Chapter XVII.—PLANING MACHINERY.

FIG. 1565 represents a planer by William Sellers and Co., of Philadelphia, Pennsylvania. This planer is provided with an automatic feed to the sliding head, both horizontally and vertically, and with mechanism which lifts the apron, and therefore the cutting tool, during the backward stroke of the work table, and thus prevents the abrasion of the tool edge that occurs when the tool is allowed to drag during the return stroke. The machine is also provided with a quick return motion, and in the larger sizes with other conveniences to be described hereafter.

The platen or table is driven by a worm set at such an angle to the table rack as to enable the teeth of the rack to stand at a right angle to the table length, and as a result the line of thrust between the worm and the rack is parallel to the **V**-guideways, which prevents wear between the **V**s of the table and of the bed.

The driving pulleys are set at a right angle to the length of the machine, their planes of revolution being, therefore, parallel to the plane of revolution of the line or driving shaft overhead, and parallel with the lathes and other machines driven from the same line of shafting, thus taking up less floor space, while the passage ways between the different lines of machines is less obstructed.

By setting the worm driving shaft at an angle the teeth of the worm rotate in a plane at a right angle to the length of the work-table rack, and as a result the teeth of the worm have contact across the full width of the rack teeth instead of in the middle only, as is the case when the axis of a worm is at a right angle to the axis of the wheel or rack that it drives.

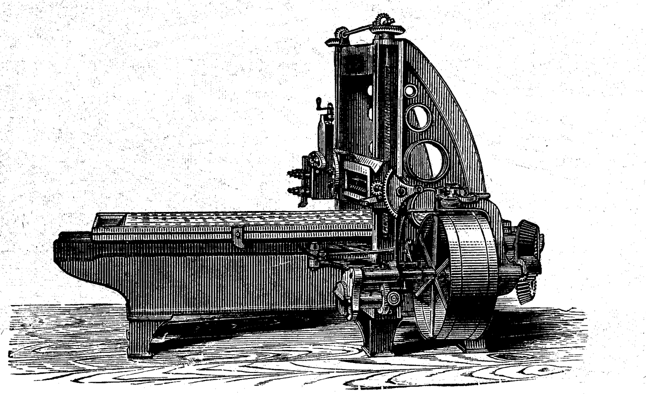


Fig. 1565.

Furthermore, by inclining the worm shaft at an angle the teeth of the rack may be straight (and not curved to suit the curvature of the worm after the manner of worm-wheels), because the contact between the worm and rack teeth begins at one side of the rack and passes by a rolling motion to the other, after the manner and possessing the advantages of Hook's gearing as described in the remarks made with reference to gear-wheel teeth.

By inclining the worm shaft, however, the side thrust incidental to Hook's gearing is avoided, the pressure of contact of tooth upon tooth being in the same direction and in line with the rack motion. As the contact between the worm teeth and the rack is uniform in amount and is also continuous, a very smooth and uniform motion is imparted to the work table, and the vibration usually accompanying the action of spur-gearing is avoided.

The worm has four separate spirals or teeth, hence the table rack is moved four teeth at each worm revolution, and a quick belt motion is obtained by the employment of pulleys of large diameter.

It is desirable that the belt motion of a planing machine be as quick as the conditions will permit, because the amount of power necessary to drive the machine can thus be obtained by a narrower belt, it being obvious that since the driving power of the belt is the product of its tension and velocity the greater the velocity the less the amount of tension may be to transmit a given amount of power.

The mechanism for shifting the belt to reverse the direction of table motion is shown in Fig. 1566 removed from all the other mechanism.

To the bracket or arm B are pivoted the arms or belt guides C and D and the piece G. In the position occupied by the parts in the figure the belt for the forward or cutting stroke would be upon the loose pulley P′, and that for the quick return stroke would be upon the loose pulley P, hence the machine table would remain at rest. But suppose the rod F be moved by hand in the direction of arrow *f*, then G would be moved upon its pivot X, and its lug *h* would meet the jaw *i* of C, moving C in the direction of arrow *a*, and therefore carrying the belt from loose pulley P′ on to the driving pulley P″, which would start the machine work table, causing it to move in the direction of arrow W until such time as the stop A meets the lug R, operating lever E and moving rod F in the direction of arrow *d*. This would move G, causing its lug *h* to meet the jaw *j*, which would move C from P″ back to the position it occupies in the figure, and as the motion of G continued its shoulder at *g*′ would meet the shoulder or lug T of K (the latter being connected to D) and move arm D in the direction of *b*, and therefore carrying the crossed belt upon P, and causing the machine table to run backward, which it would do at a greater speed than during the cutting traverse, because of the overhead pulley on the countershaft being of greater diameter than that for the cutting stroke.

It is obvious that since each belt passes from its loose pulley to the fast one, the width of the overhead or countershaft pulleys must be twice as wide as the belt, and also that to reverse the direction of pulley revolution one driving belt must be crossed; and as on the countershaft the smallest pulley is that for driving the cutting stroke, its belt is made the crossed one, so as to cause it to envelop as much of the pulley circumference as possible, and thereby increase its driving power. The arrangement of the countershaft pulleys and belts is shown in Fig. 1567, in which S is the countershaft and N, O the fast and loose pulleys for the belt from the line shaft pulley; Q′ is the pulley for operating the table on the cutting stroke (with the crossed belt), while Q is the pully for operating the table on its return stroke. The difference in the speed of the table during the two strokes is obviously in the same proportions as the diameters of pulleys Q′ and Q.

The feed rod, and feed screw, and rope for lifting the tool on the back stroke are operated as follows:—

Fig. 1568 is an end view of the mechanism viewed from the front of the machine, and Fig. 1669 is a side view of the same.

The shaft of the driving pulleys (P P′ and P″, Fig. 1567) drives a pinion operating the gear wheel W, upon the face of which is a serrated internal wheel answering to a ratchet wheel, and with which a pawl engages each time the direction of pulley revolution (or, which is the same thing, the direction of motion W) reverses, and causes the pawl and the shaft, to which the plate P, Fig. 1569, is fast, to make one-half a revolution, when the pawl disengages and all parts save the wheel W come to rest.

From this plate P the feed motions are actuated, and the tool is lifted during the back traverse of the work table by the following mechanisms.

Referring to Fig. 1570, upon the plate P is pivoted a lever Q, carrying a universal joint at Z, and a nut pivoted at V, and it is obvious that at each half-revolution of P, the rod R is moved ver-

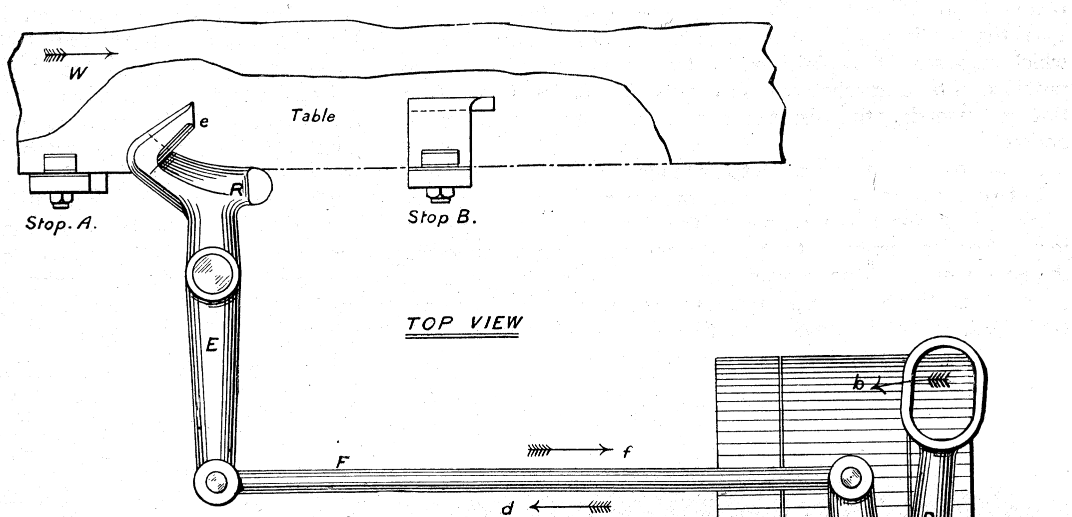
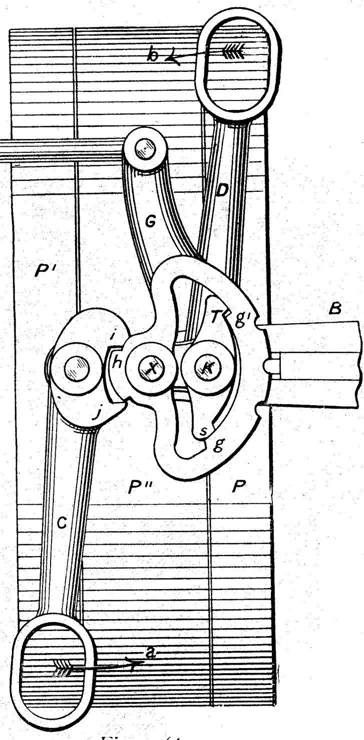



Fig. 1566.

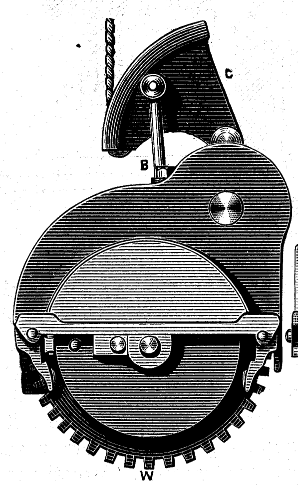


Fig. 1568.

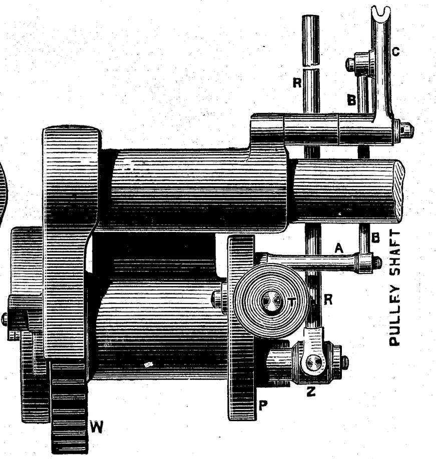


Fig. 1569.

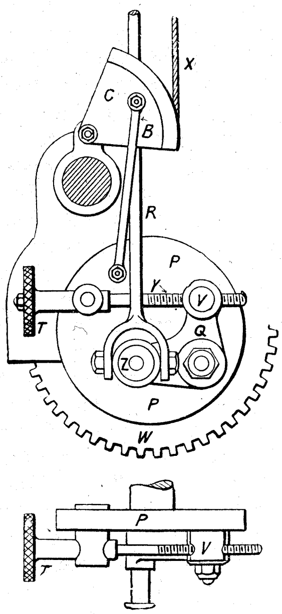


Fig. 1570.

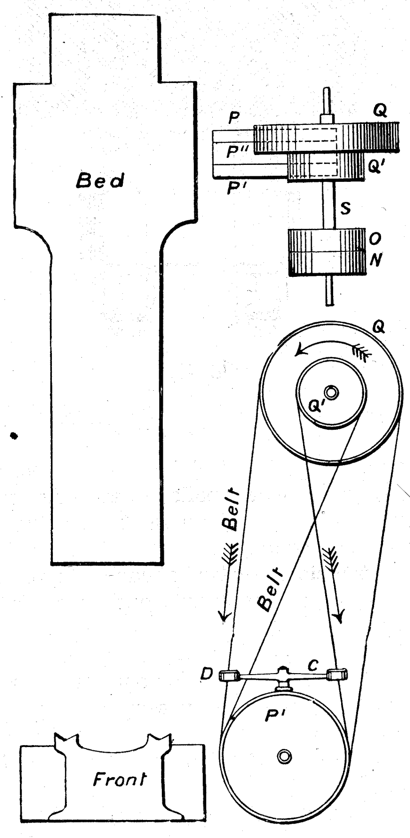


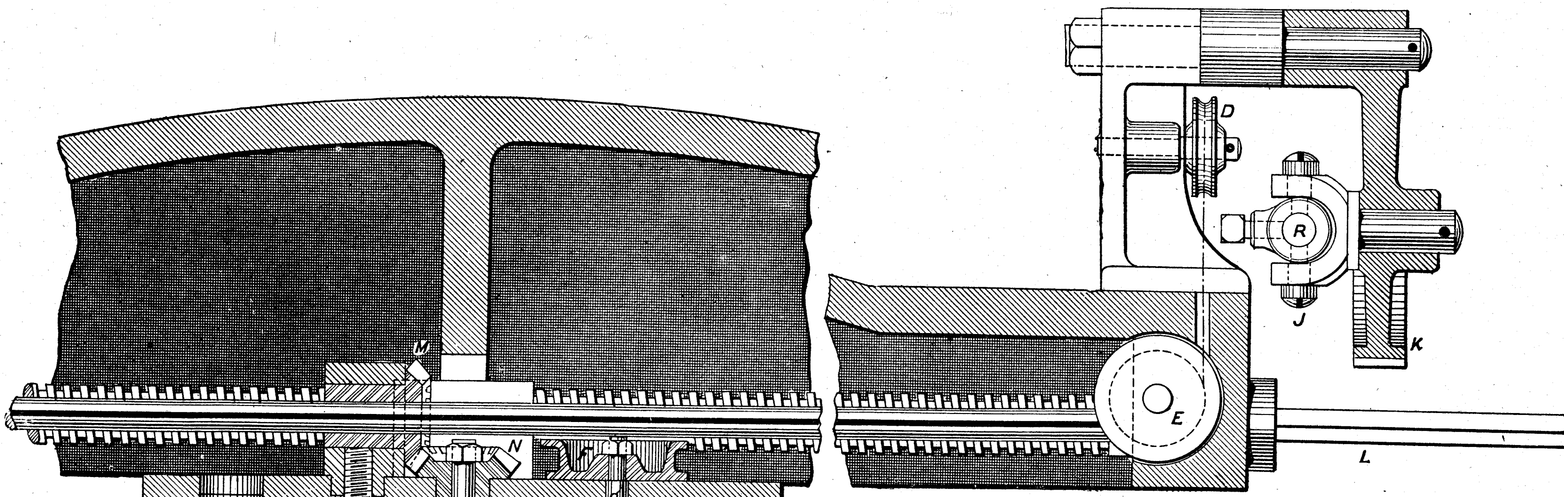
Fig. 1567.

tically. This rod connects to a universal joint J (shown in Fig. 1571) that is pivoted in a toothed segment (K, in the same figure) which engages with a pinion on the feed screw, this pinion being provided with a ratchet and feed pawl (of the usual construction) for reversing the direction of the feed or throwing it out of action.

The amount of feed is regulated as follows:—

Referring to Figs. 1569 and 1570, the amount of vertical motion of rod R is obviously determined by the distance of the universal joint Z from the centre of the plate P, and this is set by operating the hand wheel T, which revolves the screw Y in the nut V.

For lifting the tool during the return motion of the work and work table, there is provided in the plate P, Fig. 1570, a pin



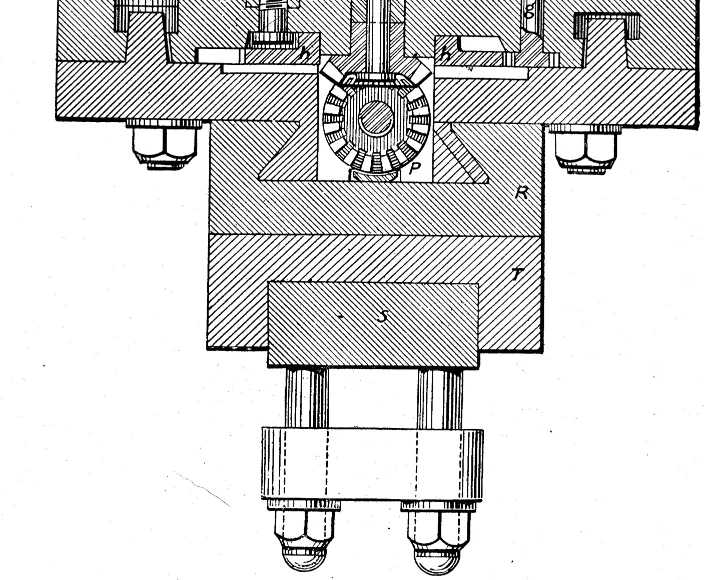


Fig. 1571.

which actuates the rod B, which in turn actuates the grooved segment C.

From this segment a cord is stretched passing over the grooved pulley D, Fig. 1571, thence over pulley E, and after taking a turn around the pulley F, Fig. 1571, it passes to the other end of the cross slide, where it is secured.

This pulley F is therefore revolved at each motion of the plate P, Figs. 1569 or 1570, or in other words each time the work table reverses its motion.

In reference to Figs. 1571 and 1572, F, Fig. 1571, is fast upon a pin *g*, at whose other end is a pinion operating a gear-wheel *h*. Upon the face of this gear-wheel is secured a steel plate shown at *m* in Fig. 1572, which is a vertical section of the sliding head. In a cam groove in *m*, projects a pin that is secured to the sleeve *n*, which envelops the vertical feed screw O. This sleeve *n* has frictional contact at *p* with the bar *q*, whose lower end receives the bell crank *r*, which on each return stroke is depressed, and thus moves the tool apron *s*, and with it the tool, which is therefore relieved from contact with the cut upon the work.

The self-acting vertical feed is actuated as follows:—

Referring to Figs. 1571 and 1572 the gear segment K operates a pinion upon the squared end of the feed rod L, this pinion L having the usual pawl and ratchet for reversing the direction of rod revolution.

The splined feed rod L actuates the bevel pinion M, which is in gear with bevel pinion N, the latter driving pinion P, which is threaded to receive the vertical feed screw O; hence when P is revolved it moves the feed screw O endways, and this moves the vertical slide R upon which is the apron box T and the apron *s*. To prevent the possibility of the friction of the threads causing the feed screw O to revolve with the pinion P, the journal *e* of the feed screw O is made shorter than its bearing in R, so that the nut *f* may be used to secure the feed screw O to the slide R.

PLANER SLIDING HEADS.—In order that the best work may be produced, it is essential that the sliding head of a planer or planing machine be constructed as rigid as possible, and it follows that the slides and slideways should be of that form that will suffer the least from wear, resist the tool strain as directly as possible, and at the same time enable the taking up of any wear that may occur from the constant use of the parts.

Between the tool point that receives the cutting strain and the cross bar or cross slide that resists it there are the pivoted joint of the apron, the sliding joint of the vertical feed, and the sliding joint of the saddle upon the cross slide, and it is difficult to maintain a sliding fit without some movements or spring to the parts, especially when, as in the case of a planer head, the pressure on the tool point is at considerable leverage to the sliding surfaces, thus augmenting the strain due to the cut.

The wear on the cross slide is greater at and towards the middle than at the ends, but it is also greater at the end nearest to the operator than at the other end, because work that is narrower than the width of the planing machine table is usually chucked on the side nearest to the operator or near the middle of the table width, because it is easier to chuck it there and more convenient to set the tool and watch the cut, for the reason that the means for stopping and starting the machine, and for pulling the feed motions in and out of operation, are on that side.

The form of cross bar usually employed in the United States is represented in Fig. 1573, and it is clear that the pressure of the cut is in the direction of the arrow *c*, and that the fulcrum off which the strain will act on the cross bar is at its lowest point *d*, tending to pull the top of the saddle or slider in the direction of arrow *e*, which is directly resisted by the vertical face of the gib. while the horizontal face *f* of the gib directly resists the tendency of the saddle to fall vertically, and, therefore, the amount of looseness that may occur by reason of the wear cannot exceed the amount of metal lost by the wear, which may be taken up as far as possible by means of the screws *a* and *b*, which thread through the saddle and abut against the gib. The gib is adjusted by these screws to fit to the least worn and therefore, the tightest part of the cross bar slideway, and the saddle is more loosely held at other parts of the cross bar in proportion as its slideway is worn.

In this construction the faces of the saddle are brought to bear over the whole area of the slideways surface of the cross bar, because the bevel at *g* brings the two faces at *m* into contact, and the set-screw *b* brings the faces in together. Instead of the screws *a* and *b* having slotted heads for a screw driver, however, it is preferable to provide square-headed screws, having check nuts, as in Fig. 1574, so that after the adjustment is made the the point of the screw of such a cone that it will bed fair against gib *c*, without passing into a recess, the construction being as in Fig. 1576, in which case the screw point forces the gib flat against the bevelled face and there is no tendency for the gib to pass down into the corner *e*, Fig. 1575, while the pressure on the screw point acts to force the slide *a* down upon the slideway, thus giving contact at *m m*.

The bearing area of such screw points is, however, so small that the pressure due to the tool cut is liable to cause the screw to indent the gib and thus destroy the adjustment, and on this

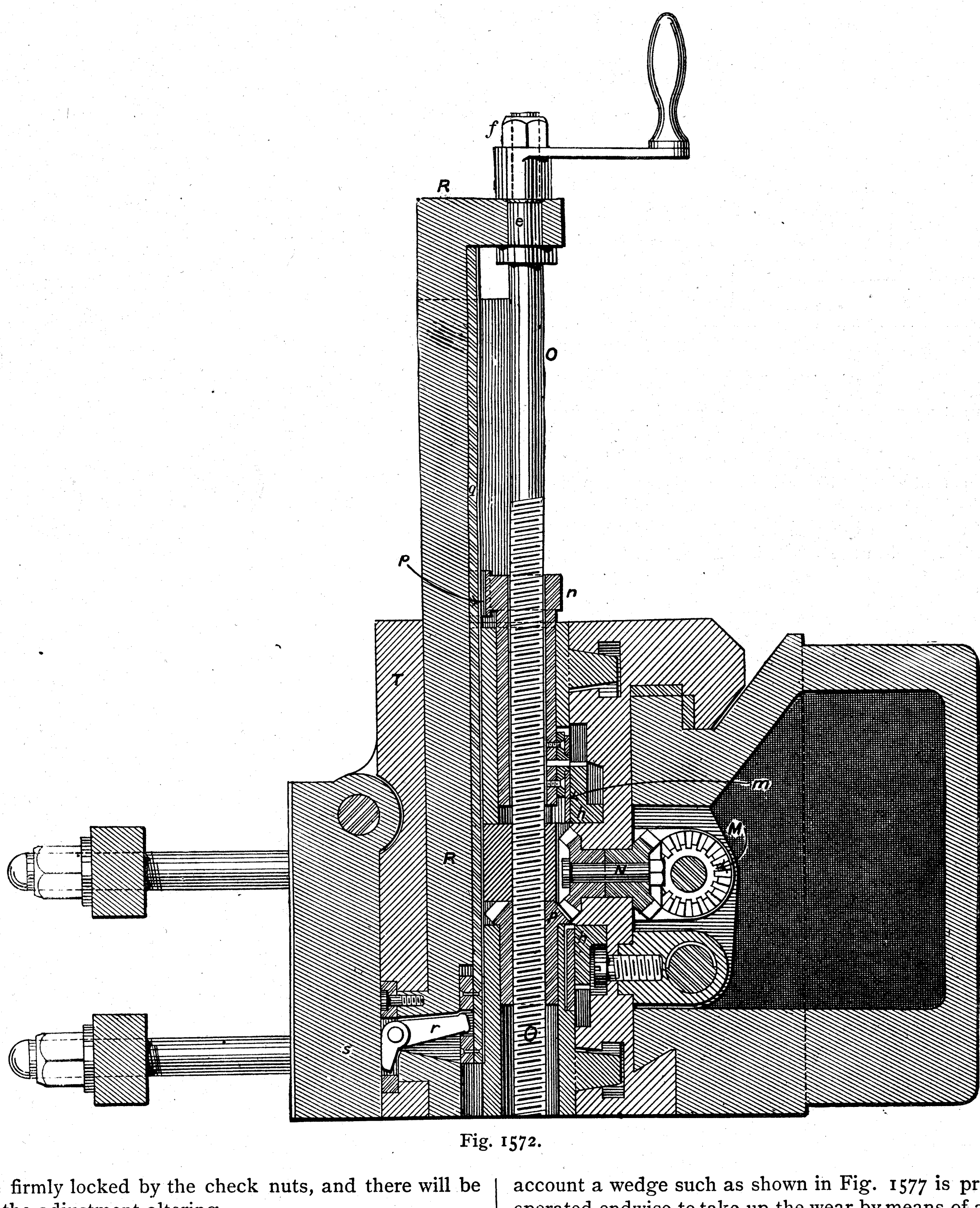


Fig. 1572.

parts may be firmly locked by the check nuts, and there will be no danger of the adjustment altering.

The wear between the slider and the raised slideways S is taken up by gibs and screws corresponding to those at *a* and *c* in the Fig. 1575, and concerning these gibs and screws J. Richards has pointed out that two methods may be employed in their construction, these two methods being illustrated in Figs. 1575 and 1576, which are taken from "Engineering."

In Fig. 1575 the end *s* of the adjustment screw *a* is plain, and is let into the gib *c* abutting against a flat seat, and as a result while the screw pressure forces the gib *c* against the bevelled edge of the slideway it does not act to draw the surfaces together at *m m* as it should do. This may be remedied by making

account a wedge such as shown in Fig. 1577 is preferable, being operated endwise to take up the wear by means of a screw passing through a lug at the outer or exposed end of the wedge.

The corners at *i*, Figs. 1575 and 1576, are sometimes planed out to the dotted lines, but this does not increase the bearing area between the gib *c* and the slide, while it obviously weakens the slider and renders it more liable to spring under heavy tool cuts.

Fig. 1578 represents a form of cross bar and gib found in many English and in some American planing machines. In this case the strain due to the cut is resisted directly by the vertical face of the top slide of the cross bar, the gib being a triangular piece set up by the screws at *a*, and the wear is diminished because of the increased wearing surface of the gib due to its lower face being diagonal.

On the other hand, however, this diagonal surface does not directly resist the falling of the saddle from wear, and furthermore in taking up the wear the vertical face of the saddle is relieved from contact with the vertical face of the cross bar, because the

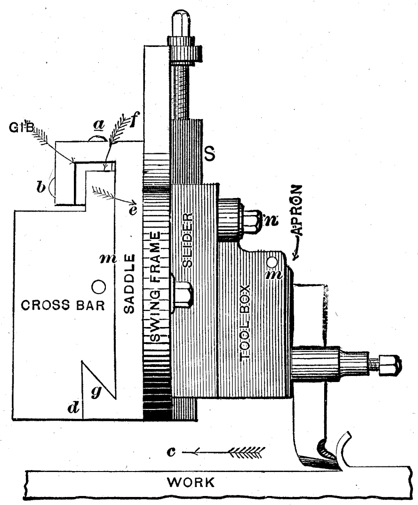


Fig. 1573.

screws *a* when set up move the top of the saddle away from the cross bar, whereas in Fig. 1573, setting up screw *b* brings the saddle back upon the vertical face of the cross bar slideway.

Fig. 1579 is a front view, and Fig. 1580 a sectional top view, of a sunk vertical slide, corresponding to that shown in Figs. 1573 and 1578, but in this case the gib has a tongue *t*, closely fitted into a recess or channel in the vertical slider S, and to allow room

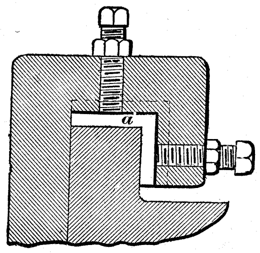


Fig. 1574.

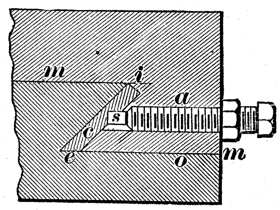


Fig. 1575.

for adjustment, the channel is made somewhat deeper than the tongue requires when newly fitted. The adjustment is effected by means of two sets of screws, *a* and *b*, of which the former, being tapped into the gib, serve to tighten, and the latter, being tapped into the slide, serve to loosen the gib. By thus acting in opposite directions the screws serve to check each other, holding the gib rigidly in place. To insure a close contact of the gib

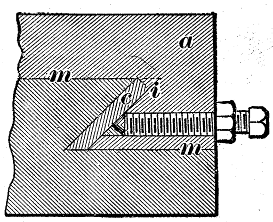


Fig. 1576.

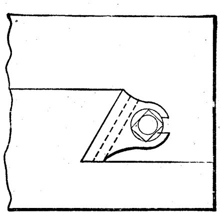


Fig. 1577.

against the vertical surface of the slide, the screws *b* are placed in a line slightly outside of the line of the screws *a*.

Fig. 1581 represents a similar construction when the slideways on the swing frame project outwards, instead of being sunk within that frame.

Fig. 1582 represents the construction of the Pratt & Whitney Company's planer head, in which the swivel head instead of pivoting upon a central pin and being locked in position by bolts, whose nuts project outside and on the front face of the swing frame, is constructed as follows :—

A circular dovetail recess in the saddle receives a corresponding dovetail projection on the swivel head or swing frame, and the

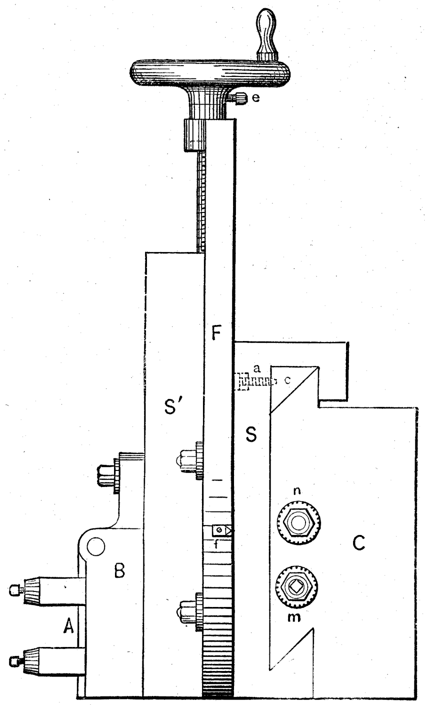


Fig. 1578.

two are secured together at that point by a set-screw A. In addition to this the upper edge B of the saddle is an arc of a circle of which the centre is the centre of the dovetail groove, and a clamp is employed to fasten the swivel head to the saddle, being held to that head by a bolt, and therefore swinging with it. Thus the swivel head is secured to its saddle at its upper edge, as well as at its centre, which affords a better support.

The tool box is pivoted upon the vertical slider, and is secured in its adjusted position by the bolts *n* in Fig. 1573, the object of

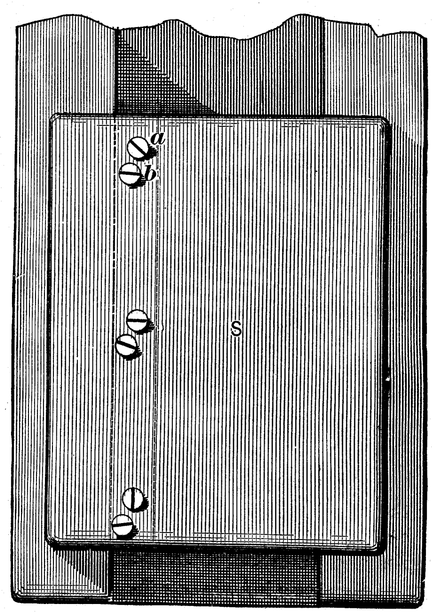


Fig. 1579.

swinging it being to enable the tool to be lifted on the back stroke and clear the cut, when cutting vertical faces, as was explained with reference to shaping machines.

The tool apron is in American practice pivoted between two jaws, which prevent its motion sideways, and to prevent any play or lost motion that might arise from the wear of the taper pivoting pin *b*, in Fig. 1583, the apron beds upon a bevel as at *a*, so that in falling to its seat it will be pulled down, taking up any lost motion upon *b*.

The bevel at *a* would also prevent any side motion to the apron should wear occur between it and the jaws. In addition to this bevel, however, there may be employed two vertical bevels *c* in the top view in Fig. 1584. In English practice, and especially upon large planing machines, the apron is sometimes made to embrace or fit the outsides of the tool box, as in Fig. 1585, the object being to spread the bearings as wide apart as possible, and thus diminish the effect of any lost motion or wear of the pivoting pin, and to enable the tool post or holder to be set to the extreme edge of the tool box as shown in the figure.

It is desirable that the tool apron bed as firmly as possible back against its seat in the tool box, and this end is much more effectively secured when it is pivoted as far back as possible, as in Fig. 1585, because in that case nearly all the weight of the apron, as well as that of the tool and its clamp, acts to seat the apron, whereas when the pivot is more in front, as *m*, in Fig. 1573, it is the weight of the tool post and tool only that acts to keep the apron seated.

In small planing machines it is a great advantage to provide an extra apron carrying two tool posts, as in Fig. 1586, so that in planing a number of pieces, that are to be of the same dimension, one tool may be used for roughing and one for finishing the work. The tools should be wider apart than the width of the work, so that the finishing tool will not come into operation until after the roughing tool has carried its cut across.

When the roughing tool has become dulled it should, after being ground up, be set to the last roughing cut taken, so that it will leave the same amount of finishing cut as before.

The advantage of this system is that the finishing tool will last to finish a great many pieces without being disturbed, and as a result the trouble of setting its cut for each piece is avoided; on which account all the pieces are sure to be cut to the same dimension without any further measuring than is necessary for the first piece, whereas if one tool only is used it rapidly dulls from the roughing cut, and will not cut sufficiently smooth for the finishing one, and must therefore be more frequently ground up to resharpen it, while it must be accurately set for each finishing cut. A double tool apron of this kind is especially serviceable upon such work as planing large nuts, for it will save half the time and give more accurate work.

In some planing machines, and notably those made by Sir Joseph Whitworth, a swiveling tool holder is made so that at each end of the stroke the cutting tool makes half a revolution, and may therefore be used to cut during both strokes of the planer table. A device answering this purpose is shown in Fig. 1587. The tool-holding box is pivoted upon a pin A, and has attached to

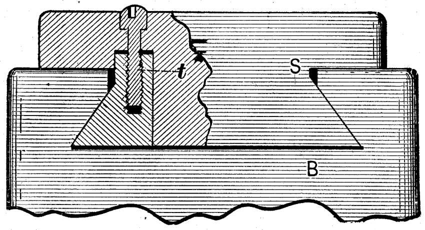


Fig. 1580.

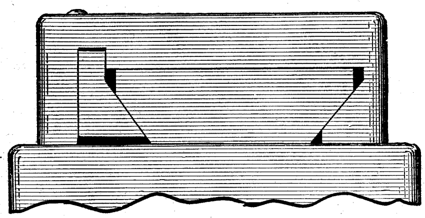


Fig. 1581.

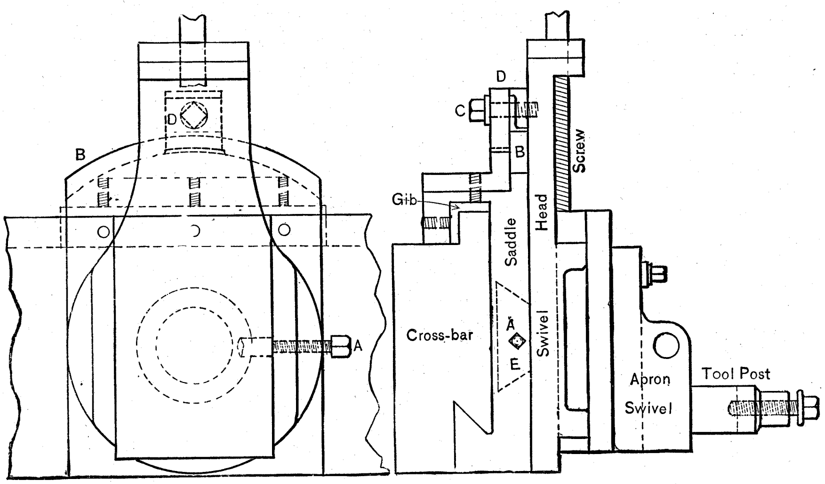


Fig. 1582.

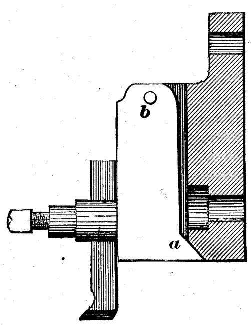


Fig. 1583.

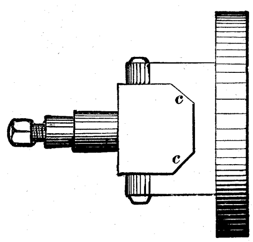


Fig. 1584.

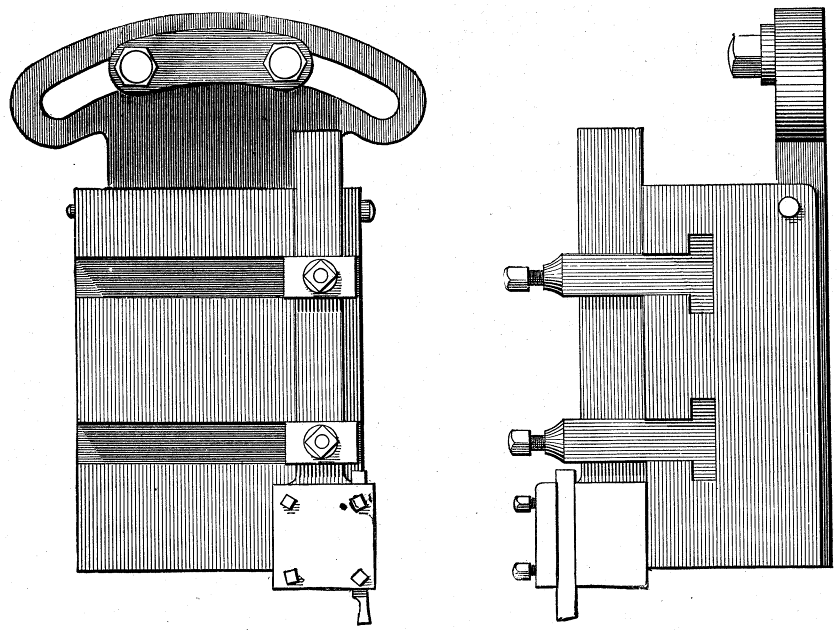


Fig. 1585.

it a segment of a circular rack or worm-wheel, operated by a worm upon a shaft having at its upper end the pulley shown, so that by operating this pulley, part of a revolution at the end of each work-table stroke, one or the other of the two tools shown in the tool box, is brought into position to carry the cut along.

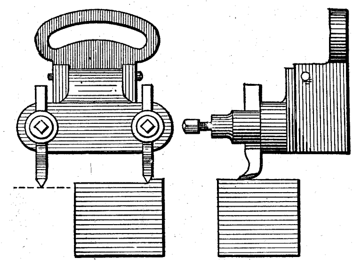


Fig. 1586.

Thus two tools are placed back to back, and it is obvious that when the tool box is moved to the right, the front tool is brought into position, while when it is moved to the left, the back or right-hand tool is brought into position to cut, the other tool being raised clear of the work.

The objections to either revolving one tool or using two tools so

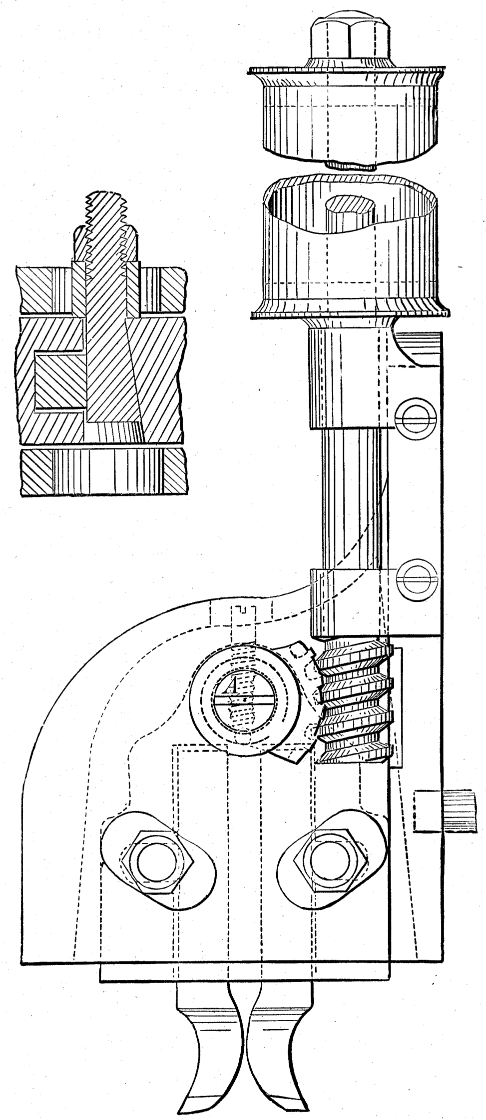


Fig. 1587.

as to cut on both strokes are twofold: first, the tools are difficult to set correctly; and, secondly, the device cannot be used upon vertical faces or those at an angle, or in other words, can only be used upon surfaces that are nearly parallel to the surface of the work table.

Figs. 1588 and 1589 represent the sliding head of the large planer at the Washington Navy Yard, the sectional view, Fig. 1589, being taken on the line X X in Fig. 1588. C is the cross bar and S the saddle, F being the swing frame or fiddle, as some term it, and S′ the vertical slider; B is the tool box, and A the apron.

The wear of the cross slider is taken up by the set screws *a*, and that of the vertical slide by the screws *b*.

The graduations of the degrees of a circle for setting over the swing frame F, as is necessary when planing surfaces that are at

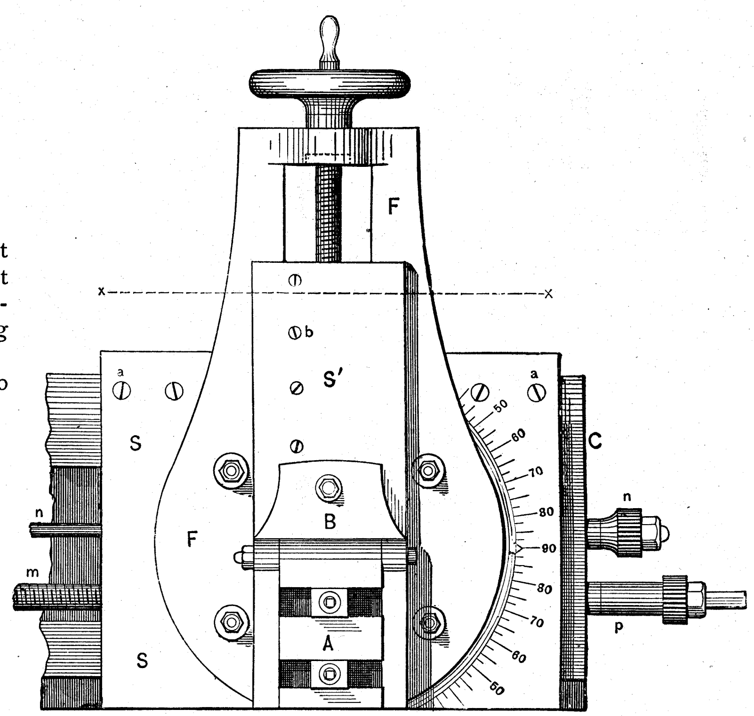


Fig. 1588.

an angle to the bed and to the cross slide, are marked on the face of the saddle, and the pointer (*f*, Fig. 1578) is fastened to the edge of the swing frame. When the swing frame is vertical the pointer is at 90° on the graduated arc, which accords with English practice generally. In American practice, however, it is customary to mark the graduations on the edge of the swing frame as in Fig. 1590, so that the pointer stands at the zero point *o* when the swing frame is vertical, and the graduations are marked on the

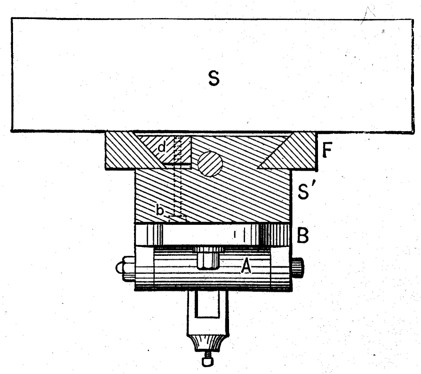


Fig. 1589.

edge of the swing frame as shown, the zero line *o* being marked on the edge of the saddle.

In the English practice the swing frame is supposed to stand in its neutral or zero position when it is vertical, and all angles are assumed to be measured from this vertical zero line, so that if the index point be set to such figure upon the graduated arc as the angle of the work is to be to a vertical line, correct results will be obtained.

Thus in Fig. 1591 (which is from *The American Machinist*) the pointer is set to 40° and the bevelled face is cut to an angle of 40° with the vertical face as marked. But if the head be graduated as in Fig. 1592, the face of the planer table being taken as the zero line *o*, then the swing frame would require to be set over to 30°

out of its normal or neutral vertical position as is shown in figure, the bevelled face being at an angle of 50° from a vertical, and 40° from a horizontal line, hence the operator requires to consider whether the number of degrees of angle are marked on the drawing from a zero line that is vertical on one that is horizontal.

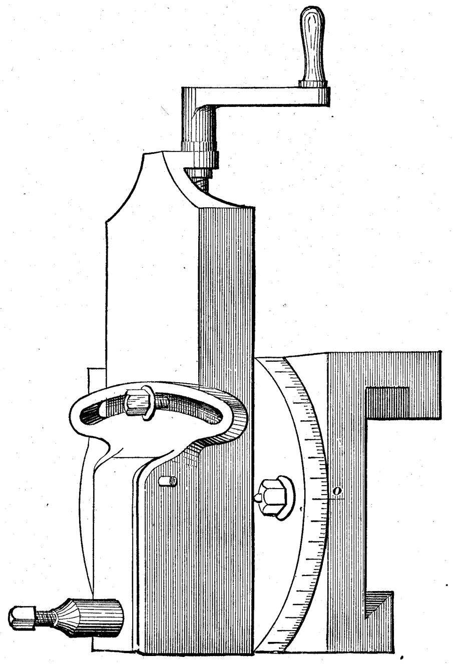


Fig. 1590.

Referring again to Fig. 1588 the slots for the tool post extend fully across the apron, so that the tool posts may be set at any required point in the tool-box width, and the tool or tool holder may be set nearer to the edge of the tool box than is the case when fixed bolts, as in Fig. 1590, are used, because these bolts come in the way.

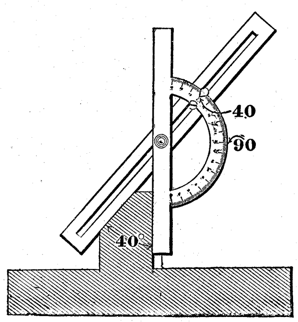


Fig. 1591.

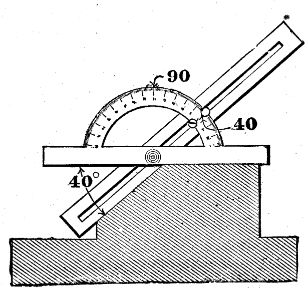


Fig. 1592.

This is mainly important when the tool is required to carry a deep vertical cut, in which case it is important to keep the tool point as close in to the holder as possible so that it may not bend and spring from the pressure of the cut.

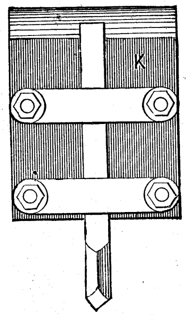


Fig. 1593.

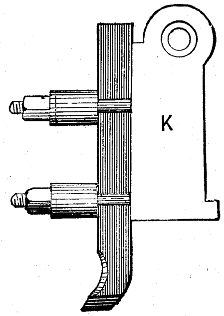


Fig. 1594.

The tool or holder may be held still closer to the edge of the head, and therefore brought still closer to the work, when the apron embraces the outside of the tool box, as was shown in Fig. 1585, and referred to in connection therewith.

A sectional side view and a top view of Fig. 1588 through the centre of the head is given in Figs. 1595 and 1596, exposing the mechanism for the self-acting feed traverse, and for the vertical feed. For the feed traverse the feed screw (*m*, Fig. 1588) passes through the feed nut N. For the vertical feed the feed rod (*n*, Fig. 1588) drives a pair of bevel-gears at P, which drives a second pair at Q, one of which is fast on a spindle which passes through

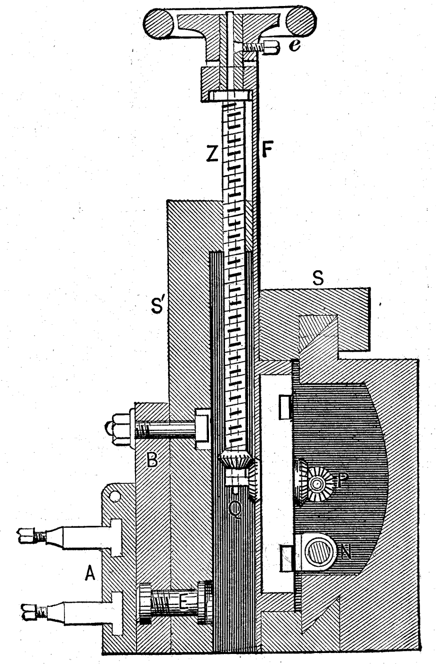


Fig. 1595.

the vertical feed screw, and is secured thereto by the set screw *e*. The object of this arrangement is that if the self-acting vertical feed should be in action and the tool or swing frame S' should meet any undue obstruction, the set screw *e* will slip and the feed would stop, thus preventing any breakage to the gears at P or Q. The feed screw is threaded into the top of S'. At E is the pin on which the tool box pivots to swing it at an angle.

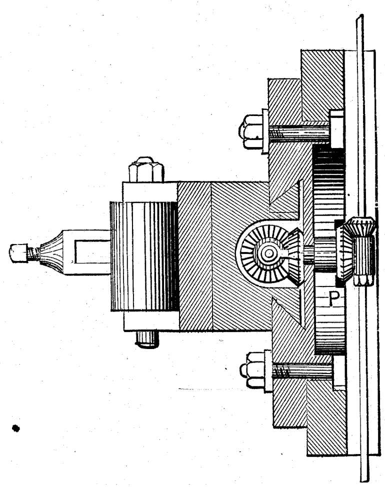


Fig. 1596.

The mechanism for actuating the cross-feed screw and the feed rod is shown in the top view, Fig. 1597, and the side view, Fig. 1598, in which A is a rod operated vertically and actuated from the stop (corresponding to stop R in Fig. 1558) that actuates the belt shifting gear. Upon A is the sleeve B, which actuates rod C, which operates the frame D. This frame is pivoted upon a stud which is secured to the cross bar C, and is secured by the nut at E. Frame D carries pawls F and G, the former of which engages gear-wheel H, which drives the pinion *n*, Fig. 1598, that is fast on the feed rod, while the latter drives the gear K, which in turn drives pinion P, which is fast upon the feed screw in Fig. 1588.

The feeds are put into or thrown out of action as follows :—On the same shaft or pin as the pawls G and F, is secured a tongue T, Fig. 1599, whose end is wedge shaped and has a correspondingly shaped seat in a plate V, whose cylindrical stem passes into a recess

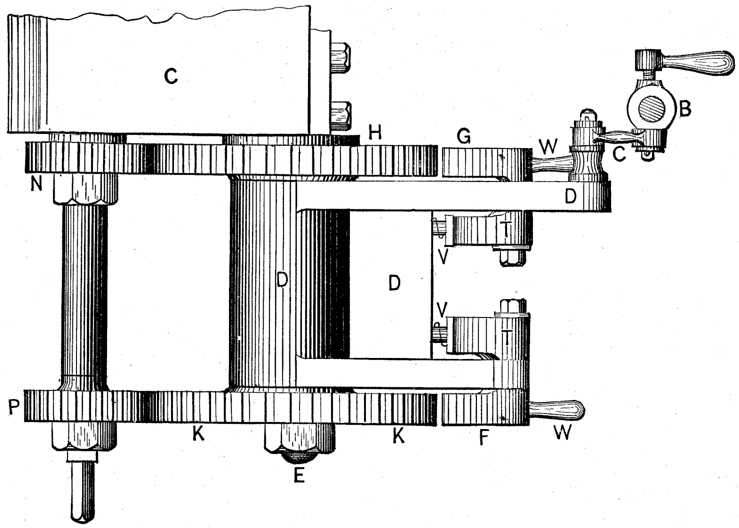


Fig. 1597.

provided in D, and is surrounded by a spiral spring which acts to force V outwards from the recess.

In the position shown in the figure the end of T is seated in the groove in V, and the pressure of the spring acts to hold T still and keep the pawl G from engaging with the teeth of gear-wheel H. But suppose the handle W (which is fast on the pawl G) is pulled upwards, and T will move downwards, disengaging from the groove in V, and the upper end of pawl G will engage with the teeth of H,

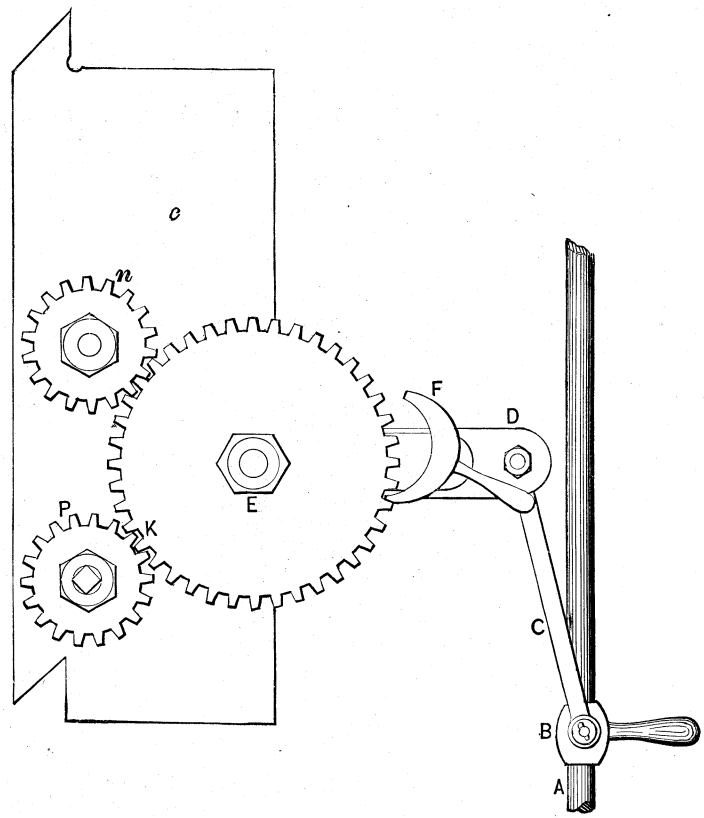


Fig. 1598.

actuating in the direction of the arrow during the upward motion of rod A, and thus actuating pinion *n* and putting the vertical feed in motion in one direction. When the rod A makes its downward stroke the pawl G will slip over the teeth of H, because there is nothing but the spiral spring to prevent the end of the pawl from slipping over these teeth. To place the vertical feed in action in the other direction, handle W is pressed downwards, causing the bottom end X of the pawl to engage with the teeth of H.

PLANER BEDS AND TABLES.—The general forms of the beds of small planers are such as in Figs. 1557 and 1558, and those of the larger sizes such as shown in Fig. 1563.

It is of the first importance that the **V**-guideways in these beds should be straight and true, and that the corresponding guides on the planer table should fit accurately to those in the bed ; for which purpose it is necessary, if the greatest attainable accuracy is to be had, that the guideways in the bed first be made correct, and those on the table then fitted, using the bed to test them by.

The angle of these guides and guideways ranges from about 60° in the smallest sizes to about 110° in the largest sizes of planers.

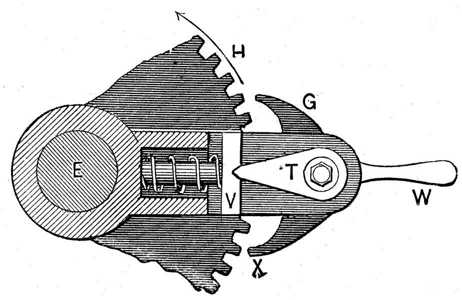


Fig. 1599.

Whatever the angle may be, however, it is essential that all the angles be exactly equal, in order that the fit of the table may not be destroyed by the wear.

In addition to this, however, it is important that each side of the guides stand at an equal height, or otherwise the table will not fit, notwithstanding that all the angles may be equal.

Suppose, for example, that in Fig. 1600 all the sides are at an equal angle, but that side *e* was planed down to the dotted line *e*, then all the weight of the table would fall on side *a*, and, moreover, the table would be liable to rock in the guideways, for whenever the combined weight of the table and the pressure of the cut was

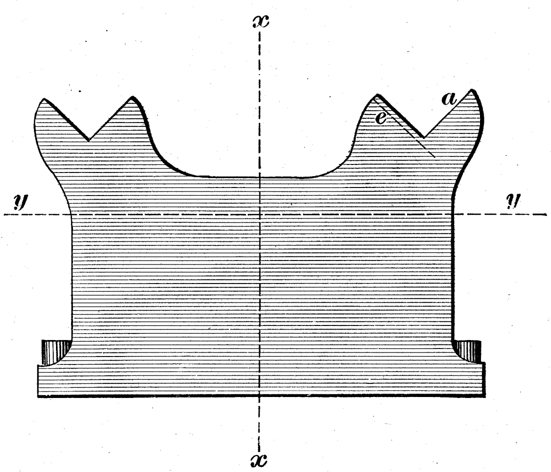


Fig. 1600.

greatest on the right-hand of the middle *x* of the table width and the feed was carried from right to left, then the table would move over, as shown exaggerated in Fig. 1601, because the weight would press guide *g* down into its guideways, and guide *h* would then rise up slightly and not fit on one side at all, while on the other side it would bear heaviest at point *p*. Great care is therefore necessary in planing and fitting these guides and ways, the processes for which are explained under the respective headings of " Examples in Planer Work," and " Erecting Planers."

In some designs the bed and table are provided with but one **V**-guideway, the other side of the table being supported on a flat side, and in yet another form the table is supported on two flat guide-ways.

Referring to the former the bearing surface of the **V** and of the flat guide must be so proportioned to that of the V that the wear will let the table down equally, or otherwise it would become out of parallel with the cross slide, and would plane the work of unequal thickness across its width.

Referring to the second, which is illustrated in Fig. 1602, it possesses several disadvantages.

Thus, if there be four gibs as at A, B, and E, F, set up by their

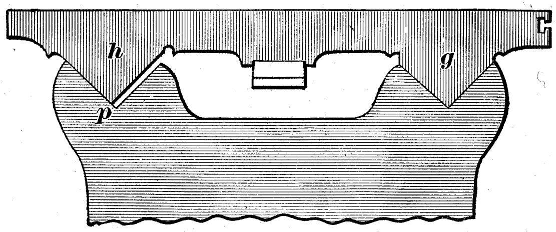


Fig. 1601.

respective set-screws, the very means provided to take up the wear affords a means of setting the bed out of line, so that the slots in the table (and, therefore, the chucks fitting to these slots) will not be in the line of motion of the table, and the work depending upon these chucks will not be true. This may be avoided by taking up the wear on two edges only, as in Fig. 1603 at A,B, but in this case

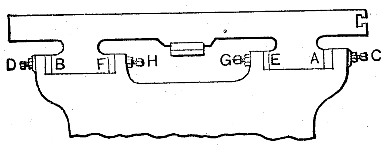


Fig. 1602.

the bearing at E and F would eventually cease by reason of the wear.

Suppose, for example, that the pressure of the tool cut tends to throw the table in the direction of arrow J, and the surfaces at A and F resist the thrust and both will wear. But when the strain on the table is in the direction of arrow K, the surfaces B, E, will

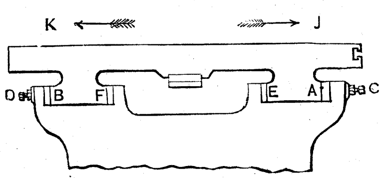


Fig. 1603.

both wear; hence while the width apart of the table slides becomes greater, the width apart of the bed slideways wears less, and the fit cannot be maintained on the inner edges of the guideways. It is furthermore to be noted that with flat guideways the table will move sideways very easily, since there is nothing but the friction of the slides to prevent it, but in the case of V-guides

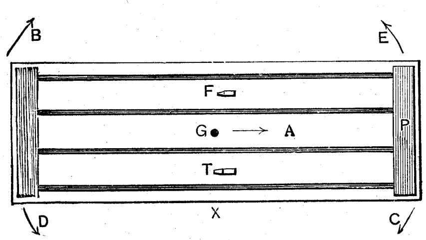


Fig. 1604.

the table must lift before it can move sideways; hence, it lies very firmly in its seat, its weight resisting any side motion.

It is found in practice that the wear of the guides and guideways in planer tables and beds is greatest at the ends, and the reason of this is as follows :—

In Fig. 1604 is a top view of a planer table, the cutting tool being assumed to be at T, and as the driving gear is at G forcing the table in the direction of the arrow A, and the resistance is at T, the tendency is to throw the table around in the direction of arrows B and C. When the tool is on the other side of the middle of the table width as at F, the tendency is to throw the table in the opposite direction as denoted by the arrows D and E, which obviously causes the most wear to be at the ends of the slides.

As the feed motions are placed on the right-hand side of the machines the operator stands on that side of the machine at X, and starts the cut from that side of the table; hence unless the work is

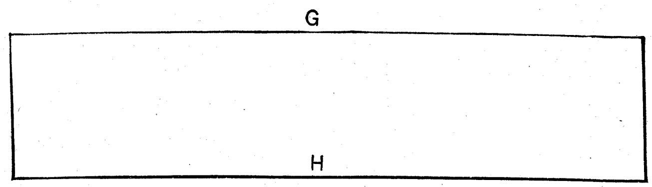


Fig. 1605.

placed in the middle of the table width, the wear will be most in the direction of arrows B and C.

The methods of fitting the guideways and guides of planer beds and tables is given in the examples of erecting.

A very good method of testing them, however, is as follows :— Suppose that we have in Fig. 1605 a plate that has been planed on both edges G, H, and that in consequence of a want of truth in the planer guideways edge G is rounding and edge H hollow, the

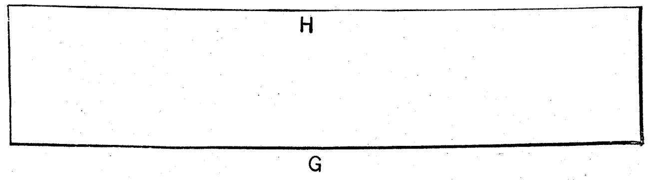


Fig. 1606.

plate being supposed to lie upon the planer table in the position in which it was planed.

Now, suppose that it be turned over on the planer, as in Fig. 1606, the rounding edge, instead of standing on the right-hand side of the planer table, will stand on the left-hand side, so that if that edge were planed again in its new position it would be made hollow instead of rounding in its length. It is obvious, therefore, that if a planed edge shows true when turned over on the planer table, the Vs of the planer are true, inasmuch as the table moves in a straight line in one direction, which is that affecting the truth of all surfaces

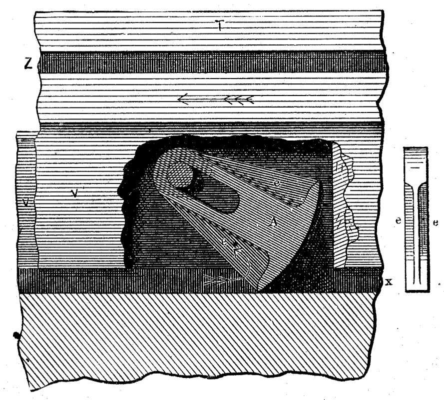


Fig. 1607.

of the work that are not parallel to the cross feed of the tool, or, what is the same thing, parallel to the surface of the planer table.

Planing Machine Tables.—In order that the guides on the table of a planer may not unduly wear, it is essential that they be kept well lubricated, which is a difficult matter when the table takes short strokes and has work upon it that takes a long time to perform, in which case it is necessary to stop the planing operations and run the work back so as to expose the guideways in the bed, so that they may be cleaned and oiled.

It will often occur that the work will not pass beneath the cross slide, and in that case it should be raised out of the ways to enable proper oiling, because insufficient lubrication frequently causes the guides and guideways to tear one another, or cut as it is commonly termed.

The means commonly employed for oiling planer **V**s or guideways are as follows :—At the top of the guideways small grooves, *g g*, Fig. 1609, are provided, and at the bottom a groove *x*. In the guides on the table there are provided pockets or slots in which are

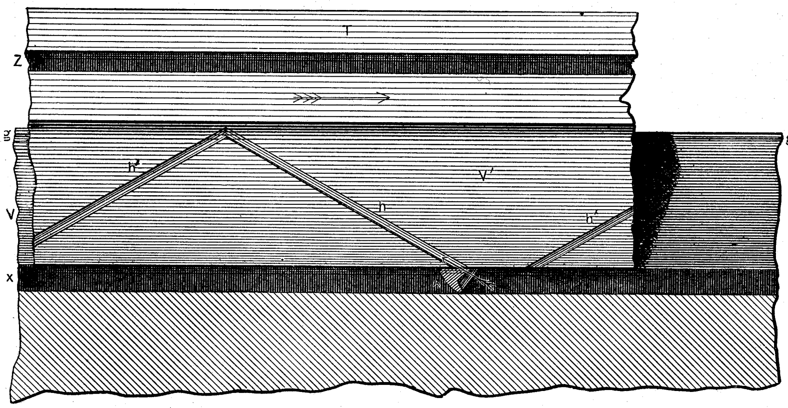


Fig. 1608.

pivoted pendulums of the form shown in Fig. 1607 at A. Each pendulum passes down to the bottom of groove *x* in which the oil lies, and is provided on each side with recesses *e*, which are also seen in the edge view on the right of the figure.

The pendulums are provided with a long slot to enable them when the table motion reverses to swing over and drag in the opposite direction (as shown in Fig. 1607) ; as they drag on the bottom of groove *x* of the bed they lift the oil it contains, which passes up

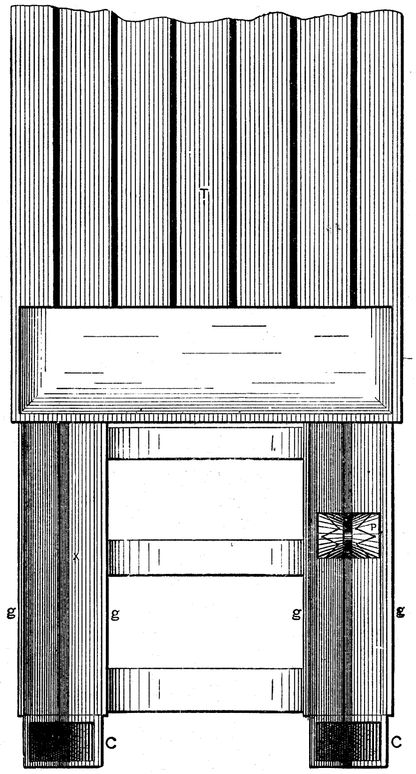


Fig. 1609.

the sides of the pendulum as denoted by the arrow, and into grooves provided on the surface of the table guide, as at *h* in Fig. 1608, in which V′ is the table guide, V the guideway in the bed, *g* oil grooves, (see sectional view, Fig. 1613), *x* the oil groove at the bottom of the bed V, and *h h* the oil grooves which receive the oil the pendulum lifts.

The oil grooves *h* on the table guide run into the grooves *g* in the **V**-guideway in the bed, hence grooves *g g* become filled with oil. But after the end of the table has passed and left the bed V exposed, the oil flows out of grooves *g* down the sides of the guideway, and constant lubrication is thus afforded at all times when the stroke of the table is sufficient to enable the pendulums to force the oil sufficiently far along oil way *h*. When the table reverses the pendulum will swing over and lift the oil up into grooves or oil ways *h*′.

Another and excellent method of oiling, also invented by Mr. Hugh Thomas, of New York, is shown in Figs. 1609 and 1610, in which P represents an oiling roll or wheel, **V**-shaped, to correspond to the shape of the **V**s. This roll is laced with cotton wick or braid, as shown by the dark zigzag lines, and is carried in a frame *f*, capable of sliding vertically in a box C, which is set in a pocket in the bed V, and contains oil. By means of a screw S, the roll P is set to touch the face of the table **V**, and the friction between the roll and the **V**, as the table traverses, rotates the roll, which carries up the oil and lubricates the table **V** over its whole surface. The dust, &c., that may get into the oil settles in the bottom of the box C, which can occasionally be cleaned out. In this case the oil is not only presented to the oil grooves (*h*, Fig. 1608), but spread out upon the **V**s ; but it is nevertheless advisable to have the grooves *h* so as to permit of an accumulation of oil that will aid in the distribution along the **V**s of the bed.

This method of oiling has been adopted in some large and heavy planers built by R. Hoe & Co., and has been found to operate admirably, keeping the guides and guideways clean, bright, and well lubricated.

Mr. Thomas has also patented a system of forced oil circulation for large planers. In this system a pump P, Fig. 1611, draws the oil from the cellars C (which are usually provided on the ends of planer beds) and delivers it through pipes passing up to the sides of the **V**s, thus affording a constant flow of oil. A reservoir at the foot of the pump enables the dirt, &c., in the oil to settle before it enters the pump, which can be operated from any desirable part of the planer mechanism. The pendulums are also used in connection with the forced circulation.

As the work is fastened to the upper face of a planing machine

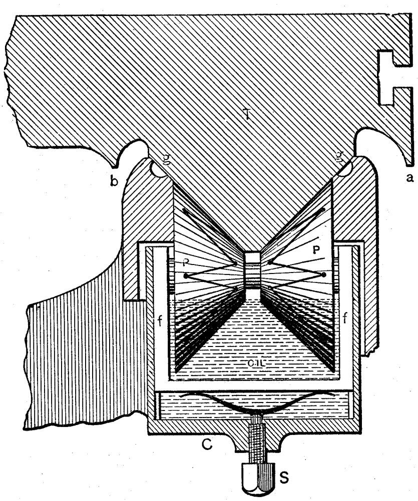


Fig. 1610.

table either directly or through the intervention of chucking devices, the table must be pierced with holes and grooves to receive bolts or other appliances by means of which the work or chuck, as the case may be, may be secured.

For receiving the heads of bolts, **T**-shaped grooves running the full length of the table are provided, and in addition there are sometimes provided short **T**-grooves, to be shown presently.

For receiving stops and other similar chucking devices, the tables are provided with either round or square holes.

In Fig. 1612 is shown a section of a table provided with **T**-grooves and rows of round holes, *a*, *b*, *c*, *d*, *e*, which pass entirely through the table, and hence must not be placed so that they will let dirt fall through to the **V**-guides or the rack. Tables with this arrangement of holes and grooves are usually used upon small planers in the United States, and sometimes to large ones also.

It is obvious that the dirt, fine cuttings, &c., will pass through the holes and may find its way to the **V**-guideways. Especially will

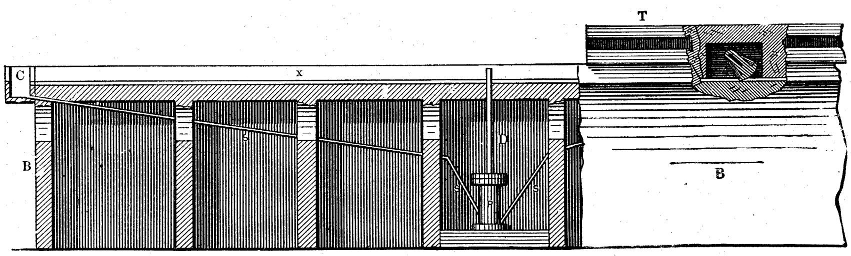


Fig. 1611.

this be the case when water is used upon the tool to take smooth cuts upon wrought iron and steel. To obviate this the construction shown in Fig. 1613 is employed.

Fig. 1613 represents a section of one guideway of a table and bed. On each side of the table **V** there is cut a groove leaving

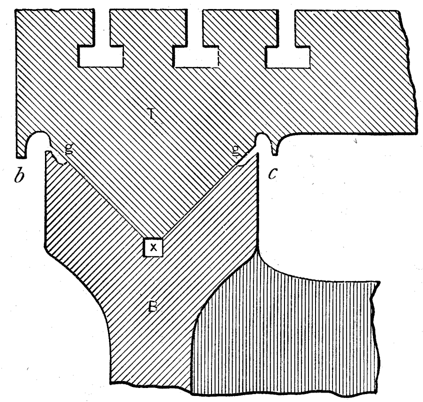


Fig. 1613.

projecting ribs *b*, *c*, and whatever water, oil, or dirt may pass through the holes (Fig. 1612), will fall off these points *b*, *c*, Fig. 1613, and thus escape the guideways, while falling dust will be excluded by the wings *b*, *c*, from the **V**s.

The capacity of a planer table may be increased by fitting thereto

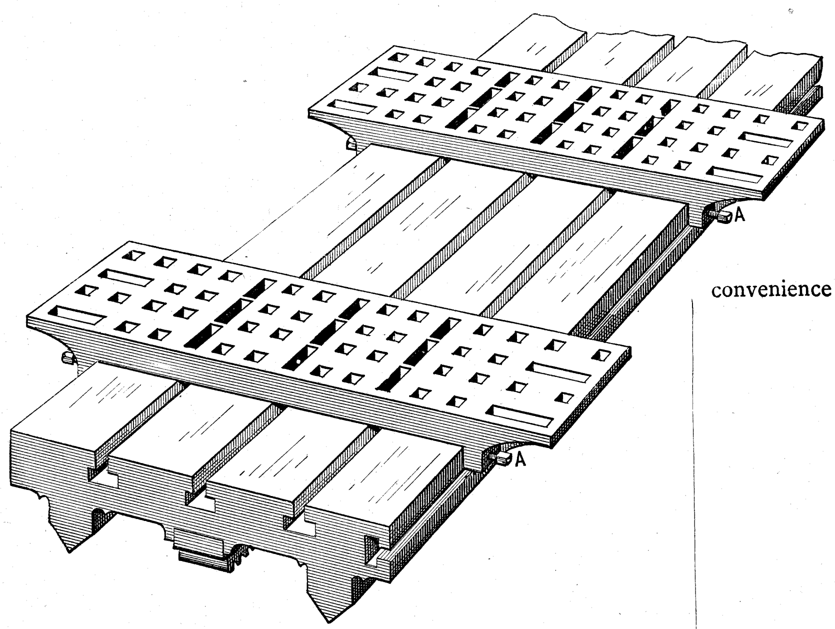


Fig. 1614.

two supplementary short tables, as shown in Fig. 1614, several applications of its use being given with reference to examples in planer work. These supplementary tables are secured to the main table by set-screws at A, and have been found of great value for a large variety of work, especially upon planing machines in which the table width is considerably less than the width between the uprights or stanchions.

Fig. 1615 represents the arrangement of square holes and **T**-

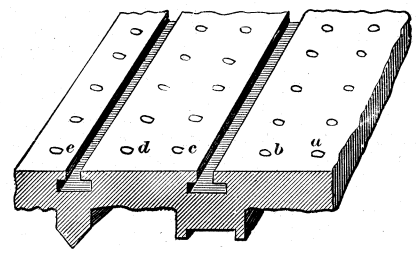


Fig. 1612.

grooves employed upon large planers. The square holes are cast in the table, and are slightly taper to receive taper plugs or stops against which the work may abut, or which may be used to wedge against, as will be hereafter described, one of these stops being shown at S in the figure.

The **T**-shaped slots *f*, *g*, *h*, are to receive the heads of bolts as

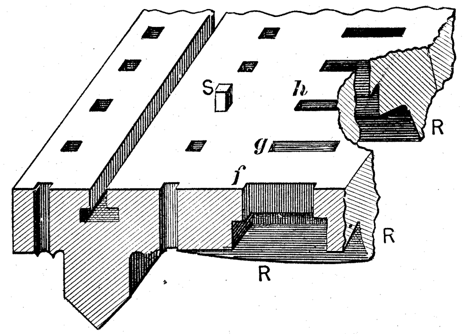


Fig. 1615.

shown in Fig. 1616. The bolt head is rounded at corners *a*, *b*, and the square under the head has the corresponding diagonal corners as *c* also rounded, so that the width of the head being slightly less than that of the slot it may be passed down in the slot and then given a quarter revolution in the direction of the arrow, causing the wings of the head to pass under the recess of the **T**-groove, as shown in Fig. 1617, which is a sectional end view of the groove with the bolt in place. The square corners at *e* and at *f* prevent the bolt from turning round more than the quarter revolution when screwing up the bolt nut, and when the nut is loosened a turn the bolt can be rotated a quarter revolution and lifted out of the groove.

Now it is obvious that these slots serve the same purpose as the longitudinal **T**-grooves, since they receive the bolt heads, and it might therefore appear that they could be dispensed with, but it is a great convenience to be able to adjust the position of the bolt across

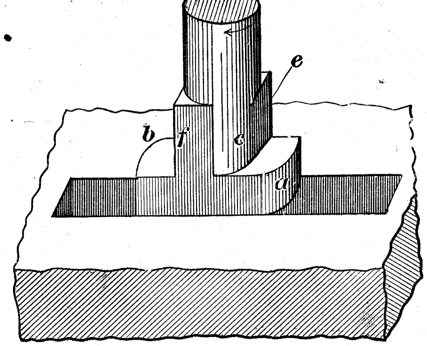


Fig. 1616.

the table width, which cannot be done if longitudinal grooves only are employed. Indeed, it might easily occur that the longitudinal grooves be covered by the work when the short transverse ones would serve to advantage, and in the wide range of work that large planers generally perform, it is desirable to give every means for disposing the bolts about the table to suit the size and shape of the work.

It is obvious that the form of bolt head shown in Fig. 1616 is

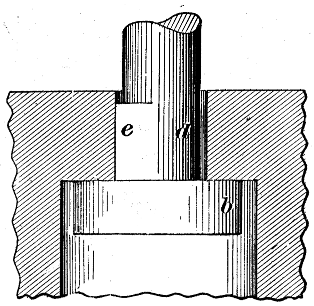


Fig. 1617.

equally applicable to the longitudinal grooves as to the cross slots, enabling the bolt to be inserted, notwithstanding that the work may cover the ends of the longitudinal slots.

The round holes *a, b, c,* &c., in Fig. 1612, are preferable to the square ones, inasmuch as they weaken the table less and are equally effective. Being drilled and reamed parallel the plugs that fit them may be passed through them to any desirable distance, whereas the square plugs being taper must be set down home in their holes,

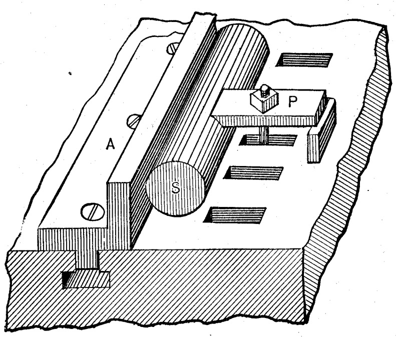


Fig. 1618.

necessitating the use of plugs of varying length, so that when in their places they may stand at varying heights from the table, and thus suit different heights of work. Whatever kind of holes are used it is obvious that they must be arranged in line both lengthways of the table and across it, so that they will not come in the way of the ribs R, which are placed beneath it to strengthen it.

The longitudinal grooves are planed out to make them straight and true with the V-guides and guideways, so that chucking appli-

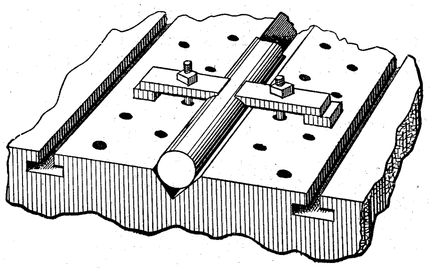


Fig. 1619.

ances fitting into the grooves may be known to be set true upon the table.

In Fig. 1618, for example, is shown an angle piece A having a projection fitting into a longitudinal groove, the screws whose heads are visible passing through A into nuts that are in the widened part of the groove, so that operating the screws secures A to the table. The vertical face of A being planed true, a piece of work, as a shaft S, may be known to be set in line with the table when it is clamped against A by clamps as at P, or by other holding devices. Angle pieces such as A are made of varying lengths and heights to suit different forms and sizes of work.

In some planing machine tables a V-groove is cut along the centre for the purpose of holding spindles to have featherways or splines cut in them, the method of chucking being shown in Fig. 1619. This, however, is not a good plan, as the bolts and plates are apt to bend the shaft out of straight, so that the groove cut in the work will not be straight when the spindle is removed from the

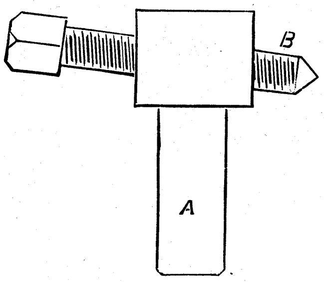


Fig. 1620.

clamp pressure. The proper method of chucking such work will, however, be given in connection with examples on planer work.

For the round holes in planer tables several kinds of plugs or stops are employed, the simplest of them being a plain cylindrical plug or stop.

Fig. 1620 represents a stop provided with a screw B. The stem A fits into the round holes, and the screw is operated to press against the work. By placing the screw at an angle, as shown, its pressure tends to force the work down upon the planer table.

A similar stop, termed a bunter screw, S, Fig. 1621, may be used

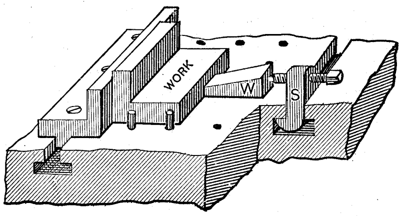


Fig. 1621.

in the longitudinal slots, the shape of its hook enabling it to be readily inserted and removed from the slot. These screws may be applied direct to the work when the circumstances will permit, or a wedge W may be interposed between the screw and the work, as shown.

Fig. 1622 represents a form of planer chuck used on the smaller sizes of planers, and commonly called planer centres. A is the base or frame bolted to the planer table at the lugs L; at B is a fixed head carrying what may be termed the live centre D, and C is a head similar to the tailstock of a lathe carrying a dead centre; F is an index plate having worm-teeth on its edge and being operated

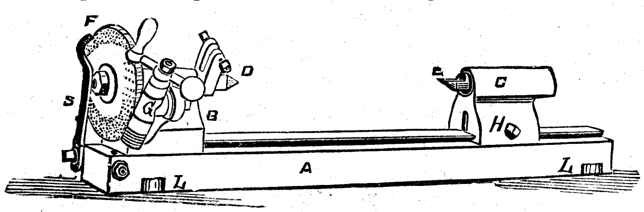


Fig. 1622.

by the worm G. At S is a spring carrying at its end the pin for the index holes. To bring this pin opposite to the requisite circle of holes, the bolt holding S to A is eased back and S moved as required. On the live centre D is a clamp for securing the work or mandrel holding dog. Head C is split as shown, and is held to the surface of A by the bolt H, which is tapped into the metal on one side of the split.

It is obvious that polygons may be planed by placing the work between the centres and rotating it by means of G after each successive side of the polygon has been planed or shaped, the number of sides being determined by the amount of rotation of the index plate.

Fig. 1623 shows a useful chuck for holding cylindrical work, such as rolls. The base is split at E, so that by means of the bolt and

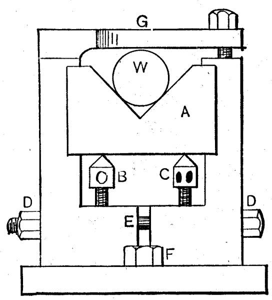


Fig. 1623.

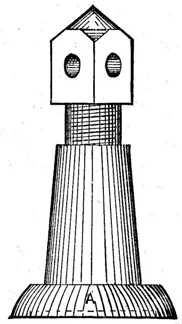


Fig. 1624.

nut D the **V**-block A may be gripped firmly; B and C are screws for adjusting the height of the **V**-block A. At F is the bolt for clamping the chuck to the planer table, and G is a cap to clamp the work W in the block A. It will be seen that this chuck can be set for taper as well as parallel work.

Fig. 1624 represents a chucking device useful for supporting or

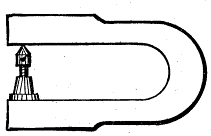


Fig. 1625.

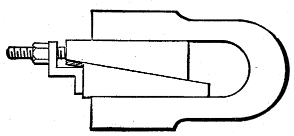


Fig. 1626.

packing up work, or for adjusting it in position ready to fasten it to the work table, it being obvious that its hollow seat at A enables it to set steadily upon the table, and that its screw affords a simple means of adjusting its height. It may also be used between the jaws of a connecting rod strap or other similar piece of work to support it, as in Fig. 1625, and prevent the jaws from springing together under the pressure of the tool cut.

Another and very useful device for this purpose is shown in Fig. 1626, consisting of a pair of inverted wedges, of which one is dovetailed into the other and having a screw to operate them endwise,

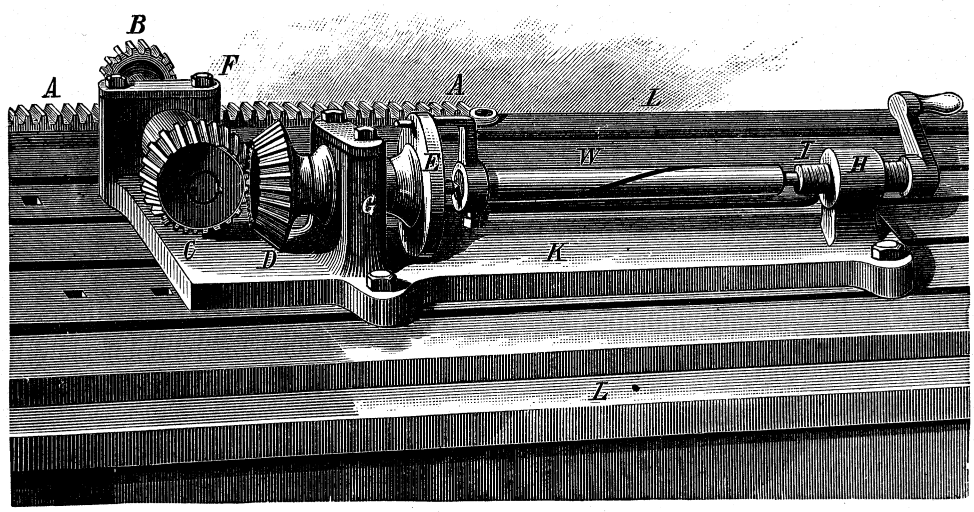


Fig. 1627.

the purpose being to hold the two jaws the proper distance apart and prevent their closure under pressure of the planer vice jaws. It is obvious that the device in Fig. 1625 is most useful for work that has not been faced between the jaws, because the device in Fig. 1626 would, upon rough work that is not true, be apt to spring the work true with the inside faces, which may not be true with the outside ones, and when the wedges were removed the jaws would spring back again, and the work performed while the inverted wedges were in place would no longer be true when they were removed.

Fig. 1627 represents a centre chuck to enable the cutting of spirals. The principle of the design is to rotate the work as it traverses, and this is accomplished as follows :—

Upon the bed of the machine alongside of the table is bolted the rack A A, into which gears the pinion B, which is fixed to the same shaft as the bevel-gear C, which meshes with the bevel-wheel D. Upon the same shaft as D is the face plate E, and in the spindle upon which D and E are fixed is a centre, so that the plate E answers to the face plate of a lathe. F is a bearing for the shaft carrying B and C, and G is a bearing carrying the spindle to which E and D are fixed. H is a standard carrying the screw and centre, shown at I, and hence answers to the tailstock of a lathe. K represents a frame or plate carrying the bearings F and G, and the standard H. L represents the table of the planing machine to which K is bolted. The reciprocating motion of the table L causes the pinion B to revolve upon the rack A A. The pinion B revolves C, which imparts

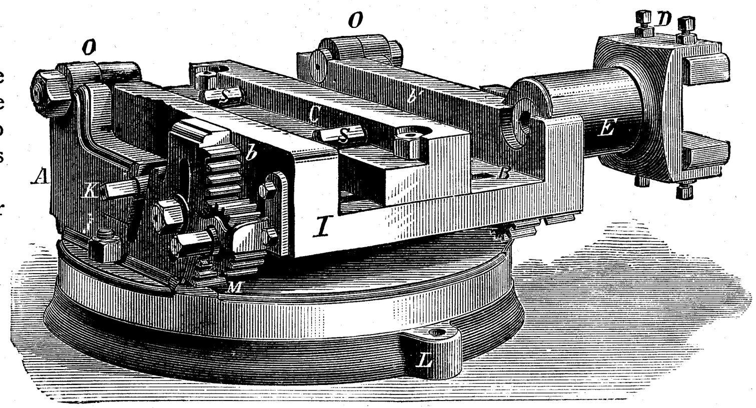


Fig. 1628.

its motion to D, and the work W being placed between the centres as shown, is revolved in unison with E, revolving in one direction when the table K is going one way, and in the other when the motion of the table is reversed; hence a tool in the tool post will cut a spiral groove in the work.

To enable the device to cut grooves of different spirals or twist, all that is necessary is to provide different sizes of wheels to take the places of C and D, so that the revolutions of E, and hence of the work W, may be increased or diminished with relation to the revolutions of B; or, what is the same thing, to a given amount of table movement, or a stud may be put in so as to enable the employment of change gears.

Figs. 1628 and 1629 represent a universal planer chuck, designed and patented by John H. Greenwood, of Columbus, Ohio, for planing concave or convex surfaces, as well as ordinary plane ones, with the cross feed of the common planer.

The base L of the chuck is bolted to the planer work table in the ordinary manner.

The work-holding frame or vice is supported, for circular surfaces, by being pivoted to the base at O, O, and by the gibbed head D, which has journal bearing at E. The work is held between the stationary jaw *b* or *b′* (at option) and the movable jaw C which may face either *b* or *b′* (by turning C round). Suppose then, that while the chuck is passing the cutting tool, end I of the work-holding frame is raised, lifting that end of the work above the horizontal level (the work-holding frame swinging at the other end on the pivots O, O), then the tool will obviously cut a convex surface. Or if end I of the work-holding frame be lowered while the cut is proceeding, the tool will cut a concave surface.

Now end I is caused to rise or lower as follows :—The head D is adjusted by means of its gibs to be a sliding fit on the bar G in Fig. 1629, which bar is rigidly fixed at P to the planer bed ; hence as the planer table and the chuck traverse, D slides along bar G. If this bar is fixed at an angle to the length of the planer head, D must travel at that same angle, causing end I of the work-holding frame to rise or lower (from O, O, as a centre of motion) as it traverses according to the direction of motion of the planer table.

Suppose that in Fig. 1629, the planer table is moving on the back or non-cutting stroke, then head D will be moving towards the point of suspension P of the bar G, and will therefore gradually lower as it proceeds, thus lowering end I of the work-holding frame and causing the curved link to pass beneath the tool with a curved motion or suppose the table to be on its cutting traverse, then head D will be raised as the table moves and the cut proceeds, and the surface cut by the tool will be concave.

Now, suppose that the bar G were fixed at an angle, with its end, that is towards the back end of the planer, inclined towards the table instead of away from it as in Fig. 1629, and then on the cutting traverse head D would cause end I (Fig. 1628) of the work-holding vice or frame to lower as the cut proceeded, and the tool would therefore plane a convex surface.

Thus the direction of the angle in which G is fixed governs whether the surface planed shall be a concave or a convex one, and it is plain that the amount of concavity or convexity will be governed and determined by the amount of angle to which G is set to the planer table.

When the chuck is not required to plane curved surfaces the bar

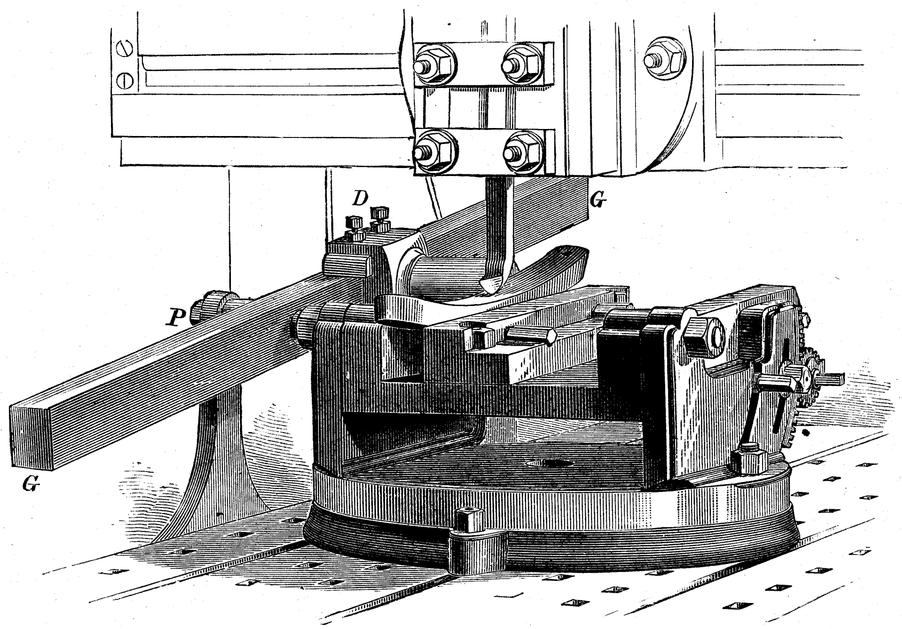


Fig. 1629.

G is altogether dispensed with, and the chuck becomes an ordinary one possessing extra facilities for planing taper work.

Thus for taper work the work-holding frame may be set out of parallel with the base of the chuck to an amount answering to the required amount of taper, being raised or lowered (as may be most convenient) at one end by means of the gears M, of which there is one on each side meshing into the segmental rack shown, the work-holding frame being secured in its adjusted position by means of a set bolt.

To set the work-holding frame parallel for parallel planing, a steady pin is employed, the frame being parallel to the base when that pin is home in its place.

The construction of the chuck is solid, and the various adjust-

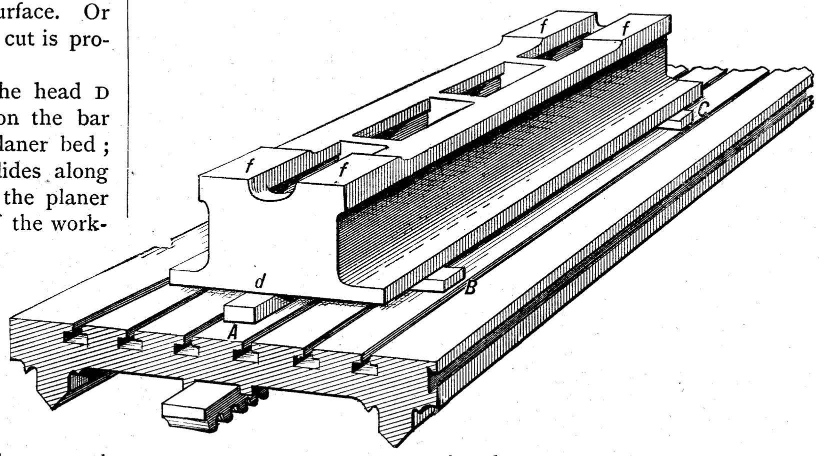


Fig. 1630.

ments may be quickly and readily made, giving to it a range of capacity and usefulness that are not possessed by the ordinary forms of planer chucks.

Planing Machine Beds.—In long castings such as lathe or planer beds, the greatest care is required in setting the work upon the planer table, because the work will twist and bend of its own weight, and may have considerable deflection and twist upon it notwithstanding that it appears to bed fair upon the table. To avoid this it is necessary to know that the casting is supported with equal pressure at each point of support. In all such work the surface that is to rest upon the foundation or legs should be planed first.

Thus supposing the casting in Fig. 1630 to represent a lathe shears, the surfaces *f* whereon the lathe legs are to be bolted should be planed first, the method of chucking being as follows :—

The bed is balanced by two wedges A, in Fig. 1630, one being placed at each end of the bed, and the position of the wedges being adjusted so that it lies level. A line coincident with the face of the bed (as face *d*) is then drawn across the upper face of each wedge. Wedges (as B, C,) are then put in on each side of the bed until they each just meet the bed,

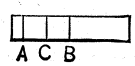


Fig. 1631.

and a line coincident with the bed surface is drawn across their upper surfaces. Wedge B is then driven in until it relieves A of the weight of the bed, and a second line is drawn across its upper face. It is then withdrawn to the first line, and the wedge on the opposite side of the bed is driven in until A is relieved of the weight, when a second line is drawn on this wedge's face. The wedges at the other end (as C) are then similarly driven in and withdrawn, being also marked with two lines, and then the four wedges (B, C, and the two corresponding ones on the opposite side of the bed) are withdrawn, having upon their surfaces two lines each (as A, B, in Fig. 1631). Midway between these two lines a third (as C) is drawn, and all four wedges are then driven in until line C is coincident with the bed surface, when it may be assumed that the bed is supported equally at all the four points. When the bed is turned over, surfaces *f* may lie on the table surface without any packing whatever, as they will be true.

Another excellent method is to balance the bed on three points, two at one end and one at the other, and to then pack it up equally at all four corners.

To test if the surface of a piece of such work has been planed straight, the following plan may be pursued :—

Suppose that surface E, Fig. 1632, is to be tested, it having been planed in the position it occupies in the figure, and the casting may be turned over so that face E stands vertical, as in Fig. 1632, and a tool may be put in the tool post of the planer, the bed being adjusted on the planer table so that the tool point will just touch the surface at each end of the bed. The planer table is then run so that the tool point may be tried with the middle of the bed length, when, if the face E is true, it will just meet the tool point at the middle of its length as well as at the ends.

In the planing of the V-guides and guideways of a bed for a machine tool, such as, for example, a planer bed and table, the greatest of care is necessary, the process being as follows :—

Beginning with the bed it has been shown in Fig. 1601 that the sides of the guideways must all be of the same height as well as at the same angle, and an excellent method of testing this point is as follows :—

In Fig. 1633 is shown at A a male gauge for testing the V-guideways in the bed, and at B a female gauge for testing those on the table. These two gauges are accurately made to the correct angle and width, and fitted together as true as they can be made, being corrected as long as any error can be found, either by testing one with the other or by the application of a surface plate to each separate face of the guides and guideways. The surfaces C and D of the respective gauges are made parallel with the V-surfaces, a point that is of importance, as will be seen hereafter. It is obvious that the female gauge B is turned upside down when tried upon the table.

Suppose it is required to test the sides *e*, *f*, of the bed guideways in Fig. 1634, and the gauge must be pulled over in the direction of the arrow so that it touches those two sides only ; a spirit-level laid upon the top of the gauge will then show whether the two faces *e*, *f*, are of equal height. It is obvious that to test the other two faces the gauge must be pulled over in the opposite direction.

This test must be applied while fitting the Vs to the gauge. Suppose, for example, that when the gauge is applied and allowed to seat itself in the ways, the two outside angles *e*, *g*, are found to bear while the two inside ones do not touch the gauge at all, then by this test it can be found whether the correction should be made by taking a cut off *e* or off *g*, for if the spirit-level stood level when the gauge was pulled in either direction, then both faces would require to be operated upon equally, but suppose that the gauge and spirit-level applied as shown proved end *e* to be high, then it would be the one to be operated on, or if when the gauge was pulled over in the opposite direction end *g* was shown (by the spirit-level) to be high, then it would be the one to be operated upon.

By careful operation the table and bed may thus be made to fit more perfectly than is possible by any other method. To test the fit of the gauge to the Vs it is a good plan to make a light chalk mark down each V and to then apply the gauge, letting it seat itself and moving it back and forth endways, when if it is a proper fit it will rub the chalk mark entirely out. It may be noted, however, that a light touch of red marking is probably better than chalk for this purpose.

It is of importance that the Vs be planed as smooth as possible, and to enable this a stiff tool holder holding a short tool, as in Fig. 1635 should be used, the holder being held close up to the tool box as shown. It will be obvious that when the head is set over to an angle it should be moved along the cross slide to plane the corresponding angle on the other side of the bed.

Fig. 1636 represents a planer chuck by Mr. Hugh Thomas. The angle piece A is made to stand at an angle, as shown, for cylindrical work, such as shafts, so that the work will be held firmly down upon the table. The base plate B has ratchet teeth at each end C, into which mesh the pawls D, and has slotted holes for the bolts which hold it down to the table, so that it has a certain range of movement to or from the angle piece A, and may therefore be adjusted to suit the diameter or width of the work.

The movable jaw E is set up by the set-screw F and is held down by the bolts shown. The pawls D are constructed as shown in Fig. 1637, the pin or stem S fitting the holes in the planer table and the tongue P being pivoted to the body R of the pawl. As the pawls can be moved into any of the holes in the table, the base plate B may be set at an angle, enabling the chuck to be used for taper as well as for parallel work, while the chuck has a wide range of capacity.

In Fig. 1614 is shown a supplementary table for increasing the capacity of planer tables, and which has already been referred to, and Fig. 1638 represents an application of the table as a chucking device. A, A, &c., are frames whose upper surfaces are to be planed. An angle plate is bolted to the planer table and the supplementary

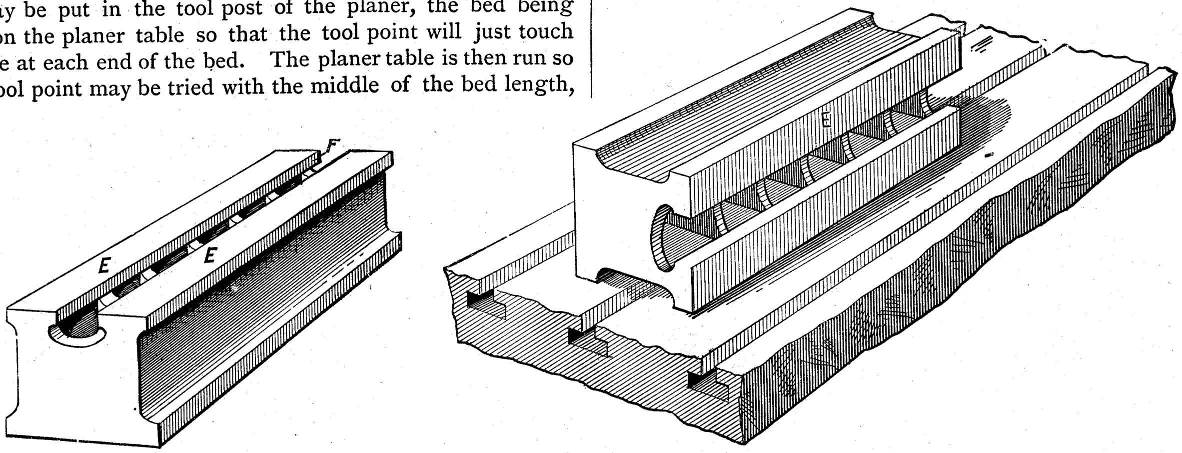


Fig. 632.

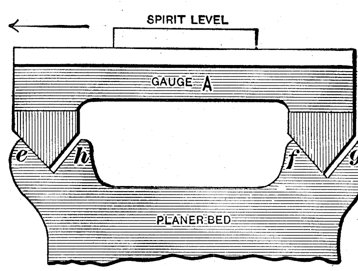


Fig. 1634.

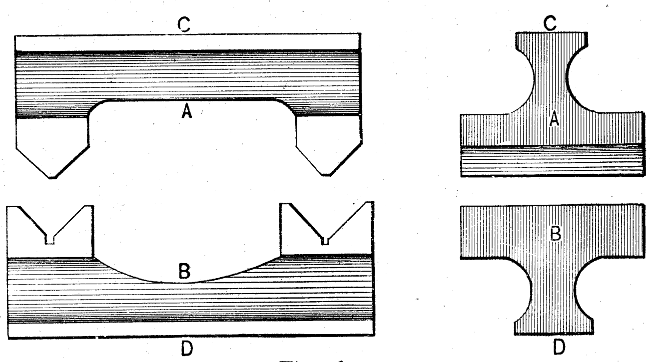


Fig. 1633.

table is bolted to the angle plate. The first frame is set against the vertical face of the supplementary table, and the remaining ones

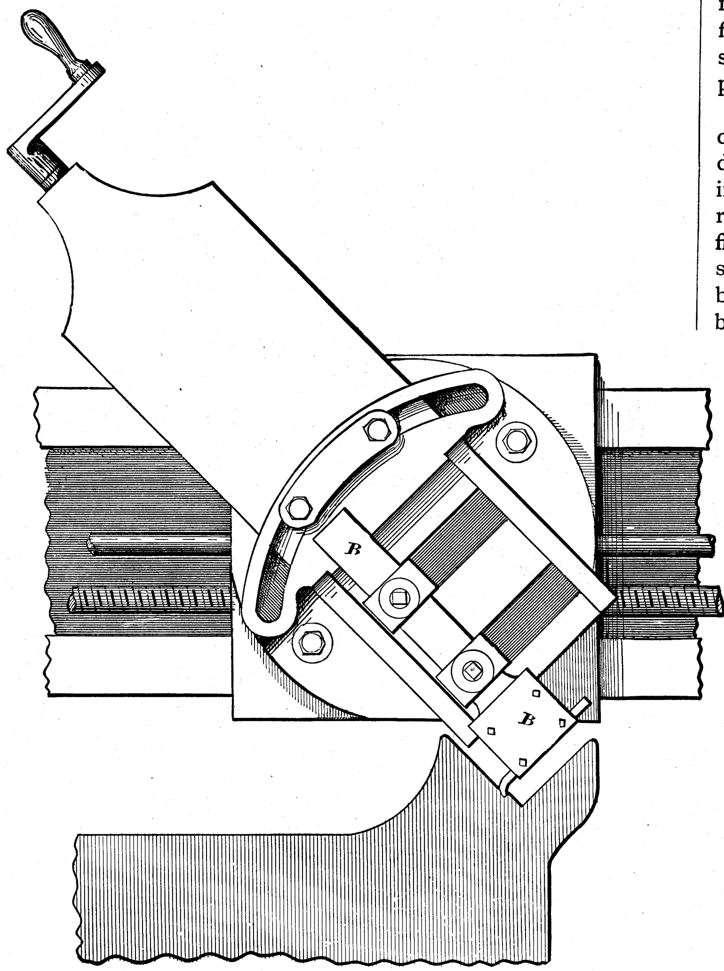


Fig. 1635.

set as near as possible, B, B, &c., being small blocks placed between the frames which are bolted to the planer table as at C.

In many cases this method of chucking possesses great advantages. Thus in the figure there are six frames to be planed, and as they would be too long to be set down upon the planer table, only three or four could be done at a time, and a good deal of measuring and trying would be necessary in order to get the second lot like the first. This can all be avoided by chucking the whole six at once, as in figure.

Another application of the same tables as useful chucking devices is shown in Fig. 1639, where two frames E, F, are shown bolted to the machine table and supported by the supplementary tables T, which are bolted to the main table and supported by angle-pieces *b*, *b*. Work that stands high up from the planer table may be very effectively steadied in this way, enabling heavier cuts and coarser feeds while producing smoother work.

As horizontal surfaces can be planed very much quicker than vertical ones, it frequently occurs that it will pay to take extra trouble in order to chuck the work so as to plane it horizontally, an excellent example being the planing of the faces of the two halves of a large pulley, the chucking of which is illustrated in Fig. 1640.

Four pieces, as at A, are made to engage the rims of the two halves of the pulley and hold them true, one with the other. The two plates T′ and T″ are set under the pulley halves to level the upper faces, and wooden clamps C, C, are bolted up to hold the pulleys together at the top, W representing wedges between the hubs. S represents supports to block up the pulley near its upper face, and at P are clamps to hold the two halves to the table. It is found that by this method of chucking more than half the time is saved, and the work is made truer than it is possible to get it by planing each half separately and laying them down on the table.

Supplemental tables may also be made in two parts, the upper one being capable of swiveling as in Fig. 1641, the swiveling device corresponding to that shown for the Thomas shaper chuck in Fig. 1530. This enables the work to be operated upon on several different faces without being released from the chuck. Thus in figure the segment could be planed on one edge and the upper table swiveled to bring the other edge in true with the table, which would be a great advantage, especially if the face it is chucked by has not been trued.

Figs. 1642 and 1643 show other applications of the same swiveling device.

It is obvious that the chuck shown in Fig. 1636 can be mounted on a supplemental and swiveling table as shown in Fig. 1644, thus greatly facilitating the chucking of the work and facilitating the means of presenting different surfaces or parts of the work to the tool without requiring to unchuck it. The pawls, also, may in heavy work have two pins to enter the work-table holes and be connected by a strap as in Fig. 1645.

In the exigencies of the general machine shop it sometimes happens that it is required to plane a piece that is too wide to pass between the uprights of the planing machine, in which case one standard or upright may be taken down and the cross slide bolted to the other, as in Fig. 1646, the blocks *a*, *a*, being necessary on account of the arched form of the back of the cross slide. In the example given the plates to be planed were nearly twice as wide as the planer table and were chucked as shown, the beam D resting on blocks E, F, and forming a pathway for the piece C, which was provided with rollers at each end so as to move easily upon D. The outer end of the plate was clamped between B and C, and the work was found to be easily and rapidly done. In this chucking, however, it is of importance that beam D be carefully levelled to stand parallel with the planer table face, while its height must be so adjusted that it does not act to cant or tilt the table sideways as that would cause one **V** of the planer ways to carry all or most of the weight, and be liable to cause it to cut and abrade the slide surfaces.

CUTTING TOOLS FOR SHAPING AND PLANING MACHINES.—All the cutting tools forged to finished shape from rectangular bar steel, and described in connection with lathe work, are used in the planer and in the shaper, and the principles governing the rake of the top face remain the same. But in the matter of the clearance

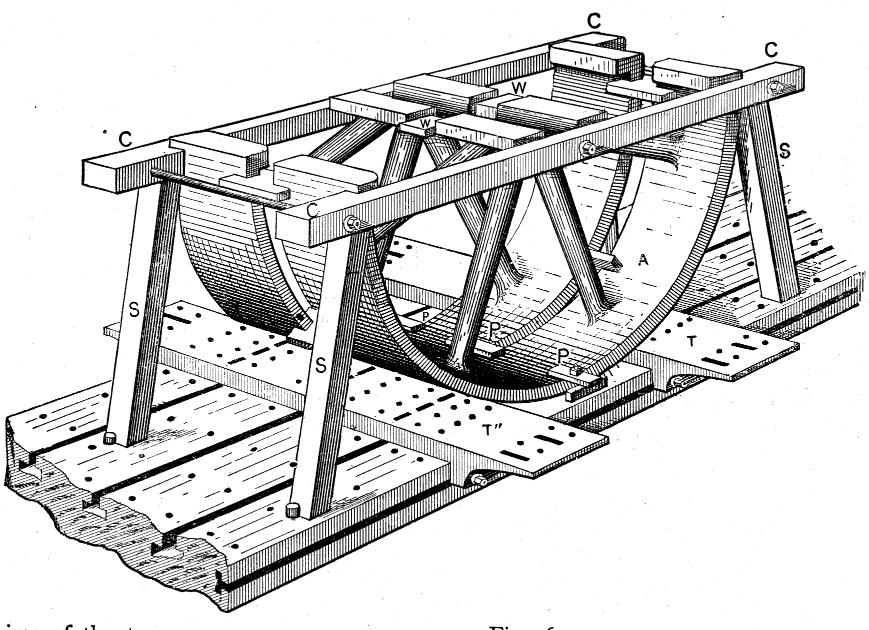


Fig. 1640.

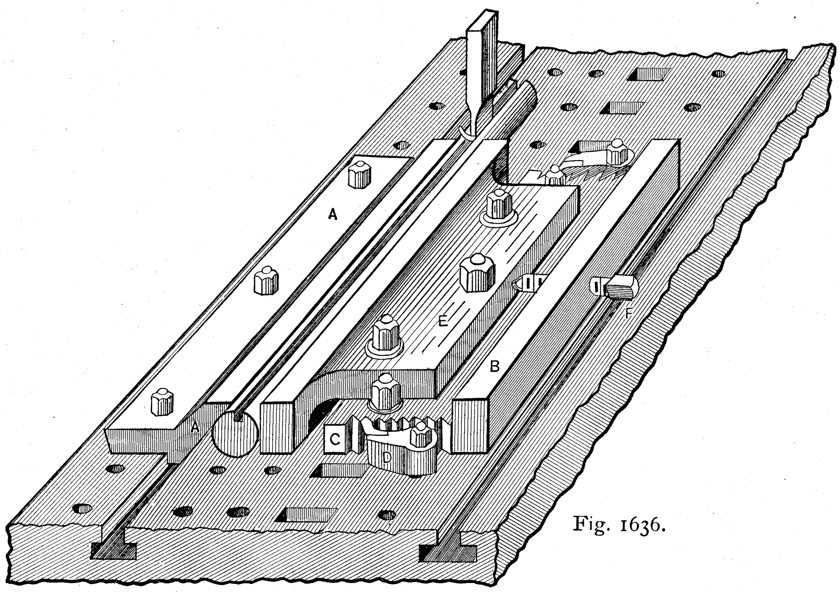


Fig. 1636.

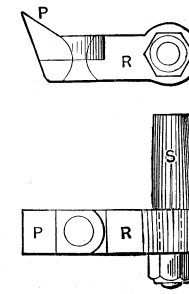


Fig. 1637.

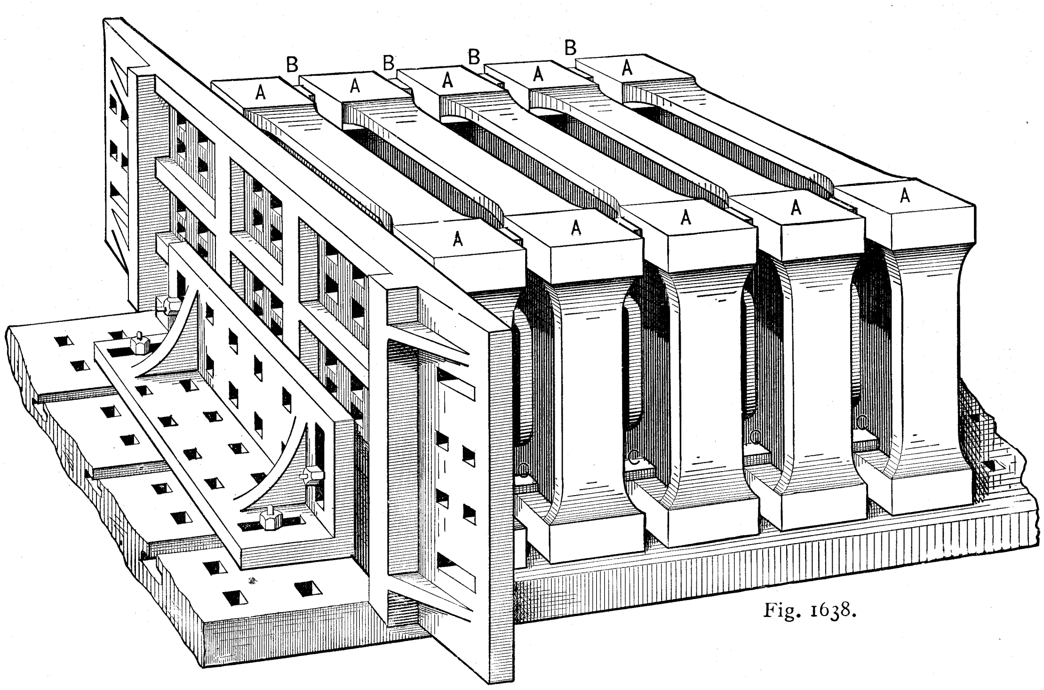


Fig. 1638.

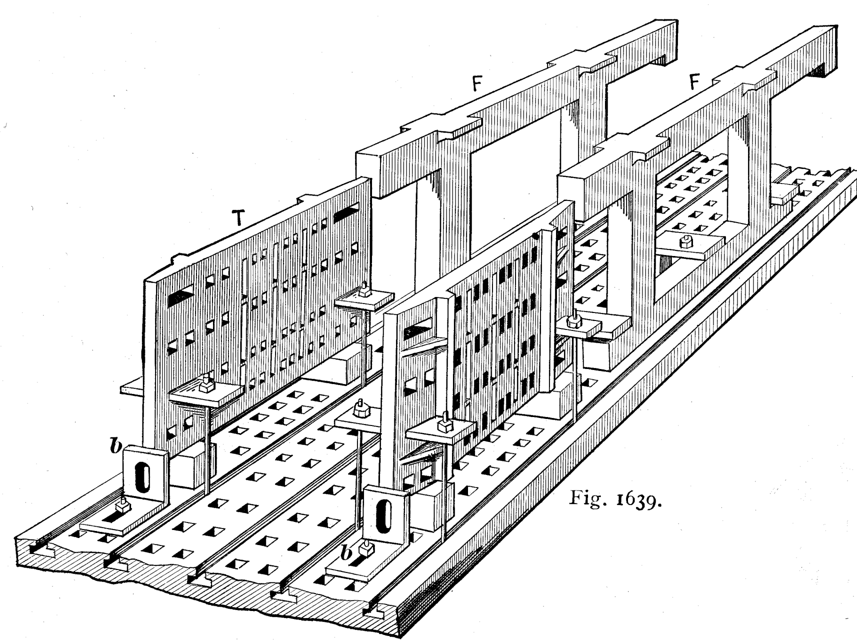


Fig. 1639.

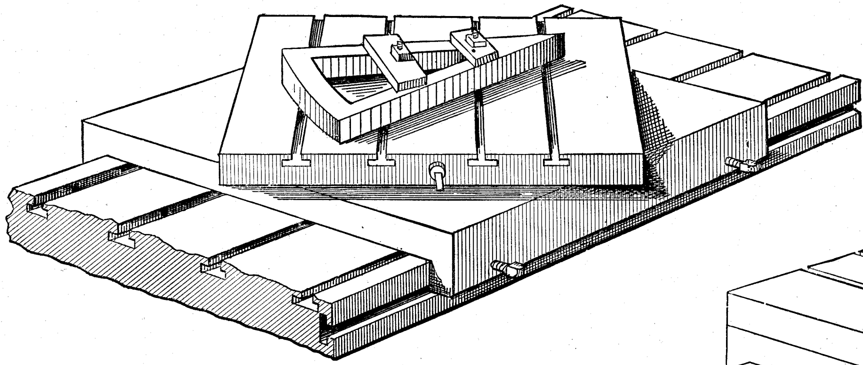


Fig. 1641.

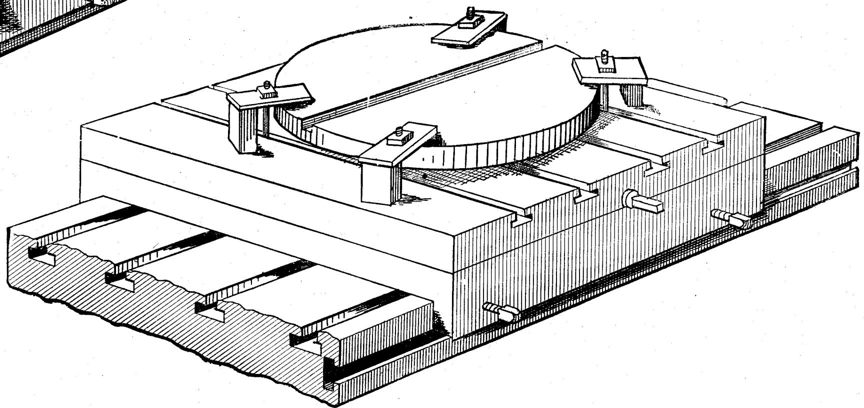


Fig. 1642.

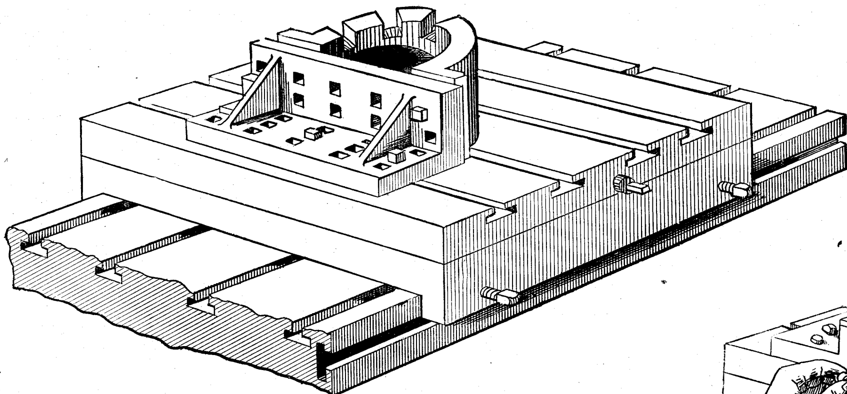


Fig. 1643.

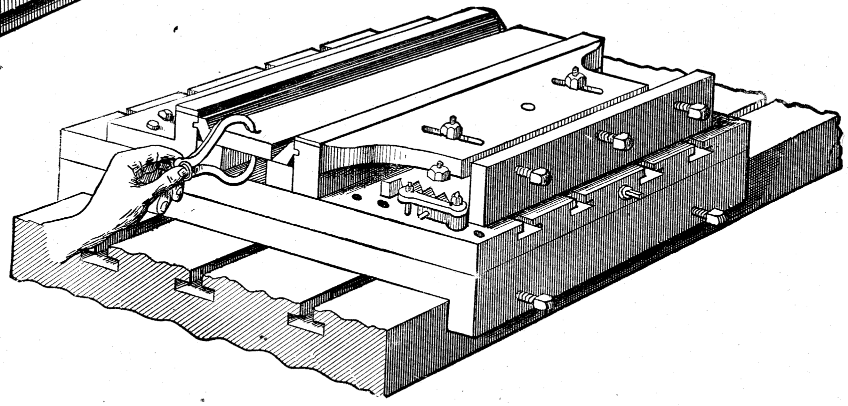


Fig. 1644.

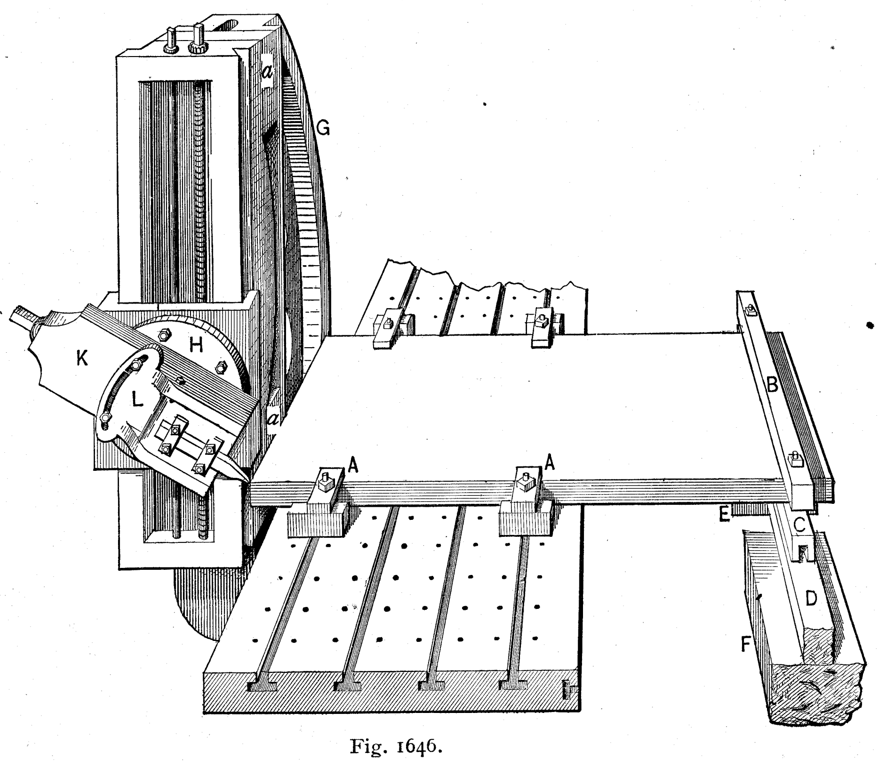


Fig. 1646.

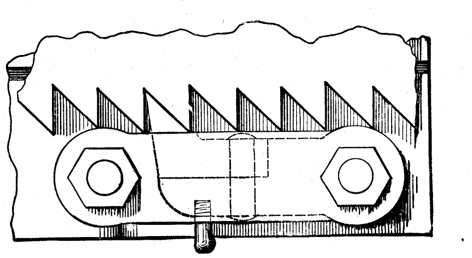


Fig. 1645.

there is the difference that in a planing tool it may be made constant, because the tool feeds to its cut after having left the work surface at the end of the back stroke, hence the clearance remains the same whatever the amount or rate of feed may be.

On this account it is desirable to use a gauge as a guide to grind

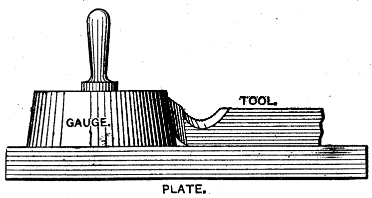


Fig. 1647.

the tool by, the application of such a gauge being shown in Fig. 1647. It consists of a disk turned to the requisite taper and laid upon a plate, whereon the tool also may be laid to test it. The tool should not be given more than 10° of clearance, unless in the case of broad flat-nosed tools for finishing, for which 5° are sufficient.

The principle of pulling rather than pushing the tool to its cut,

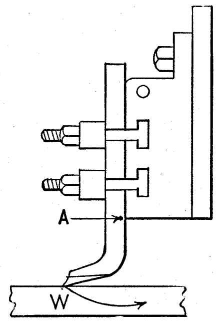


Fig. 1648.

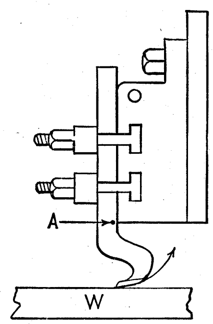


Fig. 1649.

can, however, be more readily and advantageously carried out in planer than in lathe tools, because the spring of the tool and of the head carrying it only need be considered, the position of the tool with relation to the work being otherwise immaterial. As a consequence it is not unusual to forge the tools to the end of pulling, rather than of pushing the cutting edge.

In Figs. 1648 and 1649, for example, are two tools, W representing

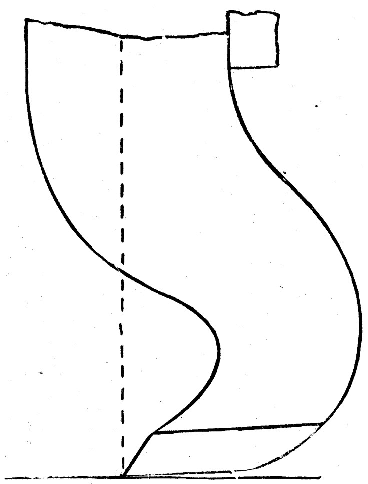


Fig. 1650.

the work, and A the points off which the respective tools will spring in consequence of the pressure; hence the respective arrows denote the direction of the tool spring. As a result of this spring it is obvious the tool in Fig. 1648 will dip deeper into the work when the pressure of the cut increases, as it will from any increase of the depth of the cut in roughing out the work, or from any seams or hard places in the metal during the finishing cut. On the other hand, however, this deflection or spring will have the effect of releasing the cutting edge of the tool from contact with the work surface during the back stroke, thus rendering it unnecessary to lift the tool to prevent the abrasion, on its back stroke, from dulling its cutting edge.

It will be noted that the radius from the point of support A is less for the tool in Fig. 1649 than for that in Fig. 1648, although both tools are at an equal height from the work, which enables that in Fig. 1649 to operate more firmly. In these two figures the extremes of the two systems are shown, but a compromise between the two is shown in Fig. 1650, the cutting edge coming even with the centre

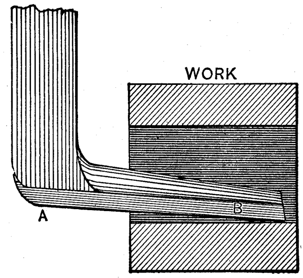


Fig. 1651.

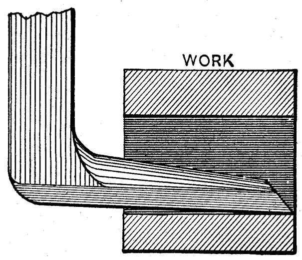


Fig. 1652.

of the body of the steel, which makes the tool easier to forge and grind, and keeps the cutting edge in plainer view when at work, while avoiding the evils attending the shape shown in Fig. 1648.

It is sometimes necessary, however, that a tool of the form in Fig. 1652 be used, as, for example, to shape out the surface of a slot, and when this is the case the tool should be shaped as in Fig. 1651, the bottom face having ample clearance (as, say, 15°) from the heel A to about the point B, and about 3° from B to the front end. The front face should have little or no clearance, because it causes the tool to dig into the work. A tool so shaped will clear itself well on the back stroke, whereas if but little clearance and front rake be given as in Fig. 1652, the tool will not only dig in, but its cutting edge will rub on the back or return stroke.

For broad feed finishing cuts the shape of tool shown in Fig. 1653 is employed, the cutting edge near the two corners being eased off very slightly with the oilstone. The amount of clearance should be

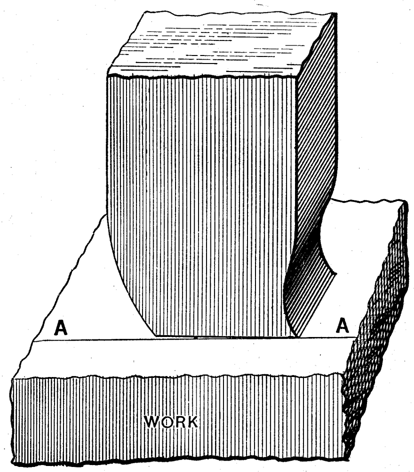


Fig. 1653.

very slight indeed, only just enough to enable the tool to cut as is shown in the figure, by the line A A. The amount of front rake may be varied to suit the nature and hardness of the metal, and the tool should be held as close in as possible to the tool clamp.

Smoother work may be obtained in shaping and in planing machine tools when the tool is carried in a holder, such as in Fig. 1654, which is taken from *The American Machinist* because in this case any spring or deflection either in the tool or in the shaper head acts to cause the tool to relieve itself of the cut instead of digging in, as would be the case were the tool put in front of the tool post as in Fig. 1654. In finishing large curves this is of great importance, because to obtain true and smooth curves it is necessary to shape the tool to cut upon the whole of the curve at once, and this gives so great a length of cutting edge, that the tool is sure to chatter if held in front of the tool post.

It is essential, therefore, to carry the tool at the back of the tool post as shown, and for curves that are arcs of circles tools

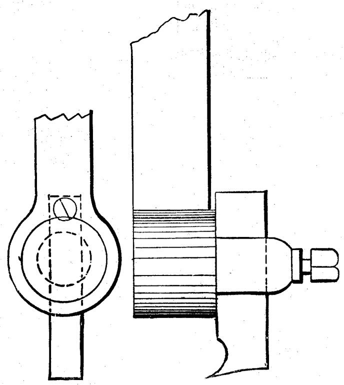


Fig. 1654.

such as in Fig. 1655 may be employed, or a circular disk will answer, possessing the advantage that its shape may be maintained by grinding its flat face to resharpen it.

Cutters of the kind shown in Fig. 1655 may be made to possess several important advantages aside from their smooth action: thus they may be made after the principle explained with reference to the Brown & Sharpe rotary cutters for gear-teeth, in which case the front face only need be ground to resharpen them, and their shapes will remain unaltered, and they may be given different degrees of front rake by placing packing between one side and the holder, and any number of different shaped cutters may be fitted to the same stock.

Tool Holders for Planing Machines.—The advantages of tool holders for planing machines are equally as great as those already described for lathes, but as applied to planing machines

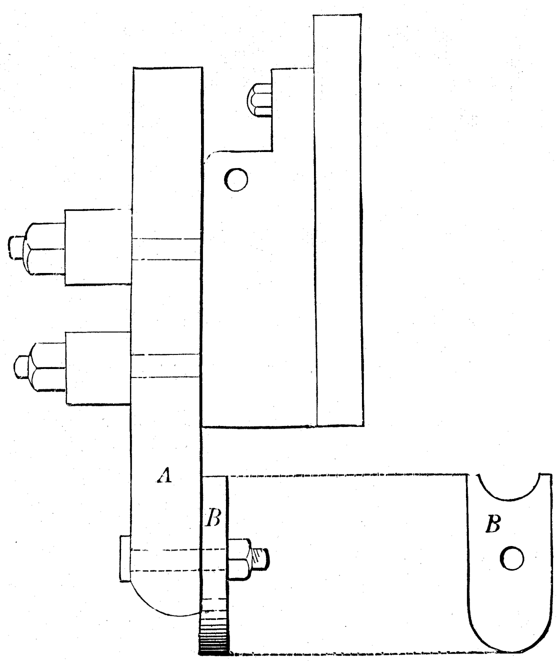


Fig. 1655.

there is the additional advantage that the clearance necessary on the tool is less variable for planer work than for lathe work, because in lathe work the diameter of the work as well as the rate of tool feed affects the tool clearance, whereas in planer work the tool feed is put on before the tool begins its cutting action; hence the degree of clearance is neither affected by the size of the work nor by the rate of feed, and as a result the tools may be given a definite and constant amount of clearance.

Fig. 1656 represents a planer tool holder (by Messrs. Smith & Coventry), in which what is, in effect, a swivel tool post is attached to the end of the holder, thus enabling the tool to be used on either the right or left-hand of the holder at will. The shape of the tool steel is shown in section on the right-hand of the engraving, being

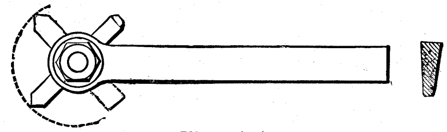


Fig. 1656.

narrow at the bottom, which enables the tool to be very firmly held and reduces the area to be ground in sharpening the tool. A side and end view of the holder is shown in Fig. 1657, in which it is seen that the tool may be given top rake or angle to render it suitable for wrought iron or steel or may be set level for brass work.

In Fig. 1658 the tool and holder are shown in position on the

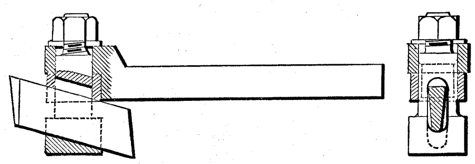


Fig. 1657.

planer head, the front rake on the tool being that suitable for wrought iron.

It is to be noted, however, that the amount of front rake should, to obtain the best results, be less for steel than for wrought iron, and less for cast iron than for wrought, while for brass there should be none; hence the tool post should be made to accomplish these

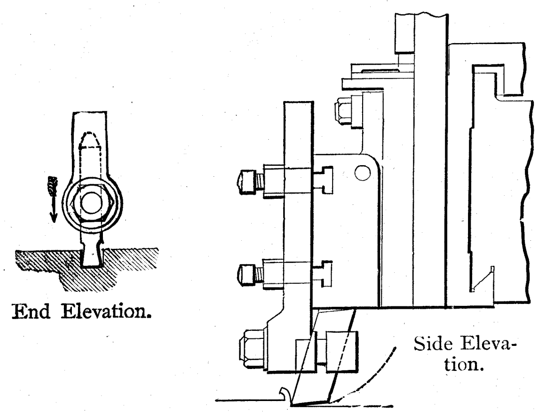


Fig. 1658.

different degrees of rake in order to capacitate such holders for the four above-named metals. It is an advantage, however, that by inclining the tool to give the top rake, this rake may be kept constant by grinding the end only of the tool to sharpen it, and as the end may be ground to a gauge it is very easy to maintain a constant shape of tool. Furthermore as the tool is held by one

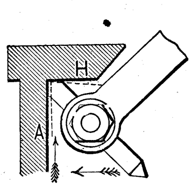


Fig. 1659.

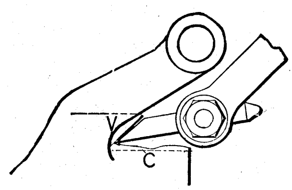


Fig. 1660.

binding screw only, it may be more readily adjusted in position for the work than is the case when the two apron clamp nuts require to be operated.

Figs. 1659 to 1661, show this tool-holder applied to various kinds of work, thus in Fig. 1659 the tool is planing under the underneath side of a lathe bed flange, while in Fig. 1660 it is acting upon a **V**-slideway and escaping an overhanging arm, and in Fig. 1661 it is shown operating on a **V**-slideway and in a **T**-groove.

Fig. 1662 represents a tool holder by Messrs. Bental Brothers, the tool being held in a swivelled tool post, so that it may be used

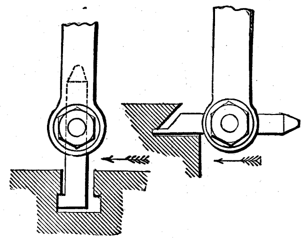


Fig. 1661.

as a right or left-hand tool. In this case the front rake must be forged or ground on the tool, and there is the further objection common to many tool holders, that the tool if held close in to the tool post is partly hidden from view, thus increasing the difficulty of setting it to the depth of cut.

Another form of planer or shaper tool-holder is shown in Fig.

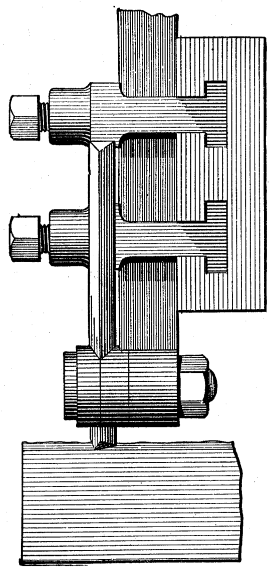


Fig. 1662.

1663, in which a tool post is mounted on a tool bar, and may be used as a right or left-hand tool at will.

Fig. 1664 represents a tool holder in which two tools may be held as shown, or a single tool right-hand or left-hand as may be

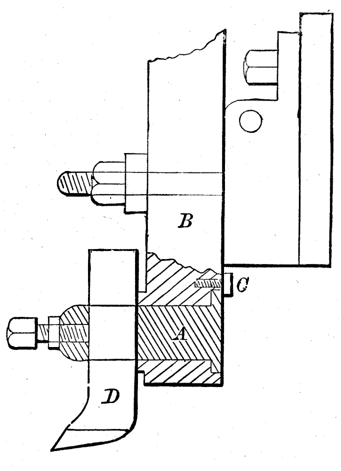


Fig. 1663.

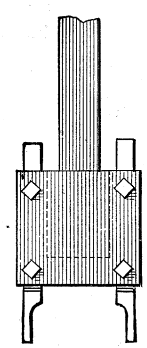


Fig. 1664.

required, or the tool may be held at the end of the holder as in Fig. 1665. The advantage of such a holder is well illustrated in the case of cutting out a **T**-shaped groove, because with such a holder a straight tool can be used for the first cuts, its position being shown in Fig. 1665, whereas in the absence of such a holder a tool bent as in Fig. 1666 would require to be used, this bend giving extra trouble in the forging, rendering the tool unfit for

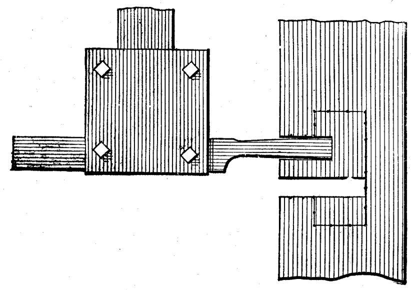


Fig. 1665.

ordinary plain work, and being unable to carry so heavy a cut or to cut so smooth as the straight tool in Fig. 1665. In cutting out the widest part of such a groove the advantage of the holder is still greater, because by its use a tool with one bend, as in Fig.

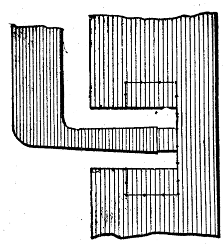


Fig. 1666.

1667, will serve, whereas without a holder the tool must have two bends, as shown in the figure, and would be able to carry a very light cut, while liable to dig into the work and break off.

The tool itself should be so forged that one side is flush with the side of the tool steel as shown at A in Fig. 1668, for if there is a

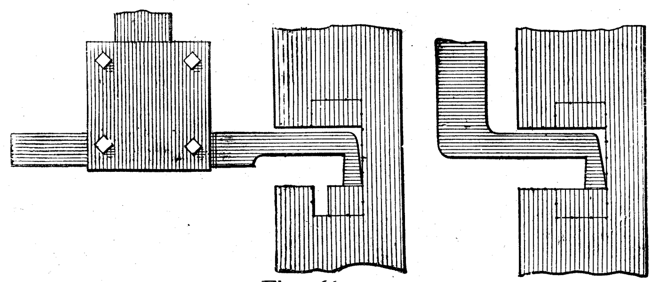


Fig. 1667.

shoulder, as at C, it sometimes prevents the tool from entering the work as shown in the figure.

Other examples in the use of this tool holder are given in Figs. 1669 and 1670.

In Fig. 1669, we have the case of cutting out the **V**-slideways

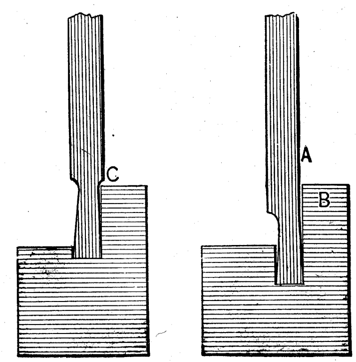


Fig. 1668.

of a planer bed, and it is seen that the tool point may be held close to the holder, the side of the tool box still clearing the side of the **V**-slideway, whereas in the absence of the holder the tool would require to have a considerable bend in it, or else would have to stand out from the bottom of the tool apron to a distance equal to the length of one side of the slideway.

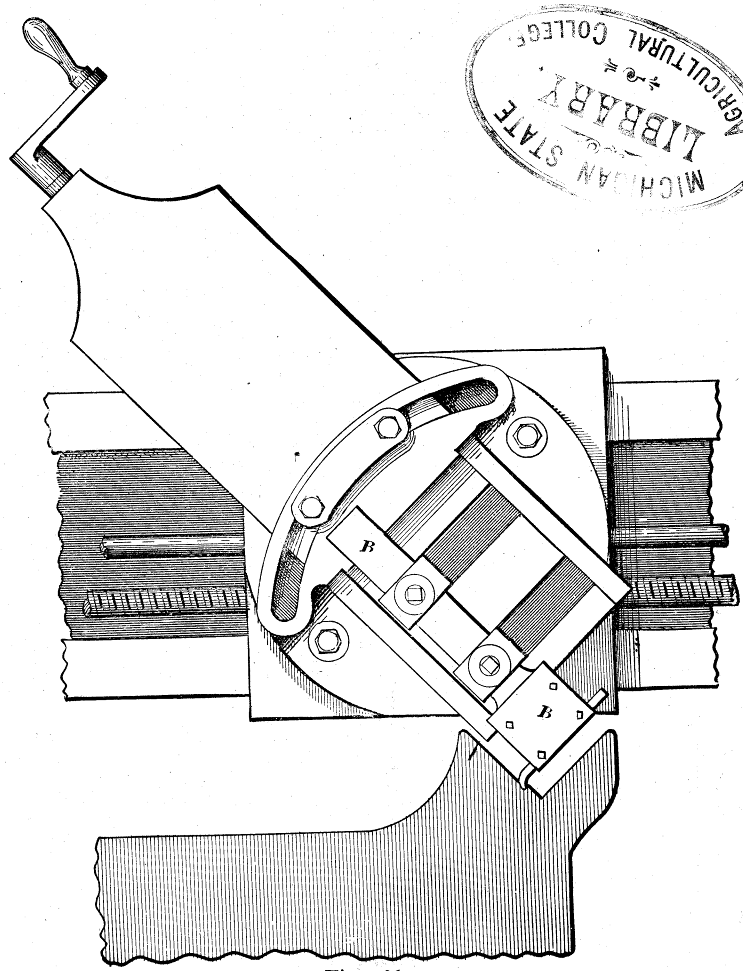


Fig. 1669.

In Fig. 1670 it is also seen that by the use of the holder the tool point may also be held as close as necessary to the holder, and still permit the side of the vertical slide S′ and the tool box B to clear the vertical face of the work.

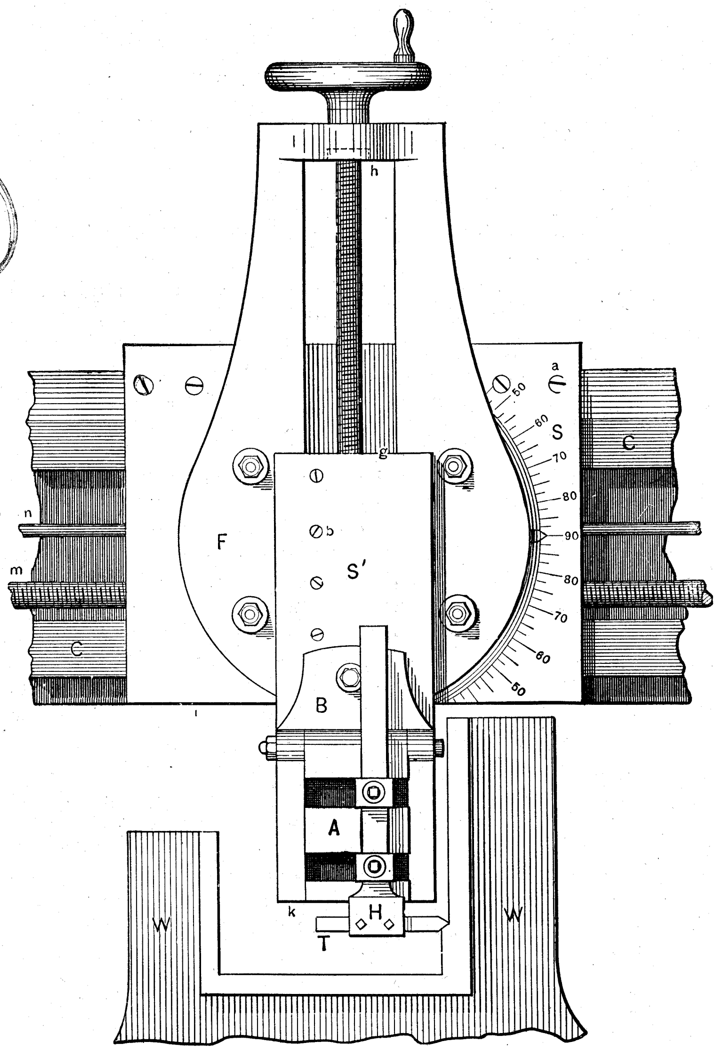


Fig. 1670.

In all planer work it is an essential in the production of true and smooth surfaces that the tool be held as close in to the tool clamp or tool box as possible, and this forms one of the main advantages of tool holders.