

described, and held in place by the set screw, *M*. *G* is a fourth leg, but need not carry any clamp. The two legs at the upper end of the plate should be higher up, and the clamps longer, than shown in the figure.

(447) Many variations can be made in the details of construction, to suit the circumstances of the workman. For instance, if he has a good upright drilling tool which he does not use, he can save considerable labor in making, by attaching the plate, *A*, to it, as that already has legs, clamps, set screws, etc., and the upright crane answers the purpose of the upright holder. The latter has this advantage, however, that after the movement is adjusted in place, and securely clamped, the upper portions of the upright holder can be removed, and leave everything free and clear above the movement, as shown in Fig. 27, with nothing in the way to interfere with either seeing or handling any part. Sometimes, also, when the balance bridge would be in the way during the test, that can be removed and the upper pivot supported by the female centre of the arbor of the upright holder, as described in section (62). Often it is not desirable to have the hair-spring of the watch in action during the trial, as it tends to move the balance around when it is not wanted to move. By using the female centre, as above, the hair-spring is not attached at its outer end, and the balance will remain where it is placed, having no tendency to move of itself by the spring. It is scarcely necessary to add that the plate, *A*, with the clamps and rings, is in effect equivalent to an upright drilling tool, and can be used as such. The object is fastened on the plate by the clamps, with the point of the arbor of the upright holder at the point to be drilled, then the arbor is inverted, and the upper end of the drill supported by the female centre while drilling. This method is adopted for drilling the hole, *B*, vertically through the plate.

(448) But when the upright drilling tool is to be utilized as part of the angle-meter, the plate, *A*, should have three short legs fitted into it, the lower ends of which are turned down considerably smaller than the rest, forming a sort of pins, or pegs, that fit snugly into three corresponding holes drilled into the bed-plate of the tool. The plate, *A*, should not be over  $\frac{1}{2}$  inch above the bed-plate, as that gives ample room for the mechanism between the two plates. The hole, *B*, must come exactly under the point of the arbor of the tool, and it is better not to drill it till the plates are fitted. The upper surface of the plate, *A*, must be parallel with the bed-plate of the tool. This can be tested by attaching a horizontal wire to the arbor, and revolving it around the circle, *E*, Fig. 27. If the wire touches only a part of the plate, that part is too high, and must be lowered by altering the shoulder of the leg underneath it, till the point of the wire will evenly graze the surface of the plate around the whole circle.

(449) The holes for the legs can first be drilled through the bed-plate, the plate *A* then adjust properly upon it, and clamped fast, when the holes already drilled can be continued through the plate, *A*, after which all the holes can be opened as required. The legs being made, and plate leveled properly, as before mentioned, the arbor point is brought down upon the plate to mark the exact position of the hole, *B*, which is then drilled. Doing this *after* the plate, *A*, is fitted in its place, insures that the hole, *B*, will be exactly under the arbor

point. The scale, *D*, Fig. 27, is not necessarily marked upon the plate, *A*, but may be made separately and screwed upon it, being careful to place the curved lines concentrically with the hole, *B*,—otherwise the pointer would appear to indicate a greater movement on the part most distant from *B*, then on the other end of the scale, although the actual motion of the piece being tested would be the same in each case. The scale should be completed before the pointer is finished, which should then be formed to suit the shape of the parts. Some workmen might think there ought to be a counterpoise to the weight of the lever and pointer, on the opposite side of the staff, *a*. But, if the tool is used in the horizontal position, that is not material, although it can be easily added if one fancies it.

(450) The employment of the spring, *f*, Fig. 28, is not obligatory, although it is more convenient in use. If dispensed with, the circle, *g*, and wheel, *h*, with their covering plate, are also omitted. In this case, the tool can be tipped up sideways while in use, so that the weight of the lever and pointer will cause the end of the arm, *i*, to remain in contact with the piece it is meant to rest against. But it would be better to fit a piece of very thin, narrow mainspring alongside of the claw, *m*, as shown on a large scale in Fig. 29. The claw being placed on one side of the piece under measurement, the spring is placed on the other side, and its pressure insures contact with the claw. A small screw driver can be inserted in the opening between the claw and spring, to pry them apart, or any other method the workman prefers. For some purposes, a claw should be made like the lowest one in Fig. 28, only all that is there shown should be of brass, and a spring fitted over the top and outside of it. By prying the spring up, the end would at the same time be moved outward from the end of the claw and, after placing it over the piece, let the spring down, when it would be firmly clasped between the claw and spring. Or two pieces of spring could be used, instead of one and a claw.

(451) To use the angle meter, the upright holder is first clamped on the plate, *A*, in any convenient place, the pointed arbor is set on the hole, *B*, and all the parts securely fastened. The arbor is then loosened and raised out of the way, and the watch movement is placed on a suitable ring, with the part to be tested looking toward the scale, *D*. The ring used must be one which will raise the movement high enough for the pivots, etc., to clear the plate, *A*, and of such a size that it does not touch any of the screw heads, false plates, or other uneven parts, but rests against the level portion of the pillar plate of the movement, and support it parallel with the plate, *A*. The point of the arbor must come exactly at the pivot hole of the part whose motion is to be measured, then the movement is fastened there by the clamps, *L*, when it is evident that the pivot hole will be over the hole, *B*, and the piece being tested will have the same centre of motion as the lever, *d*, and pointer, *e*. In the case of a pallet arbor or similar piece, it is not necessary to take the upper or potance plate off, (or the bridge or cock,) and adjust the pillar plate to get the arbor point in the lower pivot hole before fastening it, then replace the parts with the upper plate or bridge,—but, if the end of the pivot projects through its jewel, the arbor can be got over the centre of the pivot very closely, either by the point or the female centre end.