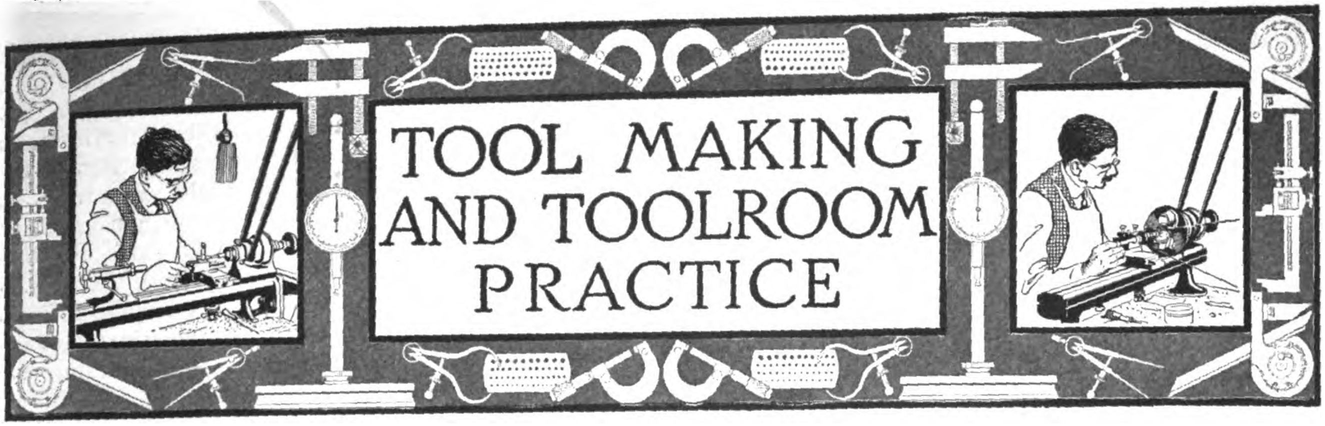


Elements of Gagemaking—II*

By C. A. MACREADY

SYNOPSIS—*Buttons and indicators are means used for the accurate locating of positions or gaging points. But neither are infallible. The possible errors peculiar to each are pointed out, together with the means for modifying or avoiding them.*

A BUTTON is a substitute for a result that is to be obtained; that is, it is a movable point that can be accurately located in a predetermined position. Generally, it is a substitute for a hole that is required in a certain place, but it can be used to locate "bosses" that are required to be an integral part of the gage. A button must be a true cylinder; and if made like Fig. 19, the ends must be parallel to each other and square with the body. The seating end only of the button shown in Fig. 20 need be square with the body. The uses of the several different styles of buttons illustrated in Figs. 19, 20 and 21 depend upon the work in hand, as for instance: The holes to be bushed in the soft gage, Fig. 22; hardened gages, as in Fig. 23, in which the holes themselves are finished by grinding and lapping; or the holes in hardened gages, which are ground out and lapped and then bushed to a certain size to maintain sizes and center distances, as in Fig. 24. In such gages the bushings when worn are replaced by new ones.

The diameter of the button in many cases is controlled by the center to center distances of the holes; also, whether it is to be used as a locating point for a surface. In Fig. 19 is illustrated a well-proportioned button. It is 0.50 in. in diameter and 0.75 in. high.

The height of a button should be, as nearly as practicable, equal to the length of the hole it is to locate. After setting, the button should run true at both ends when tested with the indicator. If the buttons are tested with a knife-edge square, or a block square from the surface to which they are secured when in position, this also will show whether or not the holes will be parallel to each other. It is good practice to test the buttons with the knife-edge square after setting and before indicating for position on the lathe faceplate.

The reason why the buttons are tested for squareness with the seating surface *A* will be made obvious by referring to the exaggerated error in squareness of the button shown in Figs. 25 and 26. At *B* and *C*, Fig. 25, are shown the contact points of the micrometer, and at *D*, Fig. 26, the location of the indicator point upon the button. The difference in distance from the surface *A*, Figs. 25 and 26, of the points of contact of the micrometer and of that of the indicator on the button might be as much as ⅛ in., and the difference in the measurement might be 0.0001 in. on each button. This gives an over-all error at the beginning of the work of 0.0002 in. between the holes; and if the holes in one plate were required to match a set of correctly located holes in another, the plugs would not enter both sets of holes.

The spherical, or ball, button, Fig. 21, is used to determine axial intersections of holes. It also serves to ascertain the relation of holes to angular sides. In Fig. 27 is illustrated a gage with two holes equidistant from the sides. In Fig. 28 is shown one with a hole that is nearer one side than the other.

Method of Using Buttons

To make plain the application of the buttons, we will take them in the order in which they are mentioned. The body of the gage, Fig. 22, is to be left soft, and all measuring points are to be renewable. This style of gage consists of an assembly of blocks, or pillars, attached by screws to a baseplate. The pillar *B* has been laid out to the measurement required, drilled in a drilling machine with a combination drill and countersunk, with an 0.031-in. drill to start the larger hole. This larger hole should be about 0.015 in. smaller than finished size, to allow material for boring to true position. This undersize hole is used for attaching the button *A* by means of a screw and nut. The screw is about 0.031 in. smaller than the drilled hole. This permits slight movement of the button, so it can be adjusted to position by light raps before tightening the nut *D*, which holds it in position.

Whenever possible, the button should be attached by screw and nut through a clearance hole in preference to tapping a hole in the piece and attaching by a screw, as shown in Fig. 19. Some gages have several of these pillars so attached to a baseplate that they are far from the edges of the plate. When so arranged and when the holes are small, the strongest boring tool that can be used is apt to be so slender that it will spring away from

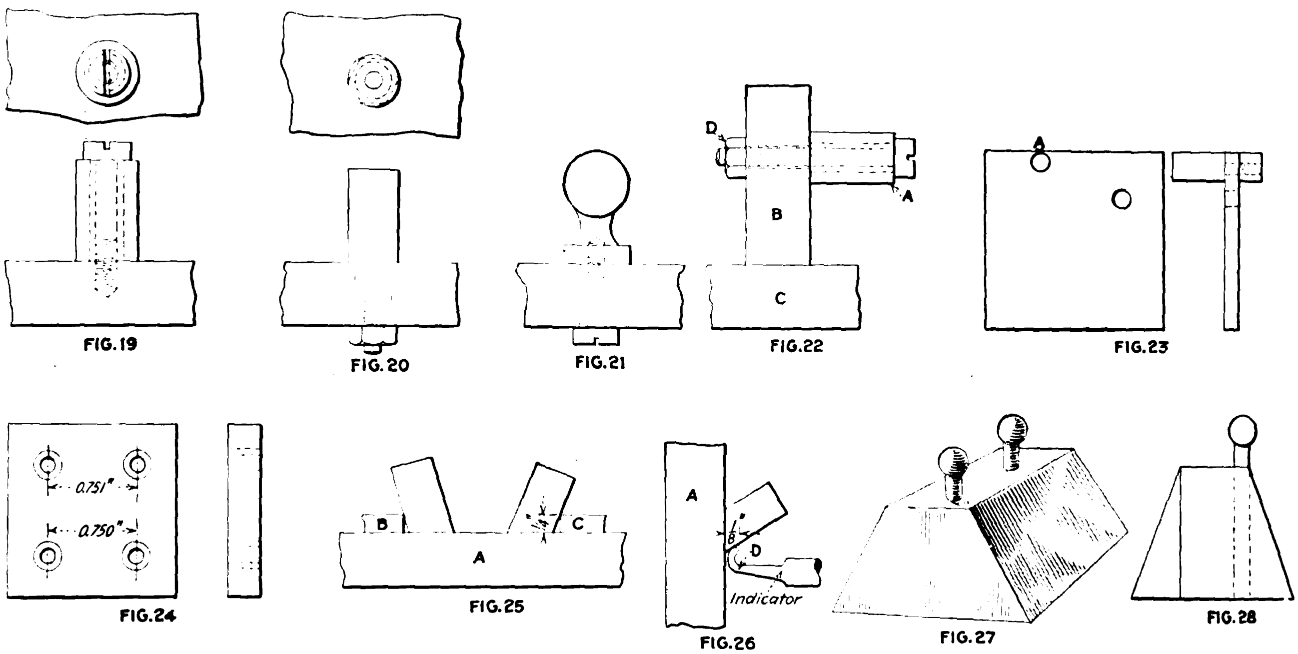
*Prepared for the author's forthcoming book on gagemaking;

the cut when retruing a threaded hole to be drilled, especially when truing the bottom of the hole. It is very evident that the tapped hole for the screw will not be in proper location, and it will be difficult to start a drill at the true axis from the old drilled center.

One source of errors will be avoided by laying out the different holes in the pillars and drilling them in the drilling machine before they are attached to the baseplate. If this is not done, the pillar *B* is liable (after correctly locating the position of the button) to spring out of place, due to the pressure of the drill. This method will also eliminate a source of error an example of which is given in Fig. 29.

The removal of a large amount of stock, such as the holes in the piece shown in Fig. 29, is very liable to cause distortion of the parallel surfaces *A*, *A'* of the *the work.* This does not mean contact with a positive surface, as when being drawn across the face of a parallel strip or sine bar or the surface of a hole that is concentric with the lathe spindle, but, for instance, when the indicator point just touches a portion of the wall of a small hole that is not set truly concentric with the lathe spindle. The tension of the spring controlling the indicator point should and can be made sensitive enough to record the slightest contact with the work.

While only two styles of indicators are shown in Figs. 30, 31 and 32, there are many other indicators that are just as good; in fact, all the commercial indicators are good. Some will indicate the front end of a small hole and also do all that the ones shown will do on work in which the holes are fairly large and not too deep. Styles of indicators, other than those shown, usually



FIGS. 19 TO 28. VARIOUS BUTTON AND INDICATOR PROBLEMS

work, Fig. 29. When these surfaces are retrued and made parallel, the removal of the further amount of stock in locating the holes correctly is not likely to again cause distortion.

In Fig. 20 is illustrated a button of which the screw is an integral part. The body of the screw should be true with the body of the button and small enough to permit radial adjustment in the roughly drilled hole in the gage. In Fig. 23 is illustrated a gage that is hardened all over. The distance from the side of the hole *A* to the edge is only 0.005 in., and the diameter of the hole itself is only 0.07 in. This style of gage is hardened all over. The button shown in Fig. 20 will have to be used on this style of gage and all holes of small diameter.

In Fig. 24 is illustrated a gage that is hardened all over to maintain given center to center distances between the holes. The holes are, however, bushed; and when the holes in the bushings become worn, they can be forced out and new bushings inserted, so that the same center distances are still retained. The buttons shown in Figs. 20 and 22 can be used on this work.

One important qualification that is seldom considered by users and manufacturers of indicators is that they should respond to and record the *lightest contact with* require more room to avoid interference with other parts of the work when the machine spindle is rotated and, so far as I know, lack the one qualification possessed by those illustrated—adjustability of the tension of the spring that controls the needle. In Fig. 32 is shown a complete set of pointers and extensions enabling one to reach and prove the positions of out of the way surfaces.

The importance of spring tension adjustment will be plain if the action of the indicator-needle spring is compared with the action of the indicator point when it comes in contact with the work. In Fig. 33 is shown the indicator point *A*, held in contact with the work by the spring *B*. It is very evident that, if the body of the pointer *A* is weaker than the spring *B*, it will give or bend and the indicator needle will not move. This in one sense is less dangerous than the condition shown in Fig. 34, as it is unreasonable to think that the button shown in Fig. 33 is central, while it is quite reasonable to think that the one shown in Fig. 34 is central.

In Fig. 34 the point *A* is shown in contact with a hole that can be seen to run out of truth. But part of the amount that the hole runs out of truth is lost through the bending of the body of the indicator point and is therefore not transferred to the registering part of the indicator. The spring *B*, which controls the indicating mechanism, is often under considerable tension merely to keep the parts in contact. That is why it is desirable to have tension adjustment for the spring controlling the indicating mechanism. Another way of showing that there could be an error even when the indicator apparently shows the hole to be concentric is as follows: Assume that the hole is 0.002 in. eccentric and that the indicator needle registers only 0.001 in. on the scale. With a condition like this the needle will not move at all when the hole is 0.0005 in. eccentric to the axis of the lathe, apparently proving the hole to be concentric. There is another possible condition conducive to false indication of untrue work, when the indicator point is so shaped that it will burnish or even cut the work and the tension of the needle spring is enough to induce either of these actions. This condition takes place, of course, with buttons like Fig. 20, which are generally left soft. When work is first

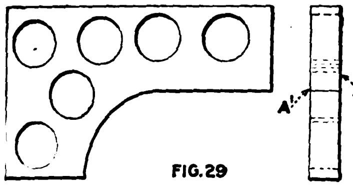


FIG. 29. EXAMPLE OF ERROR

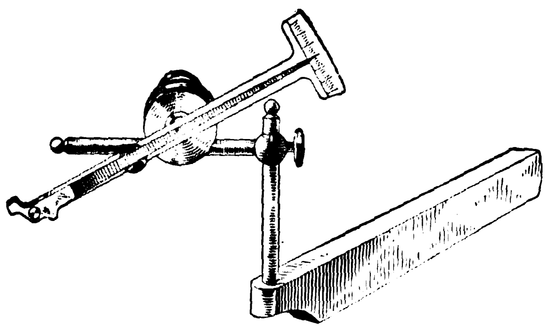


FIG. 30. ONE FORM OF INDICATOR

placed upon the faceplate, it generally runs out, say from 0.01 to 0.02 in. This gives a greater pressure of the point on the "run out" side of the work. With a strong indicator spring, a cut or burnished contact point will be made on the soft button, and errors are sure to develop.

In Fig. 30 is shown a well-known make of indicator used to set the work approximately; then if greater refinement is required, the one shown in Fig. 31 is substituted.

The centers of the holes, even in accurate gages, are often made by the use of the transfer center punch, used to indicate it when setting in the lathe must be taken into consideration. In Fig. 35 is shown how the pointer, Fig. 36, will abuse and displace a correctly located center mark if the work is moved on the faceplate while the female center of the pointer is on the tail center of the lathe and the male center of the pointer is in the center punch mark in the work. As it is only 5¾ in. from the face of the work to the tail center and

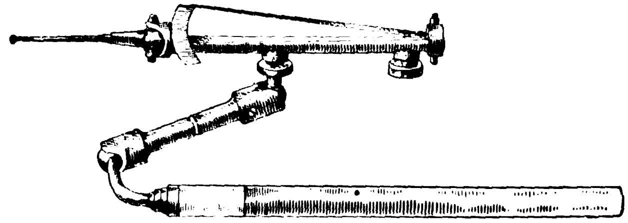


FIG. 31. INDICATOR FOR FINE WORK

as the pointer is 6 in. long, even with the greatest care when rapping the work to the true center of the lathe, the chances are considerable of forcing the sharp end of the pointer into the work and shifting the center punch mark.

This type of pointer is a very awkward one to use, even when released to allow the work to be moved, as one has to guess how much the work was moved at the last adjustment. An indicator reading cannot of course

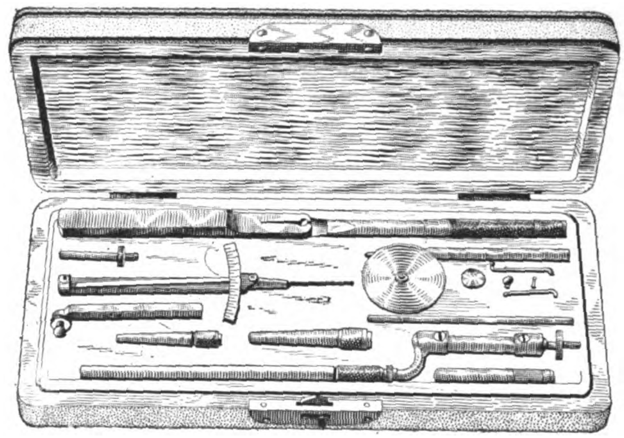
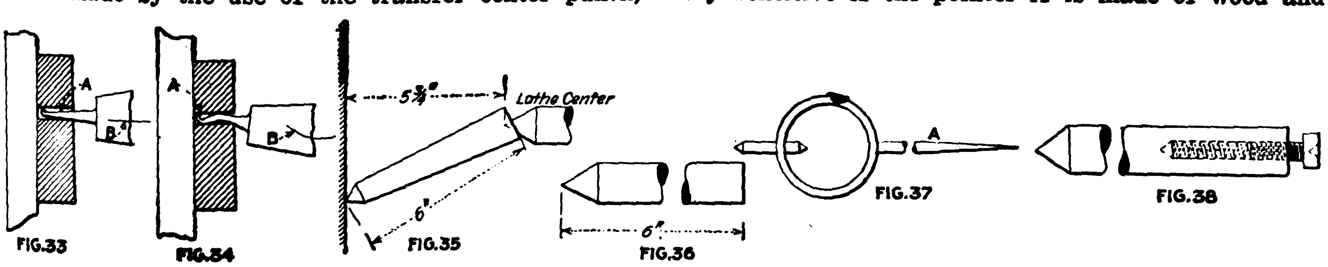


FIG. 32. POINTERS AND EXTENSIONS

be taken while the pointer is removed to allow adjusting the work toward the spindle axis.

In Fig. 37 is illustrated the principle of an indicator used by the old-time fine workmen. This indicator is very sensitive if the pointer *A* is made of wood and



FIGS. 33 TO 38. A NUMBER OF GAGEMAKING METHODS

Fig. 12, which transfers them from holes already made. The transfer center punch should be a close sliding fit in the hole that is to be transferred. As the punch mark made by this tool is only about 0.01 in. deep, the weight or mass and construction of the indicator point has little effect upon the location of the punch mark, but even with it one has to make a blind guess at the amount of movement involved in the last adjustment.

In Fig. 38 is illustrated a pointer that has a spring to compensate for the variation in length due to moving the work toward the center of the lathe. On the face of it, it looks all right; and it is all right if made like Fig. 39, which brings us to the cause of errors that are in *all* indicator pointers and that should as far as possible be eliminated when the pointer is used in delicate punch marks—that is, the inertia of the pointer.

The pointer is forced to move, not slowly, but with violent jumps when the work is rapped toward the center. The pointer should therefore be as light as is practicable, to offset as much as possible the stress upon the side of the center punch mark due to the inertia of the pointer. This stress becomes a blow the intensity of which varies with the force of the rap required to move the work, and the resistance of the indicator needle to be moved. In Fig. 39 is shown a good

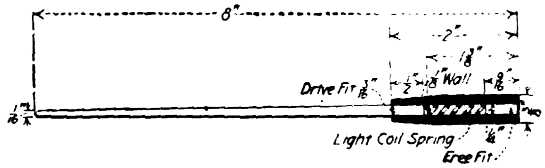


FIG. 39. A GOOD LIGHT POINTER

light pointer, which will offer the least resistance to a quick movement of the work from a state of rest.

The errors cited are brought to the attention of the reader, because they are the points that must be considered in planning the making of gages. When their recognition becomes a habit of thought, they will flash through the gagemaker's mind as he studies a gage drawing. He can then determine whether a certain error can be allowed here and corrected afterward or whether the point must be made accurate to start with. All the causes of error that creep into refined measurements are not covered, but those selected are of such a nature that they would not be considered important by the average machinist who has had neither the occasion nor the means for measuring the accuracy of his work.

By this I mean, for instance, that when a machinist makes a plug a snug sliding fit for a hole, he is probably working to the fourth or fifth demical place, often without knowing it, as he has no tools that will record such measurements. Often, men who are capable of very accurate work are not aware how accurate it really is. Results obtained in testing frequently seem to indicate to them unduly large errors, when in fact the errors are practically microscopic. Take, as an example, two plates with two through holes in each at right angles to the surfaces, the holes in one plate being only 0.00005 in. out of line with the holes in the other. If the edges of the holes are sharp and the edge of the test plug is sharp, it will come up against the edge of the hole in the opposed plate as if it were coming in contact with a solid stop.

Design of New Military Truck

The designing of the new standard military truck, which must meet the field transportation problem of modern warfare, has been completed. A sample chassis, representing the efforts of approximately two score truck specialists, will be ready by the middle of October and final tests will be conducted. Deliveries are expected to begin in January, within four months after the War Department undertook the development.

After a series of conferences between military and civilian engineers the design of the standard truck was completed early in September. Within 10 days detailed drawings were made and sample parts ordered. Ordinarily, it requires several months to perfect and turn out such parts; but various manufacturers patriotically agreed to put ahead the Government's work, and delivery of the first parts was expected to be made by Oct. 1. The crankshaft die was sunk in seven days, and the crank-case pattern and first casting were made five days after receipt of the drawings.

It is believed the new standard motor truck will fully meet the requirements of the army in the field. Rapidity of manufacture, stability and standardization are the outstanding promises of the new truck.

While the designing of the military truck lacked the dramatic features of the development of the United States aviation engine, or Liberty motor, it was brought about by similarly systematic and speedy methods. In the conduct of the war it is essential that we have large numbers of airplanes; it is also essential that transportation on land be highly developed.

In July the Quartermaster Corps initiated the movement for the production of a standardized military truck that would be an improvement over commercial designs heretofore used. Coöperation of truck manufacturers in all parts of the country was promised at a meeting held in Columbus in July. Early in August about 50 truck specialists and engineers of established reputation came to Washington at the invitation of the Quartermaster Corps. The Society of Automotive Engineers also sponsored the recent Washington conferences.

Both manufacturers and engineers generously contributed trade secrets in the designing of the military truck, just as they did in the development of the aviation engine. Engineers believe the new truck, a composite of the best there is in all commercial trucks, will be several years in advance of anything yet produced. Manufacture of the new truck will be carried on under direction of the Quartermaster Corps and the Automotive Committee of the Council of National Defense. Christian Girl, who has resigned as president of the Standard Parts Co., has been selected by Col. Chauncey Baker to supervise the work of production.

The new military truck will be made in two models, class A and class B. The engine used in the two will be the same in design, except for slight differences in cylinder bore, pistons, piston parts and riggings. To a large degree interchangeability of parts will be possible The class A model will have a nominal carrying capacity, under the arbitrary official ruling, of 1½ tons, with an actual commercial capacity of 3 tons. The class B truck will have a nominal capacity of 3 tons and an actual capacity of 5 tons. Both trucks will have a two-wheel drive, with a speed requirement of 14 miles per hour for the class A trucks and 12 miles for class B trucks.

It is planned that the first orders for the trucks shall call for 15,000 vehicles, to be delivered in the first six months of 1918. These orders will call for 10,000 class B and 5000 class A trucks. The adaptability of the new trucks to commercial as well as military uses is indicated by arrangements now being made by a number of manufacturers to produce them for commercial purposes.