wanting, cannot easily be exaggerated, and will barely be expressed by the distance that separates *comfort* from *misery*.

If there be any foundation of truth in what has been said, surely, sir, no one will venture to controvert the appropriateness and force of your suggestion that our schools, whether public or private, (who among us can forecast where his lot will fall?), should afford the means of acquiring expertness in a branch of education of such eminent and unquestionable utility to all who are able to avail themselves of it. This important question might moreover be deemed worthy of some consideration at the hands of our School Boards. It is lamentable, indeed, having regard to the vast numbers of all classes of persons that are yearly compelled to emigrate, to be obliged to confess that, as a matter of fact, this subject fails to find any place in the usual course of instruction provided for the youth of this country; and, so far as I know, there is no way, apart from considerable outlay, by which any one desiring to acquire a knowledge of it can do so. A young lad taking up his residence in the metropolis, or other large town, and occupying, as is generally the case, small lodgings, is obviously wholly without the opportunity of establishing a workshop on his own account, however capable and desirous of doing so. The noise alone would be an absolute bar to such a proceeding. And where can he find one that he can use without incurring more expense than most lads can afford? Here, then, is a want thoroughly recognised and appreciated, I doubt not, by many hundreds in this metropolis. How can it be supplied? The aim of this letter will be accomplished when I have ventured to suggest, if an outsider may do so without impertinence, that the providing a remedy for this very obvious want may form a *mission*, to employ the phrase of the hour, not wholly unworthy of the Amateur Mechanical Society. If I mistake not, in former numbers of your Journal, the idea has already been started of a room where members might find and use machinery and tools such as they cannot always procure in their own workshops. Might not this happy idea be expanded so as, while providing for your own members, to meet at the same time the requirements of the general public that I have endeavoured to indicate? How this could best be accomplished would be a question for the Council to think out and suggest, and I feel well convinced that it could not be confided to fitter or more competent hands. Were it judiciously effected it could not fail to command extensive support, and would meet an acknowledged and very real want, and the result would amply reward any labour and trouble that might be expended upon it.

C. A. W. C.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

JULY, 1872.

HON. SECRETARY'S REPORT.

THE Third Annual Dinner took place, as arranged, at Willis's Rooms, on Thursday, May 2nd. A considerable number of members and their friends were present at different times during the afternoon, many bringing specimens of work, apparatus, &c., for exhibition; and shortly after 5 o'clock about twenty-seven sat down to dinner. After the removal of the cloth, the health of the Queen having been given and most cordially responded to, business was commenced by a discussion on the proposal of Mr. Burnaby, as detailed on p. 149 of the January number of this Journal, which had been referred by the Council for consideration to this Meeting as the Annual General Meeting of the Society (v. By-Law 13). Mr. Burnaby explained his views in the first place and was followed by several other members. No alteration, however, was suggested in the proposition, though some objected to the principle involved, and it was eventually carried by 14 to 2. It is needless to say that this proposal received the most careful consideration at the hands of the Council, and was referred by them to the general meeting with the view of obtaining a more general expression of opinion. Under these circumstances it was disappointing to observe that not much more than half of the members present voted. The actual consideration of this subject was preceded by a conversation between several members as to the advisability of continuing the publication of the journal. Those in favour of its discontinuance considered that the saving thereby effected would go far to provide a place of meeting, &c., for the Society; while, on the other hand, the majority thought the establishment of the Journal a step in the right direction, and consequently advocated its continuance. The question, however, not being before the Meeting, no vote was taken. A short conversation ensued on the subject of an entrance fee to be paid by members on joining, but it appeared to be the opinion of most of those who spoke that the position of the Society, more especially in regard to the advantages it at present offers, is not sufficiently strong to justify such a step, and further consideration of the subject was consequently postponed by 9 to 5. The question of the establishment of a workshop and place of meeting next engaged attention. The number of those who took part in it as well as the animated nature of the discussion sufficiently showed the importance of this subject to the welfare, I might almost say to the very existence of our Society. The views enunciated were very diverse in character, but all were agreed on the necessity of action of some kind. It being impossible to reconcile all the plans proposed, or even to agree as to our requirements, after a protracted conversation it was decided to entrust the further consideration of the matter to a committee, who will report the result of their deliberations to the Council. The following five gentlemen consented to serve on such committee, and were formally appointed:

F. W. Blake, Esq.,
F. J. B. Beckford, Esq.,
F. C. Capel, Esq.,
J. Hutchinson, Esq., and
C. C. Welman, Esq.

No official report has yet been made to the Council of the proceedings of this Committee, but it will be satisfactory to the members to know that they have been at work, and further, that their labours are likely speedily to produce some tangible result.

I have mentioned above that both turned work and apparatus were exhibited at the meeting before the dinner, and on this subject I have an observation to make. Some short time ago I received a letter in which it was suggested that I "should enumerate and describe all the articles shown at our exhibitions, state what and what kind of work was upon boxes, pagodas, pillars, vases, &c.," and the writer went on to say that he had heard many complaints of the meagre account given of what was shown. I wonder if he really comprehends the amount of labour and repetition, void of interest, which the literal fulfilment of his suggestion would involve? Snuff-boxes, pagodas *et id genus omne*, have such a strong family resemblance that, except in rare instances, I doubt if the trouble of distinguishing their features would be repaid. I have endeavoured hitherto to notice anything conspicuous for its workmanship or good taste—as witness the engraving on page 132, but must admit that lack of leisure prevents me from doing justice to all. But as to peculiarities of material, or form or pattern, dependent wholly or in part upon new appliances, the case is different; these, I submit, it is hardly my province to deal with. No one, indeed, should be expected to discourse upon the artistic merits of his own productions, but who so fitted to describe and elucidate a novel appliance or adaptation as the originator of it? I have in my mind's eye a collection of objects in wood and ivory which made their appearance at our last conversazione, nearly all exhibiting some speciality due to one or more of a number of contrivances explained to me by the member who brought them. From this text at least three very interesting papers might have been, or rather let me say *may* be and I still trust ere long *will* be written. I hope what I have said will effectually dispel the notion that I have wilfully neglected to notice work shown, and will at the same time induce more of those to come forward as correspondents to the Journal, who are able to speak, as far as is possible for an amateur, *ex cathedrâ*. It is so clearly the interest and duty, and one would suppose the pleasure too, of inventors to explain their inventions that I hope the subject merely requires to be mentioned to be at once recognised and acted on.

Meetings of the Council.

A Meeting of the Council took place on Saturday, 27th April

—three members present—when the following gentlemen were duly elected members of the Society:

ALFRED NEWSHAM EDWARDS, Esq.,
EDWIN SERCOMBE, Esq., M.R.C.S., F.R.G.S.,
THEODORE D. ACLAND, Esq.,
HERBERT DEVAS, Esq.

On Saturday, the 1st June, three members present, the following Candidates were duly elected:

The Hon. OSBERT WILLIAM CRAVEN,
ALFRED SAVILL TOMKINS, Esq.

On Saturday, 22nd June, four members present, the following were admitted:

HERBERT BARNARD, Esq.,
Capt. T. W. GOFF.

A suggestion was made to the effect that members should have the option of paying a composition fee in lieu of the annual subscription, whereby they might secure to themselves the membership of the Society for life, but consideration of the subject was adjourned until the newly appointed workshop Committee should have reported progress. Woolwich Arsenal was selected for the Annual Excursion, and arrangements were ordered to be made accordingly.

T. W. BOORD.

CORK MODELS.

WHAT is the best material for a model of a building? By this question is not meant what is the best for an elaborate model, such as an architect might require of some great work, but what is best for a model which will well show the general effect of a building, and which can be made without a great expenditure of time, money or skill.

Cardboard will make nice work, but it does not work easily, soon blunts knives, &c., and often requires colouring after the model is finished; it also very easily soils during the making, and greatly tries the patience of the maker; it has the advantage of being clean work.

Plaster is, in a general way, a dirty material to use, and cannot be employed without some skill on the part of the modeller; it is work which cannot well be done except in a workshop.

Wood may be dismissed with a few words, as its use is only practicable to those who are good carvers, and a model would take some time and require very neat work.

Cork I consider the best for an amateur; it is easy to work, does not easily get dirty, does not usually require colour, and can be worked even in a drawing-room.

I take for granted that any one who would wish to model buildings understands ground plans, elevations, &c., and can also draw; otherwise he will find it hard work to make a model fit to be seen. The material is easily got, and the tools required are few. Cork in flat sheets of various thicknesses can be got at any cork-cutter's, and also bottle and phial corks, which are often useful. I do not advise buying it in the rough and cutting for yourself; it is by no means easy, and the attempt will very likely end in cut fingers and spoilt work. A cork-cutting knife is an awkward tool and apt to cut deep. A cutter told me once that the knife *always* cut to the bone.

Tools. — Nothing special is required; a good penknife, the thinner and finer the blade the better, is the chief thing required, and the common lancet found in many knives is useful for very fine works, a pair of scissors, or say two pairs, one large for rough work, and one fine for small work; some glass paper, a flat and a round ruler, a set square, a pair of compasses, a bottle of liquid Indian ink, common ink will do, but will sometimes fade, and a pen, steel or quill—I prefer steel—a sheet of millboard, and a glue pot. Most, if not all, of these articles are in every house. Several other little additions can be made to this list at the fancy or experience of the modeller. Pins of the ordinary size and what are called minikins are very useful.

How to make a model.—Having a stock of flat sheets of cork, which had best not be very thin (experience has shown me that thin cork is hardly firm enough for solid work), and, if wanted, large and small bottle corks, presuming that you have a plan and elevations of your work (although with a plan, some measurements and good drawings you can get very near the original), and have settled what scale you will use, the first thing to be done is to cut out the main walls of the building, taking care that the work is square, and that opposite walls are of the same length ; a little want of care in this respect will make all the work out of shape when set up, and require more time to get right than might be expected, and all this time is thrown away, as at first it takes no more time to do the work accurately than otherwise. Having cut out the main walls, the next process will be to carefully draw in all work, say windows, doors, parapets, battlements, and such like ; work which greatly projects will have to be made out of a separate piece of cork and glued in its proper position ; do not be sparing of labour in carefully putting in all work, a little neatness in ruling lines and using compasses for arches and such like will not be thrown away. When all the main body of the building has been cut out and drawn, begin with a sharp knife to cut out all openings, taking care not to cut harder than is necessary, as the point of the knife will soon get blunt if pressed into the cutting board. I work all Gothic windows and such work with a piece of flat cork under the piece I am cutting ; by so doing I keep my knife sharp for a longer time (and a sharp knife is wanted to make clean work), and it cuts smoother than on the bare millboard. I do not advise this for cutting long lines, such as for the main outlines of a building, but only for small work, windows, tracery, &c. When all this has been done, neatly cut a bevel edge (angle 45°) for all the walls that join at right angles, except in cases such as the walls of the nave, choir, and transept of a church having a central tower, in which case leave the junctions with the tower square. Perhaps if I describe how I am in the habit of glueing up my work, it will best explain the *modus operandi*. Take, for an example, a church with a central tower, and suppose that the work is all cut out and finished ready for glueing up. I first take the four pieces of the central tower and see that all the edges are fairly bevelled ; I glue them together, taking care whilst the glue is still soft that it stands quite perpendicular and square ; the set square is now of some use, but a correct eye can do a great deal. When this is done I do not wait for the glue to dry, but as soon as it will set sufficiently to hold the work together, I lay the tower on its side on a flat board, and attach one side of the nave and one side of the choir to it. With a little care these three pieces will dry in a straight line. When the glue is set I place the tower and the two walls attached to it upright, and glue the remaining walls to the tower, say the nave wall first, next the choir, and afterwards those belonging to the transepts, taking care that all the work is kept square; when fairly dry attach the west front, east end, and transept ends, taking care that these are all square with the central tower. The side aisles and their terminations are to be added in the same manner. When all this work is done (or nearly so) I glue in just above the windows a flat piece of cork and also insert a piece at the bottom of each compartment. I have now got the shell of the building, and it now requires a roof, buttresses, &c. The roofs I make of cork, cutting the edges of the ridge and base to the requisite bevels, and then fix in position with glue. The buttresses and pinnacles I make of cork of various thickness, and attach in their proper position to the building. In cases where the buttresses are flying, the roof will first require to be coloured, and in very complex work the model had best first be fixed on its stand.

For the finishing of the roof I use stout drawing paper which is coloured grey, of a dark tint for lead, or of a rather lighter tint for slate. Tiles are represented by a dull red, and carefully cut out so as to fit the cork roof, and lines have to be drawn so as to represent the joinings of the lead or of the slate or tiles; drawing these two last is rather tedious work. When all is complete glue down, for which purpose I prefer liquid glue; any corner which may not lie close fasten down with a pin, to be taken out when the glue has set.

The stand, which I usually make of a board covered with green cloth (billiard cloth is perhaps the best), being ready, I take the model and place it in its proper position, to be marked by driving pins lightly into the board at the various angles, &c., of the building, so that when taken up it can be set down again in the same place without the least trouble. I then take the model in my left hand, and, turning it over, I carefully apply liquid glue to the bottom (common glue will do, but I think the liquid glue is the easier to use), and carefully spread it, taking care that none runs on the sides, and then place it in its position on the board with as little delay as possible; any portion that may not be flat on the board I fasten down with pins; sometimes it will require a good deal of pinning down. The model will now require to be left to dry for at least twelve hours; when certain that it is secure, pull out the pins and the work is finished, except in cases where complex buttresses have not been attached, which can now be easily glued to the work.

Spires, if small, may be cut out of a solid piece of cork, but if large will have to be built, which I do in this manner: I make each side of the spire, and carefully draw in the windows and ornaments, and bevel the edges; next I make the spire in paper. The method I adopt is to draw on the paper a line equal to the height of the spire, and with that radius describe a portion of a circle with the compasses, prick off eight divisions equal to the base of each portion of the spire, from which draw lines to the center, fold so as to make the shape of the spire and fasten with gum; glue up the cork, and at once insert it into the paper spire, which will press evenly on all sides. Before dry draw out and rectify any bad fitting; with a little practice this is not so difficult as might be imagined. Octagon turrets are made in a similar manner, but they rarely want a paper case; a bit of paper rolled up and put inside will be all that is required.

Crosses, finials and such work, are made with the knife or scissors, and if a pin (minikin) is run down them, and the head afterwards cut off close to the work, they will be very secure; if this is not done, they often get broken off during the progress of the work. Sand paper will be found useful to smooth bevels, take out lines and other little errors. Gothic windows with very long mullions will sometimes require them to be stiffened by glueing thin strips of paper to their backs, which must be coloured to match the cork as near as practicable. Very deep doorways will often have to be made of several thicknesses of cork glued together, and require careful fitting to look well. The use of talc for windows I hardly advise, although I have employed it, and have also taken the trouble to paint it in imitation of stained glass. All models had best be under a glass shade to preserve them from dust and injury.

J. N.

RECTILINEAR, CIRCULAR, AND ELLIPTIC DRILLING.

PART III.—*Elliptic drilling.—Properties of the ellipse-chuck, and of ellipses described therewith.—The excentric and ellipse chucks combined.—Illustrations.—Application to drilling letters with elliptic loops*, **O C G Q D S.**

PROPERTIES OF THE ELLIPSE-CHUCK AND OF ELLIPSES DESCRIBED THEREWITH.

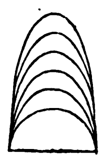
I. The semi-minor axis of an ellipse described by this chuck equals the traverse of the tool.

The semi-major axis equals the semi-minor + the excentricity of the ring of the chuck.

Hence, if t = traverse of tool = semi-minor axis,
a = semi-major axis,
e = excentricity of ring,
we have $2\,e =$ difference between major and minor axes $= 2a - 2\,t$; and let it be remembered that e is the actual amount of excentricity indicated by the scale of graduations on the ellipse ring, so that if the ring be set at, *e.g.*, $\frac{1}{20}$, the difference between the major and minor axes of the ellipse described will be $\frac{1}{10}$.

Here also let it be observed that the excentricity of the ring does not affect the minor axis, which depends only upon the traverse of the tool; whence it follows that ellipses of different excentricity may be placed on the same minor axis by simply altering the excentricity of the ring, the tool remaining in the same position; *v.* fig. 1.

FIG. 1.



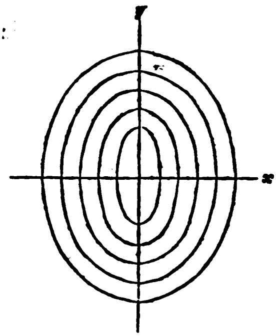
II. If in the equation $2\,e = 2\,a - 2\,t$, t be made = 0, we have $2\,e = 2\,a$; that is, when the tool is "at center," a straight line is produced, having for its length twice the excentricity of the ring.

III. The major axis of an ellipse described by this chuck is always parallel to the length of the chuck itself, that is, to the direction in which the slide of the chuck moves. Hence it follows that ellipses can be placed at any angle of inclination to the axes x and y of the work, by means of the tangent wheel of the chuck. Also it follows that in chucking a piece of work great care must be taken that the line upon which it is desired to place the major axis of an ellipse about to be cut should be accurately vertical when the chuck itself is vertical.

IV. If it be required to describe a series of ellipses, as in fig. 2, where the axes of x and y are divided into equal spaces by their points of intersection with the successive curves, then the excentricity of the ring must be constant, and the traverse of the tool alone be altered.

Thus, in fig. 2, $e = \frac{3}{20}$,
and $t = \cdot 1, \cdot 2, \cdot 3, \cdot 4$, successively.

FIG. 2.



Now in these ellipses, since $2a = 2t + 2e$, we have

for 1°, $2a : 2t :: \cdot 2 + \cdot 3 : \cdot 2 :: 60 : 24$,
2°, $2a : 2t :: \cdot 4 + \cdot 3 : \cdot 4 :: 42 : 24$,
3°, $2a : 2t :: \cdot 6 + \cdot 3 : \cdot 6 :: 36 : 24$,
4°, $2a : 2t :: \cdot 8 + \cdot 3 : \cdot 8 :: 33 : 24$;

the ratio being a continually decreasing one, and the character of the ellipse approaching gradually more and more to that of a circle.

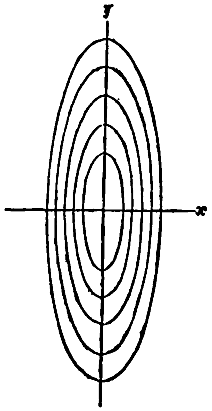
V. If it be required that the ratio of the major axis to the minor shall be constant, so that the ellipses may be homologous, as in fig. 3, then the excentricity of the ring must be increased as the traverse of the tool increases, and in the same proportion.

Thus, in fig. 3, *e* is taken successively as ·2, ·3, ·4, ·5, and ·6, while *t* is ·10, ·15, ·20, ·25, and ·30, so that

for 1°, $2a : 2t :: \cdot 2 + \cdot 4 : \cdot 2 :: 3 : 1$,
2°, $2a : 2t :: \cdot 3 + \cdot 6 : \cdot 3 :: 3 : 1$,
3°, $2a : 2t :: \cdot 4 + \cdot 8 : \cdot 4 :: 3 : 1$,
4°, $2a : 2t :: \cdot 5 + \cdot 10 : \cdot 5 :: 3 : 1$,
5°, $2a : 2t :: \cdot 6 + \cdot 12 : \cdot 6 :: 3 : 1$;

a constant ratio, the major axis being always three times as great as the minor.

FIG. 3.



VI. Referring back to § 1 it will be seen that it is easy to deduce the method of copying any given ellipse, for the length of the minor axis will give twice the traverse of the tool, and the difference between the major and minor axes will give twice the excentricity of the ring.

To measure the axes they must be drawn, and to find the axes the center must be found.

(1). *To find the center.*

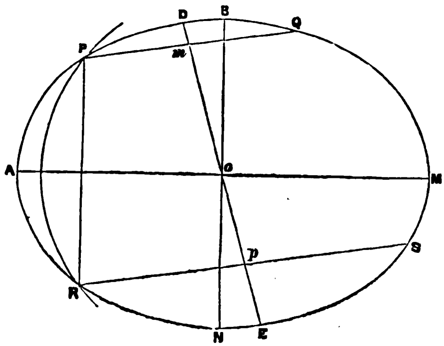
Draw any two parallel chords P Q, R S, fig. 4, and bisect them in the points *m*, *p*. Join *m*, *p*, and produce *m p* to meet the ellipse in D and E. Then O, the middle point of D E, is the center required.

(2). *To draw the axes.*

Take any point P in the ellipse, and with center O, and distance O P describe a circle, cutting the ellipse in P and R. Join

P, R; bisect P R by A O M at right angles to it; then A O M is the major axis. Draw B O N through O at right angles to A O M; then B O N is the minor axis.

FIG. 4.



VII.—Ellipses whose major axes are parallel to the axis of *y* are called vertical ellipses; those whose axes are parallel to that of *x* are called horizontal.

THE ELLIPSE AND EXCENTRIC CHUCKS COMBINED.

I. In working with the two chucks together great care must be taken that they be accurately parallel at the commencement.

To set them in this position—

(1). By the adjusting stop of the pulley set the ellipse chuck vertical with the T-square, when the pulley is stopped at 96 if possible; but if this be not possible note at what division the pulley is stopped.

(2). By the tangent wheel of the ellipse chuck set the excentric vertical, testing it also with the T-square.

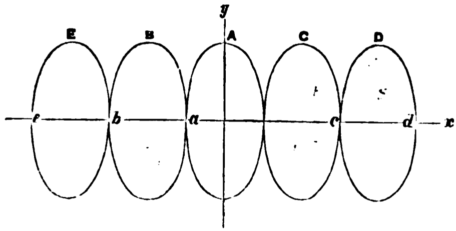
With the addition of stopping the excentric chuck wheel at 96, and bringing the tool accurately to center, and ready to move to the left without loss of time, this will be "ALL AT CENTER" for excentric elliptic drilling.

II. To adjust the excentric at right angles to the ellipse chuck.

Assuming the chucks both vertical when the pulley is stopped at *m*, bring the pulley to $m + 24$; the tangent screw of the ellipse chuck will then be on that side of the chuck which is nearest to the workman, and with its head up; the chucks are now both horizontal. By means of the tangent wheel of the ellipse chuck bring the excentric back again to a vertical position, with its head up, testing with the T-square. Stop the pulley again at *m*, and the ellipse chuck will be vertical, the excentric horizontal, with its screwhead on the right. And here remember that whenever the excentric is shifted on the ellipse chuck in order to bring the two at right angles to each other these should be their relative positions.

III. Let it be required to describe a series of vertical ellipses in contact, as in fig. 5.

FIG. 5.



1. Make the traverse of the tool equal to half the minor axis required, and the excentricity of the ring equal to half the difference between the major and minor axes.

2. Set the excentric at right angles to the ellipse chuck.

3. Bring the excentric chuck wheel to 24, or 72, and describe the first ellipse marked A, without any excentricity on the chuck.

4. Make the excentricity of the chuck equal to twice the traverse of the tool, and describe the pair of ellipses marked B and C, with the chuck stopped at 72 and 24 respectively.

5. Increase the excentricity by twice the traverse of the tool, making it now $4\,t$ in all, and describe the second pair with the chuck wheel stopped as before.

6. Proceed in the same way for any number of ellipses.

The reason for this is as follows:—

(1) brings the tool to the point *a*.

(2) enables the increased excentricity to be given to the centers

of the successive pairs of ellipses, but would make them horizontal instead of vertical, therefore

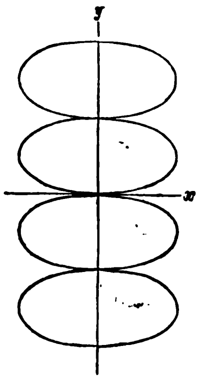
(3) is employed to place the axis of *y* again parallel to the ellipse chuck, so that the ellipses may be vertical.

(4) and (5) bring the points *b*, *c*, and *d*, *e*, successively to the tool.

Had it been intended that there should be no central ellipse, but that the axis of *y* should have been a tangent to each of the first pair, then the first pair would have been described with an excentricity of the chuck equal to the traverse of the tool, and the increase for the second pair would have been 2 *t*, making 3 *t* in all; and so on.

IV. Let it be required to describe a series of horizontal ellipses in contact, as in fig. 6, the axis of *y* bisecting them, and the axis of *x* a tangent to the first pair.

FIG. 6.



Proceed precisely as for fig. 5, only setting the excentric chuck wheel at 96 and 48, instead of at 72 and 24.

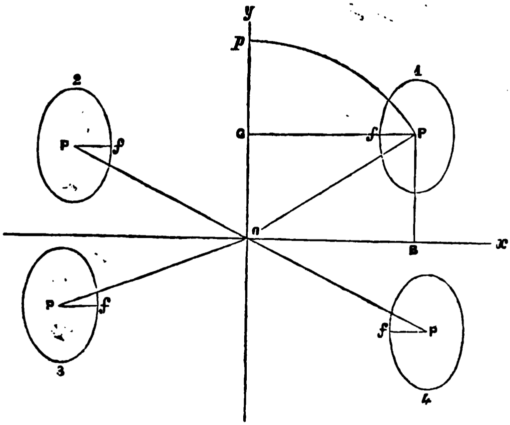
The excentricity being *t* for the first pair is increased by the amount 2*t* for each succeeding pair.

V. Let it be required to describe a vertical ellipse whose center shall be at any point P.

Since P is a given point, either the rectangular co-ordinates P G, P B, or, the angle P O B and the distance O P, will be known.

It will be seen presently that the problem is possible only when the angle P O B is an integral multiple of $3^c\ 45'$, if the excentric chuck be furnished with a click wheel of 96 teeth.

Fig. 7.



Since the excentricity of the chuck, which call E, will have to be made equal to O P, its value must be found from the equation $E = \sqrt{OB^2 + PB^2}$, and the angle G O P from tan. G O P $= \frac{GP}{OG}$, if the rectangular co-ordinates be given; but if O P and the angle P O B be given, then we have G O P $= 90^\circ - $ P O B.

For the first Quadrant.

Having all carefully "at center," make the excentricity of the chuck = O P, this brings the point *p* to the tool.

In order to bring P, the given point, to the tool, the chuck wheel must be revolved in the $+^{ve}$ direction through the angle *p* O P, *i.e.* from 96 to 96 $+n$; *n*, therefore, must be a certain number of teeth, or an integral multiple of $3^\circ\ 45'$. This will make the line O P vertical, and if the ellipse be cut now its center will be at P, but its major axis will be in the line O P, instead of being vertical to the axis of *x* as required.

The effect of the movement of the excentric chuck wheel in a $+^{ve}$ direction must, therefore, be counteracted by an equal movement of the ellipse chuck wheel in the opposite, or $-^{ve}$ direction;

shift then this wheel $(-n)$ teeth from its position for "all at center," which will bring the axis of y vertical again, so that the ellipse, if cut now, will be in the position required.

Give now such excentricity to the ring and traverse to the tool, as will enable an ellipse of the desired form to be described, thus bringing the tool opposite to the point f, and describe the ellipse.

For the Second Quadrant.

The same as for an ellipse in the first quadrant, but the excentric chuck wheel must be shifted n teeth in the $-^{ve}$ direction, and the ellipse wheel n teeth in the $+^{ve}$ direction, for the angle G O P.

For the Third Quadrant.

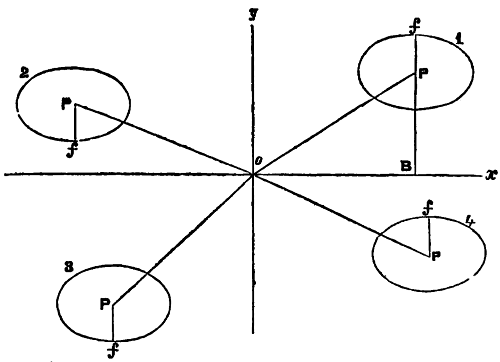
The same as for the first, but 180° must be added to the wheel of the excentric chuck, by making it start from 48 instead of from 96.

For the Fourth Quadrant.

The same as for the second, but the excentric chuck wheel starts from 48.

VI. Let it be required to describe a horizontal ellipse whose center shall be at any point P.

Fig. 8.



As in the last case, either O P and the angle P O B are given, or they can be found from P B, P G, if these co-ordinates be given.

The work is precisely the same as in the last case, but the axis of x is made to take the place of that of y, by bringing the excentric chuck wheel to 24 for a horizontal ellipse in the first quadrant. This places the first quadrant in the position held by the second in the last proposition, and the work in the first quadrant must, therefore, now be done as that in the second was done there; that in the second as in the third; in the third as in the fourth; and in the fourth as in the first.

In other words—

For the First Quadrant.—Excentric chuck starting from 24 is shifted to $24 - n$ for the angle P O B; and the ellipse chuck is shifted $(+ n)$ teeth.

For the Second Quadrant.—The excentric chuck starting from 72 is shifted to $72 + n$, and the ellipse chuck $(- n)$ teeth.

For the Third Quadrant.—The excentric chuck starts from 72, is shifted to $72 - n$, and the ellipse chuck $(+ n)$ teeth.

For the Fourth Quadrant.—The excentric chuck starting from 24 is shifted to $24 + n$, and the ellipse chuck is shifted $(- n)$ teeth.

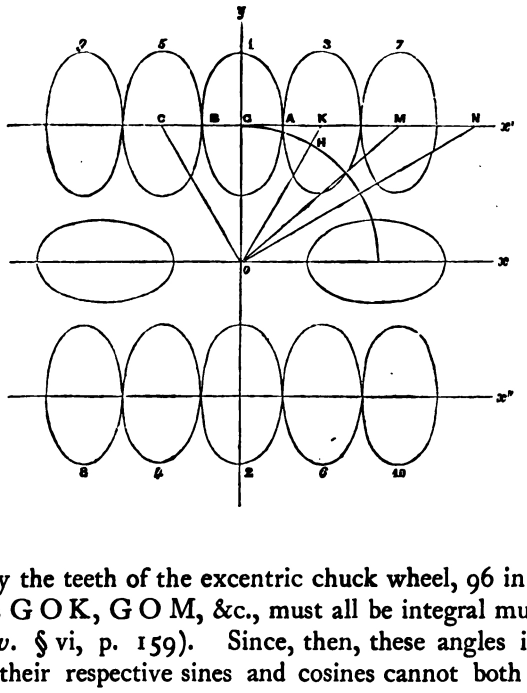
VII. Let it be required to describe a series of vertical ellipses in contact, their minor axes being on a line parallel to the axis of x, as in Fig. 9.

Great care and accuracy are required in the solution of this problem, which is almost identical with that given in § IV of "Circular Drilling," p. 204; for the excentricity of the ring of the ellipse chuck, which alone converts what otherwise would be a circle into an ellipse, does not affect the calculations, as will be presently seen. Nevertheless, it would not be wise to omit the working out of this problem in detail, though it may involve repetition; the command which it will be found to afford over the powers of the combined chucks will repay some expenditure of time.

Let then x' be the line parallel to the axis of x, in which the minor axes of the vertical ellipses are to lie, and let O G, its distance from the axis of $x = \text{E}$. Let t be the traverse of the tool, and e the excentricity of the ellipse chuck ring, necessary to describe ellipses of the form required; and, in the present instance, let the axis of y pass through the center of the first ellipse; instead of as on p. 204, where the axis of y is made a tangent to the first pair of circles.

1. Starting now from "all at center," the first ellipse would be described by screwing the excentric chuck down till the point G came to the "center," and traversing the tool from G to B; while, for the remaining ellipses, their centers K, M, N, &c., would have to be successively brought to the "center." But since this can only

Fig. 9.



be done by the teeth of the excentric chuck wheel, 96 in number, the angles G O K, G O M, &c., must all be integral multiples of 3° 45′ (*v.* § vi, p. 159). Since, then, these angles involve a constant, their respective sines and cosines cannot both be independent of the constant and of each other. In other words, if G K (which is twice the traverse of the tool) be a fixed quantity, then O G (which is the excentricity of the line *x′*) cannot be made just what we please, but must have its proper value calculated; on the other hand, if O G be fixed and unalterable, then G K must be calculated, and its nearest possible value to 2 *t* (that is, to its required value), must be employed; otherwise the centers of the next pair of ellipses, marked 3 and 5, cannot be brought to "the center."

2. The method of making these calculations is sufficiently simple, and, inasmuch as the actual work in the lathe depends entirely upon them, they should be made in full before attempting to cut such ellipses as are delineated in Fig. 9.

Let the angle G O K = a; then,

$$\tan. a = \frac{GK}{OG} = \frac{2t}{E}, \text{ or,}$$

$$\log. \tan. a = \log. 2t - \log. E + 10 \text{ .... } (1).$$

And here observe that this equation would have been identical with that given on p. 205 if the axis of y had been a tangent to the first pair of ellipses, only reading r for t.

3. Now, in this equation the value either of t or of E will be taken as known and unalterable, while a certain value must be found for the other which is to be as near as possible to a given value. Assume then, in the first place, that t is unalterable; *i. e.*, it is required to describe ellipses of a certain fixed minor axis upon a line as near as possible to x'.

Let a' and E′ be those values of a and E which satisfy the equation $\log. \tan. x' = \log. 2t - \log. E' + 10$, a' being the nearest integral multiple of $3° 45'$ to a, then

$$\log. E' = \log. 2t - \log. \tan. a' + 10 \text{ .... } (2)$$

gives the value of E′, the excentricity of x', and the ellipses marked 1, 3, 5, can be described, if not actually upon a line at a distance E from x, yet upon a line very near to it.

In the second place, let E be known and unalterable; *i. e.*, it is required to describe ellipses whose minor axes shall be upon a line at a certain fixed distance from the axis of x, and their minor axes are to be as nearly as possible equal to $2t$.

Let a' and t' be those values of a and t which satisfy the equation $\log. \tan. a' = \log. 2t' - \log. E + 10$;

then, $\log. t' = \log. \tan. a' - \log. 2 + \log. E - 10 \text{ ... } (3)$

gives the value of t', the traverse of the tool which will enable the ellipses marked 1, 3, 5, to be described upon the line x', and their minor axes will be very nearly equal to the value demanded for them.

4. For example, let $t = \cdot 3$ be known and unalterable, and let it also be required that E shall be as near as possible to ·9. From equation (1) we have

$$\begin{aligned} \text{log. tan. } a &= \text{log. } \cdot 6 - \text{log. } \cdot 9 + 10. \\ &= 9 \cdot 823908, \\ &= \text{log. tan. } 33^\circ\ 41', \text{ nearly,} \end{aligned}$$

(there is no need to find the seconds.)

The nearest integral multiple of $3^\circ\ 45'$ to $33^\circ\ 41'$ is $33^\circ\ 45'$, therefore $a' = 33^\circ\ 45'$, which is the angle that must be used (on the click wheel).

Substituting this value of a' in $= ^n$ (2), we have

$$\begin{aligned} \text{log. E}' &= \text{log. } \cdot 6 - \text{log. tan. } 33^\circ\ 45' + 10, \\ &= \cdot 953258 - 1, \\ &= \text{log. } \cdot 897962; \end{aligned}$$

so that the exact value of the excentricity of the line x' is ·897962 when $t = \cdot 3$, and the angle GOK $= 33^\circ\ 45' = 9 \times 3^\circ\ 45'$ *i. e.*, nine teeth of the chuck wheel are used.

5. Again, let $E = \cdot 7$ be known and unalterable, and let it also be required that t shall be as near as possible to ·2.

From $= ^n$ (1) we have

$$\begin{aligned} \text{log. tan. } a &= \text{log. } \cdot 4 - \text{log. } \cdot 7 + 10, \\ &= 9.756962, \\ &= \text{log. tan. } 29^\circ\ 45', \text{ nearly.} \end{aligned}$$

The nearest integral multiple of $3^\circ\ 45'$ to $29^\circ\ 45'$ is 30°, therefore $a' = 30^\circ$.

Substituting this value in $= ^n$ (3) we have

$$\begin{aligned} \text{log. } t' &= \text{log. tan. } 30^\circ - \text{log. } \cdot 2 + \text{log. } \cdot 7 - 10, \\ &= \cdot 305507 - 1, \\ &= \text{log. } \cdot 202074; \end{aligned}$$

so that the exact value of the traverse of the tool is ·202074, when $E = \cdot 7$, and the angle GOK $= 30^\circ = 8\ (3^\circ\ 45')$, or eight teeth of the chuck are used.

6. These calculations having been made, the work for fig. 9 may now be proceeded with.

The example in the margin is given as for any particular lathe that may be used, in which both the chucks are vertical when the pulley is stopped at *m*, and the ellipse chuck wheel at *n*. These numbers must vary according to the make of the lathe, but it will be easy to make the necessary substitution for the figures in the margin.

We now, therefore, proceed to

THE SETTINGS FOR FIG. 9.

1. "All at center."

Example.

1. Pulley at m on 96 row. Ellipse chuck wheel at n. Excentric chuck at 96.

2. Make the excentricity of the ring of the ellipse chuck such as may be required; and the traverse of the tool and the excentricity of the line x' as near the required values as possible according to the calculations given above.

Fix the tool box by the fluting stops.

The first ellipse may now be cut, for the point of the tool will be opposite the point B.

2. $e = \cdot 15 = \frac{3}{20}$. t is to be as near as possible to ·2 and E is to be ·7. Make t = ·20207, or say ·202, = 2 turns and $\frac{1}{5}$ of a small division, E = 7 whole turns.

3. Shift the excentric chuck wheel through 180°, cut the corresponding ellipse marked 2 in fig. 9, and bring the wheel back to 96.

3. Excentric chuck from 96 to 48, and then back to 96.

4. To cut the next ellipse, marked 3, its center K must be brought to "the center," so that the point A may be opposite to the tool. Three new arrangements of the apparatus are required to do this.

(1) The excentric chuck wheel must be moved through the angle G O K, *i. e.*, from 96 to 96 + n.

(1) Excentric chuck wheel to 96 + 8, *i. e.* to 8; because G O K = 30° (v. Ex. 2, p. 272).

(2) But if the ellipse be cut now its axis will be in the line O K, and this axis must therefore be brought to a vertical position again by shifting the wheel of the ellipse chuck through the same angle as that of the excentric was just moved, but in the opposite, *i. e.*, the — ^{ve} direction.

(2) Tangent wheel of ellipse chuck to n — 8.

To test the correctness of this last move-

Excentric chuck

ment fix the pulley at + 8 from its position for "all at center," and try if the excentric chuck be then vertical as it ought to be.

(3) If the ellipse be cut now its axis will be vertical, but its center will be at H, because O H = O G the present excentricity. The excentricity must therefore receive an increment, its new value being O K; if this increment be called h we have

$$h = \text{OK} - \text{OG} = \sqrt{\text{OG}^2 + \text{GK}^2} - \text{OG},$$
$$= \sqrt{\text{E}^2 + 4\,t^2} - \text{E}.$$

These three arrangements having been made, the ellipse marked 3 may now be cut.

5. To cut the corresponding ellipse, marked 4, on x'' move the excentric chuck wheel through 180° to 48 + n; and then come back to 96.

6. To cut the ellipse marked 5, corresponding to 3 on x', its center C must be brought to the center of the lathe, and it will be seen at once that the angle G O C = G O K, but must be measured on the excentric chuck wheel in the opposite direction. Since then this wheel was moved to 96 + n for G O K, move it now to 96 − n for G O C. To compensate this the ellipse chuck wheel must be moved through n teeth in the $-^{ve}$ direction from its position for "all at center," that is, + 2 n from its present position.

To test the correctness of this movement fix the pulley at − 8 from its position for "all at center;" the excentric chuck ought then to be vertical.

The ellipse may now be cut.

7. For the corresponding ellipse on x'',

Example.

found vertical when the pulley is stopped at m + 8.

(3) Increase the excentricity by 1 turn $1\frac{3}{5}$ small divisions, because $h = \sqrt{\cdot 49 + \cdot 163335} - \cdot 7 = 10829$, and the ·00029 may be neglected.

5. Excentric chuck to 48 + 8, or 56; and back to 96.

6. Excentric chuck wheel to 96 − 8, or 88.

Ellipse wheel to n + 8.

Excentric chuck found vertical with pulley stopped at m − 8.

7. Excentric

marked 6, move the excentric chuck wheel through 180° to $48 - n$; and then come back to 96.

Example.

chuck wheel to 48 − 8, or 40; and back to 96.

8. At this point, assuming absolute accuracy to be required, the work must stop if the excentric chuck be furnished with a click wheel only. But if this chuck, as well as the ellipse chuck, have a tangent wheel, or if it be found that the error can be so distributed, or so covered by the width of the tool, as not to be appreciable, the work may be continued.

The points M, N, . . , &c., being the centers of the ellipses on the right of the axis of y, must be successively brought to the "center."

We have then $GK = KM = MN =$ &c. $= 2t$, and t now is a known and unalterable constant, having been finally determined by the first ellipse cut. Also, $E = OG$, is now known.

To find, then, for the ellipse marked 7 in fig. 9, whose center is M, the value of O M the excentricity, and of G O M the angle through which the chuck wheel is to be moved in the $+^{ve}$ direction, we have

$$OM = \sqrt{E^2 + 16\,t^2},$$

or, if h' be the increment upon the present excentricity O K, which equals $E + h$, then

$$h' = \sqrt{E^2 + 16t^2} - \sqrt{E^2 + 4\,t^2}.$$

Again, for the angle G O M,

$$\text{tan. } GOM = \frac{E}{4t}, \text{ or}$$

$$\text{log. tan. } GOM = \text{log. } E - \text{log. } 4t + 10.$$

9. For the next ellipse whose center is N, we have in the same way

$$ON = \sqrt{E^2 + 36\,t^2},$$

or if h'' be the increment upon the present excentricity, which is $E + h + h'$, then

$$h'' = \sqrt{E^2 + 36\,t^2} - \sqrt{E^2 + 16\,t^2}.$$

And for the angle G O N,

$$\text{tan. } GON = \frac{E}{6t}, \text{ or}$$

$$\text{log. tan. } GON = \text{log. } E - \text{log. } 6t + 10.$$

10. The method of cutting the corresponding ellipses will be evident from what has already been said in paragraphs 5, 6, and 7.

11. To continue now the example in the margin of page 273 where E = ·7 and t = ·20207;
we shall have for the ellipse marked 7 in fig. 9,

$$h' = \text{O M} - \text{O K}, \text{ O K being the present excentricity,}$$
$$= \sqrt{E^2 + 16t^2} - \sqrt{E^2 + 4t^2},$$
$$= 1{\cdot}06927 - {\cdot}80829 = {\cdot}26098.$$

or, the increase upon the present excentricity is to be 2 turns $12\frac{1}{5}$ small divisions; but the present excentricity being 8 turns $1\frac{3}{5}$ small divisions, the whole value of the increased excentricity will be 10 turns $13\frac{4}{5}$ small divisions.

It may be well to verify the correctness of this by calculating the value of O M independently, thus:

$$\text{O M} = \sqrt{\text{O G}^2 + \text{G M}^2} = \sqrt{{\cdot}49 + 16 \times ({\cdot}20207)^2}$$
$$= \sqrt{1{\cdot}14331655} = 1.0692 = 10 \text{ turns } 13\tfrac{4}{5} \text{ small divisions.}$$

This makes sure of the excentricity O M.

Now for the angle G O M,

$$\text{log. tan. G O M} = \text{log. E} - \text{log. } 4t + 10,$$
$$= \text{log. } {\cdot}7 - \text{log. } {\cdot}80828 + 10,$$
$$= -1 + {\cdot}845098 + 1 - {\cdot}907523 + 10,$$
$$= 10{\cdot}062425.$$

The nearest log. tan to 10·062425 is 10·062368, which is the log. tan of 49°.6′; the nearest integral multiple of 3° 45′ to 49° 6′ is 48° 45′ or 13 × 3° 45′; and if 13 teeth of the excentric chuck in the + *ve* direction, compensated by 13 in the — *ve* direction of the ellipse chuck, be used, it will require a critical eye to discover the error when the ellipses marked 7 and 9 are cut. This, remember, is 13 teeth from "all at center," not 13 more from where the chuck is now.

It is not perhaps necessary to occupy space in pursuing the calculations for successive ellipses, sufficient having been said to indicate the method of doing it.

VIII. If a similar series of ellipses are to be described on lines parallel to the axis of y, all that has to be done is to start with the excentric chuck wheel stopped in 24 instead of 96. The first two of such a series are drawn in fig. 9.

IX. The method of finding t or E given in § 5 may possibly appear somewhat tedious, but by the help of logarithmic tables it does not take so long as to find the angle a by actual experiment on the lathe; and even when that angle is found some calculation must be made for t or E, unless a great deal of time be wasted in trials. If, however, this latter method be preferred it would be worked as follows:

1. Make the excentricity of the chuck = E, and the traverse of the tool = t: try how many teeth of the excentric chuck wheel in the $+^{ve}$ direction from 96, compensated by an equal number in the $-^{ve}$ direction on the ellipse chuck, will be required to bring the point A (fig. 7) as near as possible to the point of the tool. Let this number of teeth be n, the angle will be n ($3^{\circ}{\cdot}45'$). Then we have

$$\frac{\sin. n\,(3^{\circ}\,45')}{\cos. n\,(3^{\circ}\,45')} = \frac{2\,t'}{E}, \text{ if E be fixed,}$$

$$= \frac{2\,t}{E'}, \text{ if } t \text{ be fixed,}$$

from which of course t' or E′ can be found.

For instance, recurring to the second example in § 5, p. 272, where E = ·7; by experiment on the lathe n is found to be 8 when t is taken as ·2, to which value it must approximate as nearly as possible; also $8 \times 3^{\circ}{\cdot}45' = 30^{\circ}$.

$$\text{Then } \frac{2\,t}{\cdot 7} = \frac{\sin.\ 30^{\circ}}{\cos.\ 30^{\circ}} = \frac{\cdot 5}{\cdot 86603},$$

$$\text{whence } t = \cdot 20207.$$

ILLUSTRATIONS.

Fig. 10. 1. For the vertical ellipses at the center of this pattern the chucks are parallel.

E = ·4, or 4 turns, t = ·1, or 1 turn, and e = ·2.

The lower segment stop is fixed when the pulley is at $m + 5$; the upper when it is at $m + 75$. The elliptic segments are drilled at every sixth tooth of the excentric chuck wheel.

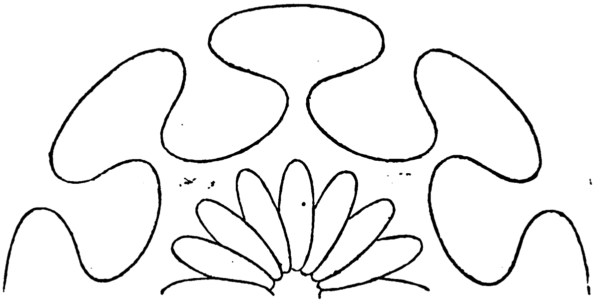
2. For the inner row of horizontal ellipses on the outside of the pattern.

E = 1 in. or 10 turns, t = ·2 or 2 turns, and $e = \frac{3}{20}$

The chucks are at right angles to each other.

The upper segment stop is fixed when the pulley is at $m+24+12$; the lower when it is at $m-24-12$; but it will be wise to drill somewhat less of the periphery than this at first in order that there may be no chance of overlapping with the next set of cuts.

FIG. 10.



The segments are drilled at every twelfth tooth of the chuck wheel.

3. For the outer row of horizontal ellipses E is increased to 1·37 or 13 turns 7 divisions, and $e = \frac{5}{20}$, t remains the same.

The lower segment stop is fixed with the pulley at $m+8$, the upper with the pulley at $m-8$.

The segments are drilled at every twelfth tooth, starting from 6 instead of from 96.

FIG. 11.

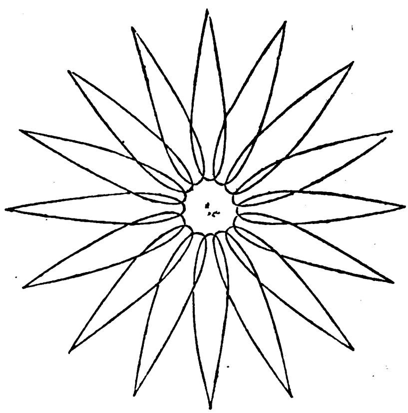


Fig. 11.—For this pattern E = ·8, t = ·2, and $e = \frac{5}{10}$.

The chucks are parallel to each other.

When the pulley is stopped at $m - 24$ the chucks are horizontal, and $\frac{28}{96}$ of the periphery is cut on each side of this horizontal line, *i. e.*, the upper segment stop is fixed when the pulley is at $m - 24 + 28$, or $m + 4$; and the lower when the pulley is at $m - 24 - 28$, or $m - 52$.

The segments are cut at every sixth tooth of the excentric chuck wheel.

APPLICATION OF THE PRECEDING LAWS TO THE DRILLING OF LETTERS WITH ELLIPTIC LOOPS, **O C G Q D S**.

The ratio 5 : 3½ is perhaps as good as any for the major and minor axes of elliptic letters.

If then the height of a letter be ·5 in. the width will be ·35, and the traverse of the tool half this or ·175, *i. e.*, 1 turn 15 small divisions; also we have for the excentricity of the ring

$$e = a - t = \cdot 25 - \cdot 175 = \cdot 075,$$

or one and a half twentieths of an inch; but this value of e applies only when vertical ellipses are used.

O at center.

Ellipse chuck only required.

1. Having determined the height and width of the letter make the traverse of the tool equal half the width, and the excentricity of the ring equal half the height less half the width.

O on the left of center.

Ellipse and excentric chucks required.

1. Same as § 1 of **O** at center.

Set the excentric at right angles to the ellipse chuck, and stop the pulley so that the ellipse chuck is horizontal, the excentric vertical with its screw-head up.

2. Set the excentric chuck wheel at 72, and screw the chuck down through the length of the line, joining the center of the work with the center of the letter to be cut.

O on the right of center.

The same as O on the left, but set the excentric chuck wheel at 24 instead of 72.

C at center.

The same as O at center, but a portion of the ellipse is not cut.

Assuming that the ellipse chuck is vertical when the pulley is stopped at m, it will be observed that the upper semi-ellipse can be drilled while revolving the pulley from m to $m + 48$, and the lower semi-ellipse while revolving in the opposite direction from m to $m - 48$. The segment stops must be fixed so as to leave such space as may be required uncut; say the upper stop when the pulley is fixed at $m + 48 - 8$, or $m + 40$, and the lower when it is at $m - (48-8)$, or $m - 40$.

C on the left of center.

The same as O on the left, but for the portion to remain uncut fix the upper segment stop when the pulley is at $m - 8$, and the lower when it is at $m + 8$; for observe here that when the pulley is stopped at m (its position for "all at center") the ellipse chuck is vertical, but the excentric being horizontal (§ 2 of O on the left) and set at 72, the letter is upside down; its lower half would be cut when revolving the pulley from m to $m + 48$, and it is the first portion of this which is not to be cut.

C on the right of center.

The same as O on the left, and for the portion uncut the segment stops are to be fixed as for C at the center.

G. The first portion of this letter is in all three cases the same as C, but for the *serif* the excentric as well as the ellipse chuck is required.

G at center.

The chucks being parallel set the excentric at 48 and screw down from the concentric position till the *serif* comes to the central horizontal line.

G on the left of center.

For the *serif;* the pulley being fixed so that the ellipse chuck is horizontal and the excentric vertical with its screw-head up, set the excentric wheel at 48, and screw down till the *serif* comes to the central horizontal position.

G on the right of center.

For the *serif;* the same as G on the left.

Q. This letter at center, on the left, and on the right, will be cut the same as O, but the excentric chuck is required for the tail.

At center. The chucks being parallel, and the letter in its correct position when the excentric is at 96, set it at 56, and drill a short line meeting the left side of the letter a little below the central horizontal line, and cutting the right side.

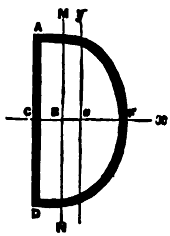
Q on the left of center. The same as at the center, but it will be found that more excentricity is required.

Q on the right of center. The same as at the center, but the chuck is set at 8 instead of 56.

D. If the major axis of the vertical semi-ellipse required for this letter be made to pass through the center of the letters and the proportion 5 : 3·5 be retained for the height and width, then the letter will appear too wide; nevertheless, as this ratio is certainly the best for the elliptic portion of the letter, it will be retained for the semi-ellipse; and in order to reduce the width of the letter the center of the ellipse will be removed a little to the left of the center of the letter.

The general arrangements for cutting the ellipse will follow those of Prop. III, Fig. 5, page 265.

D at center.



1. Having all at center set the excentric at right angles to the ellipse chuck; bring the excentric chuck wheel to 72, and screw the excentric down half that amount by which it is proposed to reduce the width of the letter.

This will bring the center of the ellipse to the point B on the left of O, which is the center of the work and the center of the letter; M N being the major axis.

2. Fix the upper segment stop when the pulley is stopped at $m + 24$, (m being its position for "all at center"); and the lower when the pulley is at $m - 24$; in each of which positions the ellipse chuck will be horizontal, and the excentric vertical. Drill between these stops, and remove them.

3. The chucks must now be placed parallel to each other again, the wheel of the excentric being kept at 72.

Now, inasmuch as O F = B F − O B = $t - \frac{1}{2}$ the reduction in width, O G, which is the excentricity for the line A D, must be the same. The excentricity of the chuck must, therefore, be increased till it equals O F. The long line A D may then be drilled.

4. For the top and bottom lines A M, D N, bring the chuck to 96 and 48, making the excentricity equal half the height.

As this letter requires a good deal of care the calculations will now be given in full for two examples.

Example. 1.—The fig. in the text.

The height = ·875 in.

Proportion for ellipse,

$$5 : 3{\cdot}5 :: {\cdot}875 : {\cdot}6145 \therefore t = \frac{{\cdot}6145}{2} = {\cdot}30725,$$

but this will require modification if the exact height, $\frac{7}{8}$ in., be to be retained.

Excentricity of ring $= e = a - t = \frac{{\cdot}875}{2} - {\cdot}30725 = {\cdot}13025,$

but this cannot be taken exactly with the scale of graduations on most lathes, therefore make $e = {\cdot}125$;

we have then to find t, by substitution in the equation $e = a - t$,

$${\cdot}125 = \frac{{\cdot}875}{2} - t, \text{ or } t = {\cdot}3125 \text{ instead of } {\cdot}30725.$$

Now, the width of the letter has to be reduced from $2t$, or ·625; and let it be reduced in the proportion of 1 : 3·5. Then, since 3·5 : 1 :: ·625 : ·175 nearly, the value of O B is $\frac{{\cdot}175}{2}$, or ·0875, which is the excentricity of the chuck employed to remove the center of the ellipse from O to B.

We now have, therefore,

$E = {\cdot}0875 = 17\frac{1}{2}$ small divisions.
$t = {\cdot}3125 = 3$ turns $2\frac{1}{2}$ small divisions.
$e = {\cdot}125 = 2\frac{1}{2}$ twentieths.

The chucks are at right angles, the tangent screw of the ellipse on the right or far off side of the lathe, the excentric vertical, the screw-head up. The upper segment stop is fixed with the pulley at $m + 24$, the lower at $m - 24$, and the semi-ellipse drilled, the excentric chuck wheel being at 72.

Then for A D we have $OG = OF = BF - OB = t - E$

$$= \cdot 3125 - \cdot 0875 = \cdot 225,$$

or the excentricity of the chuck must be increased to 2 turns $2\frac{1}{2}$ divisions; and for this line as well as for A M, and D N, the chucks are parallel to each other.

Example 2.—**D** at center.

Let the height be ·5 in., then t (as calculated on page 279) will be ·175 and e will be $1\frac{1}{2}$ twentieths.

Now let it be desired to reduce the width from ·35, which it would have been with these values of t and e, to ·25; E will be $\frac{\cdot 35 - \cdot 25}{2}$, or ·05, *i. e.* 5 divisions.

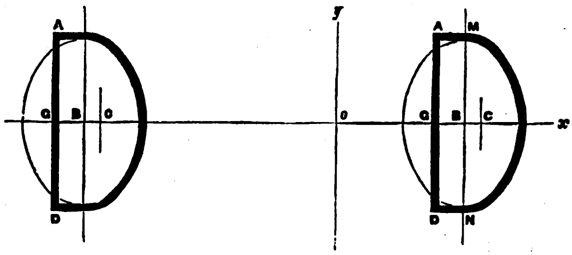
This gives the settings for the semi-ellipse.

Then for the long line we have

$$OG = t - \cdot 05 = \cdot 175 - \cdot 05 = \cdot 125,$$

or 1 turn $2\frac{1}{2}$ divisions, and as E is already 5 divisions, make it $7\frac{1}{2}$ more for the line A D.

D on the right of center.



1. If C be the center of the letter, and the distance of O C be given, then, as in the last case, B the center of the ellipse must be brought to the left of C, the center of the letter. The excentricity of the chuck will, therefore, be O C — C B ; C B being half the amount by which the width is reduced from what it would be if the center of the ellipse were at the center of the letter.

The chucks will be at right angles to each other, and the excentric wheel be stopped at 24.

2. The lower segment stop must be fixed when the pulley is

at $m + 24$, and the upper when it is at $m + 72$, which is $m - 24$.

3. For the long line A D the excentricity will be O C — C G, that is, O C — half the actual width of the letter. The chucks will be made parallel to each other.

Example 1.—The figure in the text.

The size is the same as that of *Example* 1, **D** at the center; also O C = ·75 in.

Whence we have $E = \cdot 75 - \frac{\cdot 175}{2} = \cdot 6625$ or 6 turns $12\frac{1}{2}$ small divisions for cutting the semi-ellipse; the values of t and e being the same as in the Ex. referred to.

The excentricity for A D will be O C — C G = $\cdot 75 - \frac{\cdot 625 - \cdot 175}{2} = \cdot 525$, or 5 turns $2\frac{1}{2}$ divisions.

Example 2.—The size is the same as that in Example 2 of **D** at center, viz. height = ·5 in.; width = ·35 — ·1 = ·25. And let O C = 1 in.

The excentricity of the chuck will be 1 — ·05 or ·95, *i.e.*, $9\frac{1}{2}$ turns. Also $t = \cdot 125$, $e = 1\frac{1}{2}$ twentieths, for the semi-ellipse.

Also for O G the excentricity will be $1 - \frac{\cdot 25}{2}$, or ·875, *i.e.*, 8 turns $7\frac{1}{2}$ divisions.

D on the left.

1. The chucks must here also be at right angles to each other, and the excentric stopped at 72. The excentricity O C of the center of the letter must now be increased, instead of diminished, for cutting the semi-ellipse, and will be O C + C B.

2. The upper segment stop must be fixed when the pulley is at $m + 24$, and the lower when it is at $m - 24$.

3. For the line A D the excentricity will have to be increased, for O G = O C + half the width of the letter.

For example, let O C = 1·25 in., and the size of the letter be the same as in Example 1 of **D** at center.

Then, for cutting the semi-ellipse, $E = 1 \cdot 25 + \frac{\cdot 175}{2} = 1 \cdot 3325$, or 13 turns $6\frac{1}{2}$ small divisions.

For A D, E = 1·25 + half the actual width; but the actual width being $2t$ — ·175 or ·625 — ·175 = ·45, half of this will be ·225, so that E = 1·745, or 17 turns $4\frac{1}{2}$ divisions.

S. This letter requires two equal horizontal ellipses, whose major axes equal the width of the letter, and whose minor axes equal the height. The traverse of the tool will therefore be one fourth of the height, and the excentricity indicated on the ellipse ring will be half the width minus one fourth of the height.

For example, if the whole height be ·5 in., and the proportions 5 : 3·5 be adopted, then the width will be ·35 ; so that the minor axis of each ellipse will be ·25, and t = ·125 ; also the excentricity of the ring will be $\frac{1}{2}$ (·35 — ·25) = ·05 = $\frac{1}{20}$.

S at the center.

In order that the axis of x may be a tangent to the two ellipses, the excentricity of the chuck must be precisely equal to the traverse of the tool (v. Pr. IV, p. 266), *i. e.*, it must be one fourth of the height of the latter. Also, that the ellipses may be horizontal, the excentric must be set at right angles to the ellipse chuck, the wheel of the excentric being kept at 96.

With the pulley stopped at m as for the position for "all at center," that is, with the ellipse chuck vertical (the excentric being now horizontal with its screw-head towards the workman), fix the lower segment stop.

Fix the upper segment stop when the pulley is stopped at $m + 72$; drill between these stops three fourths of the periphery of an ellipse.

2. Bring the excentric chuck wheel to 48, and without altering the segment stops drill the other half of the letter.

Inasmuch as **S** is the most troublesome of all the letters to cut properly the examples will be given in detail.

Example of **S** at center.

1. "All at center." Pulley stopped at m, when both chucks are vertical.

2. Stop pulley at $m + 24$, and set the excentric chuck vertical again by T-square ; screw-head up.

3. Let the height of the letter be ·5, therefore traverse of tool must be ·125, or 1 turn $2\frac{1}{2}$ divisions for the minor axis.

4. Height of letter : width :: ·5 : ·35,

$$\therefore 2e + 2t = \cdot 35$$

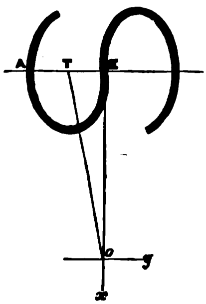
$$\therefore e = \cdot 175 - \cdot 125 = \cdot 05 = \frac{1}{20}.$$

5. The excentricity of the chuck = traverse of tool = 1 turn $2\frac{1}{4}$ divisions.

6. Fix the lower segment stop when the pulley is at *m*, *i. e.*, when the ellipse chuck is vertical, and the upper when the pulley is at $m + 72$, *i. e.*, at 56, and drill.

7. Bring the excentric chuck wheel to 48, and, without altering the segment stops, drill again.

S on left of center.



1. If T be the center of one of the pair of ellipses, then the excentricity of the chuck is required for the distance O T; the chucks, therefore, must both be vertical, and the work be done as described in Props. V and VI.

2. Having, then, "all at center," bring the excentric chuck wheel to 72, so that the work, if done, would appear as in the annexed fig.

3. The height and width of the letter being known, make the traverse of the tool and the excentricity of the ring accordingly.

4. For the excentricity of the chuck we have

$$TO = \sqrt{EO^2 + TE^2}, \text{ where } TE = t.$$

5. For the angle E O T, which must be an integral multiple of $3^\circ 45'$, we have tan. $EOT = \frac{TE}{EO}$. This angle is gained as in other similar cases by shifting the excentric chuck wheel *h* teeth in the $+^{ve}$ direction, and compensating this movement by the same number of teeth of the ellipse chuck in the $-^{ve}$ direction. These arrangements will bring the point A to the tool.

6. Fix now the upper segment stop when the axis of *x* is horizontal, which it will be if the pulley be stopped at 24 more than its position for "all at center." Fix the lower segment stop when the axis of *x* is vertical, which it will be at 48 less than its

position for "all at center." Drill between these stops three fourths of the periphery of an ellipse.

7. Bring the excentric chuck wheel, which is now at 72—h to 72 + h, and the ellipse wheel to n—h. Make the axis of x horizontal again by stopping the pulley at 24 less than its position for "all at center," and fix the upper segment stop. Fix the lower segment stop when the pulley is in the position for "all at center," and drill between these stops.

Should it have been desired to find the angle E O T experimentally, then, having first drawn the axis of x, try whether the major axis of the ellipse, which can be cut with + h teeth of the excentric and − h of the ellipse chuck will be parallel to the axis of x. In all probability, the size of the ellipses will require alteration by increasing or decreasing the traverse of the tool. This will be made clear in the examples given below.

Example 1.—S on the left of center.

1. Let it be required that E O = 1·5 in., and that the height of the latter be as nearly as possible ·5; then the width will be ·35.

2. First of all the angle E O T must be found;

$$\text{tan. EOT} = \frac{\text{TE}}{\text{EO}} = \frac{\cdot 125}{\cdot 15} = \cdot 0833$$

$$\begin{aligned}\text{log. tan. EOT} &= \text{log. } \cdot 0833 + 10 \\ &= 10 - 2 + \cdot 920818 \\ &= 8 \cdot 920818\end{aligned}$$

The nearest log. tan. to 8·920818 is 8·921096, which is the log. tan. of 4° 14′.

Now, if one tooth of the excentric chuck be used or 3° 45, there will be an error of 29′ in the angle; but as that is the only angle that can be employed, the traverse of the tool must receive correction; it cannot be exactly ·125.

To find what it ought to be we must work backwards.

3. By the tables log. tan. 3° 45′ = 8·816529

$$\begin{aligned}&= 10 - 2 + \cdot 816529 \\ &= \text{log. } \cdot 0655437 + 10\end{aligned}$$

$$\text{tan. } 3^\circ\, 45' = \cdot 0655437$$

(this may be taken out at once from a table of natural tangents, or, by division, from a table of natural sines and cosines).

$$\text{Therefore } \frac{t}{1\cdot5} = \cdot0655437$$

The difference between this value of t and that which was proposed is ·0266845, or a trifle over $2\frac{1}{2}$ hundredths of an inch: the letter will therefore have for its height about $\frac{1}{10}$ in. less than was proposed, since the total height $= 4\,t$.

4. Assuming, then, these values to be accepted, viz. E O = 1·5 and height = ·4 (or really = ·393262), we shall have T O, the excentricity of the chuck $= \sqrt{(1\cdot5)^2 + (\cdot393)^2} = 1\cdot55$ very nearly.

5. We may now proceed to set the apparatus for drilling the letter.

Make the traverse of the tool = ·0983155, which is one fourth of ·393262, or say 1 turn all but $\frac{2}{5}$ of a small division.

Make the excentricity of the chuck $15\frac{1}{2}$ turns.

Now, since the height of the letter is ·4, the width will be ·28, if the proportions of 5 : 3·5 be adopted, because 5 : 3·5 :: ·4 : ·28.

Whence we have for the excentricity of the ring of the ellipse chuck $e = a - t = \cdot14 - \cdot0983 = \cdot0417$, or a trifle less than $\frac{1}{20}$.

Example 2.—S on left of center.

1. Let O E = 1 in., the height be as near as possible to ·875, and the width therefore ·6125, as in the Fig. p. 286.

2. Then

$$\text{tan. EOT} = \frac{\cdot21875}{1},$$

$$\text{log: tan. EOT} = 10 + \text{log.} \cdot21875,$$
$$= 9\cdot339948.$$

The nearest log. tan. to 9·339948 is 9·339739, which is log. tan. of 12° 20′.

The nearest integral multiple of 3° 45′ to 12° 20′ is 11° 15′, or 3 × 3° 45′. This, therefore, must be angle used on the click wheel.

3. Now, working backwards,

$$\log.\ \tan.\ 11^\circ\ 15 = 9.298662 = 10 - 1 + \cdot298662$$
$$= 10 + \log.\ \cdot198912$$

$\therefore$ tan. E O T $= \dfrac{\cdot198912}{1}$, say ·1975, or T E, the traverse of the tool must be two turns all but $\frac{1}{2}$ a small division.

4. Next, for the excentricity of the ring,

$$e = a - t = \frac{\cdot6125}{2} - \cdot1975 = \cdot1067, \text{ a very little more than } \frac{1}{10}.$$

5. Lastly, for the excentricity of the chuck, we have

$$OT = \sqrt{1 + (\cdot1975)^2} = 1\cdot019, \text{ or say } 1\cdot02,$$

that is, 10 turns 2 divisions.

S on the right of center.

The work is precisely the same as for **S** on the left, except that the excentric chuck wheel must start from 24 instead of 72. The upper segment stop will have to be fixed when the pulley is stopped at $m - 24$, and the lower when it is at m for the lower half of the letter. While, for the upper half, the upper stop is fixed when the pulley is at $m + 24$, and the lower when it is at $m - 48$.

SHERRARD B. BURNABY.

(*To be continued.*)

GOSSIP.

" . . bald, unjointed chat . . . "

King Henry IV, Pt. I.

OUR first visit to the International Exhibition this year was disappointing; it does not seem to be the fashion at South Kensington to complete the arrangement of 'exhibits' until the time for closing approaches, and the confusion consequent on such a state of things is certainly as little calculated to produce a favorable impression, as is the persistent touting adopted by some exhibitors with the view of getting orders for their wares, a practice to which may probably be referred the homely, if somewhat undignified, sobriquet of the "South Kensington Bazaar." Judging from appearances, we should imagine that the supply of space exceeds the demand; for we notice a considerable number of articles exhibited this year which were there last summer, and in addition, some parts have a very bare appearance, *e. g.* the gallery for Scientific Inventions. This is scarcely to be wondered at, and it is an evil which, we fear, will grow apace under the "annual" system. The manufacture of paper is one of the leading subjects illustrated this year, and we think we may say satisfactorily, for although the process of paper-making is not actually carried on in the building, there are beautifully executed models of the machinery, one in particular, worthy of notice, is driven by a small turbine (which, by-the-bye, is carefully put out of sight), samples of the materials in all stages, from "blacks" and "dirty thirds" (most appropriate names) to delicately tinted note-paper, with coronets, initials, &c., charmingly embossed in colours. Wood finds a place among the raw materials, but the specimens of paper made from it, though doubtless useful for some purposes, seem too brittle for general application. There is a sheet of so-called parchment paper supporting a weight of five hundredweight, and capable, according to the makers, of bearing four more—a very sufficient proof of its strength. The envelope-folding machines (Dickinson and Co.'s, and others) are well worth a careful inspection. The blanks having been stamped out in a separate machine, are placed in a pile on the feeding plate of the folder, when a brass tube, communicating by an india-rubber pipe with an air-pump, descends, and, by the action of the pump, causes the blank which is on the top of the pile to adhere, and carries it within reach of a pair of grippers, by which it is placed over the folding box, where it is gummed, and the operation completed by a plunger and lateral slides, which fold the envelope and press it, and it is then conveyed away in a trough ready to be "banded" by the attendant.

Those of our readers who are familiar with the monotonous processes of type-casting and finishing by hand will examine with pleasure the very clever invention of Messrs. Johnson and Atkinson, by which all the different operations are carried out in one machine under the superintendence of one workman. Although it is to be found among the scientific inventions this year, it is no novelty, having been in full operation since 1862, and shown in the exhibition of that year. The apparatus consists of two distinct machines, one casting, the other "dressing" the type, mounted on the same frame and driven at any desired speed by means of a pair of differential driving cones. The casting machine has a pot heated by a single gas jet to hold the fused metal. In this is a force pump for injecting the metal into the mould, which is placed opposite the nozzle of the pump, and is kept cool by a stream of cold water conducted by piping. As soon as the metal has solidified the mould opens, and the type is pushed on to a channel which conducts it to the dressing machine. On the way there the superfluous "tail" of metal is broken off, and it is then planed on all four sides by being made to pass successively over, under, and alongside of four cutters with teeth similar to those of a drift. The foot of the type is also planed true, and it is then ready for the printer. The whole of the parts of both machines derive their motions from a number of cams carried by a shaft at one end of the framing just over the driving cones. The cost of gas is said to be but tenpence per diem, and that of labour, one man, six shillings. For small letters, such as the *i* of, say a nonpareil fount, it is practicable to drive the machine at the rate of 10,000 per hour, but the speed must necessarily vary according to the time required for the solidification of the metal in the mould, which is, of course, greater or less in proportion to the size of the letter. The invention is patented in Great Britain and Spain, and is so put out of the reach of our typefounders and those of Spain, but for other countries the inventors, with a generosity we must admit ourselves unable to comprehend, offer the machine, free of royalty, at £250, a price which, they say, is but little more than the cost; and, in addition to this, they will allow one of the purchaser's men to work a machine in their own factory, by way of instruction, for one month free of charge.

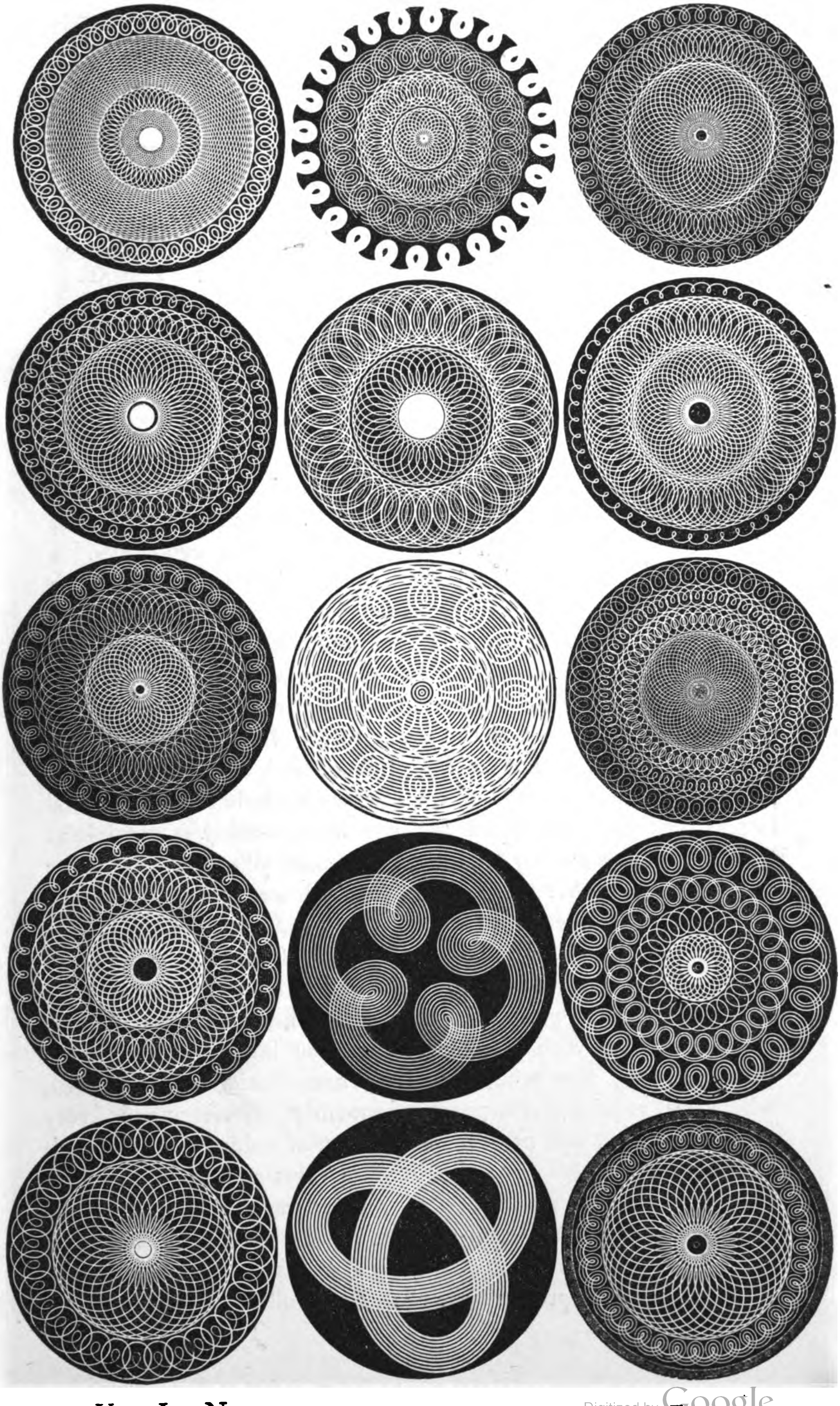
There are to be found in an obscure corner near the dining rooms at the south end of the building, specimens of the tools employed by Bombay and Japanese workmen, together with a few specimens of the well-known ebony, ivory, and silver inlaying commonly called "Bombay work." The tools, which are of the roughest possible description, consist of a pair of small rolls with grooves for shaping the triangular silver wire, a few planes, chisels, saws, and other nondescript implements, many of which appear to be of European origin, much worn, and altered to suit oriental taste. The work itself, when closely examined, is anything but accurate in its execution, but its pleasing effect is undoubtedly partially due to this very inaccuracy, coupled with the tasteful combination of colours. The Japanese tools, unlike those we have been speaking of, are remarkable for the neatness of their make; there are planes, chisels, &c., of a really serviceable pattern, though perhaps not quite of what we should consider the orthodox shape. They appear to be well finished, and are evidently of native manufacture, but a too critical examination is prevented by the articles being so arranged in the case as to conceal the parts one would most wish to see.

THE GEOMETRIC CHUCK.

THE Geometric Chuck, a modification of Suardi's Geometric Pen, was constructed by J. H. Ibbetson, about half a century ago, as an adjunct to the amateur's turning-lathe. It is admirably adapted for the purposes of ornamental turning, but is still more valuable as a means of investigating the curves produced by compound circular motion. In its simplest form it generates bicircloid curves, so called from their being the resultants of two circular movements. This is effected by a "stop wheel" at the back of the instrument giving motion to a chuck in front which rotates on its center, while that center is carried round with the rest of the instrument and the train of wheels which impart the required ratio of angular velocity of the two movements. A sliding piece gives the radial adjustment, which determines the "phases" of the curve dependent upon the radial-ratio.

By the simple geometric chuck a double motion is given to a plane on which the resultant curve is delineated by a fixed point; but it may act as a geometric pen when it is made to carry the tracing point with a double circular motion, so as to delineate the curve on a fixed plane surface. The curves thus produced being reciprocals, all the curves generated by the geometric chuck may be produced by the geometric pen, and *vice versâ*, by making the angular velocity of the one reciprocal to that of the other. For instance, the ellipse may be generated by the geometric chuck with velocity-ratio = 1 to 2, and by the geometric pen with velocity-ratio = 2 to 1, the movements of both being inverse.

The annexed curves are printed from wooden blocks turned by Ibbetson himself half a century ago. The lines are very fine, as



he was then intent upon the application of his curves to the prevention of bank-note forgery, but the cuts may be of any depth required for ornamental turning. I have often turned patterns with the geometric chuck deeper than I would have ventured to attempt with the ellipse cutter or even with the excentric cutter.

HENRY PERIGAL.

CORRESPONDENCE.

EGG-SHELL TURNING.

To the Editor.

SIR,—Having seen some beautiful photographs of egg-shell vases, by Mr. Holdich, and also having read in the January number of this Journal a letter from Mr. Baker on the subject, I venture to add a little of my own experience in turning egg-shells. I may state that the shells to which I refer are those of ostrich eggs, of large size and hard as flint. I will endeavour to explain what I found to be the best mode of chucking and drilling them. Presuming that you have a hollow mandrel with a small internal thread, turn out a plain boxwood chuck to fit the large end of the egg, fit a small iron rod to the inside screw of the mandrel with a similar screw and fly-nut at the opposite end, and fit a piece of boxwood to the small end of the egg, with a hole for the iron rod to pass through. Then drill the egg as accurately as possible at each end; if not exactly true it can be remedied afterwards. Line the chuck and other piece of wood which were made to fit the two ends of the egg, with lead plaster (*Emp. Plumbi*—to be obtained of any chemist), which may be softened by the heat of boiling water, and, having placed the shell on the rod with its ends bedded in the plaster while still hot, fix it with the fly-nut. Having marked with a pencil where you intend to divide the shell, you may now proceed to its ornamentation with the drill, which will require re-sharpening frequently, say after about every twelve cuts, and will need the application of cold water after each cut to keep it cool. The shell will be most readily divided by a very fine circular saw made to revolve rapidly in one of the cutting frames, taking care to keep it also cool by a stream of cold water. This method of chucking avoids the necessity for any support inside and prevents the shell from collapsing when severed by the saw.

THOS. FORSHAW.

REVIEW.

Patterns for Turning.*

EVERY amateur who is acquainted with the first three volumes of Holtzapffel's *Mechanical Manipulation* (and who is not?), must long for the appearance of the fourth, for therein we have been taught to believe that the special mysteries of the ornamental turner's art will be revealed. Of the magnitude of the subject to be dealt with, some conception may be formed when we call to mind the numerous works which from time to time make their appearance, each treating, more or less skilfully, either some distinct branch of the art, or on the other hand, endeavouring to compress the whole subject into the compass of one volume. The latter class of works reflect little credit on their authors, and give but small satisfaction to their readers. They produce a kind of kaleidoscopic effect on the mind, one is hurried through a variety of mechanical processes, as if in a dream, the contents of adjacent pages have barely any connexion, and, arrived at the end of the book, the tyro finds himself but little wiser than when he began. Assuming the publication of their fourth volume by Messrs. Holtzapffel to be exceedingly remote, though fully recognising the value of such a work, it is to the writers of the first-named class that we must look for materials with which, eventually, to construct a complete manual of the art of ornamental turning; and it will be well to bear in mind that the more limited the scope of each individual work, the more likely is its subject to be treated honestly, and in a manner to make it available in the production of a really exhaustive treatise. A glance at Mr. Elphinstone's book will serve to show how thoroughly he has accomplished his task. The first chapter is devoted to "General Explanations," a chapter by no means to be passed over by the reader, for besides some very wholesome advice which should be at the fingers' ends of every turner, there are sundry definitions which it will be well for the reader to consider carefully before proceeding further. The advantage of adopting a single word or phrase to represent a particular disposition of lathe

* *Patterns for Turning.* By H. W. Elphinstone. London: Trübner and Co. 1872.

apparatus is incontestable (one of the best examples is that for which we are indebted to Mr. J. H. Ibbetson in his work on *Double Counting*—"all at center"), needless repetition of words is avoided, and the possibility of error reduced to a minimum. The first definition (page 4) refers to what are there called the *direct*, *transverse*, and *oblique* positions of the slide-rest. With the two last of these terms we have no fault to find—the first we are scarcely satisfied with; the word *direct* seems to suggest the possibility of an *inverse* position: would not *parallel* have been better? Chapter IV is *the* chapter *par excellence* in the whole book. In it Mr. Elphinstone describes the completely novel method of producing surface-patterns, which he has called "Dual Counting," in contra-distinction to double counting. He explains that he was led to this discovery by the knowledge that, with the aid of the division-plate and slide-rest *alone*, the dots or circles produced by the excentric cutter could be placed in any position on any given straight or curved lines described with a pencil on the surface of a piece of wood prepared for the purpose, and that, therefore, in mathematical language, "the process of dual counting consists in cutting a curve by means of its polar co-ordinates, the excentricity corresponding to the radius vector, and the angle through which the division-plate has been moved to the anomaly of any point of the curve." From this it will be apparent that the patterns, like those of double counting, involve calculations of a somewhat abstruse nature; the non-mathematical workman is, however, happily relieved from the necessity of undertaking these by a very complete set of tables, wherein he will find all that he needs ready cut and dried. The illustrations, seventy in number, are the work of the author and well calculated to elucidate the letterpress, though in many instances they fail to convey a good idea of the effect of the patterns, which in a great measure depends on the play of light reflected from the surfaces left by a sharp tool. We wish there were a direct reference from the letterpress to the plates, and *vice versâ*, instead of having to refer each time to the index. Although we regard surface patterns as quite a subordinate means of ornamentation, we are bound to admit that they afford a wide field for the exercise of ingenuity and mathematical skill, and must compliment Mr. Elphinstone on the success which has attended his investigation of this branch of the subject.

THE QUARTERLY JOURNAL

OF THE

AMATEUR MECHANICAL SOCIETY.

OCTOBER, 1872.

HON. SECRETARY'S REPORT.

A MEETING was held on the 11th July for the purpose of visiting the Royal Arsenal at Woolwich, the experience of the first visit, now two years ago, proving a sufficient inducement to the Council to select the Arsenal again in preference to trying fresh ground. None but those who are familiar with this establishment can form an adequate idea of its resources, or of the great variety and magnitude of the operations conducted within its walls. It is true that on this occasion the members were shown what they had in great part seen two years before; still, I venture to assert that, so far from finding the repetition monotonous, it rather produced a desire for further opportunities of watching with more minute attention the operations brought under their notice. It is unnecessary for me to particularise the various processes which more especially engaged attention, for the simple reason that I could add but little to what is stated on page 6 without going into details, for which I have no space; besides, the manipulations most interesting to an amateur, as being within his scope, are in most cases such as it would be comparatively useless to describe—they must be *seen* to be of any service to him in his own workshop. There is certainly enough in one department to occupy a day profitably, and it is a question whether it should not be arranged on future occasions to pass a day in one special department, instead of attempting the whole. This plan would, of course, equally apply to any other large establishment which we may in future years have the privilege of visiting. I take this opportunity, on behalf of those who were present, of thanking the officials at the Royal Arsenal and their subordinates for the uniform courtesy we experienced at their hands.

At the only meeting of the Council which has taken place during the past quarter, it will be observed that a draft of the report of the Workshop Committee was read; this was merely for the information of the Council, the report not having then been adopted by the Committee. Since that date the report itself has been approved by the Council, and will be duly noticed in these pages, but in the mean time I think it may interest the members generally to be put in possession of an outline of what has been done for their accommodation in the way of a workshop, &c. It will be unnecessary to go into details now, as the arrangements are still incomplete; the next General Meeting will afford an opportunity of continuing the discussion which resulted in the appointment of the Committee in May last. As matters at present stand, then, we are in possession of rooms at 89, Stamford Street, S.E., consisting of a good-sized dining-room on the ground floor, which has been fitted up so as to serve for a board-room for the Council meetings, reading-room and library, and a kitchen underneath it, with large area, cellars and other accommodation for the workshop. In view of the exorbitant rents demanded in the more fashionable and convenient parts of London, the Committee thought it well to make a small beginning at once in the best situation they could find, at a moderate expense, rather than indefinitely delay the execution of our long-talked-of plans, which found favour with so large a majority at the dinner. The premises in question are within a few hundred yards of the Waterloo Railway Terminus, which renders them accessible from almost all parts of London. It should be understood that nothing has yet been done towards fitting up the workshop; the dining-room alone has been sufficiently furnished to enable the Council meetings to be held there. The mechanical journals will shortly be taken in for the use of members, but no active measures are in contemplation with respect to the formation of a library, though several promises of books have already been made by individual members; these and similar donations will be acknowledged in these pages. It is scarcely necessary to add that any suggestions with regard to the fitting up or management of the future workshop will receive due attention from the Committee.

Council Meeting.

A meeting of the Council was held on the 8th August—four members present—when the following gentlemen were duly elected members of the Society:

Thomas Harcourt Powell, Esq.,
Captain James George Scott, and
T. P. Smyth, Esq.

A draft of the proposed report of the Workshop Committee was read for the information of the Council. T. W. Boord.

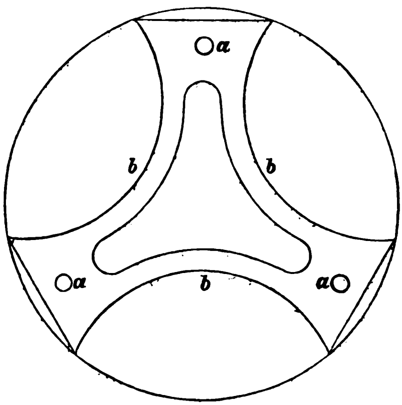
CHUCKING, ETC.

EVERY one who has had any practice in ornamental turning must have found that he occasionally meets with some difficulty in the way of chucking his work, which the ordinary books of instruction in the art give him no help in surmounting, and he has to fall back upon his own devices. One or two such cases within my own experience occur to me, and though I do not pretend to say that other, and perhaps better, ways might not suggest themselves than those I employed, yet it may possibly be useful to those who have not yet had much practice in turning to know how certain small difficulties were overcome.

Some years ago, wishing to try experiments in "double counting" by means of the excentric chuck and division plate of my lathe, I found it necessary to add to the latter what it did not previously possess, viz. a circle of 96 divisions to agree with the front wheel of my excentric chuck, which was thus divided. This, of course, could be done by mounting the division plate in a chuck carried by the excentric chuck, fixing the mandrel so as to prevent it from revolving, and then using the front wheel of the excentric chuck as a dividing plate, and drilling the holes, one for each tooth of the wheel, with a suitable drill carried by the slide rest. My difficulty was this : my division plate is of brass, forming a stout flange of about a quarter of an inch in thickness at the end of a short cylinder, through which the mandrel passes, and upon this cylinder is fixed the mandrel pulley. When, therefore, the division plate was removed, nothing remained on the mandrel to which the pulley could be attached, and not being within reach of another lathe, I had no means of fitting a chuck to receive the division plate. My lathe has a traversing mandrel for screw-cutting, and according to the usual arrangement of such mandrels, it has, at its left-hand end, a female screw to receive the nut or bolt by which the screw guides are attached. I therefore, before dismounting the pulley, turned a piece of brass with a screw fitting into the left-hand end of the mandrel, then, chucking it by this screw in an ordinary chuck, I formed, on the other end of this piece of brass, a male screw, by which a wooden pulley, some five or six inches in diameter, could be attached to the brass. Having removed the division plate from the mandrel, and replaced the latter, now bare and without a pulley, in the lathe-head, I screwed the brass carrying the temporary pulley into the left-hand end of the mandrel, and shifted the lathe-head to the right, along the bed of the lathe, until the temporary pulley stood over the large wheel, so as to receive the band, and I was thus enabled to give motion to the mandrel, and fit a chuck to receive the division plate. When this was properly mounted in front of the excentric chuck, all I had to do was to prevent the mandrel from revolving; this was effected by raising the screw guide-plate at the left of the lathe-head, until one of its semicircular recesses was jammed up against the mandrel with sufficient force to prevent the latter from moving while the holes were being drilled.

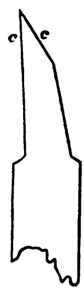
I lately had occasion to cut, from a circular disc of ivory about four inches in diameter, a piece of the form given on the next page. The edges, however, were indented with a pattern drill, instead of being smooth as represented. It formed the base of a tripod stand for a violet glass, three small ivory pillars passing through the holes *a*, having little ornamented feet screwed on to them below. The disc having been chucked by its edge, a hole, with a female screw, was formed through its center, in order that it might be secured to a wooden chuck, the face of which was made flat, with the exception of the projecting screw in its center.

FIG. 1.



This chuck, bearing the ivory disc, was mounted on the excentric chuck, and the disc was made perfectly true and flat on both sides, and polished on the upper side. The slide of the excentric chuck was then thrown down as far as the lathe-bed would allow, leaving just space for the chuck to revolve (about 2·1 in. with my lathe, which is a 5-inch center one). A tool of the form of Fig. 2 being fixed in the slide-rest, and adjusted to the height of the center of rotation, was moved to the left of the center till it had about 1·4 in. excentricity, and, the front wheel of the excentric chuck standing at 96, one of the three scallops (*b*) was cut by slowly and carefully advancing the point of the tool, while a moderate speed was given to the mandrel, the excentricity of the chuck being too great to allow of a rapid motion, for fear of shaking the lathe too much. The other two scallops were cut in the same manner, the chuck wheel being shifted 32 teeth, or the third of the circle, for each scallop. I should remark that the scallops were only *finished* by this tool, as, the ivory being about $\frac{3}{8}$ of an inch in thickness, too much resistance would have been offered to the tool if it had been made to do all the work, therefore a drill

FIG. 2.



was first mounted in the slide-rest, and by means of the division plate of the lathe a series of holes, just meeting, was made through the ivory, following the intended curve of the scallop, but with a slightly smaller degree of excentricity, until the superfluous portion of ivory dropped out, leaving a jagged edge, which was afterwards smoothed off by the fixed tool as described above. The slide of the excentric chuck being now brought back to center, and its front wheel being set midway between two of the former divisions, say at 16, the slide-rest was placed parallel to the lathe-bed, and the edge of the disc of ivory between the scallops was flattened by using the excentric cutter, with a round-ended tool in it, and traversing this, while revolving, past the ivory, the mandrel being prevented from moving by the index in a suitable hole of the division plate. The outer edge of the piece was then shaped, and the slide-rest being again brought to the front of the work, and the drill spindle placed in it, the three holes (*a*) were bored through it with a drill; then, the slide of the excentric chuck being thrown down to its former position, the front wheel was again brought to 96, 64, or 32, and a proper pattern drill being placed in the instrument, the edges of the larger scallops were ornamented by drilling a series of smaller ones, touching each other, but not penetrating through the entire thickness of the ivory, the index and division plate regulating their position and distance apart. The flat portions of the edge were finished thus: the front wheel of the excentric chuck was again brought to 16, 48, or 80, and the chuck being fixed by the index vertically, its slide was so adjusted that the upper edge of the flat portion of the ivory was at the height of the center of the drill, and as this flat portion was now in a horizontal line, the micrometer head of the slide-rest screw regulated the distance apart of the little scallops formed by the drill.

Up to this time the work had remained on the wooden chuck, held by its central screw, but now the center had to be removed altogether, therefore some other mode of chucking became necessary. Before removing it, therefore, from the chuck, the slide of the excentric chuck was once more brought up to center, the drill with which the holes (*a*) had been formed again put into the spindle, and so adjusted that it fell into one of those holes. It was then withdrawn, but without the slide-rest being in any way moved; and, the ivory being removed from its chuck, and the latter taken off the excentric chuck, another wooden chuck, previously prepared, of about the same dimensions, was placed on the excentric chuck, and the drill, whose position had not been altered, being advanced, three holes, about a quarter of an inch in depth, were formed by it in succession in the face of the chuck, which, of course, exactly corresponded with those in the ivory. Three little ivory pegs were next turned, about three quarters of an inch in length, one end fitting tightly into the holes in the chuck, the other having a screw corresponding with that by which the feet were to be attached to the ends of the pillars passing through the holes. Upon these pegs was placed the piece of ivory, with its lower surface resting on the face of the chuck, whilst it was kept from moving by screwing the feet on the projecting ends of the pegs in front of the work. The chuck being now mounted, like the former one, on the excentric chuck, and the slide of the latter being again thrown down as it was for forming the three large scallops, the central triangular space was cut out, step by step, by boring holes in contact with each other, with the drill; each of the three curves which form it being produced by a separate setting of the front wheel of the excentric chuck, and in each case using the same numbers on the division plate. The angles of the triangular space were finished by using, instead of the drill, the excentric cutter, with a tool of the shape of Fig. 3, set to cut a somewhat larger circle than the drill. *c c* are the cutting edges, in both figures.

Fig. 3.

Were I to do a similar piece of work again I should simplify matters by first making the three holes (*a*), then the chuck with the ivory pegs, and, having mounted the disc upon this, perform the rest of the operations without removing the work till finished.

G. C. C.

RECTILINEAR, CIRCULAR, AND ELLIPTIC DRILLING.

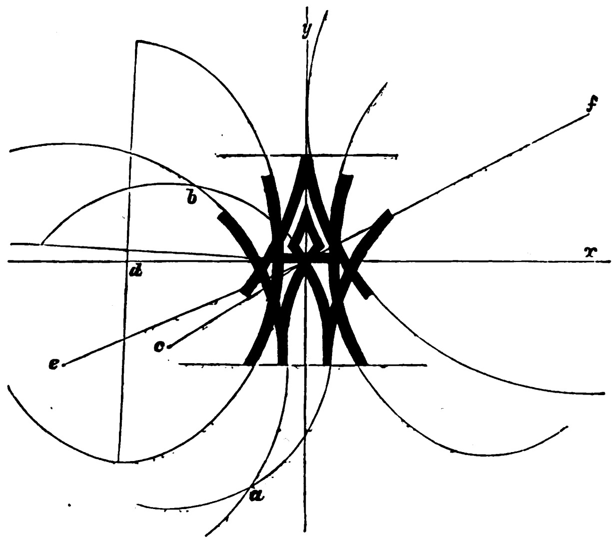
PART IV.—*Application of the laws given in the preceding parts to drilling letters in combination.*

THE following paper, which concludes the series on drilling, contains examples of letters drilled in combination to form words or monograms.

It will be found that much time and labour may be saved if a careful drawing, with accurate measurements, be made of a proposed design before commencing any work at all on the lathe. For this purpose Letts's sectional paper is most valuable. It is ruled with faint lines in squares $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{3}$, and $\frac{1}{8}$ inch, increasing by eighths to 1 inch. Of these the first is the most useful, as the ruling corresponds to the graduations on the apparatus of the lathe, but drawings are more easily made upon the second, on the scale of two to one. The method of proceeding is extremely simple; the axes of x and y having been first drawn, all the angles are set off with a protractor, whether for angular or circular letters, remembering always that every angle for which the excentric chuck is to be used must be an integral multiple of $3^\circ\ 45'$. If the letter be circular, the center of its circle will be in one of the lines containing such an angle; the distance of that center from the center of the work will be the excentricity of the chuck, and the radius of the circle will be the traverse of the tool. Thus, various sized circles can be tried with the compasses till that which suits the design be found.

Take now as an illustration of this the monogram of the letters A H W, the settings for which will be found on p. 312. The axes of x and y being drawn it is seen that the center of the circle $a\ o\ b$, a portion of which is used for the **W**, lies in the third quadrant; the protractor is placed against the axis of y, with its centre at o, and the angle $c\ o\ d$ is set off such that it may be a multiple of $3^\circ\ 45'$ and that $c\ o$ may pass through c, the desired center of the circle. In the present instance $c\ o\ d = 30^\circ$, so that 8 teeth on the excentric chuck must be used. Of course it is possible that this angle may not afford an exact copy of the design, but it has to be taken as affording the nearest possible copy.

The radius *c o* is now measured and found to be ·875, which gives the traverse of the tool, and also the excentricity of the chuck, since the circle passes through the center of the design. It is very likely that measurement, unless extremely accurate, may give ·85 or ·9, but this is corrected when we come to the lathe; all that is required now is an approximation. With respect to the segment of this circle which will be drilled, the arc is readily found either on the lathe itself or by measurement of the angle which it subtends. The corresponding angle and circle in the second quadrant are now laid down, if it be thought well to draw the whole monogram.

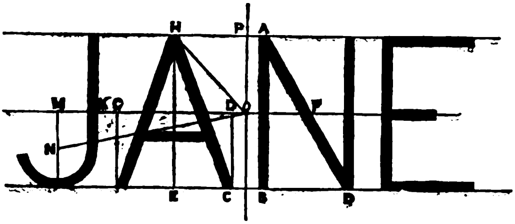


Next, for the circles that form the outside strokes of the **W**, the center is found to be somewhere near the point *e*, the angle *e o d* is therefore set off with the protractor as a multiple of 3° 45′, such that the line *e o* may pass as nearly through the desired position of *e* as possible, viz. 22° 30′, and 6 teeth of the chuck will be used, measuring from that tooth which would cause a circle to be described whose diameter would lie upon the axis of *x*, *i. e.* 72; the chuck is therefore set at 72—6; and for the corresponding circle, to form the right-hand outside stroke, at 24+6, because the angle required is 22° 30′, or 6 teeth, more than 90°. The radius of this circle is then measured for the traverse of the tool, and found to be, let us assume, 1·15, but the more accurate measurement of the lathe gives it as 1·17. The excentricity of the chuck, or the distance $e\,o$, is also measured, and gives 1·4.

Again, for the **A**, a few trials find the correct position of f, the center of the circle, to be given by $f\,o\,x = 26°\,15'$, and $f\,o = 1·675$; also that the radius of this circle is 1·5. Consequently, 7 teeth of the chuck are used, substracted from 24 for the circle on the right side, and 7 teeth added to 72 for that on the left.

For the elliptic curves which form the **H**, trial with a few ellipses cut out in paper which have been previously drawn in the lathe, and marked with the values of their major and minor axes, will soon give the right one as well as the inclination of its major axis to the perpendicular. In the instance before us a cursory inspection of the monogram alone might suggest that the ellipses are vertical; this, however, is not the case, their axes are slightly inclined towards each other, and this inclination is given by using one tooth of the excentric chuck wheel, the least possible quantity, *i. e.* $3°\,45'$. Then the question has to be decided whether the ellipses are of the class called "horizontal" or of the class called "vertical." At first sight they would naturally be called "vertical," being referred to the axis of x. But inasmuch as their centers lie to the right and left of the axis of y, the excentric power of the chuck will be required to traverse the work horizontally to the right or left. Therefore, the chucks have to be set at right angles to each other; this brings the axis of y into the normal position of that of x, and to the axis of y therefore the ellipses must be referred. With respect to this axis they are clearly "horizontal," and are cut accordingly with the excentric chuck wheel stopped at 24 — 1 and 72 + 1, instead of at 96 — 1 and 48 + 1, the one tooth being given for the inclination spoken of above.

It is exceedingly desirable to take some pains in drawing and measuring all letters on paper before proceeding to the lathe, and I wish to impress this strongly. One hour at the desk with the compasses will save two or three at the lathe, excepting, perhaps, in the case of work done under the segment stops, where the results are given by the lathe rapidly and without difficulty.



The excentric chuck alone is required.

Let the height of the letters be ·4, and the space between each letter be ·1. In accordance with the rule that the size of a curved letter should always determine the size of other letters in combination with it (p. 207), we must first find the position of the center of the **J**, and then find what the radius of the circular portion of this letter *can* be in such a position; four times this radius will be the height of the letters.

1. If the angle at the apex of **A** be $37^\circ 30'$ (*v.* p. 166, § 2, *margin*), then E H C = $18^\circ 45'$, and we have, to find E C

$$\tan. \text{E H C} = \frac{\text{E C}}{\text{E H}},$$

$$\text{or, E C} = {}^{\cdot}4 \times \tan. 18^\circ 45' = {}^{\cdot}1358 \text{ nearly.}$$

Also, G D = 2 E C = ·2716,

and K O = K G + G D + D O = ·1 + ·2716 + ·05 = ·4216. This gives the first approximation for the position of the **J**, but it must be remembered that it assumes the height of the letters to be exactly ·4, and it yet remains to be seen whether it be possible to drill them of this height.

2. To find, therefore, now whether a **J** of the required height can be drilled in this position, we have M N = ·1, and

$$\text{M O} = \text{M K} + \text{K O} = {}^{\cdot}1 + {}^{\cdot}4216 = {}^{\cdot}5216,$$

for M K is $\frac{1}{4}$ of the height of the letter. Whence we have

$$\tan. \text{M O N} = \frac{\text{M N}}{\text{M O}} = \frac{{}^{\cdot}1}{{}^{\cdot}5216} = {}^{\cdot}1917 \text{ nearly;}$$

$$\therefore \log. \tan. \text{M O N} = 10 + \log. {}^{\cdot}1917 = 9{\cdot}2826.$$

The nearest log. tan. to this is 9·2825, which is log. tan. $10^\circ 51'$; the nearest integral multiple of $3^\circ 45'$ to $10^\circ 51'$ is $11^\circ 15'$, or $3 \times 3^\circ 45'$; three teeth of the excentric chuck must therefore be used for the angle M O N, which is now determined as $11^\circ 15'$.

3. There is not a great difference between $10^\circ 51'$ and $11^\circ 15'$, and it might, perhaps, be considered that sufficient accuracy was

obtained; it is, however, better to be as accurate as possible, and the work, therefore, is continued as follows:—

$$\log. \tan. 11^\circ 15' = 9{\cdot}2986 = 10 + \log. {\cdot}1989,$$

$$\therefore \tan. 11^\circ 15' = {\cdot}1989 = \frac{MN}{MO}.$$

Now, since the height of the letters is to be retained as ·4, the value of M N must be constant as ·1, and M O must be variable; but $MO = MK + KG + GD + DO = {\cdot}1 + KG + {\cdot}2716 + \frac{KG}{2} = {\cdot}3716 + \frac{3KG}{2}$, so that the variation in the value of M O must be made by altering that of K G. To find, then, the new value of K G we have, by substitution in the equation

$${\cdot}1989 = \frac{MN}{MO}, \quad {\cdot}1989 = \frac{{\cdot}1}{{\cdot}3716 + \frac{3\,KG}{2}},$$

$$\therefore KG = {\cdot}0875 \text{ nearly};$$

that is, the distance between the letters must be reduced from ·1, which was originally proposed, to ·0875 if the height ·4 be retained.

4. The letters on the right of the center. The **N** and the **E** must occupy the same space as has been determined for the **J** and **A**, viz., $\cdot 1 + MO$, or $\cdot 1 + {\cdot}3716 + \frac{3}{2} \times {\cdot}0875 = {\cdot}60285$. Subtracting from this half of ·0875 for the distance of the vertical stroke of the **N** from the center, and ·0875 for the space between **N** and **E**, we have left ·4716 for the joint width of the two letters; dividing this would give ·2358 for the width of each.

5. It must now be ascertained whether the letter **N** with a height of ·4 can be drilled so as to occupy this space.

$$\tan. BAD = \frac{BD}{AB} = \frac{{\cdot}2358}{{\cdot}4} = {\cdot}5895,$$

$\log. \tan. BAD = 10 + \log. {\cdot}5895 = 9{\cdot}7704 = \log. \tan. 30^\circ 31'$. The nearest angle that can be used on the chuck is 30°, or $8 \times 3^\circ 45'$. The angle B A D must, therefore, be 30°, and

$$\tan. 30^\circ = {\cdot}5773 = \frac{BD}{{\cdot}4}, \text{ or } BD = {\cdot}2309;$$

consequently the width proposed for the **N** will have to be reduced by ·0018, and this difference must be given to the **E**. The width of the **N** will therefore be ·2358 — ·0018, or ·2340.

6. We may now proceed to set the apparatus.

(*a*) For the **J**. $E \doteq ON \doteq \sqrt{\cdot5028^2 + \cdot1^2} \doteq \cdot5125$ nearly, 5 turns $2\frac{1}{2}$ small divisions; for let it be remembered that M O does not $\doteq \cdot5216$, as proposed in § 2, but has been altered to $\cdot5028$ by the alteration of K G from $\cdot1$ to $\cdot0875$.

$t \doteq \cdot1$, one turn from "all at center."

Bring the pulley to $72 + 3$, and fix the lower segment stop; to $20 + 3$ for the upper segment stop. Drill the circular portion of the letter, the chuck wheel being at $72 - 3$.

Bring the pulley to 96, and the chuck wheel to 72. Make $E \doteq KO = MO - MK \doteq \cdot4028$, say 4 turns and $\frac{1}{2}$ a small division. Drill the straight line of the **J**.

(*b*) For the **A**.

The apex has to be brought vertically over the center, (p. 166), by shifting the chuck wheel through the angle P O H. To find this angle we have

$$\tan. POH = \frac{PH}{OP} = \cdot8975,$$

$$\text{because } PH \doteq \frac{GD}{2} + DO = \frac{\cdot2716}{2} + \frac{\cdot0875}{2} \doteq \cdot1795,$$

and $OP \doteq \cdot2$;

$$\log. \tan. POH = 10 + \log. \cdot8975 \doteq 9\cdot9530.$$

The nearest log. tan. to this is $9\cdot9529$, or log. tan. $41° 54'$; the nearest angle that can be used on the chuck is $41° 15'$ or $11 \times 3° 45'$; log. tan. $41° 15' = 9\cdot9429$, which is sufficiently near to $9\cdot9529$, so that 11 teeth of the chuck may be used. Make then $E \doteq HO \doteq \sqrt{PH^2 + OP^2} \doteq \cdot2687$, say 2 turns $13\frac{3}{4}$ small divisions.

Set the excentric chuck wheel at $96 - 11$, or 85, to bring the apex vertically over the center. Fix the pulley at $96 - (24 - 11)$, *i.e.* $72 + 11$, or at 83, to make H E horizontal, and drill the sides of the letter at 5 more and 5 less than this, *i. e.* with pulley at 88 and 78.

(*c*) For the **N**. Pulley at 96, chuck wheel at 24.

$$E = OF = \text{half the width} + \frac{KG}{2} = \frac{\cdot234}{2} + \frac{\cdot0875}{2} = \cdot1607,$$

or 1 turn 6 divisions. Observe here that in this and similar cases any slight error made in the value of E upon the chuck in the third place of decimals only involves thousandths of an inch.

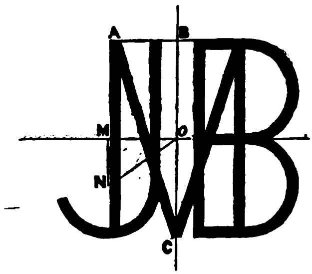
Fix the pulley at $96 - 8$, or 88, and drill the central line.

Bring the pulley back to 96. Make E = ·04375, *i. e.* half the value of K G as determined in § 3, say $8\frac{3}{4}$ small divisions, for the first vertical line of the letter, which, with this value of E, ought to meet the cross line.

For the second vertical line, E = ·04375 + width of letter = ·04375 + ·2376 = ·2813, say 2 turns 8 divisions.

(*d*) For the **E**.

Increase the excentricity by ·0875; making it, say, 3 turns $13\frac{7}{10}$ small divisions for the vertical stroke. Then, bringing back all "to center," make E = ·2 for the top line, whose length must be ·60285 — (·04375 + ·2376 + ·0875) = ·234; drill this between the fluting stops, and then the bottom line with the pulley at 48, and the chuck at 48.



Let the height be 1 in.; the distance between the **J** and the **B** as near as possible to ·2. The radius of the circular portions of the letters will be one fourth of the height, ∴ M N = ·25, and M O = ·25   ·1, or ·35; this is the first approximation.

1. We have then

$$\text{tan. } MON = \frac{\cdot 25}{\cdot 35} = \cdot 7143,$$

$$\therefore \text{log. tan. } MON = 10 + \text{log. } \cdot 7143 = 9 \cdot 8538$$
$$= \text{log. tan. } 35^\circ 32'.$$

The nearest integral multiple of $3^\circ\ 45'$ to $35^\circ\ 32'$ is $33^\circ\ 45'$, or $9 \times 3^\circ\ 45'$;

$$\text{log. tan. } 33^\circ 45' = 9 \cdot 8248 = 10 + \text{log. } \cdot 6681.$$

2. We have now found that nine teeth of the excentric chuck must be used, and that $\frac{\cdot 25}{OM} = \cdot 6681$,

whence we have $OM = \frac{\cdot 25}{\cdot 6681} = \cdot 3743$,

i. e. O M must be increased from ·35 to ·3743.

3. The excentricity of the vertical strokes of the **J** and the **B** equals O M − ·25 = ·3743 − ·25 = ·1243; and consequently the distance between these letters will be ·2486, which is as near to ·2 as possible, if the letters are to be exactly one inch high.

4. The total width occupied by the monogram will be ·5 + ·2486 + ·5, or 1·2486; for the width of the **J** and of the **B** is twice the radius ·25.

5. We may now proceed to set the tools for cutting the **J** and the **B**.

(*a*) First, for the circular portions.

Excentricity of chuck = O N = $\sqrt{\cdot 3743^2 + \cdot 25^2}$ = ·45 very nearly. Traverse of tool to left = M N = ·25. Chuck wheel in 72 − 9, or 63. Pulley in 72 + 9 for the lower and in 20 + 9 for the upper segment stop. Drill the circular portion of the **J**.

(*b*) The excentricity of the chuck and the traverse of the tool remain as they are. Chuck wheel at 24 − 9. Pulley at 96 + 9 for the lower and at 48 + 9 for the upper segment stop. Drill the upper portion of the **B**.

(*c*) Chuck wheel at 24 + 9. Pulley at 96 − 9 for the lower and at 48 − 9 for the upper segment stop. Drill the lower portion.

(*d*) With excentricity = ·1243, chuck wheel at 72, and pulley at 96, drill the long stroke of the **J**.

(*e*) Bring the pulley to 24, and drill the long stroke of the **B**.

(*f*) With excentricity = ·5, chuck at 96, and pulley at 96, drill the top line of the **B**; and with chuck at 48, pulley at 48, drill the lower line.

(*g*) Make the chuck concentric, and drill the central line.

6. Lastly, for the **M**.

We have B C = 1, and for a first approximation A B = O M = ·3743, so that tan. B C A = $\frac{\cdot 3743}{1}$, and

log. tan. B C A = 10 + log. ·3743 = 9·5732 = log. tan. 20° 30′. The nearest integral multiple of 3° 45′ is 18° 45′, or 5 × 3° 45′, which is the angle proposed for **M** on p. 169. A B will consequently be ·3394, because

$$\text{log. tan. } 18^\circ 45' = 9\cdot 5307 = 10 + \text{log. } \cdot 3394,$$

$$\therefore \text{ tan. } 18^\circ 45 = \cdot 3394 = \frac{A\,B}{B\,C}, \text{ and } B\,C = 1.$$

This shows that the vertical lines of the letter will come a trifle nearer to the central vertical line than they would do if they passed through the centers of the **J** and **B**. Hence the settings are :—

(*a*) Excentricity of chuck = ·5. Chuck wheel at 48. Pulley at 72 + 5, and 72 − 5, for the two central lines of the letters.

(*b*) Excentricity = ·3394. Pulley at 96, and chuck at 24, for the right-hand vertical line. Chuck at 72 for the left-hand vertical line.

AHW

(monogram), for figure see page 305. Ellipse and excentric chucks required. The discussion of this monogram having been already given, it will be sufficient now to indicate the settings only.

For the inner stroke of the **W** :—

1. E = ·875, t = ·875, excentric chuck at 24 + 8. Fix the lower segment stop when the pulley is at m − (24 + 9), or m − 33, and the upper when it is at m − (24 − 2), or m − 22; thus drilling 11 divisions.

2. Excentric chuck at 72 − 8. Lower segment stop with pulley at m − (24 + 2), or m − 26. Upper with pulley at m − (24 + 2) + 11, or m − 15.

For the outside strokes of the **W**.

1. E = 1·4, t = 1·17, excentric chuck at 72 − 6. Upper segment stop with pulley at m − 18, the axis of x being then horizontal; and the lower with pulley at m − 30, thus cutting 12 divisions.

2. Excentric chuck in 24 + 6. Lower segment stop with pulley at m − (24 + 6), or m − 30; and upper with pulley at m − 18.

For the **A**.

1. Right side. E = 1·675, t = 1·5, excentric chuck at 24 − 7, or 17.

The circle that may now be cut would have the axis of y for a tangent at a point too high, if the upper segment stop were fixed with the pulley at m − 17, which would allow nothing for the thickness of the drill. The upper segment stop is therefore fixed somewhat short of this, say with the pulley stopped at m − 19; and the lower with the pulley at m − 27, so that 8 divisions are cut.

2. Left side. Excentric chuck wheel at 72 + 7, or 79. Lower segment stop with pulley at $m - (24 + 5)$, or $m - 29$; and upper with pulley at $m - 20$. If, however, the drill be very fine, another division may be safely used.

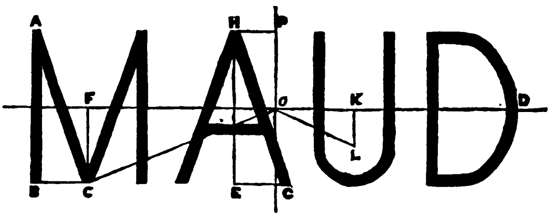
For the **H**. Set the excentric at right angles to the ellipse chuck.

1. $E = 9{\cdot}5$, $t = {\cdot}8$, and e (the excentricity of the ellipse chuck wheel) = 6 twentieths. Excentric chuck wheel at 24 − 1. Fix the upper segment stop when the pulley is at $m + 6$; the lower when it is at $m - 8$.

2. Excentric chuck wheel at 72 + 1. Lower segment stop with pulley at $m - 6$; upper with pulley at $m + 8$.

For the angle inside the apex of the **A**, the chucks are parallel again; and the pulley is stopped at m. Excentric chuck wheel first at 72 + 6, then at 24 − 6.

The cross stroke of the **H** is, finally, drilled along the central horizontal line.



Ellipse and excentric chucks required.

The discussion of these letters is given in full, as affording an example of the work that has sometimes to be done when more than two angles are involved, and the letters are not all of the same breadth.

1. The first step is to find the position of the letters with respect to "the center," for the **M** and the **A** take up more room than the **U** and the **D**. Let the proposed height be ·4; then, taking 18° 45′ for the angle B A C, we have

$$\text{log. tan. } 18^\circ\, 45' = 9{\cdot}5307 = 10 + \text{log. } {\cdot}3394,$$

$$\therefore\ \text{tan. } BAC = {\cdot}3394 = \frac{BC}{AB} = \frac{BC}{{\cdot}4},$$

$$\therefore\ BC = {\cdot}1357.$$

The width of the **M** = 2 B C	= ·27152
Allow for space between **M** and **A**	= ·1
Width of **A** same as of **M**	= ·27152
Space between **A** and **U**	= ·1
Width of **U** = half the height	= ·2
Space between **U** and **D**	= ·1
Width of **D** same as of **U**	= ·2

Total horizontal space = 1·24304, this, however, being only for a first approximation.

2. To find, now, where the **A** should stand with respect to "the center."

Half of the total estimated width is ·6215, of which the **M**, the first space, and the **A** together occupy ·6430, so that, if the right leg of the **A** be allowed to touch the central vertical line, too much of the word will be on the left and too little on the right. The simplest remedy for this would be to increase the width of the **D**, in such a manner that the **U**, the **D**, and two spaces, might occupy as much room as the **M**, the **A** and one space.

3. Assume, then, that the right leg of the **A** will touch the central vertical line; and, if this be found not possible, care must be taken to choose such an one of its possible positions as will not remove it anything to the left. We have then the following calculation:—

In order to bring the apex of the **A** vertically over "the center," the excentric chuck wheel must be shifted through the angle P O H; to find this angle we have

$$\text{tan. } POH = \frac{HP}{OP} = \frac{\cdot 13576}{\cdot 2} = \cdot 6788, \text{ (proposed value)};$$

$\therefore$ log. tan. P O H = 10 + log. ·6788 = 9·8317 = log. tan. 34° 10′. The nearest angle to this on the excentric chuck is 33° 45′, or $9 \times 3^\circ 45'$;

$$\text{log. tan. } 33^\circ 45' = 9{\cdot}8248 = 10 + \text{log. } \cdot 6681,$$

$$\therefore \text{tan. } POH = \cdot 6681 = \text{actual value of } \frac{HP}{OP}.$$

Hence either H P or O P must be altered from their proposed values. If it be desired to retain the height ·4, then O P is ·2, and we find H P from

$$\frac{\mathrm{H\,P}}{\cdot 2} = \cdot 6681\,; \;\therefore\; \mathrm{H\,P} = \cdot 1336\,;$$

this is less than half the width of the letter, indicating that, if the height be ·4, and the angle 33° 45′ be that at which the chuck is set, the right leg of the **A** will extend beyond the central vertical line by the difference in value between E G and H P, or ·1357 — ·1336, which equals ·0021, a small quantity, but in the right direction.

4. It must now be seen how far this suits the **M**. In order to bring the point C vertically over the center, the chuck must be shifted through the angle P O C, that is, through F O C from 72; to find this angle we have

tan. F O C = $\frac{\mathrm{F\,C}}{\mathrm{F\,O}}$, and F O = half width of **M** + space + half the width of **A** + H P = ·13576 + ·1 + ·13576 + ·1336 = ·5051, (proposed value);

$$\therefore \text{tan. F O C} = \frac{\cdot 2}{\cdot 5051} = \cdot 3959,$$

$$\text{and log. tan. F O C} = 10 + \text{log. } \cdot 3959 = 9\cdot 5975$$
$$= \text{log. tan. } 21^\circ\, 35'.$$

The nearest angle to this on the excentric chuck is 22° 30′, and

$$\text{log. tan. } 22^\circ\, 30' = 9\cdot 6172 = 10 + \text{log. } \cdot 4142,$$

$$\therefore \text{tan. F O C} = \cdot 4142 = \text{actual value of } \frac{\mathrm{F\,C}}{\mathrm{F\,O}}.$$

Now, this being all founded on the supposition that F C = ·2, that value must be retained, and $\cdot 4142 = \frac{\cdot 2}{\mathrm{F\,O}}$ gives F O = ·4828 instead of ·5051, a reduction of ·0223, which, perhaps, may be safely spared from the proposed space between the **M** and the **A**, the more so as it is another step in the right direction, that of reducing the space occupied on the left of the center.

5. To recapitulate then; we have found that with a height ·4, the **A** can be drilled with an angle on the chuck of 33° 45′, or at 96 + 9; its width will be ·27152, of which ·0021 will be on

the right, and ·2694 on the left of the center. The interval between the **A** and the **M** will be $\cdot 1 - \cdot 0223$, or ·0777. The **M**, whose width will be ·27152, can also be drilled with an angle on the chuck of 22° 30′, or at 72 — 6. Thus the total space occupied on the left of the center will be ·6186, and the width of the **D** will only (thus far) have to be increased by ·0186.

6. There is, however, another angle to be attacked, that for the circular arc of the **U**; and it remains now to consider whether this letter can be drilled under the conditions imposed by the **M** and **A**. The angle through which the excentric chuck must be shifted is P O L, or K O L from 24; to determine this angle we have

$$O K = \cdot 0021 + \cdot 1 + \cdot 1, \text{ and } K L = \cdot 1,$$

$$\text{so that tan. } K O L = \frac{K L}{O K} = \frac{\cdot 1}{\cdot 2021} = \cdot 4948 ;$$

$$\therefore \text{log. tan. } K O L = 10 + \text{log. } \cdot 4948 = 9 \cdot 6944$$

$$= \text{log. tan. } 26° \ 19'.$$

The nearest angle that can be used on the chuck is 26° 15′, or $7 \times 3° \ 45'$,

$$\text{log. tan. } 26° \ 15' = 9 \cdot 6929 = 10 + \text{log. } \cdot 4931 ;$$

·4931 is so close to ·4948 that no further trouble need be taken. This, however, does not always fall out so favorably, and therefore the method of calculation is herewith continued for example's sake.

The actual value for tan. K O L is $\cdot 4931 = \frac{\cdot 1}{O K}$,

$\therefore O K = \cdot 2028$ instead of ·2021; *i. e.* O K is ·0007 longer than was intended, and the increase will be in the space between the **A** and the **U**, not in the radius of the **U**. If this increase had been too great, it would have been necessary to make some alteration in the value of K L, working from $\frac{K L}{\cdot 2021} = \cdot 4948$, and this would have altered the height of the letters, so that the calculations for the **A** and **M** would have to be made over again.

7. It now only remains to make the calculations for the **D**. O D ought to equal ·6186, that the excentricity of the point D

may equal that of A B; of this, ·3028 is already occupied, leaving ·3158 for the space and the **D**. If, therefore, ·1 be kept for the space, there is ·2158 left for the letter, whose center, therefore, will have an excentricity of $\cdot 3028 + \cdot 1 + \frac{\cdot 2158}{2}$, or ·5107. (This is O C in the fig. on p. 283.) Now, following the directions given on pages 281 and 283, we have first to find the size of the ellipse. The height of the letter is ·4; this is the major axis required, and if ·4 : minor axis :: ·5 : ·35, the minor axis will = ·28. We have, however, seen that the width of the letter can only be ·2158, so that the amount of reduction (p. 283, § 1, **D** on the right) is ·28 — ·2158, or ·0642. The excentricity of the chuck is half of this subtracted from the excentricity of the central point of the letter, or E = ·5107 — ·0321 = ·4786.

8. We may now proceed to set the apparatus. Having drawn (if it be thought necessary) the upper and lower horizontal lines, when E = ·2, start from "all at center." Ellipse and excentric chucks.

(*a*) For the **A**. $E = OH = \sqrt{\cdot 1336^2 + \cdot 2^2} = \cdot 2405$ = 2 turns $8\frac{1}{10}$ small divisions. Excentric chuck wheel at 96—9, or 87, to make O H vertical. Pulley at *m* — (24 — 9), to make O H horizontal (p. 166). Drill with the pulley stopped 5 divisions on each side of *m* — (24 — 9).

(*b*) For the **M**. $E = OC = \sqrt{\cdot 4828^2 + \cdot 2^2} = \cdot 5225$ = 5 turns $4\frac{1}{3}$ small divisions. Excentric chuck wheel at 72 — 6, or 66, to make O C vertical. Pulley at *m* + (6 — 5), or *m* + 1, and at *m* + 1 + 10, to drill the central lines (p. 169). Pulley back to *m*, chuck to 72. E = ·6186 and ·3471, for the vertical lines.

(*c*) For the **U**. $E = OL = \sqrt{\cdot 2028^2 + \cdot 1^2} = \cdot 2252$, say 2 turns 5 small divisions. *t* = ·1, one turn. Excentric chuck wheel at 24 + 7, or 31. Pulley at *m* — (24 + 7), or *m* — 31, for the upper, and at *m* — 31 + 48, or *m* + 17, for the lower segment stop, to drill the semicircle. E = ·1028 and ·3028, for the vertical lines; the chuck wheel being at 24, the pulley at *m*.

(*d*) For the **D**. Excentric chuck wheel at 24. Pulley at *m*. E = ·4028, for the vertical line. Set the excentric at right angles to the ellipse chuck. Excentric chuck wheel still at 24.

E = ·4786, $t = \frac{·28}{2}$ = ·14, one turn 4 divisions. $e = a - t$ = ·2 — ·14 = ·06 = $1\frac{1}{3}$ twentieths. Fix the upper segment stop when the pulley is at $m - 24$, and the lower when it is at $m + 24$, to drill the semi-ellipse.

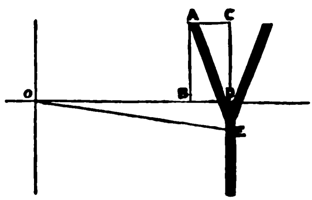
MARY

Excentric chuck alone required.

1. The same calculations that have already been made for the **M**, **A**, and **U** of **MAUD**, will do for the **M**, **A**, and **R** of **MARY**. It is, however, a different portion of the circle which is to be drilled for the **R**, the settings for which are as follows:

E = ·2252, as for the **U**. t = ·1. Excentric chuck wheel at 24 — 7, or 17. Pulley at $m + 7$ for the lower segment stop, and at $m + 7 + 48$ for the upper; drill the semicircle.

For the line H E (*v.* fig. p. 236). E = O H × sin. 60°; but O H is the O K in **MAUD**, and = ·2028 (*v.* § 6, p. 316), ∴ E = ·2028 ·866 = ·1755, say 1 turn 15 small divisions. Drill with the chuck wheel at 24 — 7, pulley at 96.



2. With respect to the **Y**. The space left for it to occupy is, as with the **D**, ·2158, which must be the width of its opening at the top, and the tail must bisect this space. We have then—

$$O B = ·4028, \text{ as with the D in MAUD,}$$

$$O D = ·4028 + \frac{·2158}{2} = ·5107,$$

$$A C = \frac{·2158}{2} = ·1079; \text{ and } C D = ·2.$$

The apex has to be brought a trifle below the central horizontal line by one tooth of the chuck wheel, so that the angle

$D\,O\,E = 3^\circ\ 45'$, and since $\tan.\ D\,O\,E = \frac{D\,E}{OD}$,

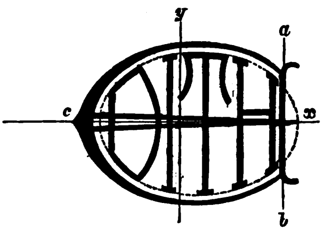
$\therefore D\,E = O\,D \times \tan.\ 3^\circ\ 45' = \cdot 5107 \times \cdot 06554 = \cdot 0334$. This gives the value of C E, which equals $C\,D + D\,E = \cdot 2 + \cdot 0334 = \cdot 2334$.

We can now find the angle A E C, for

$$\tan.\ A\,E\,C = \frac{A\,C}{C\,E} = \frac{\cdot 1079}{\cdot 2334} = \cdot 4623,$$

$\therefore$ log. tan. $A\,E\,C = 10 + \log.\ \cdot 4623 = 9 \cdot 6649 = \log.\ \tan.\ 24^\circ\ 48'$. This angle will have to be taken on the pulley, not on the chuck (see p. 174), and if the 96 row be used the nearest angle is $26^\circ\ 15'$, or $7 \times 3^\circ\ 45'$, which will be found sufficiently near. The settings then will be as follows:

$E = O\,E = \sqrt{\cdot 5107^2 + \cdot 0334^2} = \cdot 5118$, say 5 turns $2\frac{1}{3}$ small divisions. Excentric chuck wheel at 24 + 1. Pulley at 96 — 1. Drill with the pulley at 7 more, and 7 less, than 96 — 1. For the tail, bring the pulley back to 96.



Ellipse and excentric chucks required.

It is recommended that these letters be cut first on double the scale of the figure in the text, and the discussion of the work is given accordingly. The settings for the exact size of the figure will, however, be added below.

Let the height be 1·6, the breadth 2·2. Observe that the center of the principal ellipse which forms the E is ·2 on the right of the center of the work, which is marked by the intersection of the vertical and horizontal axes.

1. Starting from "all at center," draw the horizontal and vertical central lines, and with $t = 1 \cdot 1$ describe a circle, or at

least mark the point *c*. With the chuck wheel stopped at 24, and E, the excentricity of the chuck, = 1·1, draw the vertical line *a b*.

2. Describe a horizontal ellipse with the chuck wheel still at 24, E = ·2, *t* = ·8, *e* = 6 twentieths (because *e* = *a* – *t* = 1·1 – ·8 = ·3); a segment of this ellipse is drilled with the pulley fixed at *m* + 15 for the upper, and at *m* – (48 + 15) for the lower segment stop; *m* being the division on the 96 row at which the pulley is stopped when "all is at center."

3. Diminish *t* by ·1 (or *t* = ·7), and draw the inner ellipse for a guide; portions of its periphery will be used for the top and bottom of the D and the top of the T.

4. Increase E to ·7, and with the chuck wheel at 72 drill the vertical line of the D to meet the inner ellipse which was drawn as a guide.

5. Set the chucks at right angles, and still keeping the chuck wheel at 72 describe a segment of a vertical ellipse with E = ·5 and *t* = ·3 for the elliptic portion of the D, the upper segment stop being fixed when the pulley is at *m* + 18, the lower when it is at *m* – 18. This will leave a space of ·2 from the extreme right of the D to the center of the work.

6. Stop the pulley now at *m* + 24 to make the axis of *y* horizontal, and with E = ·1 drill the I.

7. Bring now the chuck wheel to 24, and, increasing E to ·6, drill the left side stroke of the H. Increase E to 1·0, and drill the right side of the H. This leaves a space of ·7 between the I and the H, so that if the stroke of the T be drilled with E = ·25 it will fall half way between them.

8. Increase E to 1·1, and drill the vertical line forming the outside boundary of the E on the right.

9. Bring the chuck wheel to 96; make E = ·115 and drill the cross stroke of the H.

10. The left-hand serif of the T is part of a small ellipse whose axis is slightly inclined to the vertical. To drill it start from "all at center," make *e* = 5 twentieths, E = ·7, *t* = ·2, and stop the excentric chuck wheel at 96 – 2. Fix the upper segment stop when the pulley is at *m* – (24+2) or *m* – 26, the 2 being to compensate for the movement of the chuck wheel; and the lower, when the pulley is at *m* – 47.

11. For the right-hand serif increase E to ·8, and shift the excentric chuck wheel to 96 + 14, compensating this movement by altering the ellipse chuck wheel to $n - 14$. Fix the upper segment stop when the pulley is at $m + 7$, and the lower when it is at $m - 12$.

12. To drill the long line of the E which passes through the centers of the letters, set the chucks at right angles to each other; make $e = 0$, E = 1·1, and stop the excentric chuck wheel at 24, the pulley at m. Transfer the pulley stop from m on the 96 row to p on the 360 row, so that the ellipse chuck still remains vertical, the excentric horizontal. Drill with the pulley first stopped at $p + 2$, and then at $p - 2$.

13. Now come back to the positions for all the apparatus in which the inner or guide ellipse was drawn in § 3; viz., $e = 6$ twentieths, E = ·2 and $t = $ ·7, and the chucks parallel; drill the top and bottom of the D, the top of the T, and the serifs to the other letters.

14. To form the loop at the left hand of the E, portions of two horizontal ellipses are required intersecting each other, and their major axes must be respectively above and below the central horizontal line. Set the chucks at right angles, so that the ellipse may be horizontal and yet the excentric chuck be available for placing the major axes of the ellipses above or below the central line. Diminish e to 3 twentieths; make E = ·15, and $t =$ ·97, the excentric chuck wheel being at 96, so that the point of intersection of the ellipses to be described may be at the point c, where the central horizontal line cuts the circle described in § 1. Then, with the pulley at $m + 21$ for the upper, and at m for the lower segment stop, drill the lower elliptic segment. Bring the chuck wheel to 48, and with the pulley at m for the upper stop, at $m - 21$ for the lower stop, drill the upper elliptic segment; these stops may, however, require a trifle more space between them, which will be given by their adjusting screws. The value E = ·15 as above was found by stopping the pulley at m when the excentric chuck wheel was at 96 and the value ·97 had been given to t. The work was then traversed by the slide of the excentric chuck till the extremity of the minor axis of the principal ellipse came to the tool.

15. Now diminish e to 2 twentieths, and, with the same values

of E and *t*, put in the thickening lines at the left, using the same positions for the segment stops as in § 14, and remembering that the chuck will be at 48 and 96.

16. Nothing now remains but the small circular segments on the right-hand side of the **E** above and below. Make $e = 0$, E = 1·265, twelve turns $6\frac{1}{2}$ divisions; and $t = \cdot 1$. Bring the excentric chuck wheel to 24—6. Fix the lower segment stop when the pulley is at $m + 6$, and the upper when it is at $m + 24 + 6$. Bring the chuck wheel then to 24 + 6. Fix the upper segment stop with the pulley at $m - 6$, and the lower with the pulley at $m - (24 + 6)$.

The settings for the figure of the same size as shown in the text, p. 319, are as follows:

1. $t = \cdot 55$, for marking the point *c*.
   E = ·55, for the horizontal line *a b*.
2. E = ·1, $t = \cdot 4$, $e = 3$ twentieths, for horizontal ellipse.
3. $t = \cdot 35$, for drawing the guide ellipse.
4. E = ·35, for the vertical line of **D**.
5. E = ·25, $t = \cdot 15$, for the elliptic portion of the **D**.
6. E = ·05, for the **|**.
7. E = ·3, and ·5, for the **H**.
   E = ·125, for the **T**.
8. E = ·55, for the vertical line.
9. E = ·0575, for the cross stroke of the **H**.
10. E = ·35, $e = 2\frac{1}{2}$ twentieths, $t = \cdot 1$. Chuck wheel at 96—3 is better than 96—2. Pulley at $m - 27$, and $m - 47$, for segment stops.
11. E = ·4.
12. E = ·55.
13. E = ·1, $e = 3$ twentieths, $t = \cdot 35$, for the serifs.
14. E = ·075, $t = \cdot 485$, $e = 1\frac{1}{2}$ twentieths.
15. $e = 1$ twentieth.
16. $e = 0$, E = ·6325, $t = \cdot 05$.

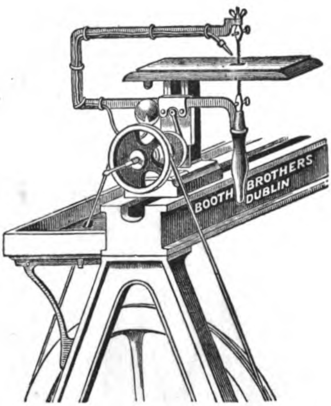
No alterations need be made other than those here given.

SHERRARD B. BURNABY.

NEW TOOLS.

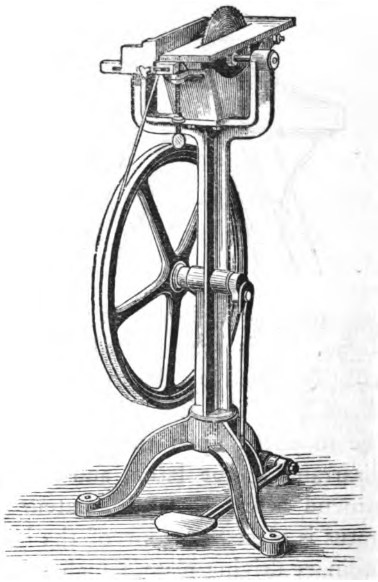
WE have much pleasure in bringing under notice two very neat circular and fret-sawing machines, both manufactured by Messrs. Booth Bros., of Dublin, who are also the makers of an extremely well-designed amateurs' shaping machine, of which we hope shortly to give a description.

FIG. 1.



The fret-sawing machine is shown in the illustration above as applied to the lathe. It is seen placed upon the lathe bed in the position usually occupied by the mandrel head, and is driven direct by a gut band from the foot wheel. But if preferred, the apparatus may be mounted upon the lathe bed in front of the head without disarranging the lathe, and this arrangement will generally recommend itself to the amateur for that reason. When the apparatus is placed in front of the head it is driven by the pin of the ordinary driving plate, which is introduced between the arms of the pulley of the sawing frame. Placed upon the end of the lathe bed, however, as shown, the spindle of the saw can be made to answer the purpose of a drilling machine, being furnished with a receptacle for the drill shank. A drill is seen projecting from the left-hand end of the spindle in the figure. The saw frame proper is an ordinary hand fret-saw, which can be taken out and used by hand when this mode of procedure would be more convenient than that of executing the work on the table of the machine. The idea of utilising the hand sawing frame in this way is a very ingenious one, and as worked out it certainly answers every purpose with a minimum of machinery. The reciprocating motion of the saw frame is obtained from a crank on the spindle of the machine, a connecting rod being, of course, interposed to convert the rotary motion of the spindle into the reciprocating motion of the saw frame. The dust is blown away from the guide line upon the work by a blower formed of a common india-rubber air-ball. The price of the complete apparatus, including saw-frame and blower, is but £3.

FIG. 2.

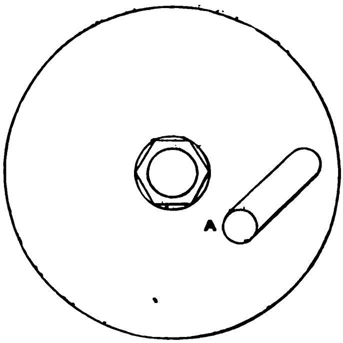


The circular saw is sufficiently described by the illustration, from which it will be seen that the saw spindle is placed upon a separate stand, independent of the lathe, and is driven by foot with a treadle and fly-wheel. The saw table has a rising and falling motion, and an adjustable guide-fence. The fret-sawing machine, in like manner, is sometimes mounted on an independent stand, which is undoubtedly better than fixing it on the lathe bed, and we imagine, where both machines are required they might be advantageously combined so as to occupy but one stand and so take up less room.

Most turners will agree that, for a simple chuck, the driver is one of the most useful. We need not here enter into a detail of its merits, of which the capability of allowing the work to be reversed end for end and of still preserving its truth is not one of the least. But there has always been this great defect in the chuck when used with a common carrier, viz. that, unless the centers are screwed up very tight, which is never proper and not always possible, directly the friction of the tool is taken from the work the driving pin ceases to keep up the necessary pressure on the carrier, the heaviest end of which then falls by the action of gravity; the consequence of this is, that whilst making a very disagreeable jarring on the driving arm of the chuck, the work is not in its proper position on again applying the tool. This back-lash, if it may be so called, though annoying enough even in hand turning, is of course more felt when using the slide rest, and in a self-acting lathe becomes quite a serious evil, especially in screw cutting, whether the lathe has to be reversed in order to return the tool to the beginning of the cut or not, and unless the alteration in the position of the work is attended to and set right at every cut, the result is very likely to be a mutilated screw.

Mr. J. W. P. Chatto, a member of our Society, whose invention we are about to describe, states that he has tried many ways to obviate this defect, such as using a rubber on the work, binding the carrier to the driving arm with clamps, wire, string, &c.; the string, of all these contrivances, being about the most successful in its operation, but decidedly not workmanlike in appearance. All these methods, besides being unworkmanlike, are in themselves only temporary expedients, and have to be renewed, or at all events refixed at every fresh adjustment or shift of the work, and involve a loss of time for which their utility is scarcely an equivalent. The arrangement of the driver chuck shown in the drawing (Fig. 3) is a perfect and simple cure for the defects above hinted at, and it is an alteration that an amateur can easily make for himself, especially in a chuck of the ordinary pattern; it is very compact and suitable to the cranked driving pin, but any variety of the chuck can soon be adapted to this plan, without calling for any

Fig. 3.



great exercise of ingenuity; the carriers will require a little more trouble to alter or make, but when the result is so good this much need not be grudged by either amateur, workman, or manufacturer.

Fig. 4.

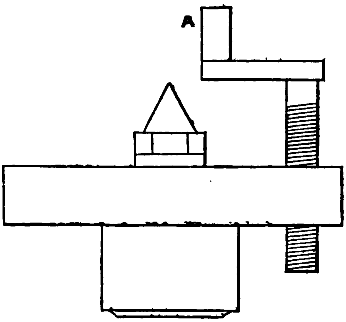
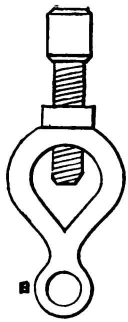


Fig. 5.



The cranked driving arm works in the chuck with an easy screw, and at the end of the arm is a pin, which fits neatly but not too tightly, in a hole in the tail of the carrier, and as the arm turns on its screw it adjusts itself at once to any sized piece of work within the limits of the chuck, without the least trouble, holding it, as nearly immovable as need be, always in the same position, as well as getting rid entirely of the jarring, which is an evil, it only a minor one. This linking, as it were, of the carrier to the arm does not prevent the work from being put on and taken off with the same ease as when the common carrier is used. The arm working in a screw not only has the advantage or turning, so that it may at once fit any diameter as the pin recedes from or approaches the center, but also, by unscrewing and so lengthening the arm as required, it enables the carrier to be fastened to the work at any place within the length of the screw on the crank, which is often useful in finishing and in other than cylindrical forms. Fig. 3 is the chuck in plan, A being the pin on the crank driving arm which holds the carrier. Fig. 4 shows the chuck in section, by which it will be readily seen what scope there is, by turning the arm, for using it with various diameters of work and sizes of carriers, and also the power of lengthening or shortening horizontally. Fig. 5 is the carrier with the hole B in the tail, drilled to fit the driving pin A. This tail is drawn rather too long here; the hole may be as near the body of the carrier as it can conveniently be made, giving it the advantage of compactness, and any other pattern of carrier may be used by merely having an eye on it to fit the pin A. The drawings are just half the size of a chuck suited to a five-inch center lathe.

A FEW WORDS ON GRINDING.

THE importance of keeping cutting-tools properly ground and set, is by many amateurs very inadequately appreciated. Time is often lost, and work spoiled or imperfectly executed, by "making a tool do" as long as it will produce any impression on the material, it being forgotten that a sharp tool will cut, not only more accurately, but more rapidly than a blunt one. Large sums are laid out on tools which are not allowed full scope for want of a judicious expenditure on grinding appliances. It is not difficult to account for this, nor are amateurs necessarily to be charged with indolence. Some practice and steadiness of hand are required, and the discovery that a tool has been spoiled instead of sharpened by grinding is not encouraging. Moreover, there is a popular delusion that a grindstone must be a bulky affair, requiring two men to work it effectively.

A very convenient and efficient grinding machine is shown in Fig. 1, which is taken from the catalogue of a well-known tool-maker in the City; I have had one of them in constant use for several years, and can strongly recommend it. The frame is of iron, and the total height of the machine about four feet; it stands very firmly, and occupies but little room. A is a water-cistern; B a stone of fine grit, four or five inches in diameter; the axis of the stone carries also a pulley for the driving-band, and at either end an emery wheel, C, and a wheel-brush, D, for cleaning off the dirt; the treadle, E, vibrates on centers, F F; the connecting rod, G, works by a pushing action against a pin which is attached to one of the spokes of the fly-wheel. The machine goes very easily and gives no trouble. A small piece of coarse sponge for wiping the edge of the stone occasionally while it revolves will be found a very useful appendage. With such a machine as this close at hand *in the workshop itself*, there will be no excuse for blunt tools. It is a wonderful help to the oilstone in keeping the cutting bevels of turning tools slightly concave, so that they can be sharpened without excessive time and labour, and it is of great use in occasionally altering the shape of a tool for a special purpose. Nor is its application limited to steel; photographers will often find it handy in grinding down a scrap of glass for a dipper, taking off the sharp edges of glass plates, converting a broken wineglass into a developing cup, &c.

The next stage in grinding is the oilstone. There should be two oilstones in every workshop, one being used exclusively for plane-irons and other broad tools. The other may be assigned to the lathe, and this can be used more conveniently if two slips of wood are fixed across the bottom of the block it is bedded in, just far enough apart to embrace both the lathe bearers. These projecting pieces will keep the oilstone steady, leaving both hands available for the tool, which can thus be held more accurately, and the stone will not be in danger of being thrown down if hastily pushed aside. The oilstone devoted to carpenters' tools may have three or four short iron points underneath to keep it from slipping about on the bench. It is a great mistake for any London amateur to attempt to grind large notches out of his plane-irons and carpenters' chisels, as there are many tool-makers who will do them infinitely better at a penny apiece, or even less.

For plain turning tools, which yet require some accuracy in the angle, I would recommend a flat circular oilstone, which is made to revolve rapidly by a pair of multiplying cogwheels, the tool being held still against the face of the stone. In some of these machines the face of the stone is horizontal and in others vertical; I prefer the latter position, because the hand which holds the tool can rest more firmly on the bench.

Small slide-rest chisels, cutters for the excentric and vertical frames, and drills, which are ground to the angles marked upon them, cannot be accurately sharpened without the instrument *mis*-called a goniometer; but this is so well known to amateur turners that any description of it here would be superfluous. One word of advice, however, I will venture to give. *Do not spare the use of this instrument.* He who guesses at an angle "to save time," in doing some unimportant job, will find that he has to spend much

FIG. 1.

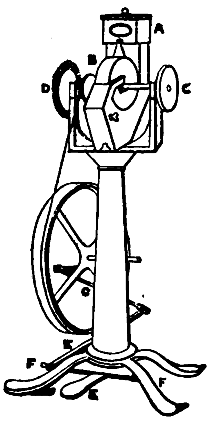
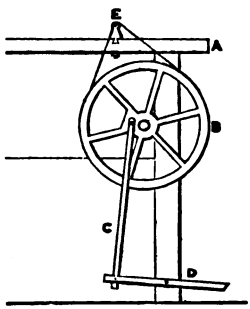


FIG. 2.



more time, and waste good steel in recovering the true angle afterwards.

There is yet another class of turning tools requiring a special grinding apparatus, viz. all those having hollow curves in their cutting edges and called *bead* and *moulding tools*. The apparatus is very generally known, although, speaking from my own experience, I doubt if it be as generally used as the goniometer. The reason is obvious. Those hollow curves are ground upon cones chucked in a miniature lathe-head, the pulley of which must be made to revolve with extreme rapidity; and the motive power comes usually through the lathe itself, a wooden pulley five or six inches in diameter being screwed upon the mandrel nose, and driving the miniature lathe-pulley by a fine catgut band. Therefore when, in the course of work, any bead tool becomes blunt, the single-lathe amateur must dismount his work in order to grind the tool—a more than inconvenient proceeding. He will, of course, resort to any possible expedient rather than do this.

Want of room has made me a single-lathe man, and the difficulty has been surmounted in the following manner. A, Fig. 2, represents the end of a carpenter's bench. To the side of this is screwed a strong, square iron plate carrying a pin, upon which revolves a cast-iron fly-wheel, B, sixteen inches in diameter, having a groove turned on its edge. An inch and a half from its centre this wheel carries a pin, on which works the upper end of a wooden rod, C, connecting it with a treadle, D. E is the little lathe-head in which the grinding cones revolve; it slips into a dovetailed groove in the bench. The whole apparatus takes up very little space, and can be dismounted in two minutes if necessary. The cost of the iron fly-wheel, with plate and pins, was under 25*s*., and any person who is able to use carpenters' tools can fit it up. There is another reason for thus separating the apparatus for grinding bead tools from an expensive lathe, and that is the danger of any minute particles of emery getting between the spindle and collar of the mandrel. I offer these few words in the hope that the result of my own experience may be useful to other amateurs.

VIRION NIGHTON.

NOTES ON THE USE OF THE ECCENTRIC CHUCK.—I.

1. A movement of n divisions of the wheel of the eccentric chuck moves the work through an angle $\frac{2n\pi}{96}$; and a movement of m divisions of the division plate of the lathe on the scale s, the eccentricity of the chuck being zero, moves the work through an angle $\frac{2m\pi}{s}$. If we combine both these movements we shall move the work through an angle—

$$\left(\frac{n}{96} \pm \frac{m}{s}\right) 2\pi \quad . \quad . \quad . \quad (1),$$

where we take the upper or lower sign according as we move the chuck and the lathe in the same or opposite directions. Every value of s on a division plate divided in the usual manner, has a common factor with 96; and if $96\,t$ be the least common multiple of 96 and s, we can put expression (1) under the form—

$$\frac{t\,n \pm b\,m}{96\,t}\, 2\pi \quad . \quad . \quad . \quad (2).$$

The number $96\,t$ can be divided into several pairs of integer factors; let such a pair of factors be $k\,l$, and putting—

$$t\,n \pm b\,m = k \quad . \quad . \quad . \quad . \quad (3),$$

the expression (1) becomes $\frac{2\pi}{l}$, the expression for the angle through which the work would be turned by a movement of one division on the scale l.

We only want integer values of m and n, and therefore we shall confine ourselves to the lower sign in equation (3), for we know that as t and b have no common factor the equation

$$t\,n - b\,m = k \quad . \quad . \quad . \quad . \quad (4)$$

is susceptible of positive integer solutions.

It will be observed that the fact of our taking the negative sign in the equation is equivalent to our saying that the division plate and chuck are to be turned in opposite directions; this is extremely convenient, as the chuck and division plate are, generally speaking, numbered in opposite directions. Let us now consider separately the effect of combining the motion of the chuck wheel with that of the division plate on each scale.

Division plate scale 112. We have

$$\frac{n}{96} - \frac{m}{112} = \frac{1}{16}\left(\frac{n}{6} - \frac{m}{7}\right) = \frac{1}{672}(7n - 6m).$$

We must split 672 into every possible pair of factors $k\,l$; we need only consider those which contain a value of l that we cannot obtain directly from the division plate. The useful pairs of factors are:—

1×672
2×336
4×168

$$8 \times 84$$
$$16 \times 42$$
$$32 \times 21$$
$$3 \times 224$$

Now, giving to k in succession the value of each of the left-hand numbers in three pairs, we shall have the equations—

$$7n - 6m = 1$$
$$7n - 6m = 2$$
$$7n - 6m = 4$$
$$7n - 6m = 8$$
$$7n - 6m = 16$$
$$7n - 6m = 32$$
$$7n - 6m = 3$$

Solving these equations, and remembering the meanings of n, m, k and l, we obtain the following results :—

Number of divisions on the chuck wheel.		Number of divisions on the scale of 112.		Correspond to one division on the scale of
1	...	1	...	672
2	...	2	...	336
4	...	4	...	168
2	...	1	...	84
4	...	2	...	42
8	...	4	...	21

Division plate scale 120. We have

$$\frac{n}{96} - \frac{m}{120} = \frac{5n - 4m}{480}$$

Performing the calculations, we have—

Number of divisions on the chuck wheel.		Number of divisions on the scale of 120.		Correspond to one division on the scale of
1	...	1	...	480
2	...	2	...	240
3	...	3	...	160
2	...	1	...	80

Division plate scale 144. We have

$$\frac{n}{96} - \frac{m}{144} = \frac{3n - 2m}{288}$$

The only useful pair of factors is 1×288; we have $3n - 2m = 1$; and we have—

Number of divisions on the chuck wheel.		Number of divisions on the scale of 144.		Correspond to one division on the scale of
1	...	1	...	288

Division plate scales 192 and 360. As 96 is a factor of each of the numbers 192 and 360, these scales give us no new values of *l*.

2. It is, perhaps, worthy of notice that all the patterns described in my *Patterns for Turning* can be cut by means of the eccentric chuck without the employment of the eccentric cutter, as the "eccentricity" can be given by throwing out the slide of the chuck, while the "radius" can be given by moving the toolholder of the slide-rest to the left, cutting the pattern with a slide-rest tool.

3. The word "eccentricity" is used by turners in different meanings; sometimes it is used to denote the distance that the toolholder of the slide-rest has to be moved forward from a given position, so as to enable a given cut to be made with the eccentric cutting frame; at other times it is used to denote the distance that the slide of the eccentric chuck must be moved through, from its position "all at centre," to enable a given cut to be made with a tool in the slide-rest. It is obvious that if we make a cut with the eccentric cutter, and determine its position by movements both of the slide of the chuck and of the toolholder of the slide-rest from their positions of "all at centre," ambiguity will arise. I purpose, therefore, in the succeeding articles to employ the language following:

Definition 1.—The distance that the toolholder of the slide-rest has to be moved forward from its central position to enable a given cut to be made is called the "eccentricity" of that cut.

Definition 2.—The distance that the slide of the eccentric chuck has to be moved forward to enable a given cut to be made is called the "chuck eccentricity" of that cut.

Definition 3.—The distance of the centre of any circle from the the centre of the work is called the true eccentricity of that circle.

I shall in the following paper denote the eccentricity, chuck eccentricity, and the true eccentricity, by the letters s, c, and e, respectively. If the slide of the eccentric chuck makes an angle with a horizontal line, and the slide-rest is in its transverse position, we have—

$$e^2 = s^2 + c^2 + 2sc \cos a.$$

H. W. ELPHINSTONE.

(*To be continued.*)

GOSSIP.

" . . bald, unjointed chat . . . "

King Henry IV, Pt. I.

CORRECT spelling is an accomplishment more easy of attainment to some people than to others, and in different languages the difficulty of its acquirement will be found to vary considerably, Spanish being one of the easiest, and our own one of the most difficult. We remember to have seen in some book, the title of which we do not at the moment recollect, an amusing chapter setting forth some of the incongruities which perplex the foreigner who is bold enough to visit the shores of "perfidious Albion" with a view of making himself master of her tongue. The language of science possesses peculiar facilities for the puzzlement of her votaries. It is well known that chemical nomenclature, for example, has undergone so complete a change within the last decade that it is not without difficulty that the student of some fifteen years ago, who has not had leisure to keep pace with the times, can recognise his old friends in their new garb. The subject, however, to which we would draw attention lies, comparatively speaking, within a nutshell—it relates merely to the spelling of a few words in common use by ornamental turners. Exception has been taken to our mode of spelling the words *excentric* and *center*, and in one paper which appears in this number it will be observed that we have, in deference to the author's wish, adopted the alternative spelling—*eccentric* and *centre*. Generally speaking, there is a right and a wrong way of doing a thing, and doubt is impossible as to the course to be pursued; this, however, does not appear to be the case as regards the spelling of these two words, for we find authors whom all will admit to be authorities holding different views; for instance, Professor Willis, in his *Principles of Mechanism*, writes *center* and *excentric*; Professor Tyndall has *centre*; Snowball (*Trigonometry*), *center*; Goodeve, *centre* and *eccentric*; Denison (*Clocks and Watches*), *centre*; and Holtzapffel, *center* and *eccentric*. Foreign languages, one and all, so far as we know, would appear to favour the spelling *centre*, and, supposing the two Greek words ἐκ and κέντρον to be the parents of the other, we might write *eccentric*; still the French have *excentrique*, and we see no reason why the derivation should not be from the Latin *ex centro*. In the face of such authorities at Professors Willis and Tyndall, it can scarcely be maintained that either is wrong, though one may be preferable to the other, and where a word is capable, not only of two modes of spelling but also of two meanings, it would seem convenient to assign a different spelling to each meaning; we therefore entirely concur with Mr. Perigal in his remarks on this subject at p. 110. There are other words of frequent occurrence as to the spelling of which there is a similar variety of opinion; such are *pulley* and *gear*, sometimes written *pully* and *geer*, but as both of these boast an Anglo-Saxon derivation we are content to leave the task of discussing them to abler hands, trusting that what we have said will be the means of eliciting some comments from those holding various views and able to speak with authority. In the mean time it may not be out of place to add that Dr. Richardson, one of the highest authorities, has (in his *English Dictionary*) *centre*, *eccentric*, *gear* or *geer*, and *pulley*.

A fond parent is apt to imagine that he has discovered latent mechanical talent in his offspring when he notes the eager curiosity common to most boys as to the internal mechanism of every new toy; this becomes the more apparent in proportion to the complicated nature and cost of the article in question, and is usually appeased by the summary, if not satisfactory, process of smashing in order to gain a view of the interior. In due time a box of tools is procured and the household furniture is duly "mended," the remedy being but too frequently worse than the disease. Up to this point, perhaps, the mechanical exploits of the child exert no material influence on the after-career of the man; but should the talent for mending and manufacturing continue to develope, it is quite possible that the question may present itself to the mind of a parent, whether the profession of an engineer is not that for which his son should be trained. Insufficient as the grounds may be, let us assume such a decision to have been arrived at. The next step is to article the lad at a proper age to some duly qualified engineer, for which a considerable premium will have to be paid, varying in amount with the degree of eminence reached in his profession. A young man so articled would have a place allotted to him in the office of his principal, and would be at liberty to gain all the information he could, but of personal instruction he would probably receive but a minimum, and that chiefly from those of his fellow-clerks who were disposed or competent to give it. Such a state of things must of necessity exist in a greater or less degree in the office of an engineer whose time and attention are absorbed in his business. Practical knowledge of the manipulation of materials, which should form the basis of his professional education, the aspirant must seek elsewhere, after payment of another premium; unless, indeed, he takes the middle course which is open to him, of combining both branches of instruction as a pupil at one of the large engine works, of which so many exist in our manufacturing districts. In some cases his "shop" experience will hardly be of an agreeable character, turned adrift, as he would be, to gain experience among workmen who individually are under no obligation to teach him, and who may possibly feel inclined to resent his presence as an intrusion, though, generally speaking, we believe the "gentleman apprentice," if he conduct himself with ordinary civility and propriety, will find but little difficulty in securing that co-operation and assistance from the workmen on which the successful issue of this portion of his studies must so greatly depend.

The foregoing observations will serve as preface to the subject which we propose to introduce to the notice of our readers—the Practical Engineering Classes which are about to be established at the Crystal Palace in connection with the already existing and, we understand, successful, School of Art, Science and Literature. The following outline of the scheme is derived partly from the prospectus, and partly from information furnished by Mr. Shenton the superintendent of the Art and Science Department. Several floors in what is known as the South Tower, at the Norwood end of the Palace, are being fitted up as engineering workshops, comprising a pattern-shop, foundry, smithy, fitting and erecting shops, drawing office, &c., the whole being under the superintendence of Mr. J. W. Wilson, the engineer who designed the principal portion of the company's hydraulic machinery, as Principal. It is proposed to divide the annual course of instruction into three terms of fifteen weeks each, one to be devoted to mechanical drawing, another to pattern making and foundry work, and the third to fitting and smith's work. Lectures on engineering subjects are to be given twice in each week, and an examination will take place at the end of each term. The premium for the whole course of three terms is to be fifty guineas; students providing their own drawing intruments, carpenter's and fitter's tools as required. The regulations, as they at present stand, appear rather stringent, though, perhaps, not more so than is necessary to ensure regularity and attention on the part of the pupils. Rewards in the shape of certificates of proficiency will be given, and, as punishments, we observe fines, work after hours, and "rustication" are mentioned. The strictness of the discipline above referred to may possibly be explained by a statement in the prospectus that "the students will be engaged in Mechanical Drawing, Estimating and Calculating, Pattern-making, and *constructing machinery for the market.*" From this point of view the prevention of idleness and inattention will doubtless benefit alike the students and the Company. Intending pupils will be required to pass a preliminary examination in the rudiments of arithmetic, algebra and geometry. In support of this scheme it is argued that pupils who have successfully passed through the course will, on entering an engineer's office, at once be able to make themselves useful, thereby diminishing or entirely avoiding the necessity for paying a premium, and will, in addition, be better able to take advantage of the opportunities afforded them during the term of their articles. These classes are also suggested as offering advantages to those who desire to compete for the Whitworth Scholarships, or to enter the Steam Mercantile Marine. The very accessible situation of the Crystal Palace is all that could be desired, and, in addition, the building contains a variety of engineering models, hydraulic, pumping, and other machinery, besides the Company's own works, which are close at hand. The requisite lathes and machines are in course of construction at Nottingham, and will be ready for the commencement of the first course early in January next.

The inauguration of any project by a Company which patronises alike high art and low comedy, and which, at one and the same moment, assumes to do justice to Handel and Beethoven, and condescends to shows such as are prevalent at country fairs, with all their concomitant touting, must necessarily subject it to the sneers of those who are ever more ready to discover the mote in their neighbour's eye than to remove the beam from their own. It is not, therefore, surprising to find that a weekly contemporary has already treated the subject in its characteristically caustic style, and sought to create merriment at the expense of the Crystal Palace Company, notwithstanding which we are of opinion that the step proposed is in the right direction. We have already taken occasion to lament the want of mechanical education in this country, and, in the April number, there appeared an able letter on the subject. Our complaint is that technical training is almost entirely excluded from the *curricula* of our public and private schools. It may, perhaps, be said that the Crystal Palace Company's scheme will not help us much in this respect, being intended as the introduction to a professional career, but doubtless, there will be found some few idle young men who, though entertaining no intention of entering the profession, will still be glad to avail themselves of the opportunity of instruction in an art which cannot but conduce to the maintenance of their bodily health and the expansion of their mental powers. It is among amateurs such as these that we must look for advocates for increased facilities for such education in our schools, and we boldly assert, without fear of contradiction, that the man who has once put his hand to the plough, in this as in every branch of science, will rarely, if ever, turn back, and having himself experienced the advantages and enjoyment to be derived from such pursuits, may naturally be expected to seek similar opportunities for his children. We heartily wish the Crystal Palace Company success in their new undertaking, feeling sure that every advance they make in the direction of true art and science will ultimately contribute to their advantage, and go far towards securing for them a position amongst the recognised institutions of the country.

CORRESPONDENCE.

Double Counting.

To the Editor.

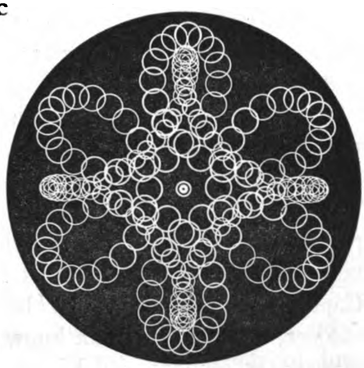
Sir,—Having successfully ornamented a few draughtsmen with looped figures, on the system of double counting, the question occurred to me, what kind of patterns would be produced by working a sort of double ratio in the same pattern, *e.g.* 6 to 1, and 4 to 1, together. On trial I produced Fig. 1, which seemed to me sufficiently satisfactory to induce me to try again, so I proceeded with varying results, the patterns being occasionally somewhat confused, though traceable and correct. There is not very much to say about them, but I will give the methods of working two or three, that any to whom they are new may not only be enabled to try, but to improve upon them, which, without doubt, may easily be done. I must premise that I used a division plate with 96 holes and an excentric chuck with 96 teeth.

Fig. 1.—" All at center."

Division plate 24, excentric chuck 96, then move—

Excentric chuck 5 turns,
Slide-rest 3 "
Excentric cutter 4 "

FIG. 1.



Cut 6 on the division plate to 1 on excentric chuck, all round in contrary directions, and the outer circle, or 1st ratio, of loops is done. For the smaller inner pattern, or 2nd ratio, beginning again " all at center," move—

Excentric chuck 5 turns,
Slide-rest 2 "
Excentric cutter 3 "

Start from the same point as before, and cut all round in the ratio of 4 to 1 in contrary directions, and the whole pattern will be finished.

Fig. 2.—Here I have used the same numbers as before with one exception, viz. the 2nd pattern, where the cutter is moved

only 2½ turns instead of 3, which seems to give it greater distinctness. Work with 6 to 1 as before for the 1st ratio, and 3 to 1 for the 2nd, both in contrary directions.

FIG. 2.

FIG. 3.

Fig. 3.—Numbers and 1st ratio as before. The 2nd ratio thrice repeated. The cutter for the 2nd ratio is moved 2½ turns. The inner ratio begins with 24 on division plate for each ellipse. The numbers on the excentric chuck for the 3 ellipses are 24, 56, and 88, worked in *contrary* directions.

It will be observed that in these examples I have retained very nearly the same numbers, &c., throughout for the 1st ratio or outer pattern. Of course they may be varied *ad libitum*.

Now, I have had very little experience in double counting, and probably never shall have much, as, though the results are often very satisfactory, the work is sufficiently tedious. Nor have I Captain Ash's or any other book with much instruction on the subject, so really I do not know whether the above idea is new to others as it is to me. I have not pursued the subject farther, and perhaps never may, but it strikes me as rather curious and interesting, so, if it is not already done, I hope some one with subtler brains and quicker eyes than mine may find some amusement in following it out. Mine is a mere hint at best, and, most likely, good for nothing; nevertheless, *accipe quantum valeat*.

JOHN H. HOLDICH.

INDEX.

ERRATA.

Page 82, line 28, *for* the vase or foot, *read* the base or foot.
„ 87, the diagram is printed upside down.
„ 91, line 7, *for* intermitted, *read* intermittent.
„ 91, „ 17, *for* feet, *read* foot.
„ 92, „ 36, *for* blackening-brushes, *read* blacking-brushes.
„ 98, the signature to the article concluding on this page should be SHERRARD B. BURNABY.
„ 102, line 33, *for* hand-saw *read* band-saw.
„ 106, „ 25, omit the word "the."
„ 110, „ 25, omit the first "or."
„ 111, „ 5, omit "(er);" the word "center" should be in italics.
„ 114, „ 25, *for* Leroy, *read* Lenoir.
„ 130, in the table, first column, *for* 6, *read* 16.
„ 160, line 1, 4th column, *for* 105, *read* 135 degrees.
8th „ 52½, „ 67½ „
3, 1st „ 30, „ 45 „
„ 295, foot-note, *for* Trübner & Co., *read* John Murray.
„ 296, line 2, *for* Mr. J. H. Ibbetson, *read* Captain Ash.