Chapter VI.—THE LATHE.

THE lathe may be justly termed the most important of all metal-cutting machine tools. Not only on account of the rapidity of its execution which is due to its cutting continuously while many others cut intermittently, but also because of the great variety of the duty it will perform to advantage. In the general operations of the lathe, drilling, boring, reaming, and other processes corresponding to those performed by the drilling machine, are executed, while many operations usually performed by the planing machine, or planer as it is sometimes termed, may be so efficiently performed by the lathe that it sometimes becomes a matter of consideration whether the lathe or the planer is the best machine to use for the purpose.

The forms of cutting tools employed in the planer, drilling machine, shaping machine, and boring machine, are all to be found among lathe tools, while the work-holding devices employed on lathe work include, substantially, very nearly all those employed on all other machines and, in addition, a great many that are peculiar to itself. In former times, and in England even at the present day, an efficient turner (as a lathe operator is termed),

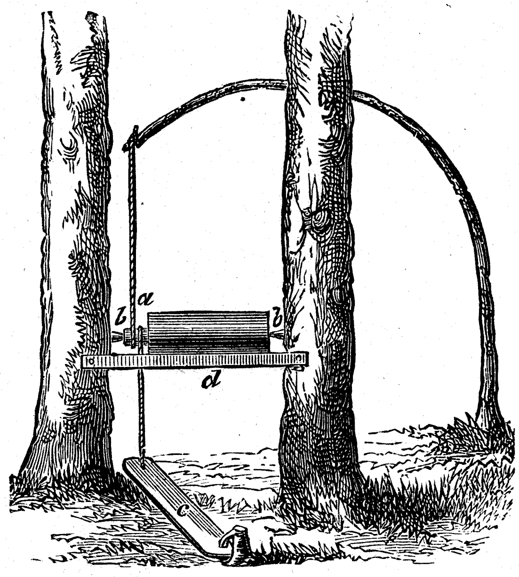

Fig. 479.

or lathe hand, is deemed capable of skilfully operating a planer, boring machine, screw-cutting machine, drilling machine, or any of the ordinary machine tools, whereas those who have learned to operate any or all of those machine tools would prove altogether inefficient if put to operate a lathe.

In almost all the mechanic arts the lathe in some form or other is to be found, varying in weight from the jewellers' lathe of a few pounds to the pulley or fly-wheel lathe of the engine builder, weighing many tons.

The lathe is the oldest of machine tools and exists in a greater variety of forms than any other machine tool. Fig. 479 represents a lathe of primitive construction actually in use at the present day, and concerning which the "Engineering" of London (England), says, "At the Vienna Exhibition there were exhibited wood, glasses, bottles, vases, &c , made by the Hucules, the remnant of an old Asiatic nation which had settled at the time of the general migration of nations in the remotest parts of Galicia, in the dense forests of the Carpathian Mountains. The lathe they are using has been employed by them from time immemorial. They make the cones *b*,*b* (of maple) serve as centres, one being fixed and the other movable (longitudinally). They rough out the work with a hatchet, making one end *a* cylindrical, to receive the rope for giving rotary motion. The cross-bar *d* is fastened to the trees so as to form a rest for the cutting tool, which consists of a chisel." C, of course, is the treadle, the lathe or pole being a sapling.

In other forms of ancient lathes a wooden frame was made to receive the work-centres, and one of these centres was carried in a block capable of adjustment along the frame to suit different lengths of work. In place of a sapling a pole or lath was employed, and from this lath is probably derived the term lathe.

It is obvious, however, that with such a lathe no cutting operation can be performed while the work is rotating backwards, and further, that during the period of rest of the cutting tool it is liable to move and not meet the cut properly when the direction of work rotation is reversed and cutting recommences, hence the operation is crude in the extreme, being merely mentioned as a curiosity.

The various forms in which the lathe appears in ordinary machine shop manipulation may be classified as follows:—

The *foot lathe*, signifying that the lathe is driven by foot.

The *hand lathe*, denoting that the cutting tools must be held in the hands, there being no tool-carrying or feeding device on the lathe.

The *single-geared lathe*, signifying that it has no gear-wheels to reduce the speed of rotation of the live spindle from that of the cone.

The *back-geared lathe*, in which gear-wheels at the back of the headstock are employed to reduce the speed of the lathe.

The *self-acting lathe*, or *engine lathe*, implying that there is a slide rest actuated automatically to traverse the tool to its cut or feed.

The *screw-cutting lathe*, which is provided with a *lead* screw, by means of which other screws may be cut.

The *screw-cutting lathe with independent feed*, which denotes that the lathe has two feed motions, one for cutting threads and another for ordinary tool feeding ; and

The *chucking lathe*, which implies that the lathe has a face plate of larger diameter than usual, and that the bed is somewhat short, so as to adapt it mainly to work held by being chucked, that is to say, held by other means than between the lathe centres.

There are other special applications of the lathe, as the boring lathe, the grinding lathe, the lathe for irregular forms, &c., &c.

This classification, however, merely indicates the nature of the lathe with reference to the individual feature indicated in the title ; thus, although a foot lathe is one run by foot, yet it may be a single or double gear (back-geared) lathe, or a hand or self-acting lathe, with lead screw and independent feed motion.

Again, a hand lathe may have a hand slide rest, and in that case it may also be a back-geared lathe, and a back-geared lathe may have a hand slide rest or a self-acting feed motion or motions.

Fig. 480 represents a simple form of foot lathe. The office of the shears or bed is to support the headstock and tailstock or tailblock, and to hold them so that the axes of their respective spindles shall be in line in whatever position the tailstock may be placed along the bed. The duty of the headstock is to carry the live spindle, which is driven by the cone, the latter being connected by the belt to the wheel upon the crank shaft driven by the crank hook and the treadle, which are pivoted by eyes W to the rod X, the operation of the treadle motion being obvious. The work is shown to be carried between the live centre, which is fitted to the live spindle, and the dead centre fitting into the tail spindle, and as it has an arm at the end, it is shown to be driven by a pin fixed in the face plate, this being the simplest method of holding and driving work. The lathe is shown provided with a hand tool rest, and in this case the cutting tools are supported upon the top of the tool rest N, whose height may be adjusted to bring the tool edge to the required height on the work by operating the set screw S, which secures the stem of N in the bore of the rest.

To maintain the axes of the live and dead spindles in line, they are fitted to a slide or guideway on the shears, the headstock being fixed in position, while the tailstock is adjustable along the shears to suit the length of the work.

To lock the tailstock in its adjusted position along the shears, it has a bolt projecting down through the plate C, which bolt receives the hand nut D. To secure the hand rest in position at any point along the shears, it sets upon a plate A and receives a bolt whose head fits into a T-shaped groove, and which, after passing through the plate P receives the nut N, by which the rest is secured to the shears.

To adjust the end fit of the live spindle a bracket K receives an adjusting screw L, whose coned end has a seat in the end J of the live spindle, M being a check nut to secure L in its adjusted position.

The sizes of lathes are designated in three ways, as follows :— First by the *swing* of the lathe and the total length of the bed, the term *swing* meaning the largest diameter of work that the lathe is capable of revolving or swinging. The second is by the *height of the centres* (from the nearest corner of the bed) and the length of the shears. The height of the centres is obviously equal to half the swing of the lathe, hence, for example, a lathe of 28-inch swing is the same size as one of 14-inch centres. The third method is by the swing or height of centres and by the greatest length of work that can be held between the lathe centres, which is equal to the length of the bed less the lengths of the head and tailstock together.

The effective size of a lathe, however, may be measured in yet another way, because since the hand rest or slide rest, as the case may be, rests upon the shears or bed, therefore the full diameter of work that the lathe will swing on the face plate cannot be held between the centres on account of the height of the body of the hand rest or slide rest above the shears.

Fig. 481 shows a hand lathe by F. E. Reed, of Worcester, Massachusetts, the mechanism of the head and tail stock being shown by dotted lines. The live spindle is hollow, so that if the work is to be made from a piece of rod and held in any of the forms of chucks to be hereafter described, it may be passed through the spindle, which saves cutting the rod into short lengths. The front bearing of the headstock has two brasses or boxes, A and B, set together by a cap C.

The rear bearing has also a bearing box, the lower half D being threaded to receive an adjustment screw F and check nut G to adjust the end fit of the spindle in its bearings. In place of grooved steps for the belt the cone has flat ones to receive a flat belt.

The tail spindle is shown, in Fig. 482, to be operated by a screw H, having journal bearing at I, and threaded into a nut fast in the tail spindle at J. To hold the tail spindle firmly the end of the tail stock is split, and the hand screw K may be screwed up to close the split and cause the bore at L to clasp the tail spindle at that end.

To lock the tail stock to the shears the bolt M receives the lever N at one end and at the other passes through the plate or clamp O, and receives the nut P, so that the tail stock is gripped to or released from the shears by operating N in the necessary direction. The hand rest, Fig. 483, has a wheel W in place of a nut, which dispenses with the use of a wrench.

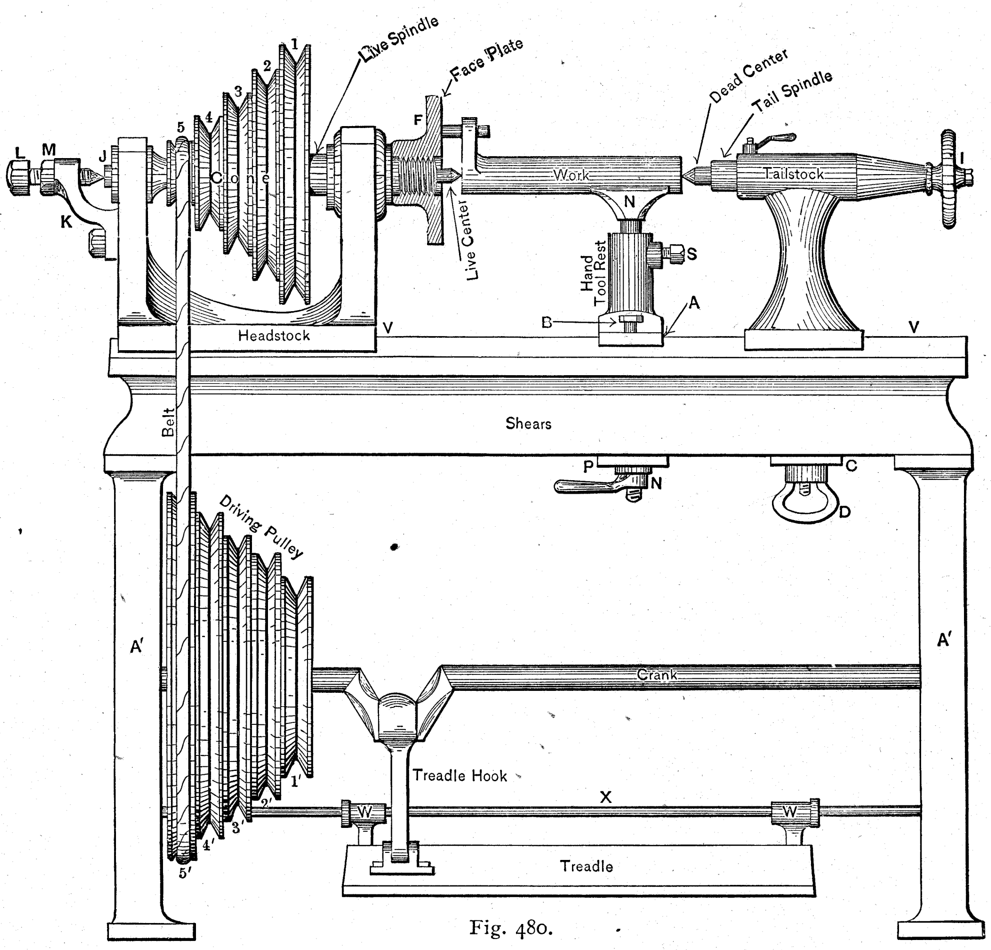

Fig. 480.

What are termed bench lathes are those having very short legs, so that they may for convenience be mounted on a bench or fastened to a second frame, as shown in Fig. 484.

It is obvious that when work is turned by hand tools, the parallelism of the work depends upon the amount of metal cut off at every part of its length, which to obtain work of straight outline, whether parallel or taper, involves a great deal of testing and considerable skill, and to obviate these disadvantages various methods of carrying and accurately guiding tools are employed. The simplest of these methods is by means of a slide rest, such as shown in Fig. 485.

The tool T is carried in the tool post P, being secured therein by the set screw shown, which at the same time locks the tool post to the upper slider. This upper slider fits closely to the cross slide, and has a nut projecting down into the slot shown in the same, and enveloping the cross feed screw, whose handle is shown at C, so that operating C traverses the upper slider on the

The lower or feed traverse slide is pivoted to its base B, so that it may be swung horizontally upon the same, and is provided with means to secure it in its adjusted position, which is necessary

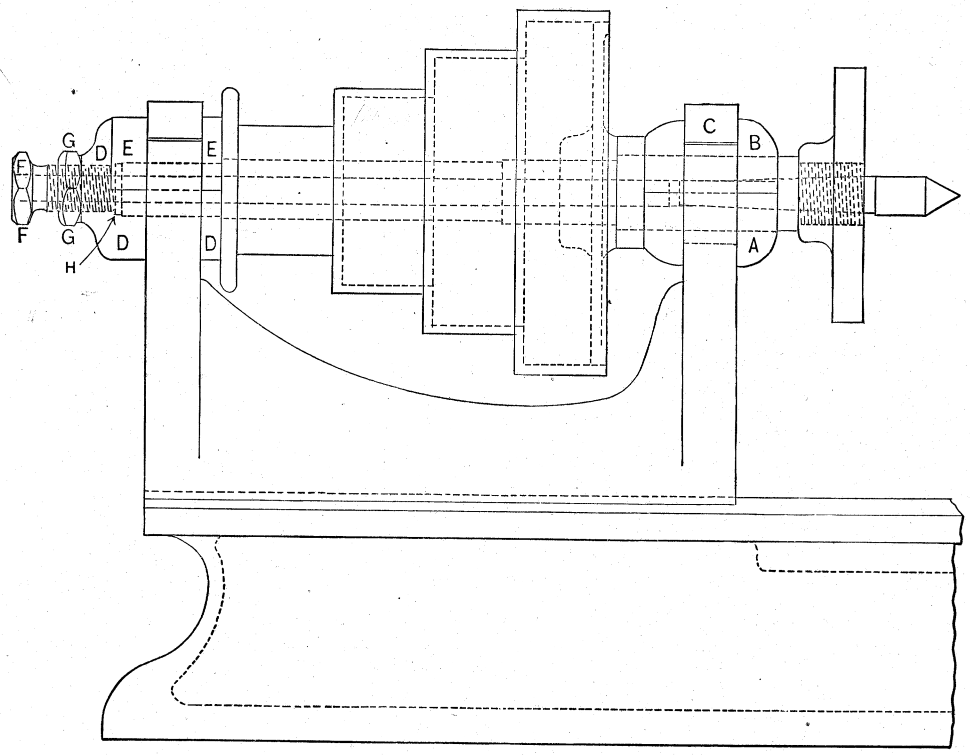

Fig. 481.

cross slide and regulates the depth to which the tool enters the work, or in other words, the depth of cut.

The cross slide is formed on the top of the lower slider, which has beneath a nut for the feed screw, whose handle is shown at A, hence rotating A will cause the lower slider to traverse along

to enable it to turn taper as well as parallel work. To set this lower slide to a given degree of angle it may be marked with a line and the edge of base B may be divided into degrees as shown at D.

When a piece of work is rotated between the lathe centres its axis of rotation may be represented by an imaginary straight

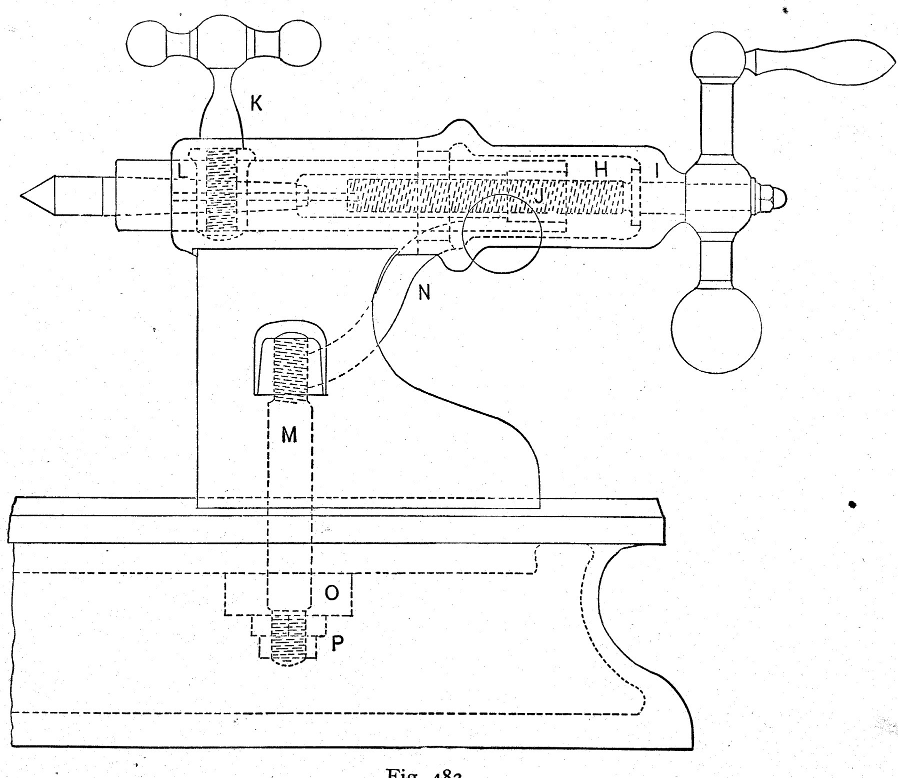

Fig. 482.

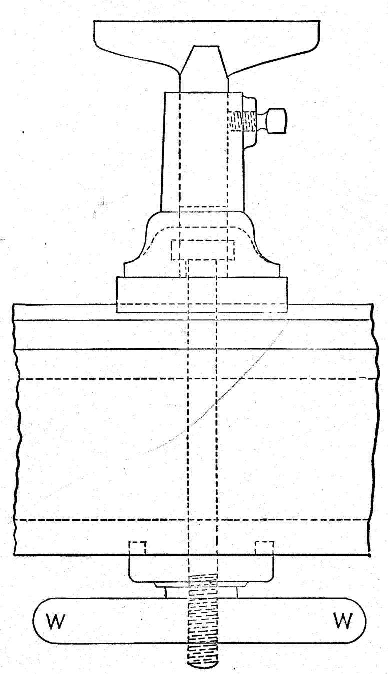

Fig. 483.

the lower slide and carry the tool along the work to its cut. To maintain the fit of the sliders to the slides a slip of metal is inserted, as at *e* and at *c*, and these are set up by screws as at *f,f* and *b,b*.

line and the lower slides must, to obtain parallel work, be set parallel to this straight line, while for taper work the slide rest must be set at an angle to it. Now, in the form of slide rest shown in figure the cross slide is carried by the lower or feed traverse slide, hence setting the lower slide out of parallel with the work axis sets the cross slide out of a right angle to the work axis, with the result that when a taper piece of work is turned that has a collar or flange on it, the face of that collar or flange will be turned not at a right angle to the work axis as it should be, but at a right angle to the surface of the cone. Thus in Fig. 486 A represents the axis of a piece of work, and the slide nut having been set parallel to the work axis,

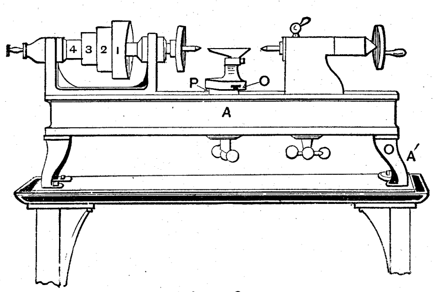

Fig. 484.

the face C will be at a right angle to the surface B or axis A, but with the slide nut set at an angle to turn the cone D, the cross slide will be at an angle to A, hence the face E will be undercut as shown, and at a right angle to the surface D instead of to A A. This may be obviated by letting the cross slide be the lower one as in the English form of slide rest shown in Fig. 487, in which the upper slide is pivoted at its centre to the cross slide and may be swung at an angle thereto and secured in its

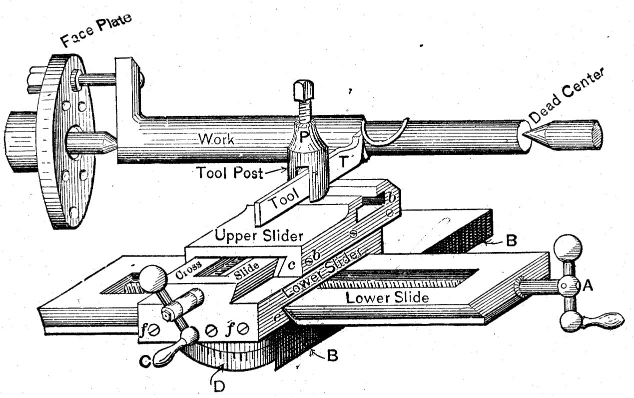

Fig. 485.

adjusted position by the bolt at F. The projection at the bottom of the lower slider fits between the shears of the lathe and holds the lower slider parallel with the line of lathe centres, which causes the slide rest to cut all faces at a right angle to the work axis whether the feed traverse slide be set to turn parallel or taper. In either case, however, there is nothing to serve as a guide to set the feed traverse slide parallel to the work axis, and this must, therefore, be done as near as may be by the eye and by taking a cut and testing its parallelism.

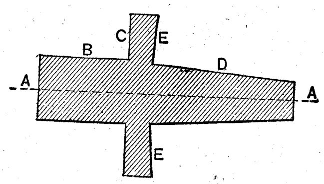

Fig. 486.

The rest may be set approximately true by bringing the operator's eye into such a position that the edge *a a*, Fig. 488, of the slide rest come into line with the edge *b b* of the lathe shears, because that edge is parallel to the line of lathe centres, and therefore to the work axis.

Slide rests which have a slide for traversing the tool along the work to its cut are but little used in the United States, being confined to very small lathes, and then (except in the case of watchmakers' lathes whose forms of slide rest will be shown hereafter), mainly as an expedient to save expense in the cost of the lathe, it being preferred to feed the tool for the feed traverse (as the motion of the cutting tool along the work is termed) by mechanism operated from the live spindle and to be hereafter described. In England, however, slide rests are much used, a specimen construction being shown in

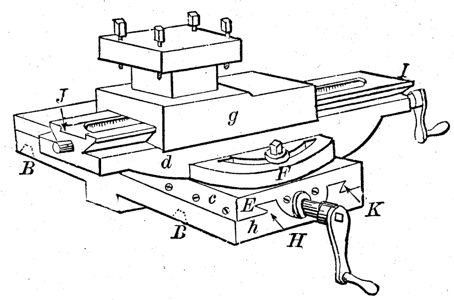

Fig. 487.

Fig. 489. The end face A of the rest comes flush so that the tool shall be carried firmly when taking facing cuts in which solidity in the rest is of most importance. The tool is held by two clamps instead of by single tool posts, because the slide rest is employed to take heavy cuts, and when this is the case with boring tools whose cutting edges stand far out from the slide rest, a single tool post will not hold the tool sufficiently firm.

The gib *e*, Fig. 485, is sometimes placed on the front side of

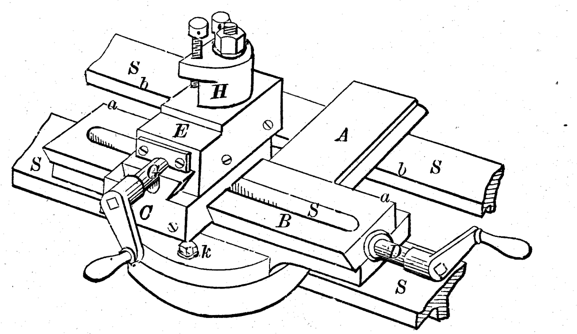

Fig. 488.

the slider, as in the figure, and at others on the back; when it is placed in the front the strain of the cut causes it to be compressed against the slide, and there is a strain placed upon the screws *f* which lifts them up, whereas if placed on the other side the screws are relieved of strain, save such as is caused by the setting of the gib up.

On the other hand, the screws are easier to get at for adjustment if placed in front. When the screws *b* of the upper gib *c*,

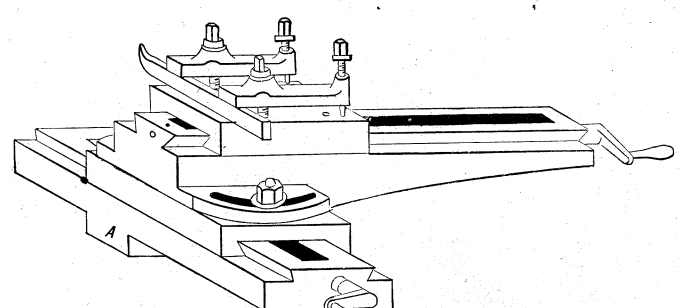

Fig. 489.

Fig. 485, are on the right-hand side, as in that figure, there is considerable strain on the screws when a boring tool is used to stand far out, as for boring deep holes. On the other hand, however, the screws can be readily got at in this position, and may therefore be screwed up tightly to lock the upper slider firmly to the cross slide, which will be a great advantage in boring and also in facing operations. But the screws must not in this case have simple saw slot heads, such as shown on a larger scale in Fig. 490, but should have square heads to receive a wrench, and if these four screws are used, the two end ones may be set to adjust the sliding fit of the slider, while the two middle ones may be used to set the slider form on its slide when either facing or boring. The corners of the gibs as well as those of the slider and slide may with advantage be rounded so that they may not become bruised or burred, and, furthermore, the slider is strengthened, and hence less liable to spring under the pressure of a heavy cut.

A slide rest for turning spherical work is shown in Fig. 491. A is the lower slide way on which is traversed the slide B, upon

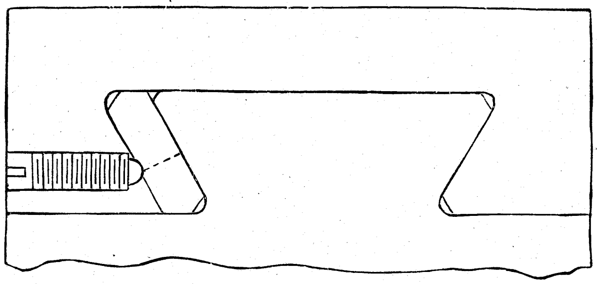

Fig. 490.

which is fitted the piece C, pivoted by the bolt D; there is provided upon C a half-circle rack, shown at E, and into this rack gears a worm-wheel having journal bearing on B, and operated by the handle F. As F is rotated C would rotate on D as a centre of motion, hence the tool point would move in an arc of a circle whose radius would depend upon the distance of the tool point from D as denoted by J, which should be coincident with the line of centres of the lathe.

The slide G is constructed in the ordinary manner, but the way on which it slides should be short, so as not to come into contact with the work. If the base slide way A be capable of being traversed along the lathe shears S S by a separate motion, then the

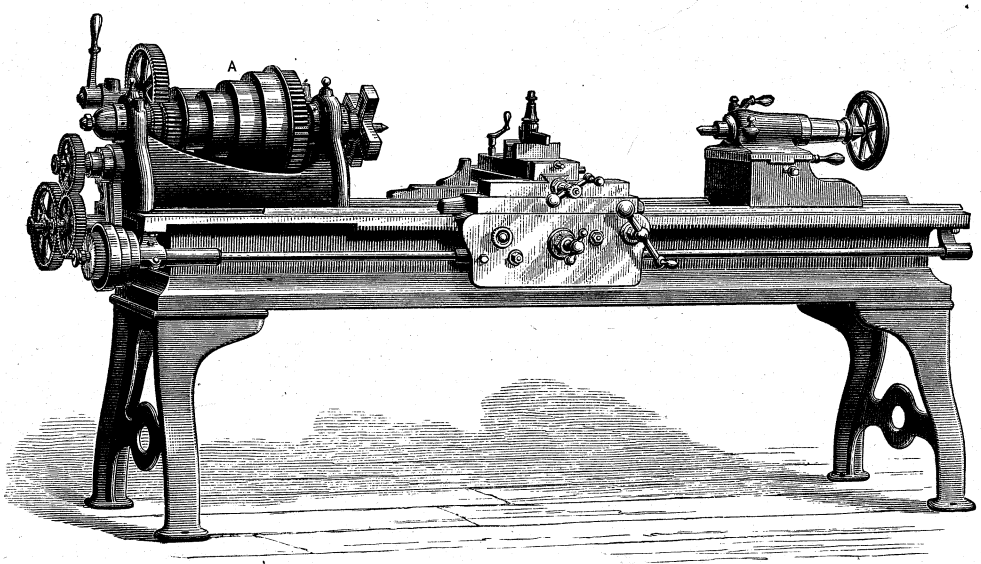

Fig. 492.

upper slide way and slide may be omitted, G and C being in one piece. It is to be noted in a rest of this kind, however, that the tool must be for the roughing cut set too far from D to an amount equal to about the depth of cut allowed to finish with, and for the finishing cut to the radius of the finished sphere in order to obtain a true sphere, because if B be operated so that D does not stand directly coincident with the line of lathe centres, the centre of motion, or of the circle described by the tool point, will not be coincident with the centre on which the work rotates, hence the work though running true would not be a true sphere but an oval. This oval would be longest in the direction parallel with the line of centres whenever the pivot D was past the line of centres, and an oval of largest diameter at the middle or largest diameter turned by the tool whenever the pivot D was on the handle H side of the line of centres. To steady C it may be provided with a circular dovetail, as shown at the end I, provision being made (by set screw or otherwise) for locking C in a fixed position when using the rest for other than spherical work.

To construct such a rest for turning curves or hollows whose outline required to be an arc of a circle, the pivot D would require to be directly beneath the tool post, which must in this case occupy a fixed position. The radius of the arc would here again be determined by the distance of the tool point from the centre of rotation of the pivot, or, what would be the same thing, from that of the tool post.

Next to the hand slide rest lathe comes the self-acting or engine lathe. These are usually provided with a feed motion for

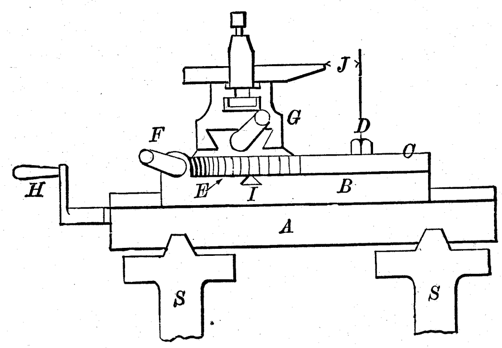

Fig. 491.

traversing the slide rest in the direction of the length of the bed, and sometimes with a self-acting cross feed, that is to say, a feed motion that will traverse the tool to or from the line of centres and at a right angle to the same.

In an engine lathe the parallelism or truth of the work depends upon the parallelism of the line of centres with the shears of the lathe, and therefore upon the truth of the shears or bed, and its alignment with the cone spindle and tail spindle, while the truth of the radial faces on the turned work depends upon the tool rest moving on the cross slide at a true right angle to the line of centres.

Fig. 492 represents an 18-inch engine (or self-acting) lathe designed by and containing the patented improvements of S. W. Putnam, of the Putnam Tool Company, of Fitchburg, Massachusetts. The lathe has an elevating slide rest self-acting feed traverse and self-acting cross feed, both feeds being operative in either direction. It has also a feed rod for the ordinary tool feeding and a lead screw for screw-cutting purposes.

Fig. 493 represents a cross-sectional view of the shears beneath the headstock; A A are the shears or bed having the raised Vs marked V′ and V on which the headstock and tailstock rest, and V″ and V‴ on which the carriage slides. A and A′ are the shears connected at intervals by cross girts or webs B to stiffen them. C C are the bolts to secure the headstock to the shears. D is a bracket bolted to A′ and affording at E journal bearing for the spindle that operates the independent feed spindle. E is split at *f* and a piece of soft wood or similar compressible material is inserted in the split. The bolt F is operated to close the split, and, therefore, to adjust the bore E to properly fit the journal of the feed spindle, and as similar means are provided in various parts of the lathe to adjust the fits of journals and bearings the advantages of the system may here be pointed out. First, then, the fit of the bearing may be adjusted by simply operating the screw, and, therefore, without either disconnecting the parts or performing any fitting operation, as by filing. Secondly, the presence of the wood prevents the ingress of dust, &c., which would cause the bearings and journals to abrade; and, thirdly, the compression of the wood causes a resistance and pressure on the adjusting screw thread, which pressure serves to lock it and prevent it from loosening back of itself, as such screws are otherwise apt to do.

As the pressure of the tool cut falls mainly on the front side of the carriage, and as the weight of the carriage itself is greatest on that side, the wear is greatest; this is counteracted by forming the front **V**, marked V‴ in figure, at a less acute angle, which gives it more wearing area and causes the rest to lower less under a given amount of wear.

The rib A″ which is introduced to strengthen the shears against torsional strains, extends the full length of the shears.

Fig. 494 is a sectional side elevation of the headstock; A A′ represents the headstock carrying the bearing boxes B and B′,

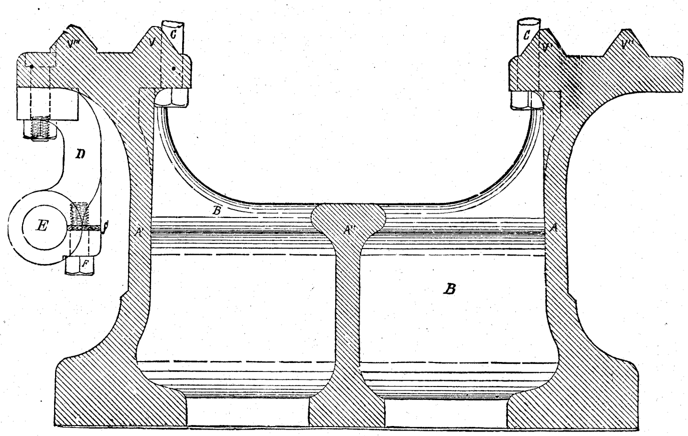

Fig. 493.

which are capable of bore closure so as to be made to accurately fit the spindle S by the construction of the front bearing B, being more clearly shown in Fig; 495; B is of composition brass, its external diameter being coned to fit the taper hole in the head; it is split through longitudinally, and is threaded at each end to receive the ring nuts C and C′. If C be loosened from contact with the radial face of A, then C′ may be screwed up, drawing B through the coned hole in A, and, therefore, causing its bore to close upon S.

At the other end of S, Fig. 496, C″ is a ring nut for drawing the journal box B′ through *a′* to adjust the bore of B′ to fit the journal of S, space to admit the passage of B′ being provided at *e*. D is a box nut serving to withdraw B′ or to secure it firmly in its adjusted position, and also to carry the end adjusting step E. F is a check nut to lock E in its adjusted position.

The method of preventing end motion to S is more clearly shown in Fig. 496, in which *h* is a steel washer enveloping S, having contact with the radial face of B′ and secured in its adjusted position by the check nuts *g*, hence it prevents S from moving forward to the right. *f* is a disk of raw hide let into E; the latter is threaded in D and is squared at the end within F to admit of the application of a wrench, hence E may be screwed in until it causes contact between the face of *f* and the end of S, thus preventing its motion to the left. By this construction the whole adjustment laterally of S is made with the short length from *h* to *f*, hence any difference of expansion (under varying temperature) between the spindle and the head A A′, or between the boxes and the spindle S, has no effect towards impairing the end fit of S in its bearings.

The method of adjusting the bearings to the spindle is as follows:—C″ and C′ are slackened back by means of a "spanner wrench" inserted in the holes provided for that purpose. C and D

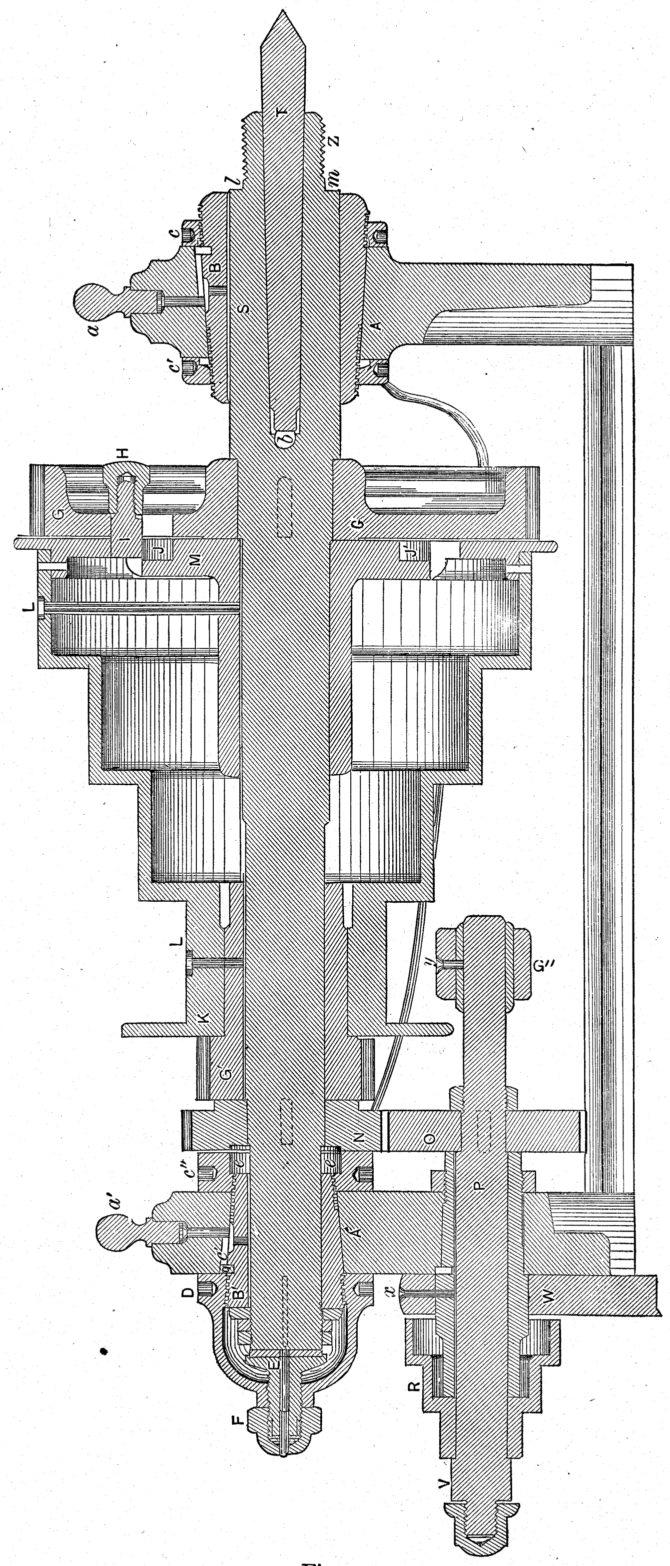

Fig. 494.

are then screwed up, withdrawing B and B′ respectively, and leaving the journal fit too easy. C′ is then screwed up until B is closed upon the spindle sufficiently that the belt being loose on the cone pulley, the latter moved by the hand placed upon the smallest step of the cone can just detect that there is contact between the bore of B and the spindle, then, while still moving the cone, turn C′ back very slowly and a very little, the object being to relieve the bore of B from pressure against S. C may then be screwed up, firmly locking B in its adjusted position. C″ may then be operated to adjust B′ in a similar manner, and D screwed up to lock it in its adjusted position. Before, however, screwing up D it is better to remove F and release E from pressure against *f*, adjusting the end pressure of E after D has been screwed home against A′.

To prevent B and B′ from rotating in the head when the ring nuts are operated, each is provided with a pin, *q*, grooves *c* and *c*′ permitting of the lateral movement of B and B′ for adjustment. The boxes B, B′ admit of being rotated in their sockets in A and A′ so as to assume different positions, the pins *q* and *q*′ being removable from one to another of a series of holes in the boxes B, B′ when it is desired to partly rotate those boxes. The tops of the boxes are provided with oil holes, and the oil ways shown at *r*, *s* being the oil groove through the head and *a* simply a stopper to prevent the ingress of dust, &c.

The thread on S at Z, Fig. 494, is to receive and drive the face plates, chucks, &c., which are bored and threaded to fit over Z. To cause the radial faces of such face plates or chucks to run true, there is provided the plain cylindrical part *l*, to which the bore in the hub of the face plate or chuck is an accurate fit when the radial face of that hub meets the radial face *m*.

Referring again to Fig. 494, G′ is the pinion to drive the back gear while G receives motion from the back-gear pinion. The object of the back gear is to reduce the speed of rotation of S and to enable it to drive a heavier cut, which is accomplished as follows :—G′ is secured within the end K of the cone and is free to rotate with the cone upon S; at the other end the cone is secured to M, which is free to rotate upon S so far as its bore is concerned. G is fixed upon S and hence rotates at all times with it; but G may be locked to or released from M as follows :—

In G is a radial slot through which passes a bolt I provided with a cap nut H, in M is an annular groove J. When I is lifted its head passes into a recess in M, then H is screwed

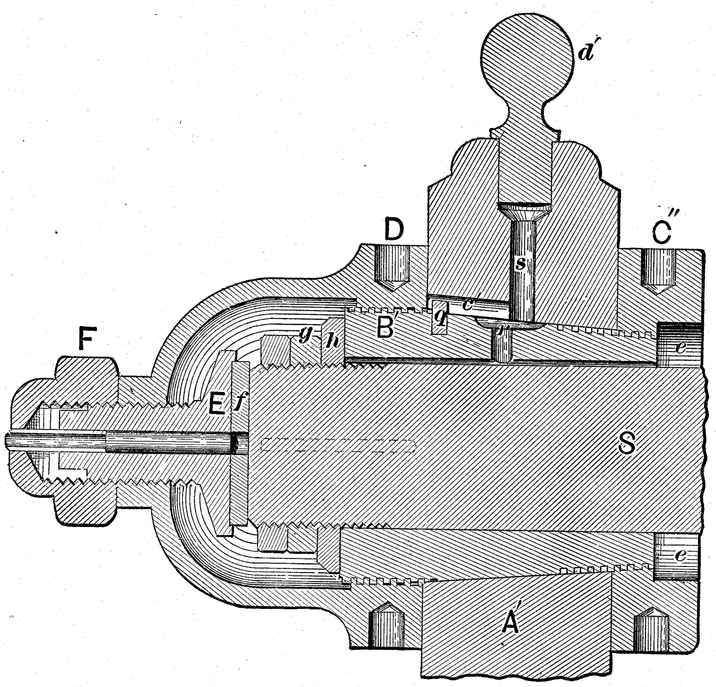

Fig. 496.

up and G is locked to M. This is the position of I when the back gear is not in use, the motion of the cone being communicated to S through I. But if H be loosened and I be moved inwards towards S, the head of I passes into the annular groove J, and the cone is free to rotate upon S while the latter and G remain stationary unless the back gear is put into operation. In this latter case the pinion G′ rotating with the cone drives the large gear of the back gear and the small pinion of the

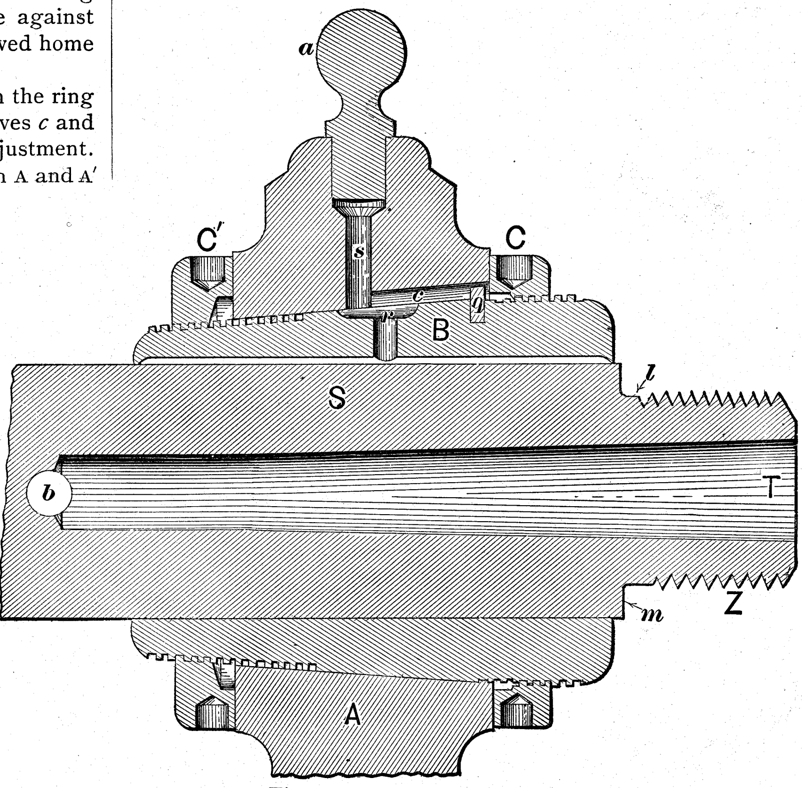

Fig. 495.

latter drives G, whose speed of rotation is reduced by reason of the relative proportions of the gear wheels.

In this case it is obvious that since the pulley rotates upon the spindle it requires lubrication, which is accomplished through the oil hole tubes L.

The means of giving motion to the feed spindle and lead screw are as follows :—N, Fig. 494, is a pinion fast upon S and operating the gear O, which is fast upon the spindle P, having journal bearing in a stem in A′ and also at G″. P drives the three-stepped cone R, which is connected by belt to a similar cone fast upon the independent feed spindle. The seat for the driving gear of the change wheels for the lead screw is on P at V. To provide ample bearing surface for P in A′ the bush or sleeve shown is employed, but this sleeve also serves to pivot the swing frame W which carries the studs for the change wheels that go between the wheel on V and that on the lead screw; *x y* are simply oil holes to lubricate P in its bearings.

To provide a wider range of tool feed than that obtainable by the steps on the feed cones, as R, they are provided at their ends with seats for change wheels, the swing frame W carrying the intermediate wheels for transmitting motion from V to a similar seat on the cone on the feed spindle.

Fig. 497 represents the tailstock (or tailblock as it is sometimes termed), shown in section. A represents the base which slides upon the raised Vs on the bed and carries the upper part B, in which slides the tail spindle C, which is operated longitudinally by the tail screw D, having journal bearing in E, and threaded through the nut F which is fast in C. The hand wheel G is for rotating D, whose thread operating in the nut F, causes C to slide within B in a direction determined by the direction of rotation of G. To lock C in its adjusted position the handled nut H is employed in connection with the bolt I, which is shown in dotted lines; C is split as shown by the dotted lines at *f*; J is the dead centre fitting accurately into a conical hole in C. When it is required to remove J from C the wheel G is operated to withdraw C entirely within B, and the end *d* of D meets the end *e* of J and forces J from the coned hole in C.

The method of securing the tailstock to the shears or releasing it from the same is as follows. A vertical prolongation of B affords at B″ a bearing surface for the nut-handle L and washer M. K is a bolt threaded into L passing through M, B″ and N, the latter of which it carries. N spans the shears beneath the two Vs on which the tailstock slides. Moving or rather partly rotating the handle L in the necessary direction lifts K and causes N to rise, and grip the shears beneath, while the pressure of M on B″ causes B to grip A and the latter to grip the raised Vs on the shears. If L be rotated in the opposite direction it will cause N to fall, leaving A free to slide along the shears. To prevent N from partly rotating when free, its ends are shaped to fit loosely between the shears as shown at *n*.

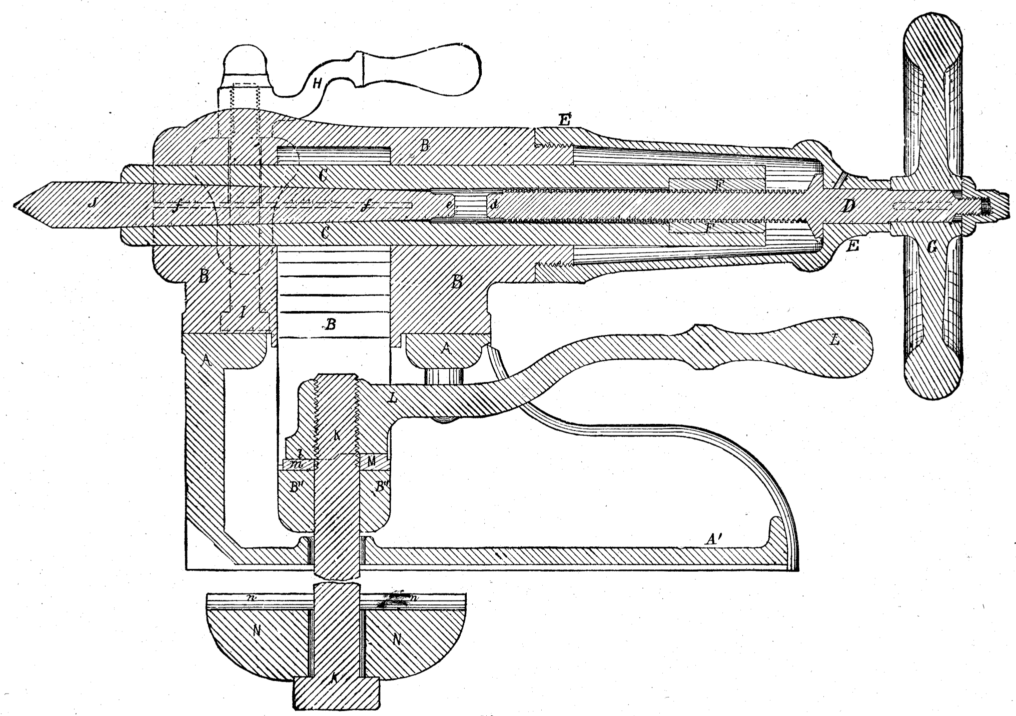

Fig. 497.

To give to N sufficient rise and fall to enable it to grip or fall entirely free from the shears with the small amount of rotary motion which the handle-lever L is enabled from its position to have, the following device is provided. M is a washer interposed between L and B″. This washer has upon it steps of different thickness as shown at M and *m*, the two thicknesses being formed by an incline as shown. The face of L has, as shown, similar steps; now as shown in the cut the step *l* on lever L meets the steps *m* of the washer, the handle having receded to the limit of its motion. The bolt K then has fallen to the amount due to unscrewing the threaded or nut end of L, and also to the amount of the difference of thickness at M and at *m* of the washer, the plate N being clear of the lathe-shears. But suppose the handle L be pulled towards the operator, then the surface *l* passing from a thin section on to a thick one as M of the washer, will lift the bolt K, causing N to meet the under surface of the shears, and then the motion of L continuing the pressure of the thread will bind or lock N to the bed.

The surface A′ in Fig. 497 affords a shelf or table whereon tools, &c., may be placed instead of lying on the lathe bed, where they may cause or receive damage.

Fig. 498 represents an end view of the tailstock viewed from the dead centre end, the same letters of reference applying to like parts that are shown in Fig. 497. The split at *f* is here shown to be filled with a piece of soft wood which prevents the ingress of dust, &c. At *d* is a cup or receptacle for oil, *e* being a stopper, having attached to it a wire pin flattened and of barb shape at the end, the object being to cause the wire to withdraw from the cup a drop of oil to lubricate the dead centre and centre in the work. The proximity of *e* to the dead centre makes this a great convenience, while the device uses much less oil than would be used by an oil can.

The method of setting over the upper part B to enable the turning of the diameter of work conical or taper instead of parallel is shown in figure: P and P′ are square-headed screws threaded into the walls of A and meeting at their ends the surface of B′. In A there is at *a* a wide groove or way, and on B there is at *b* a projection fitting into the way *a* so as to guide B when it slides across A, as it will when P is unscrewed in A and P′ is screwed into A. This operation is termed setting over the tailstock, and its effect is as follows:—Suppose it be required to turn a piece of work of smaller diameter at the end which runs on the dead centre, then, by operating the screw P towards the front of the lathe (or to the left as shown in the cut) and screwing P′

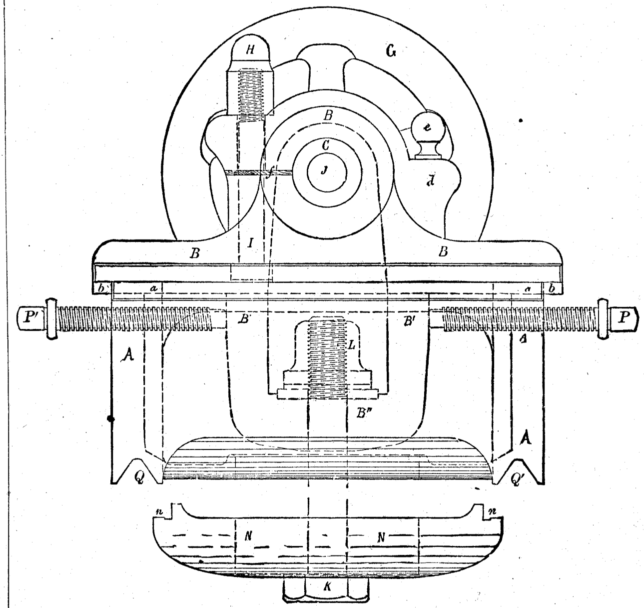

Fig. 498.

farther into A, the end of P′ will meet the surface of B′, causing B′ to move over, and the centre of the dead centre J (which is the axis of rotation of the work at that end) will be nearer to the point of the cutting tool. Or suppose the work requires to be turned a taper having its largest diameter at the end running on the dead centre, then P′ would be unscrewed and P screwed farther into A, carrying B farther towards the back of the lathe.

The V grooves Q and Q′ fit upon the inner raised Vs shown at V, V′ in Fig. 499.

Fig. 499 is a side view of the slide rest for holding and traversing the cutting tool. A represents the carriage resting upon the raised Vs marked V″ and V‴ and prevented from lifting by its own weight, and in front also by the gib *a* secured to A by the bolt *b* and having contact at *c* with the shears. A carries at *d* a pivot for the cross slide B and at *e* a ball pivot for the cross slide elevating screw C. This screw is threaded through the end of B so that by operating it that end of B may be raised or lowered to adjust the height of the cutting tool point to suit the work. To steady B there is provided (in addition to the pivots at *d*) on A two lugs *f*, between the vertical surfaces of which B is a close working fit. The upper surface of B is provided with a V-slide way *g*, to which is fitted the tool rest D (the construction being more clearly shown in Fig. 500).

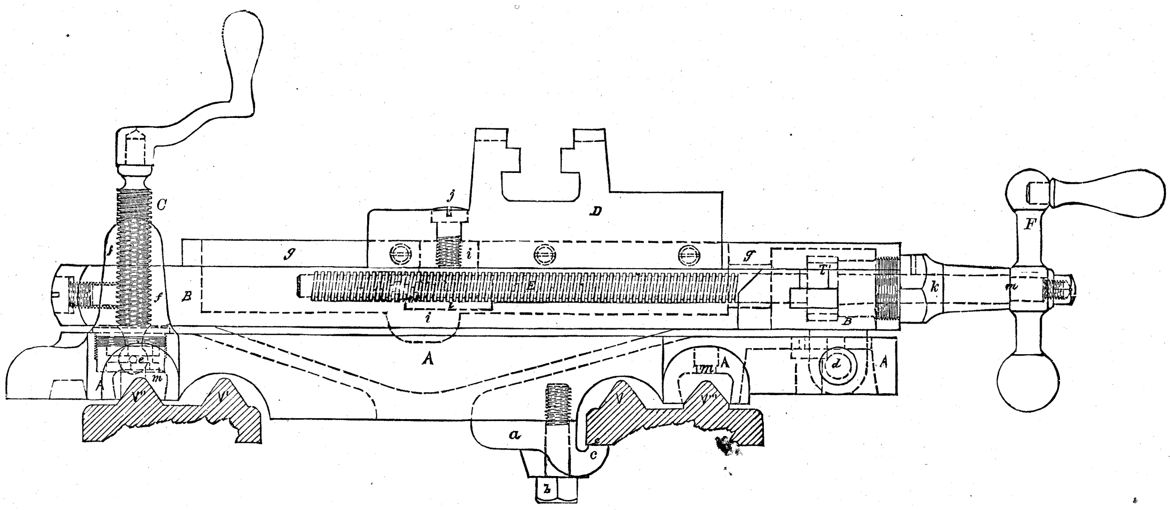

Fig. 499.

The means for traversing D along the slide *g* on B is as follows :—

A nut *i* is secured to D by the screw bolt *j*, and threaded through the nut *i* is the cross-feed screw E, which has journal bearing in the piece *k*, which is screwed into the end face of B; there is a collar on E which meets the inner end of *k*, and the handle F being secured by nut to that end of E its radial face forms a shoulder at *m* which with the collar prevents any end motion of E, so that when F is rotated E rotates and winds through the nut *i* which moves D along B.

An end view of A, B, and D is shown in Fig. 500, in which the letters of reference correspond to those in Fig. 499. B′ and B″ are the projections that pass into A and receive the pivoting screws *d* and *d*. To adjust the fit and take up any wear that may ensue on the slide *g*, on B and on the corresponding surface on D, the piece *n* is provided, being set up by the adjusting screws O.

To adjust the fit and take up the wear at the pivots *d* they are made slightly taper, fitting into correspondingly taper holes in B.

The dotted circle T′, represents a pinion fast upon the cross-feed screw (E, Fig. 499); the similar circles T and S″ also represent pinions, the three composing a part of the method of providing an automatic or self-acting cross feed or cross traverse to D by rotating it through a gear-wheel motion derived from the rotation of the independent feed spindle, as is described with reference to Fig. 501.

m in Fig. 500 represents a cavity or pocket to receive wool, cotton or other elastic or fibrous material to be saturated with oil and thus lubricate the raised Vs while keeping dirt from passing between the rest and the Vs. The shape of these pockets is such as to enable them to hold the cotton with a slight degree of pressure against the slides, thus insuring contact between them.

The mechanical devices for giving to the carriage a self-acting traverse in either direction along the bed, so as to feed the tool automatically to its cut, and for giving to the tool rest (D, Fig. 499) traverse motion so as to feed the tool to or from the line of centres along the cross slide, are shown in Fig. 501, which presents two views of the feed table or apron. The lower view supposes the feed table to be detached from the carriage and turned around so as to present a side elevation of the mechanism. The upper view is a plan of the same with two pinions (N and N′), omitted. A represents the part of the lathe carriage shown at A in Fig. 500. It has two bolts *p* and *p*′, which secure the apron G, Fig. 501, to A. At H is the independent feed spindle or feed rod operated by belt from the cone pulley R, Fig. 494, or by a gear on stud P at V. H is carried in bearings fixed to each end of the lathe shears or bed, both of these bearings being seen in Fig. 492. H is also provided with a bearing fixed on the feed apron as seen in Fig. 501, and is splined as shown at *h*. At I is a bracket fast upon the apron G and affording journal bearing to J, which is a bevel pinion having a hub which has journal bearing in the bracket I. The fit of the bearing to the journal is here again adjusted by a split in the bearing with a screw passing through the split and threaded in the lower half (similar to the construction of D in Fig. 493); J is bored to receive H, and is driven by means of a feather projecting into the spline *h*. When therefore, the carriage A is moved it carries with it the apron G, and this carries the bracket I holding the bevel pinion J, which is in

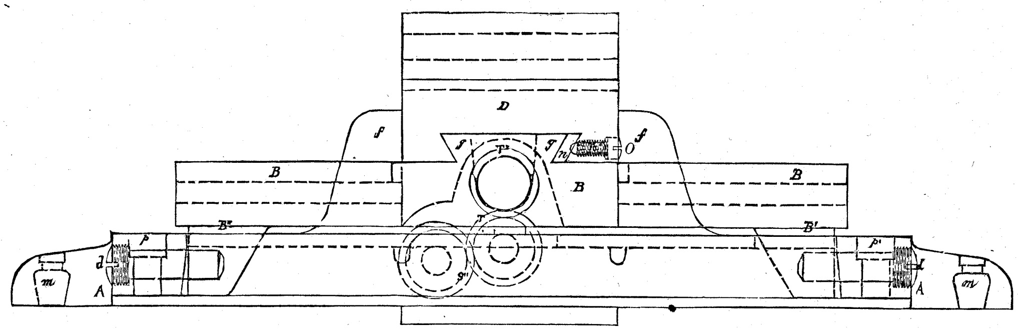

Fig. 500.

gear with the bevel-wheel K, and therefore operates it when H has rotary motion. At the back of K, and in one piece with it, is a pinion K′, both being carried upon the stud L; pivoted upon this same stud is a plate lever M, carrying two pinions N and N′ in gear together, but N only is in gear with K′, hence K′ drives N and N drives N′. Now in the position shown neither N or N′ is in gear with the gear-wheel O, but either of them may be placed in gear with it by means of the following construction :—

At the upper end of M there is provided a handle stud M′ passing through the slot M″ in G. Screwing up this stud locks M fast by binding it against the surface of G. Suppose, then, M′ to be unscrewed, then if it be moved to the right in the slot M″, N will be brought into gear with O and the motion will be transmitted in the direction of the arrows, and screwing up N would retain the gear in that position. But suppose that instead of moving M′ to the right it be moved to the left, then N′ will be brought into gear with O and the direction of rotation of O will be reversed.

lathe and a section of which is shown in the cut, the whole feed table or apron will be made to traverse along the lathe shears.

The direction in which this traverse will take place depends upon the adjusted position of M′ in M″, or in other words upon whether N or N′ be the pinion placed in gear with O. As shown in the cut neither of them is in gear, and motion from H would be communicated to N and N′ and would there cease; but if M′ be raised in the slot M″, N would drive O, and supposing P′ to be held to O, the motion of all the gears would be as denoted by the arrows, and the lathe carriage A would traverse along the lathe bed in the direction of arrow Q″. But if N′ be made to drive O all the motions would be in the opposite directions. The self-acting feed motion thus described is obviously employed to feed the cutting tool, being too slow in its operation for use to simply move the carriage from one part of the lathe bed to another; means for this purpose or for feeding the carriage and cutting tool by hand

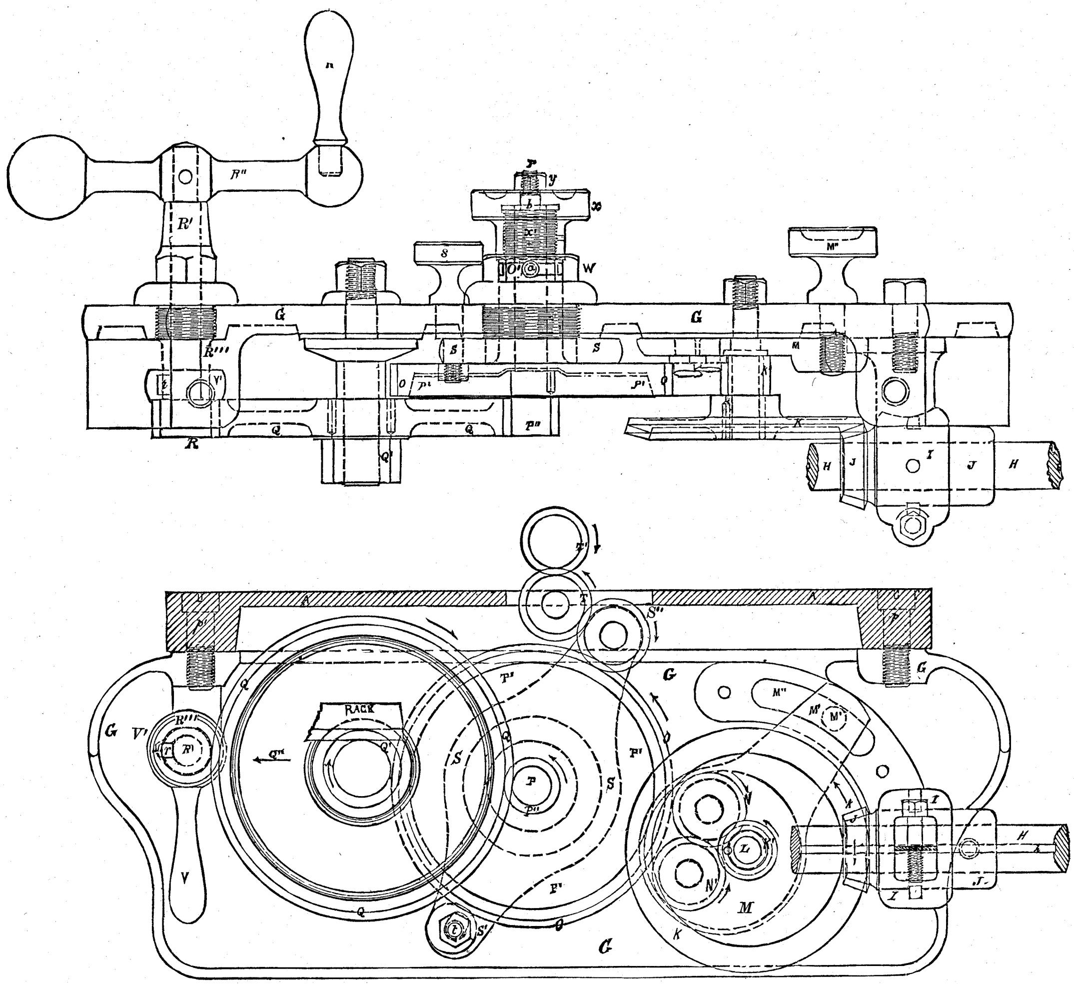

Fig. 501.

Thus, then, O may be made to remain stationary or to rotate in either direction according to the position of M′ in the slot M″, and this position may be regulated at will.

The gear O contains in its radial face a conical recess, and upon the same stud or pin (P) upon which O is pivoted, there is fixed the disk P′, which is in one piece with the pinion P″; the edge of P′ is coned to fit the recess in the wheel O, so that if the stud P is operated to force the disk P′ into the coned recess in O the motion of wheel O will be communicated to disk P′, by reason of the friction between their two coned surfaces. Or if P be operated to force the coned edge of the disk out of contact with the coned bore or recess in gear O, then O will rotate while P′ and P″ will remain stationary. Suppose the coned surfaces to be brought (by operating x) into contact and P′ to rotate with O, then P″ being in gear with wheel Q will cause it to rotate. Now Q is fast to the pinion Q′, hence it will also rotate, and being in contact with the rack which is fixed along the shears of the

are provided as follows:—R is a pinion in gear with Q and fast upon the stud R′, which is operated by the handle R″. The motion of R″ passes from R to Q and Q′ which is in gear with the rack. But Q′ being in gear with P″ the latter also rotates, motion ceasing at this point because the cone on P′ is not in contact with the coned recess in O. When, however, P′ and O are in contact and in motion, that motion is transmitted to R″, which cannot then be operated by hand.

It is often necessary when operating the cross feed to lock the carriage upon the lathe bed so that it shall not move and alter the depth of the tool-cut on the radial face of the work. One method of doing this is to throw off the belt that operates the feed spindle H, place N in gear with O and P′ in contact with O, so that the transverse feed motion will be in action, and then pull by hand the cone pulley driving H, thus feeding the tool to its necessary depth of cut. The objection to this method, however, is that when the operator is at the end of the lathe, operating the feed cone by hand he cannot see the tool and can but guess how deep a cut he has put on. To overcome this difficulty a brake is provided to the pinion R as follows :—

The brake whose handle is shown at V has a hub V′ enveloping the hub R‴ which affords journal bearing to the stud R′. In the bore of this hub V′ is an eccentric groove, and in R‴ is a pin projecting into the eccentric groove and meeting at its other end the surface of the stud R′. When, therefore, V is swung in the required direction (to the left as presented in the cut), the cam groove in V′ forces *r* inwards, gripping it and preventing it from moving, and hence the movement of R which also locks Q and Q′.

It remains now to describe the method of giving rotary motion to the cross-feed screw E (Fig. 499) so as to enable it to self-act in either direction. S is a lever pivoted upon the hub of O and carrying at one end the pinion S″, while at the other end is a stud S′ passing through a slot in G. The pinion S″ is in gear with O and would therefore receive rotary motion from it and communicate such motion to pinion T, which in turn imparts rotary motion to T′. Now T′ is fast upon the cross-feed screw as shown in Fig. 499 and the cross-feed screw E in that figure would by reason of the nut *i* in figure cause the tool rest D to traverse along the cross-slide in a direction depending upon the direction of motion of T′, which may be governed as follows :—

If S′ be moved to the left S″ will be out of gear with T and the cross-feed screw may be operated by the handle (F, Fig. 499). If S′ be in the position shown in cut and M″ also in the position there shown (Fig. 501), operating the feed screw by its handle would cause its pinion T′ to operate T, S″, and O ; hence S′ should always be placed to disconnect S″ from T when the cross-feed screw is to be operated by hand, and S′ operated to connect them only when the self-acting cross feed is to operate. In this way when the cross feed is operated by hand T′ and T will be the only gears having motion. It has been shown that the direction of motion of O is governed by the position of M′, or in other words, is governed by which of the two pinions N or N′ operates, and as O drives S″ its motion, and therefore that of T′, is reversible by operating M′.

The construction of S′ is as follows :—Within the apron as shown in the side elevation it consists of what may be described as a crank, its pin being at *t* ; in the feed table is a slot through which the shaft of the crank passes ; *s* is a handle for operating the crank. By rotating *s* the end S′ of S is caused to swing, the crank journal moving in the slot to accommodate the motion and permit S to swing on its centre.

The device for forcing the cone disk P′ into contact with or releasing it from O is as follows :—The stud P is fast at the other end in P′ and has a collar at *b* ; the face of this collar forms one

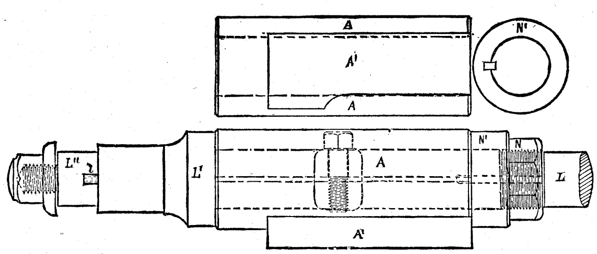

Fig. 502.

radial face, and the nut W affords the other radial face, preventing end motion to *x* without moving P endwise. If *x* be rotated its thread at *x*′ causes it to move laterally, carrying P with it, and P being fast to P′ also moves it laterally. P′ is maintained from end motion by a groove at O′ in which the end of a screw *a* projects, *a* screwing through W and into the groove O′.

The lead screw of a lathe is a screw for operating the lathe carriage when it is desired to cut threads upon the work. It is carried parallel to the lathe shears after the same manner as the independent feed spindle, and is operated by the change wheels shown in Fig. 492 at the end of the lathe. These wheels are termed change wheels on account of their requiring to be changed for every varying pitch of thread to be cut, so that their relative diameters, or, what is the same thing, their relative number of teeth, shall be such as to give to the lead screw the speed of rotation per lathe revolution necessary to cut upon the work a thread or screw of the required pitch.

The construction of the bearings which carry the lead screw in the S. W. Putnam's improved lathe is shown in Fig. 502, in which A represents the bearing box for the headstock end of the lathe, having the foot A′ as a base to bolt it to the lathe shears. L represents the lead screw, having on one side of A the collar L′ and on the other the nut and washer N and N′. The seat for the change wheel that operates the lead screw is at L″, the stop pin *l* fitting into a recess in the change wheel so as to form a driving pin to the lead screw. The washer N′ is provided with a feather fitting into a recess into L so that it shall rotate with L and shall

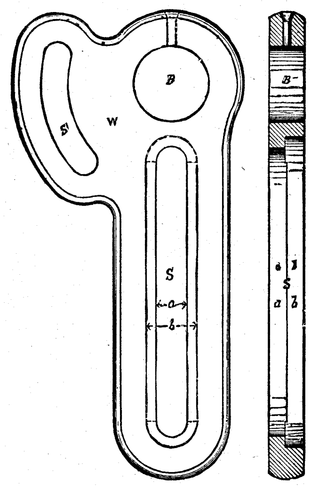

Fig. 503.

prevent the nut N from loosening back as it would be otherwise apt to do. End motion to L is therefore prevented by the radial faces of L′ and N′.

At the other end of the lathe there are no collars on the lead screw, hence when it expands or contracts, which it will do throughout its whole length under variations of atmospheric temperature, it is free to pass through the bearing and will not be deflected, bent, or under any tension, as would be the case if there were collars at the ends of both bearings. The amount of this variation under given temperatures depends upon the difference in the coefficients of expansion for the metal of which the lead screw and the lathe shears are composed, the shears being of cast iron while lead screws are sometimes of wrought iron and sometimes of steel.

The bearings at both ends are split, with soft wood placed in the split and a screw to close the split and adjust the bearing bore to fit the journal, in the manner already described with reference to other parts of this lathe.

The construction of the swing frame for carrying the change wheels that go between the driving stud V, Fig. 494, and that on the seat L″, Fig. 502, are as follows :—

Fig. 503 represents the change wheel swing frame, an edge view of which is partly shown at W in Fig. 494. S is a slot narrower at *a* than at *b*. Into this slot fit the studs for carrying the change wheels.

By enabling a feed traverse in either direction the lathe carriage may be traversed back (for screw-cutting operations) without the aid of an extra overhead pulley to reverse the direction of rotation of the lathe, but in long screws it is an advantage to have such extra overhead pulley and to so proportion it as to make the lathe rotate quicker backwards than forward, so as to save time in running the carriage back.

The mechanical devices for transmitting motion from the lead screw to the carriage are shown in Fig. 504, representing a view from the end and one from the back of the lathe. B is a frame or casting bolted by the bolt *b* to the carriage A of the lathe. C is a disk having a handle C′ and having rotary motion from its centre. Instead of being pivoted at its centre, however, it is guided in its rotary motion by fitting at *d d* into a cylindrical recess provided in B to receive it. C contains two slots D and D′ running entirely through it. These slots are not concentric but eccentric to the centre of motion of C. Through these slots there pass two stud bolts E and E′ shown by dotted lines in Fig. 504, and these bolts perform two services: first by reason of the nuts F and F′ they hold C to its place in B, and next they screw into and operate the two halves G and G′ of a nut.

Suppose, now, that the handle C′ be operated or moved towards arrow *e*, then the dot at *f* being the centre of its motion and the slots D and D′ gradually receding from *f* as their ends *g* are approached they will cause E to move vertically upward and E′ to move vertically downward, a slot in B (which slot is denoted by the dotted lines *h*) guiding them and permitting this vertical movement.

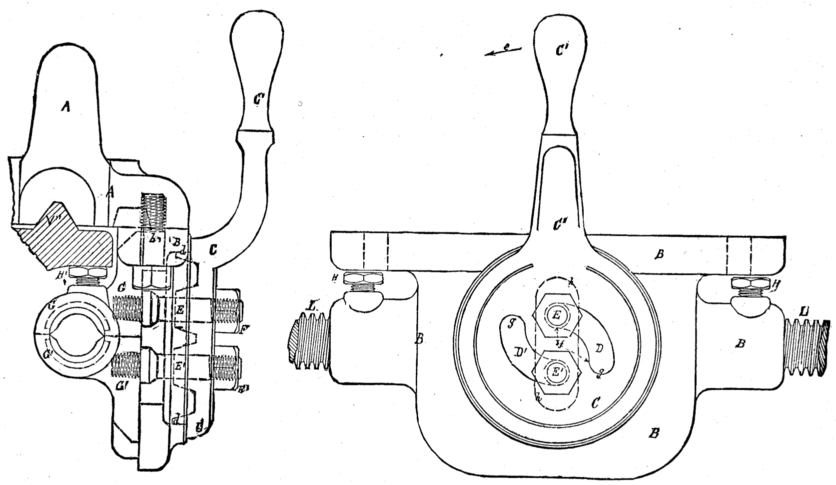

Fig. 504.

Since E and E′ carry the two halves of the nut which envelops the lead screw L it is obvious that operating C′ will either close or release the half nuts from L according to which direction it (C′) is moved in.

The screws H and H′ screw tightly into B, and the radial faces of their heads are made to have a fair and full bearing against the underside of the shears, so that they serve as back gibs to hold the carriage to the shears and may be operated to adjust the fit or to lock the carriage to the bed if occasion may require. This lathe is made with a simple tool rest as shown in the engravings or with a compound slide rest. In some sizes the rest is held to the carriage by a weight upon a principle to be hereafter described. The bed is made (as is usual) of any length to suit the purposes for which the lathe is to be used.

The next addition to the lathe as it appears in the United States is that of a compound slide rest.

Fig. 505 represents a 28-inch swing lathe by the Ames Manufacturing Company, of Chicopee, Massachusetts. It is provided with the usual self-acting feed motion and also with a compound slide rest. The swing frame for the studs carrying the change wheels for screw cutting here swings upon the end of the lead screw, the same spindle that carries the driving cone for the independent feed rod which is in front of the lathe, also carries the driving gear for the change wheels used for screw cutting.

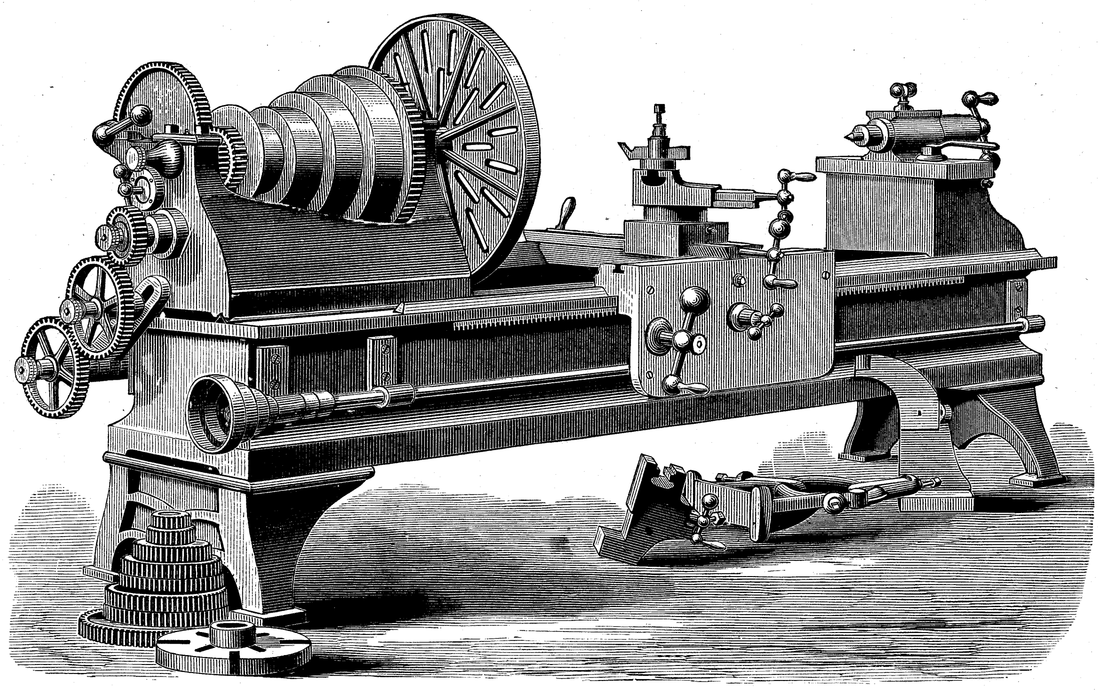

Fig. 505.

The construction of the compound rest is shown in Figs. 506 and 507. N is the nut for the cross-feed screw (not shown in the cut) and is carried in the slide A. A and the piece L above it are virtually in one, since the latter is made separate for convenience of construction and then secured to it firmly by screws. B is made separate from C also for convenience of construction and fixed to it by screws; L is provided with a conical circular recess into which the foot B of C fits. E is a segment of a circle operated by the set screw F to either grip or release B. The bolt D simply serves as a pivot for piece B C; at its foot C is circular and is divided off into the degrees of a circle to facilitate setting it to any designated angle.

If, then, F be unscrewed, C may be rotated and set to the required angle, in which position screwing up F will lock it through the medium of E. G is the feed nut for the upper slider H, which operates along a slide way provided on C, the upper feed screw having journal bearing at C'. I is the tool post, having a stepped

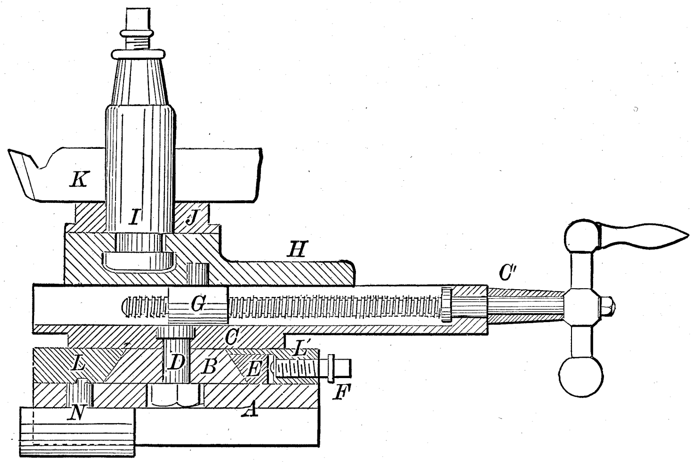

Fig. 506.

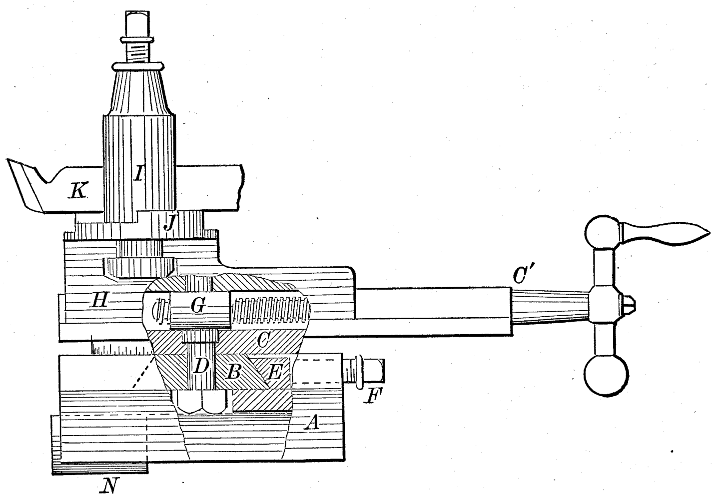

Fig. 507.

washer J, by means of which the height of the tool K may be regulated to suit the work.

Suppose, now, that it be required to turn a shaft having a parallel and a taper part; then the carriage may be traversed to turn the parallel part, and the compound slide C may be set to turn the taper part, while the lower feed screw operating in N may be used to turn radial faces.

The object of making A and L in two pieces is to enable the boring and insertion of B, which is done as follows:—The front end of L as L' is planed out, leaving in it a groove equal in diameter and depth to the diameter and depth of B, so that B may be inserted laterally along this groove to its place in L. The segment E is then inserted and a piece is then fitted in at L' and held fast to A by screws. It is into this piece that the set screw F is threaded.

Various forms of construction are designed for compound rests, but the object in all is to provide an upper sliding piece carrying the tool holder, such sliding piece being capable of being so set and firmly fixed that it will feed the tool at an angle to the line of the lathe centres.

Another and valuable feature of the compound rest is that it affords an excellent method of putting on a very fine cut or of accurately setting the depth of cut to turn to an exact diameter; this is accomplished by setting the upper slide at a slight angle to the line of centres and feeding the tool to the depth of cut by means of the screw operating the upper slide. In this way the amount of feed screw handle motion is increased in proportion to the amount to which the tool point moves towards the line of lathe centres, hence a delicate adjustment of depth of cut may be more easily made.

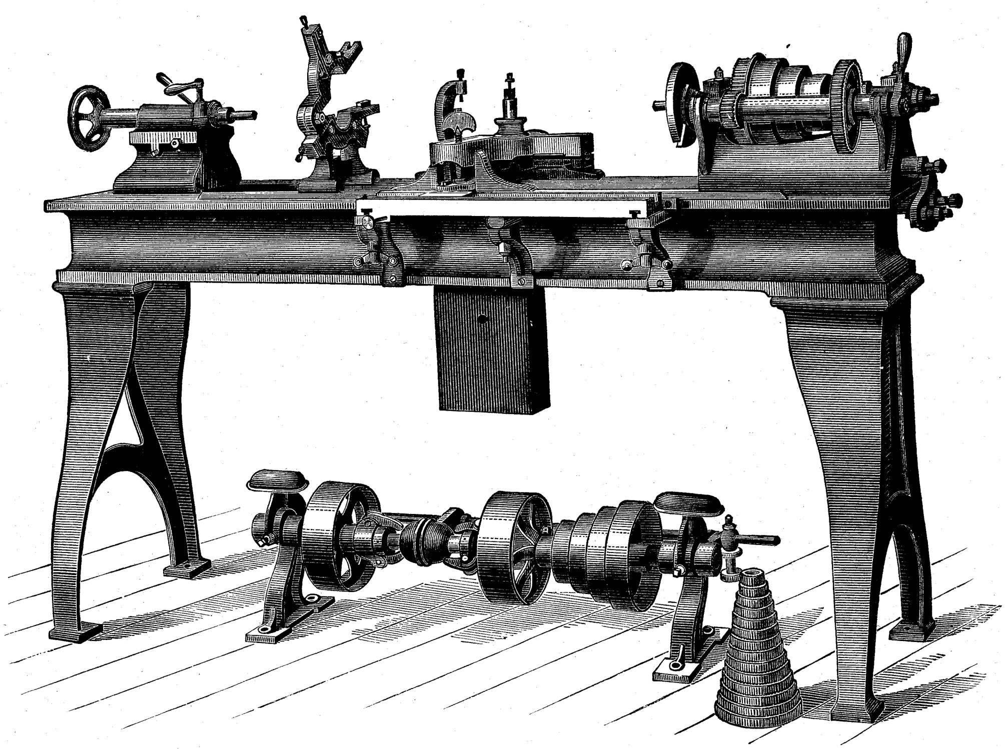

Fig. 508.

Suppose, for example, that a cut be started and that it is not quite sufficiently deep, then, while the carriage traverse is still proceeding, the compound rest may be operated to increase the cut depth, or if it be started to have too deep a cut the compound rest may be operated to withdraw the tool and lessen its depth of cut. Or it may be used to feed the tool in sharp corners when the feed traverse is thrown out, or to turn the tops of collars or flanges when the tailstock is set over to turn a taper.

It is obvious, however, that comparatively short tapers only can be conveniently turned by a compound slide rest; but most tapers, however, are short.

To turn long tapers the tailstock of the lathe is set over as described with reference to the Putnam lathe, but for boring deep

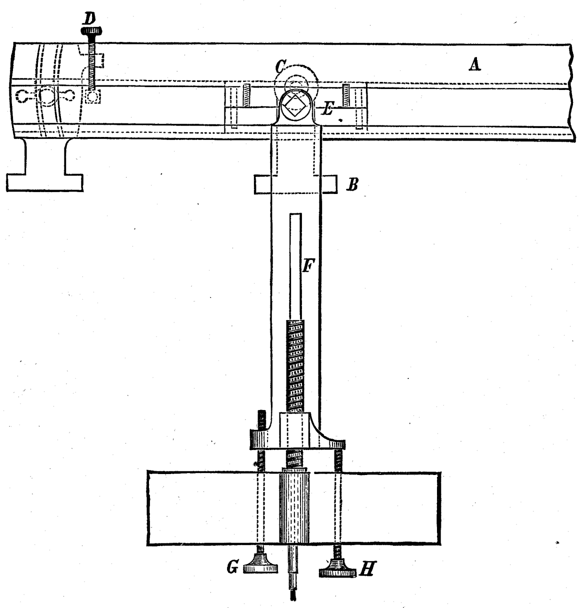

Fig. 509.

holes the slide rest must either be a compound one or a taper turning former or attachment must be employed.

When, however, the tailstock is set over, the centres in the work are apt to wear out of true and move their location (the causes of which will be hereafter explained).

In addition to this, however, the employment of a taper turning attachment enables the boring of taper holes without the use of a compound slide rest, thus increasing the capacity of the lathe not having a simple or single rest.

In Fig. 508 is shown a back view of a Pratt and Whitney weighted lathe having a Slate's taper turning attachment, the construction of which is as follows:—Upon the back of the lathe shears are three brackets having their upper surfaces parallel with and in the same plane as the surface of the lathe shears. Pivoted to the middle bracket is a bar which has at each end a projection or lug fitting into grooves provided in the end brackets, these grooves being arcs of a circle whose centre is the axis of the pivot in the middle bracket.

The end brackets are provided with handled nuts upon bolts, by which means the bar may be fixed at any adjusted angle to the lathe shears. Upon the upper surface of the bar is a groove or way in which slides a sliding block or die, so that this die in traversing the groove will move in a straight line but at an angle to the lathe bed corresponding to the angle at which the bar may be adjusted. The slide rest upon being connected by a bar or rod to the die or sliding block is therefore made to travel at the same angle to the lathe bed or line of centres as that to which the bar is set. The method of accomplishing this in the lathe, shown in Fig. 508, is as follows:—

In Fig. 509 A is the bar pivoted at C upon the centre bracket B; E is the sliding block pivoted to the nut bar F. This nut bar carries the cross-feed nut, which in turn carries the feed screw and hence the tool rest. When the nut bar is attached to the sliding block to turn a taper it is free to move endways upon the lower part of the carriage in which it slides, but when the taper attachment is not in use the bar is fastened to the lower part of the carriage by a set screw.

The screw at D is provided to enable an accurate adjustment for the angle of the bar A. G and H are screws simply serving to adjust the diameter to which the tool will turn after the manner shown in Fig. 588, G being for external and H for internal work.

When the lathe has a bed of sufficient length to require it, a slide is provided to receive the brackets, which may be adjusted to any required position along the slide, as shown in Fig. 510. This is a gibbed instead of a weighted lathe, and the method of attaching the sliding block to the lathe rest is as follows:—

A separate rod is pivoted to the sliding block. This rod carries at its other end a small cross head which affords general bearing to the end of the cross-feed screw, which has a collar on one side of the cross head and a fixed washer on the other, to prevent any end motion of the said screw.

The cross-feed nut is attached to the traversing cross slide. The other or handle end of the cross-feed screw has simple journal bearing in the slide rest, but no radial faces to prevent end motion, so that one may from the rod attached to the sliding-block traverse the cross-feed slide, which will carry with it the feed screw. As a result, the line of motion of the tool rest is governed by the sliding die, but the diameter to which the tool will turn is determined by the feed screw in the usual manner. When it is not required to use the taper attachment, the rod or spindle is detached from the sliding die and is locked by a clamp, when the rest may be operated in the usual manner.

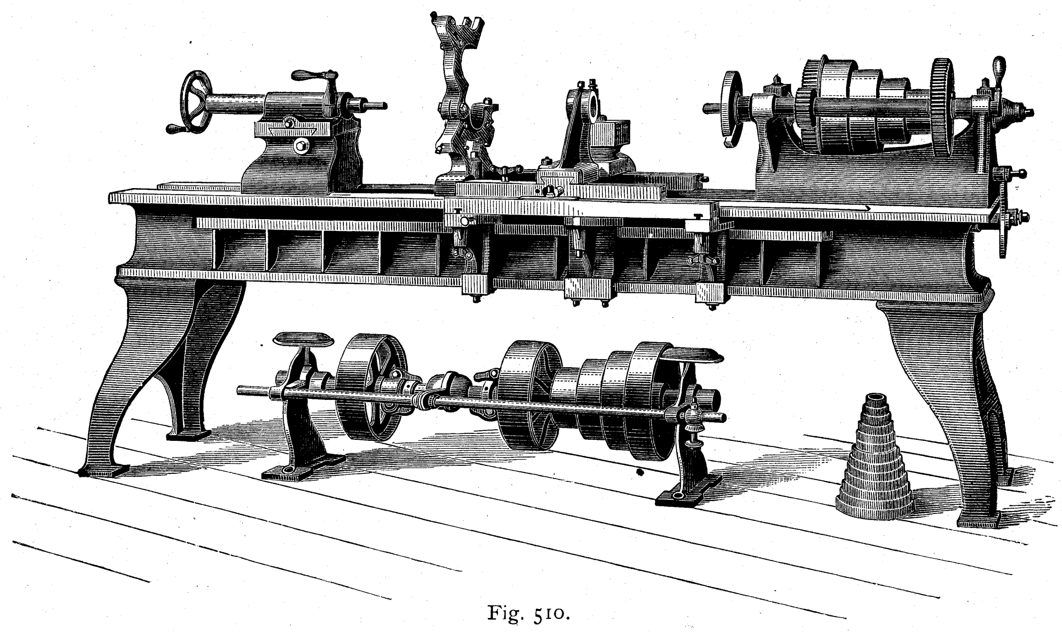

Fig. 510.

Fig. 511 represents a compound duplex lathe of a design constructed by Sir Joseph Whitworth, of Manchester, England.

The two rests are here operated on the same cross slide by means of a right and left-hand cross-feed screw.

The tool for the back rest is here obviously turned upside down.

The lead screw is engaged at two places by the feed nut, which is in two pieces attached to levers; while at a third point in its circumference it is supported by a bracket, bolted to the lathe bed.

Fig. 512 represents the New Haven Manufacturing Company's three tool slide rest, for turning shafting. It is provided

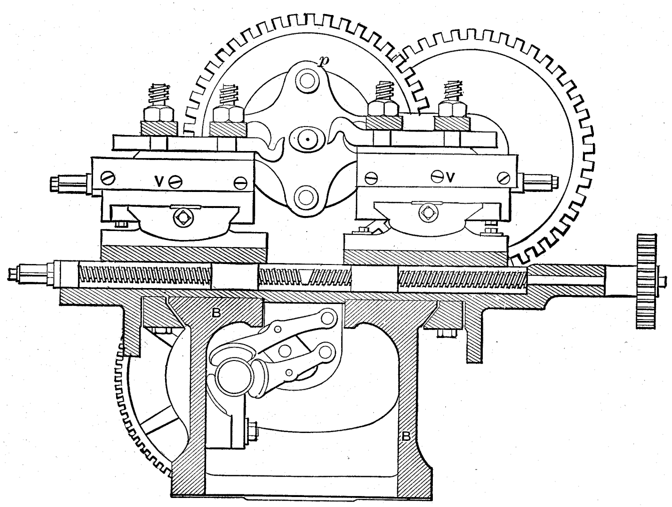

Fig. 511.

with a follower rest, in front of which are two cutting tools for the roughing cuts, and behind which is a third tool for the finishing cut. The follower rest receives bushes, bored to the requisite diameter, to leave a finishing cut. The first tool takes the preliminary roughing cut; the second tool turns the shaft down to fit the bush or collar in the follower rest; and, as stated, the last tool finishes the work.

Fig. 513 represents a 44-inch swing lathe, showing an extra and detachable slide rest, bolted on one side of the carriage and

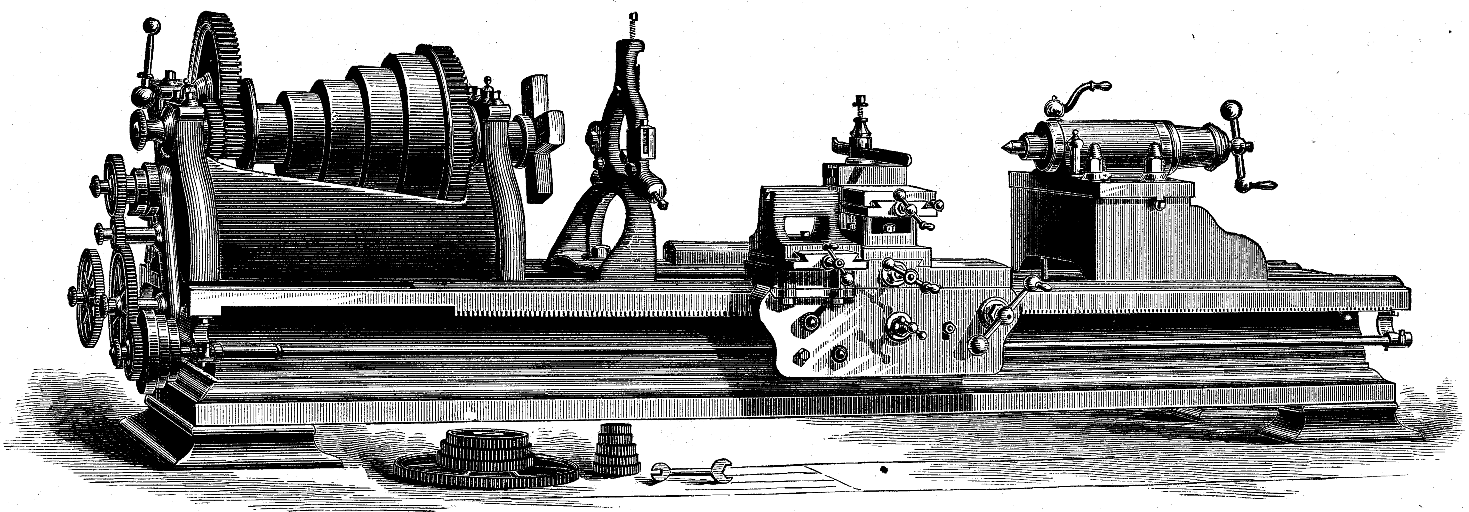

Fig. 513.

intended for turning work of too large a diameter to swing over the slide rest. By means of this extra rest the cutting tool can be held close in the rest, instead of requiring to stand out from the tool-post to a distance equal to the width of the work. The ordinary tool post is placed in this extra rest.

When it is desired to bolt work on the lathe carriage and rotate the cutting tools, as in the case of using boring bars, the cross slide is sunk into instead of standing above the top surface of the carriage so as to leave a flat surface to bolt the work to, and T-shaped slots are provided in the carriage, to receive bolts for fastening the work to the carriage, an example of this kind being shown in Fig. 514.

Fig. 515 represents a self-acting slide or engine lathe by William Sellers and Co., of Philadelphia. These lathes are made in various sizes from 12 inches up to 48 inches swing on the same general design, possessing the following features:—The beds or shears are made with flat tops, the carriage being gibbed to the edges of the shears, these edges being at a right angle to the top face of the bed. The dead centre spindle is locked at each end of its bearing in the tailstock, thus securing it firmly in line with the live spindle. The ordinary tool feed is operated by a feed rod in front of the lathe, and this rod is operated by a disc feed, which may be altered without stopping the lathe so as to vary the rate of tool feed; and an index is provided whereby the operator may at once set the discs to give the required rate of feed. The lead screw for screw cutting is

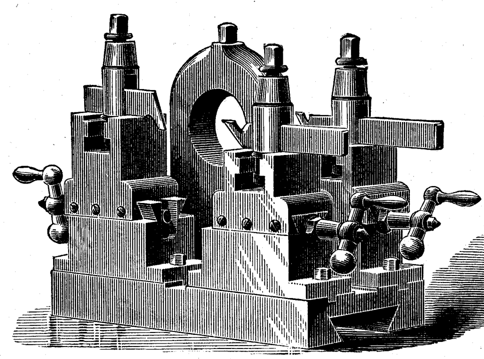

Fig. 512.

placed in a trough running inside the lathe bed, so that it is nearer to the cutting tool than if placed outside that bed, while it is entirely protected from the lathe cuttings and from dirt or dust; and the feed-driving mechanism is so arranged that both may be in gear with the live spindle, and either the rod feed or screw-cutting feed may be put into action instantly, while putting one into action throws the other out, and thus avoid the breakage that occurs when both may be put into action at the same time. The direction of the turning feed is determined by the motion of a lever conveniently placed on the lathe carriage, and the feed may be stopped or started in either direction instantly. The mechanism for putting the cross feed in action is so constructed (in those lathes having a self-acting cross feed) that the cross feed cannot be in action at the same time as the turning feed or carriage traverse by rod feed.

Lathes of 12 and 16 inches swing are back-geared, affording six changes of speed, and the lathe tool has a vertical adjustment on a single slide rest. Lathes of 20 inches swing are back-geared with eight changes of speed. Lathes of 25 inches and up to 48 inches swing inclusive are triple-geared, affording fifteen changes of speed, having a uniformly progressive variation at each change.

The construction of the live head or headstock for a 36-inch lathe is shown in the sectional side view in Fig. 516, and in the top view in Fig. 517, and it will be seen that there are five changes of speed on the cone, five with the ordinary back-gear, and five additional ones obtained by means of an extra pinion on the end of the back-gear spindle, and gearing with the teeth on the circumference of the face plate, the ordinary pinion of the back-gear moving on the back-gear spindle so as to be out of the way and clear the large gear on the cone spindle when the wheel of the extra back-gear pinion is in use, as shown in Fig. 517.

The front bearing of the live spindle is made of large diameter to give rigidity, and the usual collar for the face plate to screw against is thus dispensed with. End motion to the live spindle is prevented by a collar of hardened steel, this collar being fast on the live spindle and abutting on one side against the end face of the back bearing and on the other against a hardened steel thrust collar.

All these parts are enclosed in a tight cast-iron tail-block, which serves as an oil well to insure constant and perfect lubrication. The surfaces which confine the revolving collar back and front are so adjusted as to allow perfect freedom of rotary motion to the spindle and collar, but no perceptible end motion. The securing of the live spindle endwise is thus confined to the thickness of the steel collar only, and this is so enclosed in a large mass of cast iron as to insure uniformity of temperature in all its parts, hence there is no liability for the live spindle to stick or jam in its bearings, while the expansion of the live spindle endways from this collar (if it expands more than the lathe head) is allowed for in freedom of end motion through the front journal, which is a little longer than the bearing it runs in. In turning work held between the lathe centres the end thrust is taken against the hardened steel collar on the live spindle, and the hardened steel collar at the back of it, while in turning work chucked to the face plate the spindle is held in place endways by the confinement of the steel collar on the spindle between the steel collar behind it and the back end of the back bearing. With this arrangement of the spindle the change from turning between the lathe centres and turning chucked work requires no thought or attention to be given to any adjustment of the live spindle to accommodate it for the changed condition of end pressure between turning between the centres and turning chucked work, as is the case in ordinary lathes.

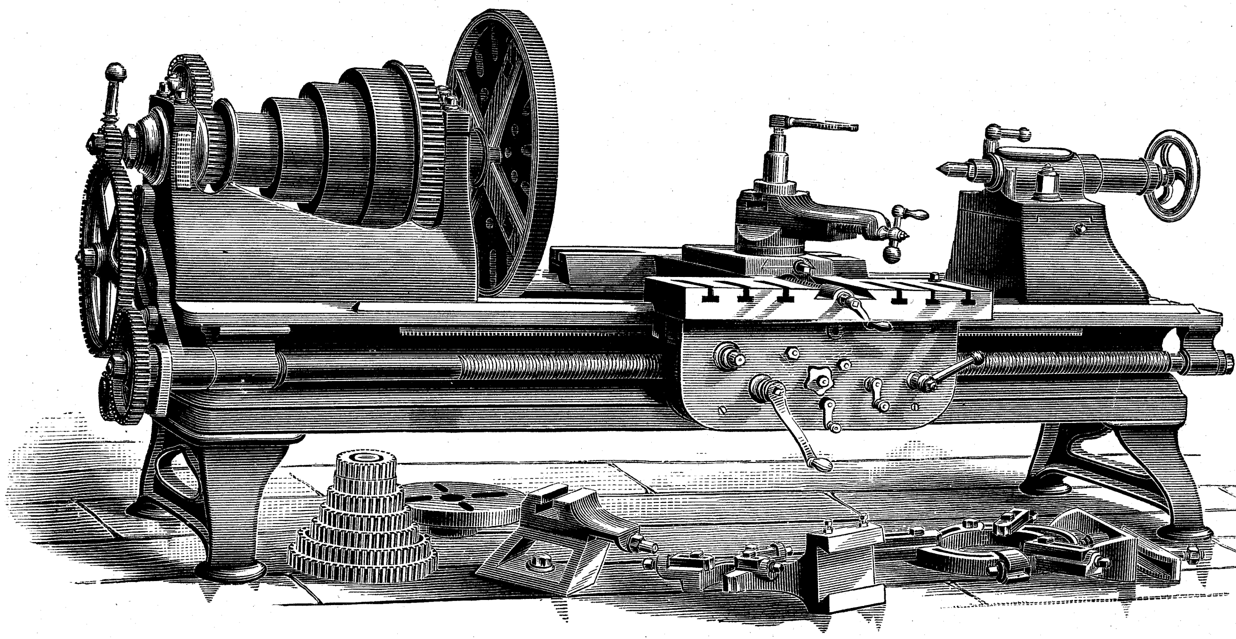

Fig. 514.

The double-geared lathes, as those of 12, 16 and 20 inches swing, are provided with face plates that unscrew from the live spindle to afford convenience for changing from one size of face plate to another, and all such lathes have their front live spindle journal made of sufficiently enlarged diameter above that of the screw, to afford a shoulder for the face plate to abut against. The nose of the live spindle is not threaded along its entire length, but a portion next to the shoulder is made truly cylindrical but without any thread upon it, and to this unthreaded part the face plate accurately fits so that it is held true thereby, and the screw may fit somewhat loosely so that all the friction acts to hold the

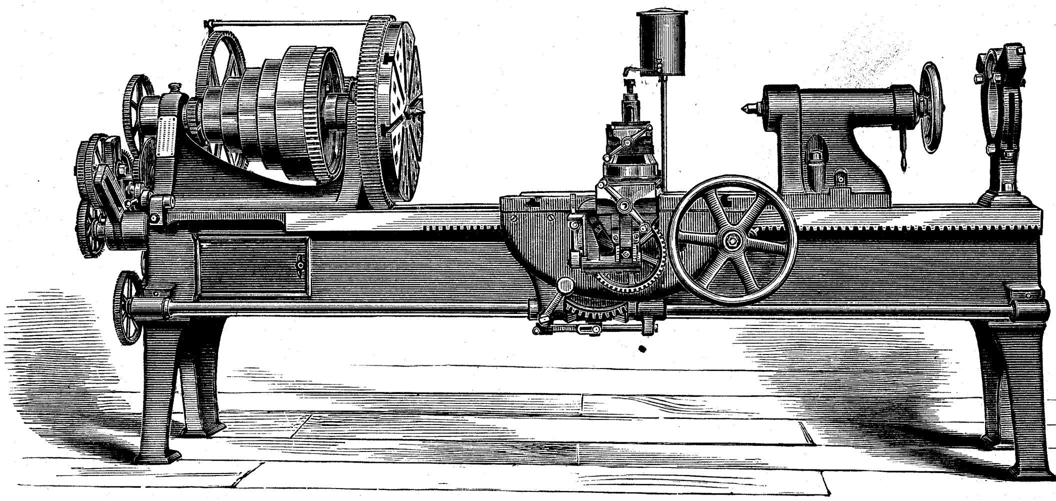

Fig. 515.

face plate true and hard up against the trued face of the spindle journal. Face plates fitted in this way may be taken off and replaced as often as need be, with the assurance that they will be true when in place unless the surfaces have been abused in their fitting parts.

The construction of the tailstock or poppet-head, as it is sometimes termed, is shown in Figs. 518, 519, and 520. To hold it in line with the live spindle it is fitted between the inner edges of the bed, and it will be seen that one of the bed flanges (that on the left of the figure) is provided on its under side with a V, and the clamp is provided with a corresponding V, so that in tightening up the bolt that secures the tailstock to the bed the tailstock is drawn up to the edge of the shears, and therefore truly in line with the live spindle, while when this bolt is released the tailstock is quite free to be moved to its required position in the length of the bed. As a result of this form of design there is no wear between the clamp and the underneath V, and the tailstock need not fit tightly between the edges of the bed, hence wear between these surfaces is also avoided, while the tailstock is firmly clamped against one edge of the bed as soon as the clamp is tightened up by the bolt on that side.

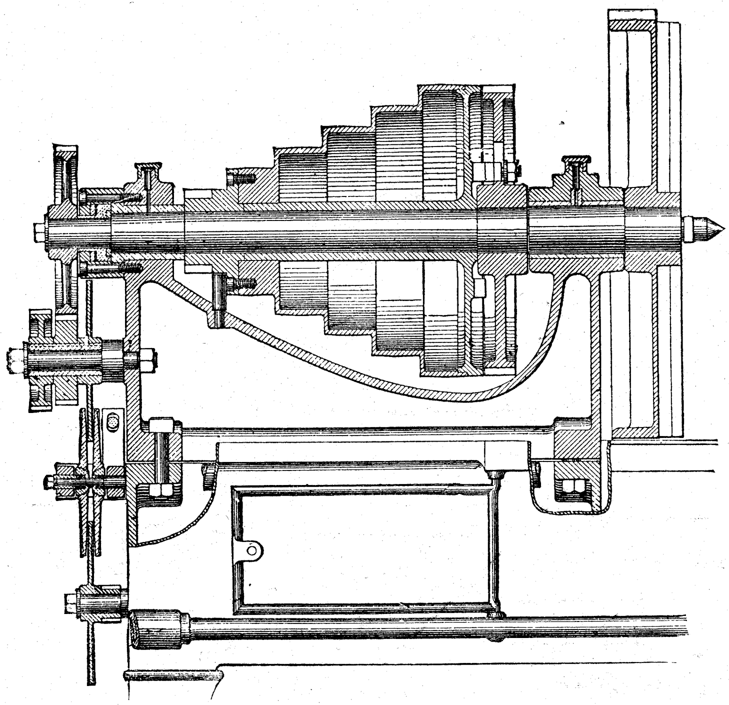

Fig. 516.

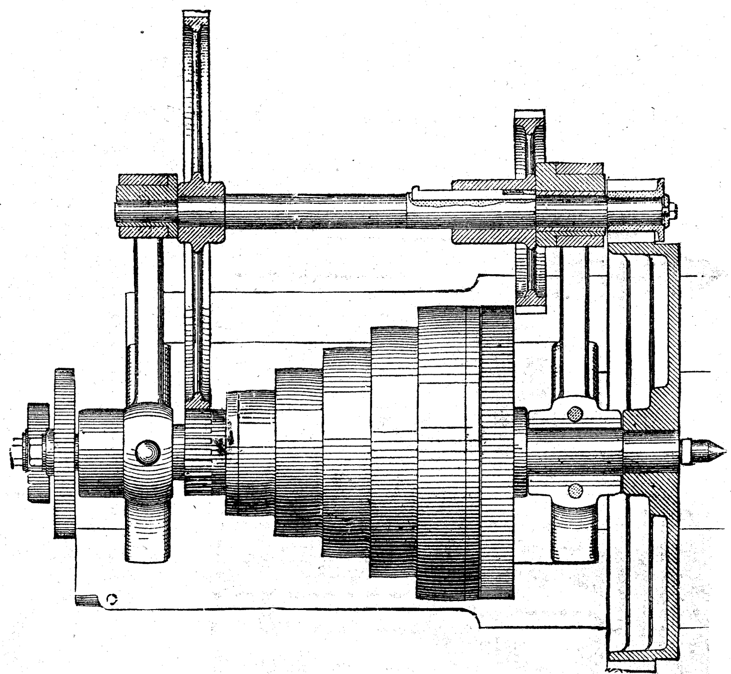

Fig. 517.

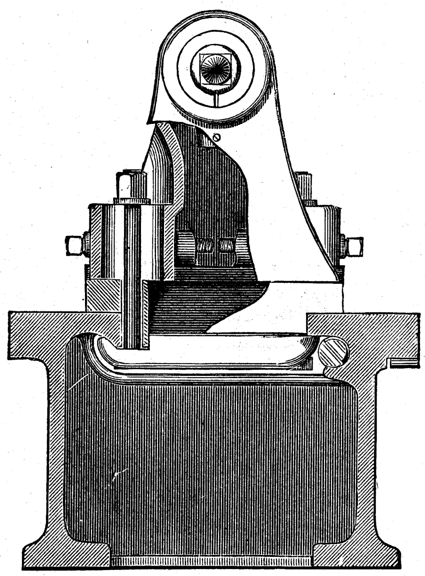

Fig. 518.

Fig. 520 shows the method of locking the tailstock spindle and of preventing its lateral motion in the bearing in the tailstock. At the front or dead centre end of this bearing there is between the spindle a sleeve enveloping the spindle, and coned at its outer end, fitting into a corresponding cone in the bore of the tailstock. Its bore is a fit to the dead spindle, and it is split through on the lower side. Its inner end is threaded to a sleeve that is within the headstock, and whose end is coned to fit a corresponding cone at the inner end of the bore of the tailstock.

To this second sleeve the line shown standing vertically on the left of the hand wheel is attached, so that operating this handle revolves the second sleeve and the two sleeves screw together, their coned ends abutting in their correspondingly coned seats in the tailstock bore, and thus causing the first-mentioned and split sleeve to close upon the dead centre spindle and yet be locked to the tailstock.

As the bore of the tailstock is exactly in line with the live spindle, it follows that the dead spindle will be locked also in line with it.

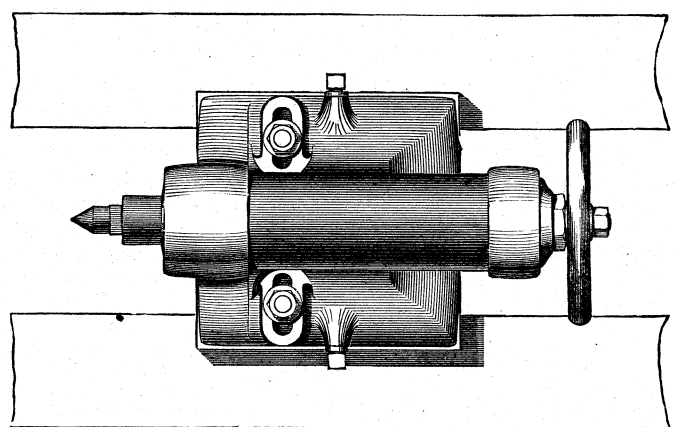

Fig. 519.

Figs. 521 and 522 represent sectional views of the carriage and slide rest of these lathes of a size over 16 inches swing. On the feed rod there are two bevel pinions P, one on each side of the bevel-wheel A, and by a clutch movement either of these wheels may be placed in gear with bevel-wheel A.

The clutch motion is operated by a lever which, when swung over to the right, causes the bevel pinion on the right to engage with the bevel-wheel A, and the carriage feeds to the right, while with the lever swung over to the left the carriage feeds to the left.

On the inclined shaft is a worm, or, as the makers term it, a spiral pinion of several teeth which gears into a straight toothed spur gear-wheel, giving a smooth and rolling tooth contact, and therefore producing an even and uniform feed motion.

This spur gear is fast on a shaft C, which is capable of end motion and is provided on each of its side faces with an annular toothed clutch. On each side of this spur-wheel is a clutch, one of which connects with the train of gears for the turning feed, and the other with the cross-feed gear B.

When the shaft (whose end is shown at C, and to which the spur gear referred to is fast) is pulled endways outwards from the lathe bed, its front annular clutch engages with the clutch that sets the cross-feed gear B in motion, and B engages with a pinion which forms the nut of the cross-feed screw.

When shaft C is moved endways inwards its other annular clutch engages the clutch on that side of it, and the turning feed is put into operation. The method of operating shaft C endways is as follows :—

In a horizontal bearing D is a shaft at whose end is a weighted lever L, and on the end of this shaft is a crank pin shown engaging a sleeve E which affords journal bearing to the outer end of shaft C, so that operating the weighted lever L operates E, and therefore shaft C with the spur gear receiving motion from the worm. A simple catch confines lever L to either of its required limits of motion, and allows the free motion of the operating lever to start or stop either the longitudinal or the cross feed, either of which is started or stopped by this lever, but no mistake can occur as to which feed is operated, because the catch above mentioned requires to be shifted to permit the feed to be operated.

The lower end of the bell crank F engages with the sleeve E, so that when the shaft C is operated outwards the horizontal arm of bell crank F is depressed and the spur pinion of the cross-feed nut is free to revolve, being driven by the cross-feed motion. When the lever F is moved towards the lathe bed (which occurs when the stop or catch is set to allow the longitudinal feed to be used) the nut of the cross feed is locked fast by the horizontal arm of the bell crank F. This device makes the whole action from one direction of feed to another automatic, and the attention of the workman is not needed for any complicated adjustment of parts preparatory to a change from one feed to the other.

At H is a hand wheel for hand feeding, the pinion R meshing into the rack that extends along the front of the lathe bed; back of the hand wheel and at H′ a clamp is provided whereby the saddle or carriage may be locked to the lathe bed when the cross feed is being used, thus obviating the use of a separate clamp on the bed.

The top slide of the compound rest is long and its guideway is short, the nut being in the stationary piece G, and it will be observed that by this arrangement at no time does the bearing surfaces of the slides become exposed to the action of chips or dirt.

Fig. 523 is a sectional view of the carriage and slide rest as arranged for 12 and 16-inch lathes when not provided with a self-acting cross feed. In this case end motion to shaft C is given by lever H, which is held in its adjusted position by the tongue T. In this lathe the screw-cutting and the turning feed cannot be put into gear at the same time.

The tool nut is arranged to enable the tool to be adjusted for height after it is fastened in the tool post by pivoting it to the cross slide, a spring S forcing it upwards at its outer end, thus holding the tool point down and in the direction in which the pressure of the cut forces it, thus preventing the wear of the pivot from letting the tool move when it first meets the cut. The nut N is operated to adjust the tool height, and at the same time enables the depth of cut to be adjusted very minutely. A trough catches the water, cuttings, &c., and thus protects the slides and slideways from undue wear.

In all these lathes the feeding mechanism is so arranged that there are no overhanging or suspended shaft pins or spindles, each of such parts having a bearing at each end and not depending on the face surface of a collar or pin, as is common in many

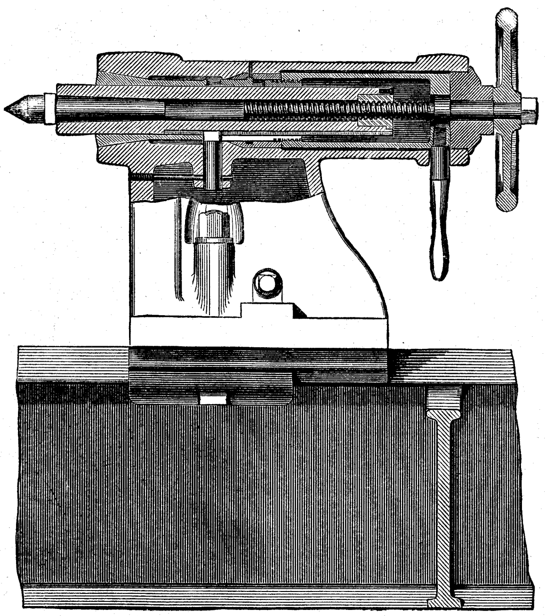

Fig. 520.

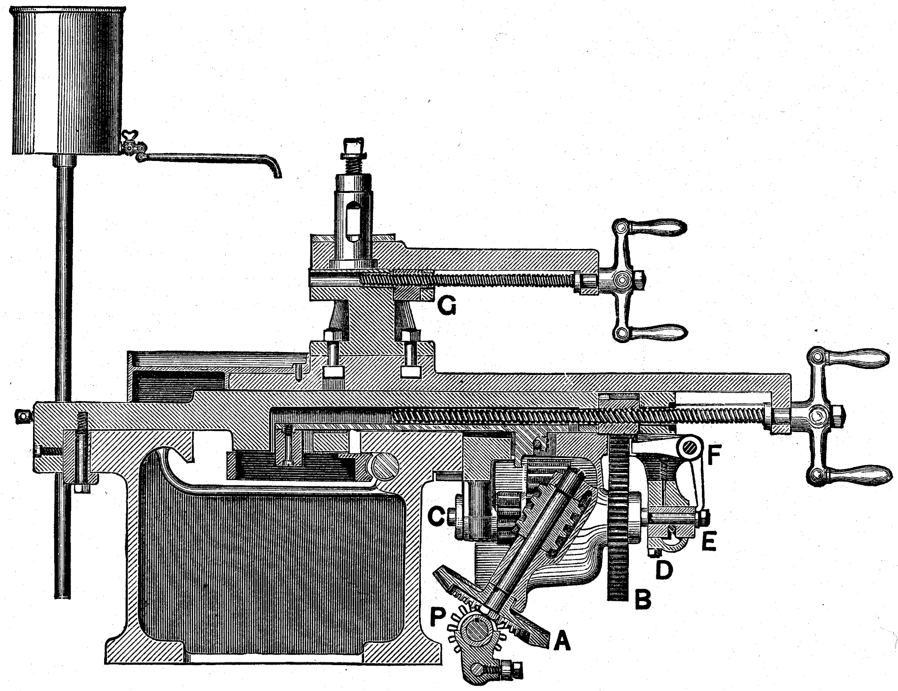

Fig. 521.

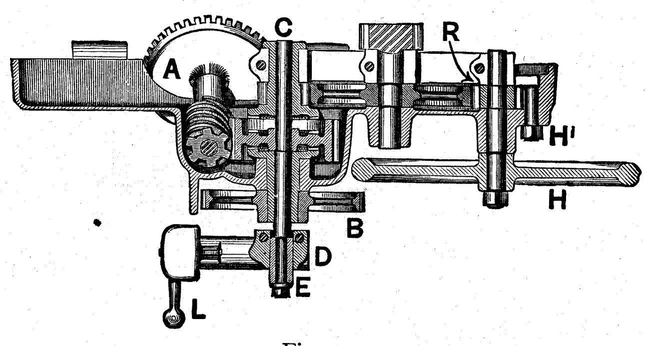

Fig. 522.

lathes. Furthermore, in these lathes the handle for the hand carriage feed moves to the right when the carriage moves to the right; the cross-feed screw (and the upper screw also in compound slide rests) has a left-hand thread, so that the nut being fixed the slides move in the same direction as though the nut moved as in ordinary lathes. The tailstock or poppet-head screw is a right hand because the nut moves in this case. The object of employing right-hand screws in some cases, and left-hand ones in others, is that it comes most natural in operating a screw to move it from right to left to unscrew, and from left to right to screw up a piece, this being the action of a right-hand screw, left-hand screws being comparatively rarely used in mechanism, save when to attain the object above referred to.

Fig. 524 represents the Niles Tool Works car axle lathe, forming an example in which the work is driven from the middle of its length, leaving both ends free to be operated upon simultaneously by separate slide rests.

The work being driven from its centre enables it to rotate upon two dead centres, possessing the advantage that both being locked fast there is no liberty for the work to move, as is the case when an ordinary lathe having one live or running spindle is used, because in that case the live spindle must be held less firmly and rigidly than a dead centre, so as to avoid undue wear in the live spindle bearings; furthermore, the liability of the workman to neglect to properly adjust the bearings to take up the wear is avoided in the case of two dead centres, and no error can occur because of either of the centres running out of true, as may be the case with a rotating centre.

The cone pulley and back gear are here placed at the head of the lathe driving a shaft which runs between the lathe shears and drives a pinion which gears with the gear on the work driving head shown to stand on the middle of the shears. This head is hollow so that the axle passes through it. On the face of this gear is a Clement's equalizing driver constructed upon the principle of that shown hereafter in Fig. 756.

The means for giving motion to the feed screw and for enabling a quick change from the coarse roughing feed to a finer finishing feed to the cutting tool without requiring to change the gears or alter their positions, is shown in Fig. 525. *a* and *b* are two separate pinions bored a working fit to the end of the driving shaft S, but pierced in the bore with a recess and having four notches or featherways *h*. The end of the driving shaft S is pierced or bored to receive the handled pin *i*, and contains four slots to receive the four feathers *j* which are fast in *i*. In the position shown in the figure these feathers engage with neither *a* nor *b*, hence the driving shaft would remain motionless, but it is obvious that if pin *i* be pushed in the feathers would engage *b* and therefore drive it; or if *i* were pulled outwards the feathers would engage *a* and drive it, because *a* and *b* are separate pinions with a space or annular recess between them sufficient in dimensions to receive the feathers. The difference in the rate of feed is obviously obtained through the difference in diameters of the pair of wheels *a, c* and the pair *d, b*, the lathe giving to the lead screw the slowest motion and, therefore, the finest feed.

The means for throwing the carriage in and out of feed gear with the feed screw and of providing a hand feed for operating the tool in corners or for quickly traversing the carriage, is shown in Fig. 526, in which S represents the feed screw and B a bracket

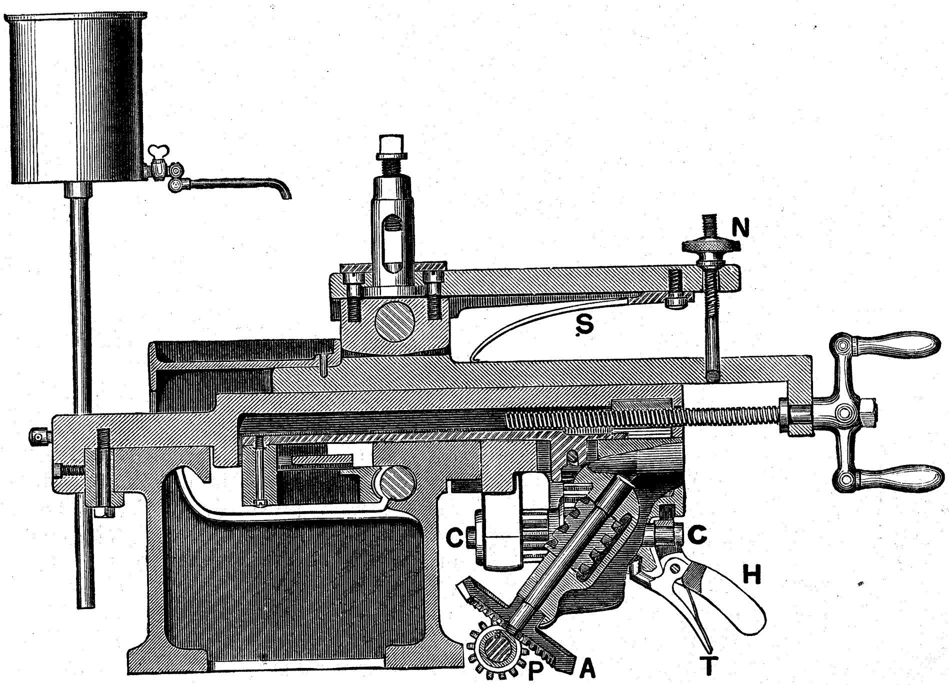

Fig. 523.

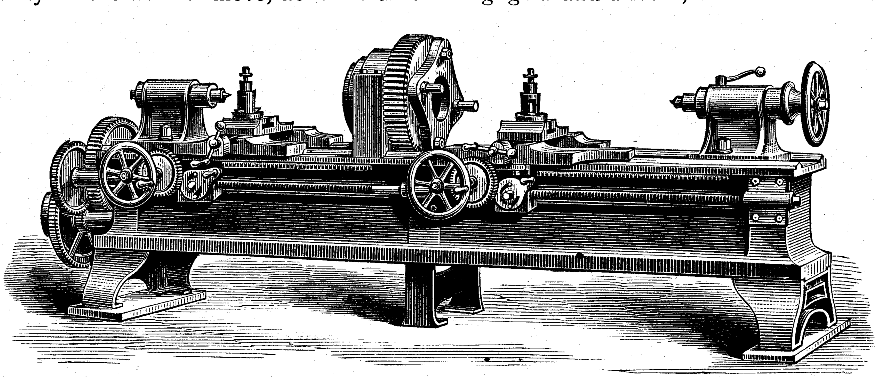
Fig. 524.

or casting bolted to the carriage and carrying the hand wheel and feed mechanism shown in the general cut figure.

B provides a slide way denoted by the dotted lines at *b*, for the two halves N and N′ of the feed nut. It also carries a pivot pin shown at *p* in the front elevation, which screws into B as denoted

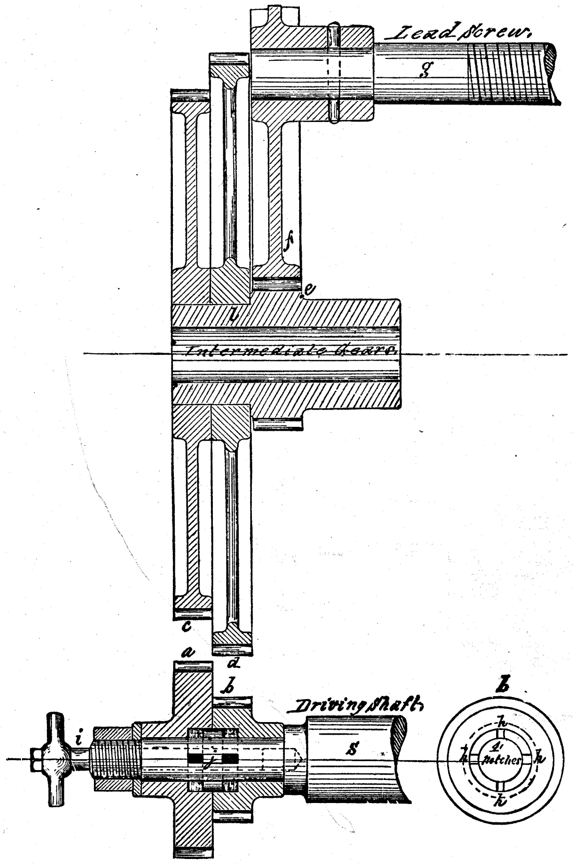

Fig. 525.

by *p*′ in the end view ; upon this pivot operates the piece D, having the handle *d*. In D are two cam grooves *a a* ; two pins *n*, which are fast in the two half-nuts N N′, pass through slots *c c* in B, and into the cam grooves *a a* respectively.

As shown in the cut the handle *d* of D is at its lowest point, and the half-nuts N′ and N are in gear upon the feed screw; but suppose *d* be raised, then the grooves *a a* would force their respective pins *n* up the slots *c*, and these pins *n* being each fast to a half of the nut, the two half-nuts would be opened clear of the feed screw, and the carriage would cease to be fed.

The hand-feed or guide-carriage traverse motion is accomplished as follows :—B provides at *e* journal bearing to a stud on which is the hand wheel shown in the general cut; attached to this hand wheel is a pinion operating a large gear (also seen in general cut) whose pitch line is seen at *g*, in figure. The stud carrying *g* has journal bearing at *f*, and carries a pinion whose pitch circle is at *h* and which gears with the rack.

Fig. 527, which is taken from *The American Machinist*, represents an English self-acting lathe capable of swinging work of 12 inches diameter over the top of the lathe shears, which are provided with a removable piece beneath the live centre, which when removed leaves a gap, increasing the capacity of the lathe swing. The gears for reversing the direction of feed screw motion are here placed at the end of the live head or headstock, the screw being used for feeding as well as for screw cutting

Fig. 528 represents a pattern-maker's lathe, by the Putnam Tool Co., of Fitchburg, Massachusetts. This lathe is provided with convenient means of feeding the tool to its cut by mechanism instead of by hand, as is usually done by pattern-makers, and this improvement saves considerable time, because the necessity of frequently testing the straightness of the work is avoided.

It is provided with an iron extension shears, the upper shears sliding in V-ways provided in the lower one. The hand-wheel is connected with a shaft and pinion, which works in a rack, and is used for the purpose of changing the position of the upper bed, which is secured in its adjusted position by means of the tie bolts and nuts, as shown on the front of the lower shears. This enables the gap in the lower shears to be left open to receive work of large diameter, and has the advantage that the gap need be opened no more than is necessary to receive the required length of work. The slide-rest is operated by a worm set at an angle, so as to operate with a rolling rather than a sliding motion of the teeth, and the handle for operating the worm-shaft is balanced. The carriage is gibbed to the bed. The largest and smallest steps of the cone pulley are of iron, the intermediate steps being of wood, and a brake is provided to enable the lathe to be stopped quickly. This is an excellent improvement, because much time is often lost in stopping the lathe while running at a high velocity, or when work of large diameter is being turned. The lathe will swing work of 50 inches within the gap, and the upper shears will move sufficiently to take in 4 additional feet between the centres.

In the general view of the lathe, Fig. 528, the slide-rest is shown provided with a T-rest for hand tools, but as this sets in a clip or split bore, it may readily be removed and replaced by a screw tool, poppet for holding a gauge, or other necessary tool. To enable the facing of work when the gap is used, the extra attachment shown in Figs. 529 and 530 is employed. It consists of an arm or bar A, bolted to the upper shears S by a bolt B, and clamp C, in the usual manner, and is provided with the usual slideway and feed-screw *f* for operating the lower slide T, which carries a hollow stem D ; over D fits a hub K, upon the upper slide E, which hub is split and has a bolt at F, by means of which the upper slide may be clamped to its adjusted angle or position. The upper slider H receives the tool-post, which is parallel and fits in a split hub, so that when relieved it may be rapidly raised or lowered to adjust the height of the tool.

The construction of the brake for the cone pulley is shown in Figs. 531 and 532, in which P represents the pulley rim, L the brake lever, S a wooden shoe, and W a counter-weight. The lever is pivoted at G to a lug R, provided on the live headstock, and the brake obviously operates on the lowest part of the cone flange ; hence the lever handle is depressed to put the brake in action.

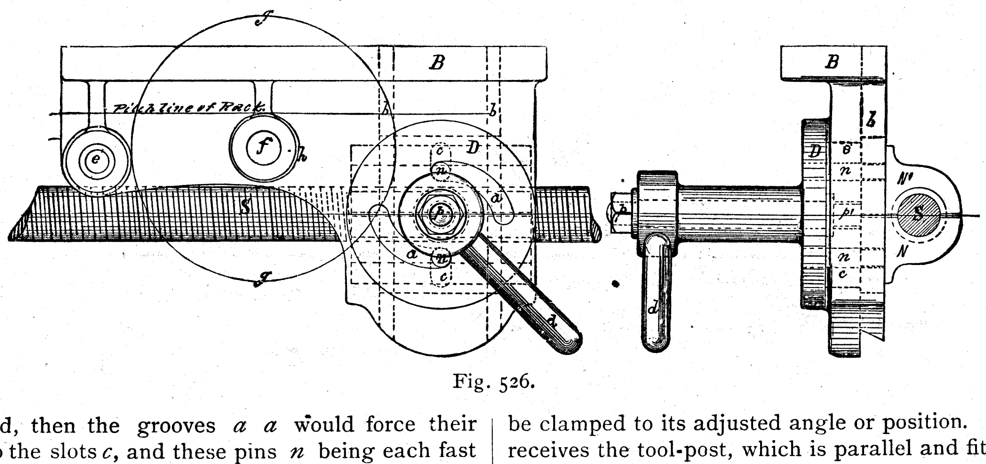

Fig. 526.

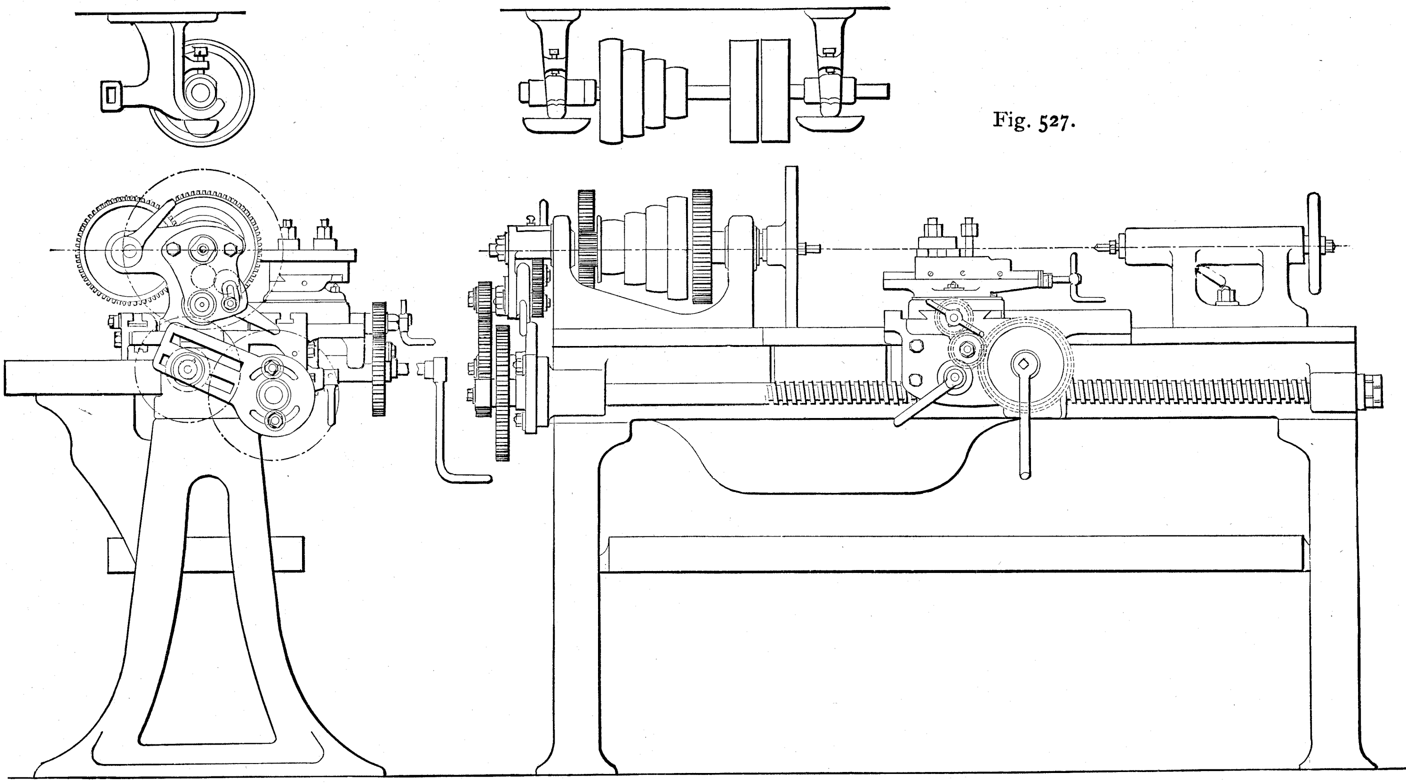

Fig. 527.

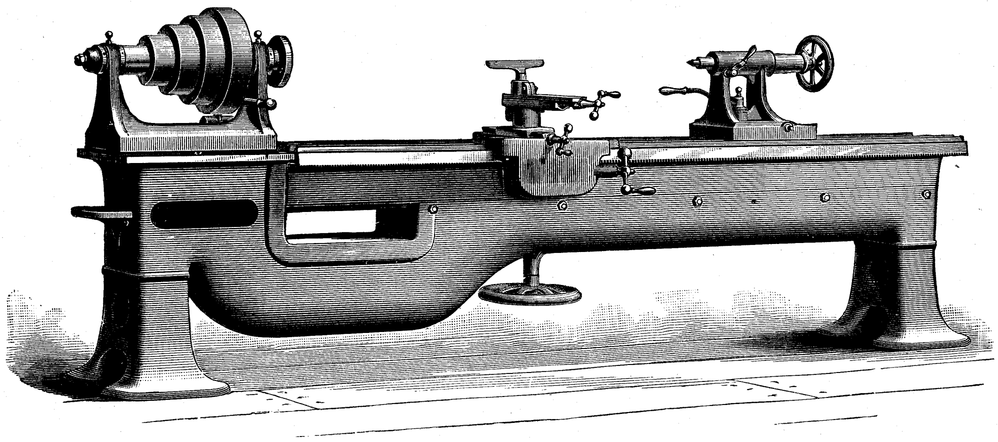

Fig. 528.

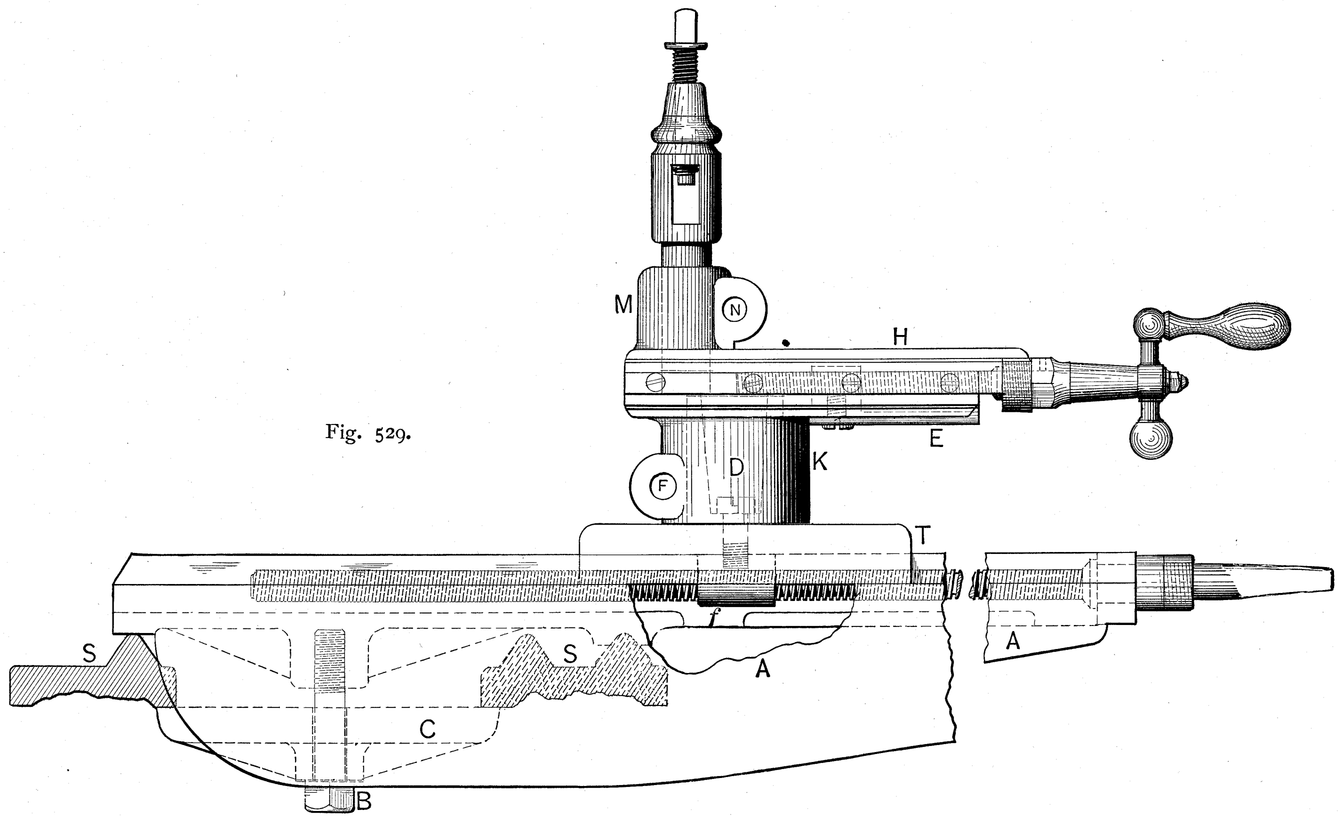

Fig. 529.

The construction of the front and back bearings for the live spindle is the same as that shown in Figs. 495 and 496.

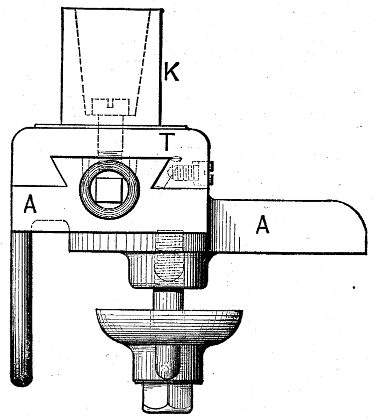

Fig. 530.

Wood turners sometimes have their lathes so made that the headstock can be turned end for end on the lathe shears, so that

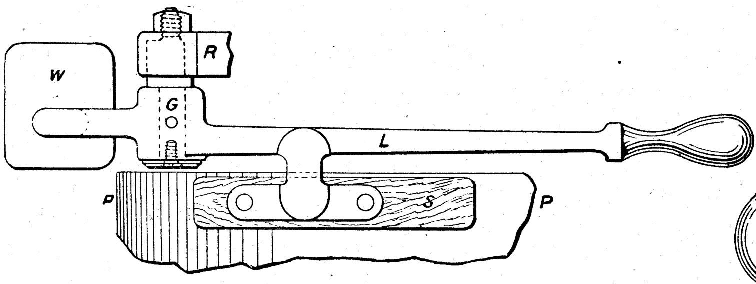

Fig. 531.

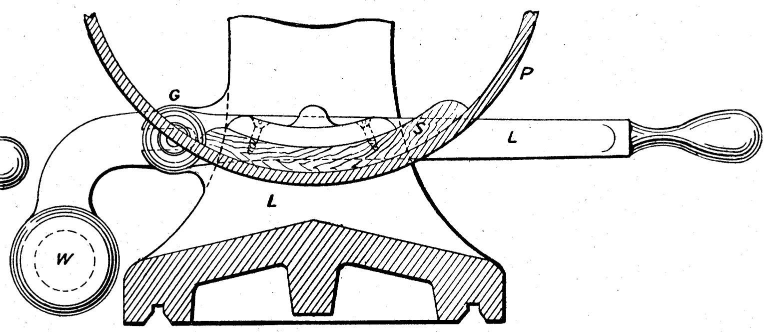

Fig. 532.

the face plate may project beyond the bed, enabling it to turn work of large diameter. A better method than this is to provide the projecting end of the lathe with a screw to receive the face plate as shown in Fig. 533, which represents a lathe constructed by

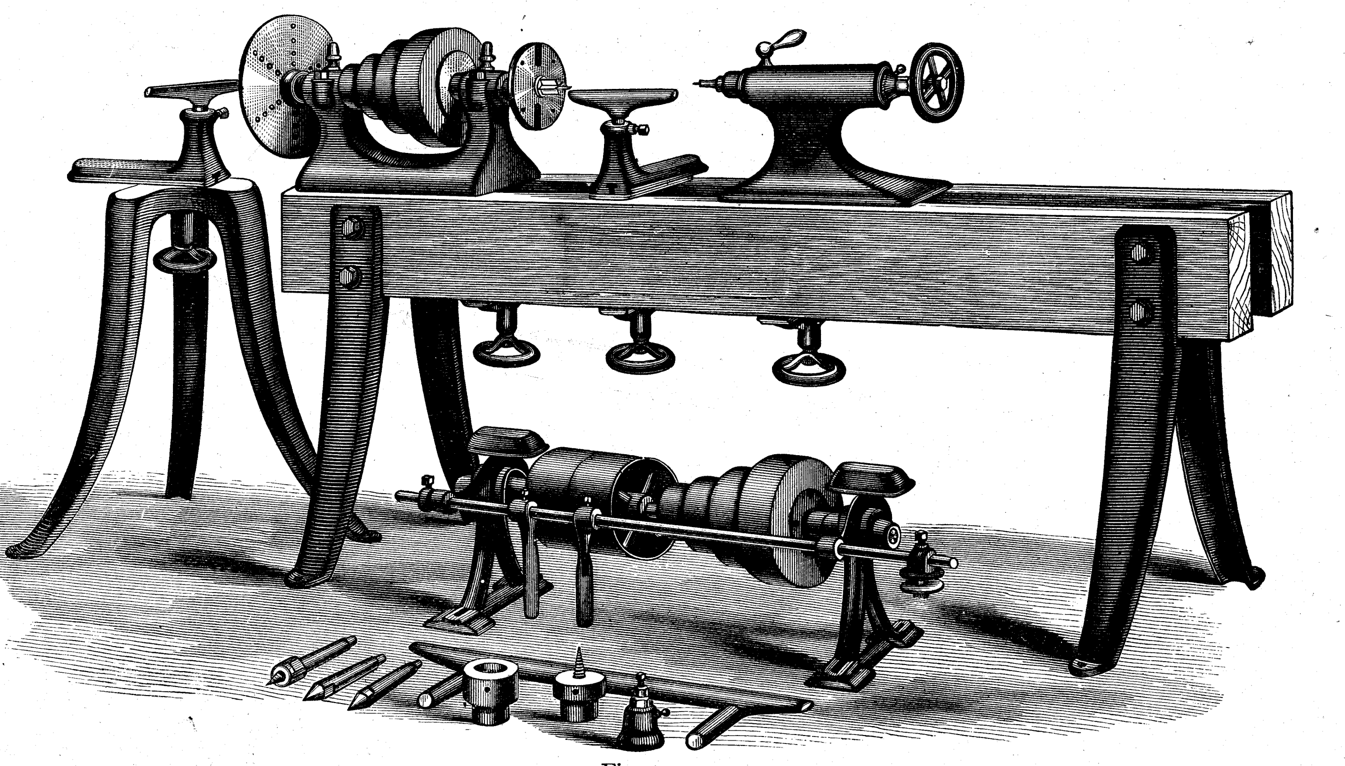
Fig. 533.

Walker Brothers of Philadelphia. At the end of the lathe is shown a hand rest upon a frame that can be moved about the floor to accommodate the location, requiring to be turned upon the work.

For very large work, wood-workers sometimes improvise a facing lathe, as shown in Fig. 534, in which A is a headstock bolted to the upright B; C is the cone pulley, and E a face plate built up of wood, and fastened to an iron face plate by bolts. The legs A, of the tripod hand rest, Fig. 535, are weighted by means of the weights B.

In Fig. 536 is shown a chucking lathe, especially adapted for boring and facing discs, wheels, &c. The live spindle is driven by a worm-wheel, provided around the circumference of the face plate. The driving worm (which runs in a cup of oil) is on a driving shaft, running across the lathe and standing parallel with the face of the face plate. This shaft is driven by a pulley as shown, changes of speed being effected by having a cone pulley on the counter-shaft and one on the line of shafting.

This lathe is provided with two compound slide rests. One of which may be used for boring, while the other is employed for facing purposes. These rests are adjustable for location across the bed of the lathe by means of bolts in slots, running entirely across the lathe bed.

These slide rests are given a self-acting motion by the following arrangement of parts: at the back of the live spindle is an eccentric rod, operating a connecting rod, which is attached at its lower end to the arm of a shaft running beneath the bed, and parallel to the lathe spindle. This shaft passes beyond the bed where it carries a bevel gear-wheel, which meshes with a bevel gear-wheel upon a cross shaft. This cross shaft carries three arms, one at each end and inside its journal bearings in the bed, and one beneath and at a right angle to the other two. These receive oscillating motion by reason of the eccentric connecting rod, &c.

For each compound rest there are provided two handles as usual, and in addition an **L** lever, one arm of the latter being provided with a series of holes, while the other carries a weight.

The **L** lever carries a pawl which operates a ratchet wheel, placed on the handle end of the slide rest cross feed screw. If then a

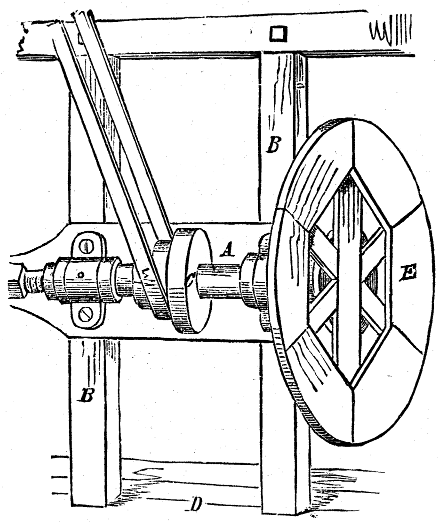

Fig. 534.

chain be attached to one of the holes of the **L** lever, and to the oscillating arm, the motion in one direction of the latter will be imparted to the **L** lever (when the chain is pulled). On the return motion of the oscillating arm, the chain hangs loose, and the weight on the **L** lever causes that lever arm to fall, taking up the slack of the chain, the feed taking place (when the pawl is made to engage with the ratchet wheel) during the motion of the oscillating arm from right to left, or while pulling the chain.

The rate of feed is varied by attaching the chain to different holes in the **L** lever.

To operate the rests in a line parallel to the lathe spindle, a similar **L** lever is attached by chain to the third oscillating arm, which is placed on the cross shaft, mid-way of the bed, or between the two slide rests. It is obvious then that with an **L** lever attachment on each feed screw, both slides of each rest may be simultaneously operated, while either one may be stopped either by detaching the chain or removing the **L** lever.

For operating the rests by hand, the usual feed-screw handles are used.

Fig. 537 represents a 90-inch swing lathe by the Ames Manufacturing Company of Chicopee, Massachusetts.

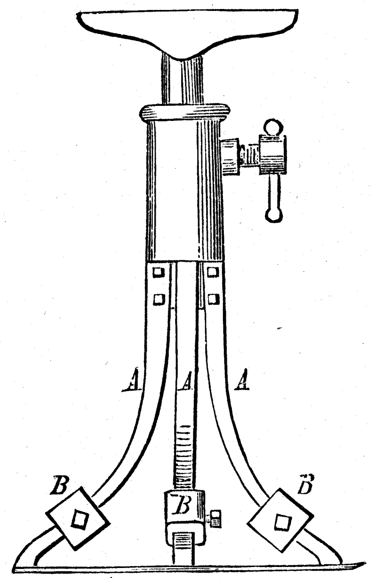

Fig. 535.

The distinguishing feature of this lathe is that the tailstock spindle is made square, to better enable it to bear the strain due to carrying cutting tools in place of the dead centre; and by means of a pulley instead of a simple hand wheel for operating the tail spindle, that spindle may be operated from an overhead countershaft, and a tool may be put in to cut key-ways in pulleys, wheels, &c., chucked on the face plate (which of course remains stationary during the operation), thus dispensing with the necessity of cutting out such key-ways by hammer, chisel, and file, in wheel bores too large and heavy to be operated upon in a slotting machine.

On account of the weight of the tailstock it is fitted with rollers, which may be operated to lift it from the bed when it is to be moved along the lathe bed.

Fig. 538 represents a 50-inch swing lathe by the New Haven

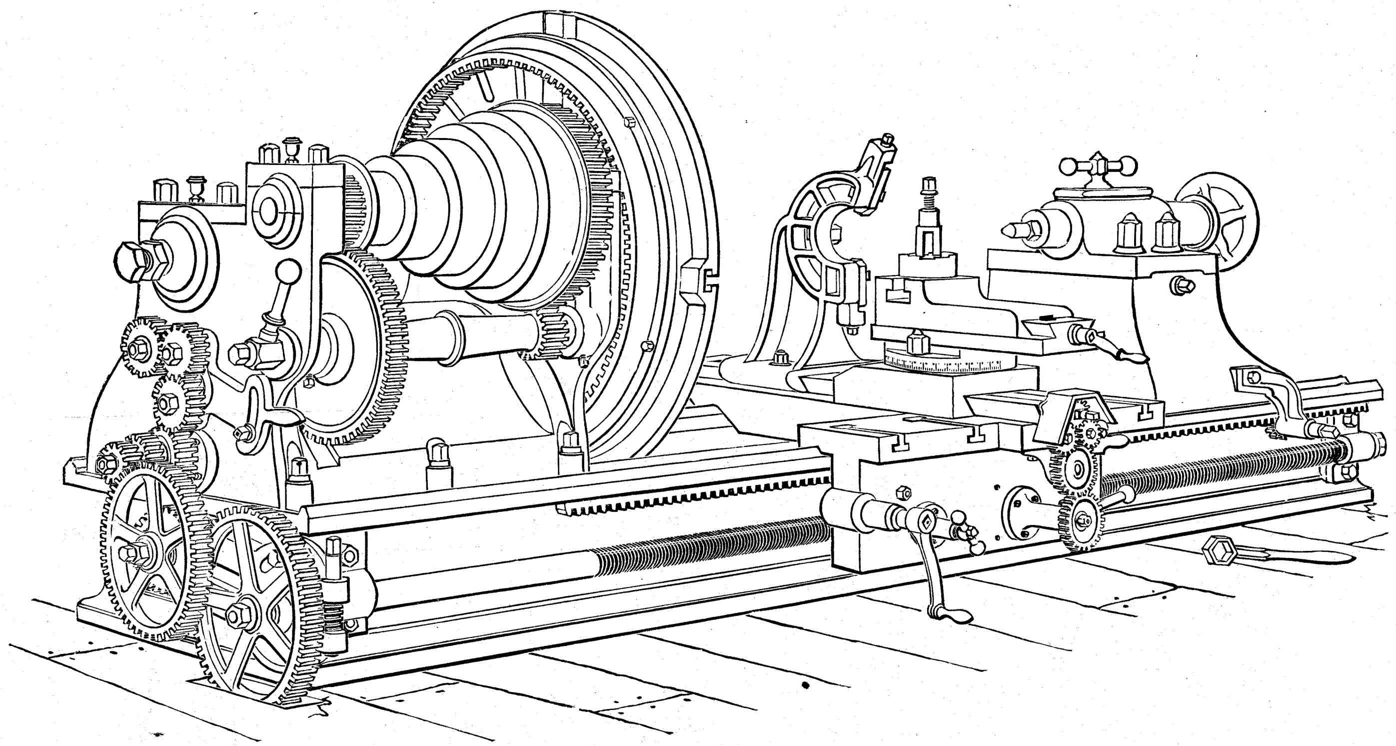

Fig. 538.

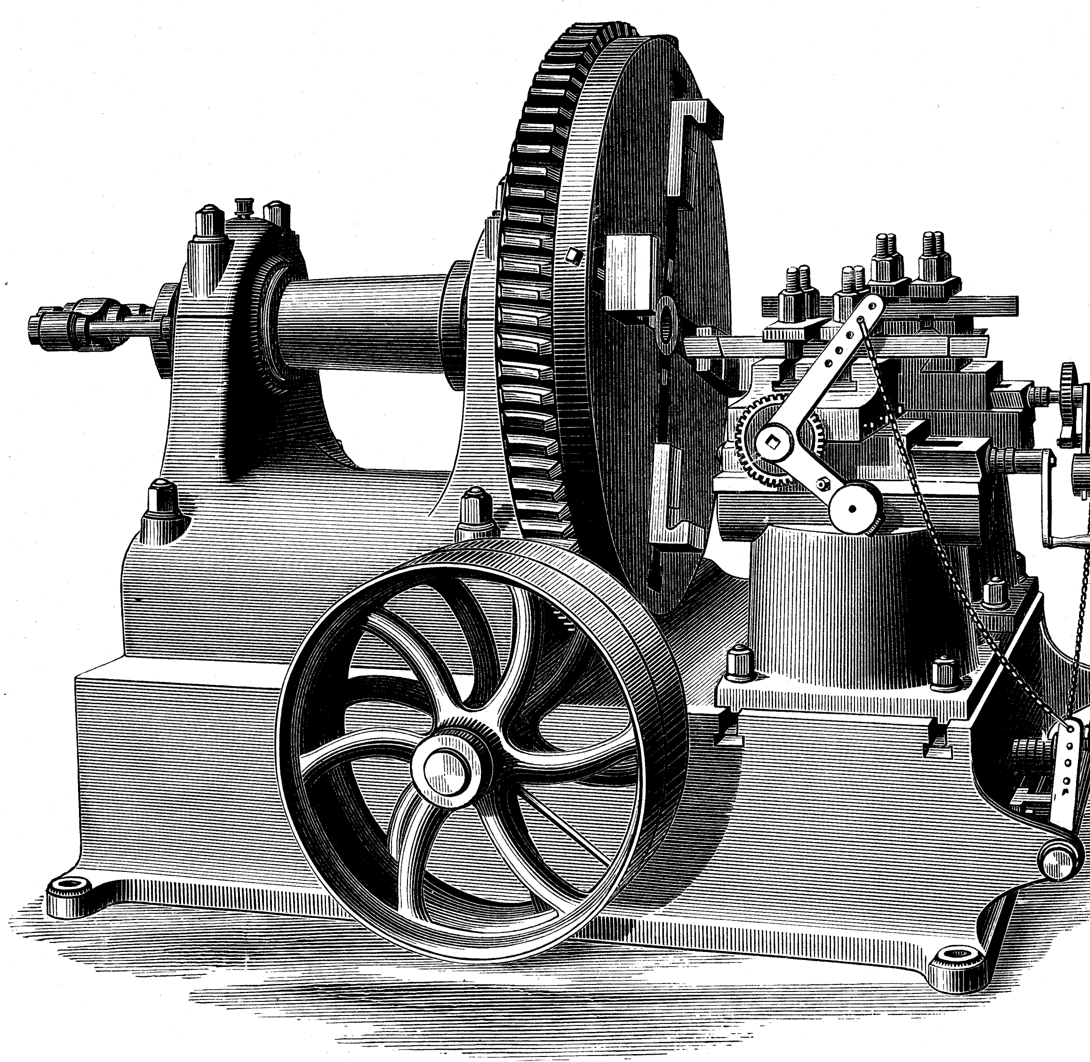

Fig. 536.

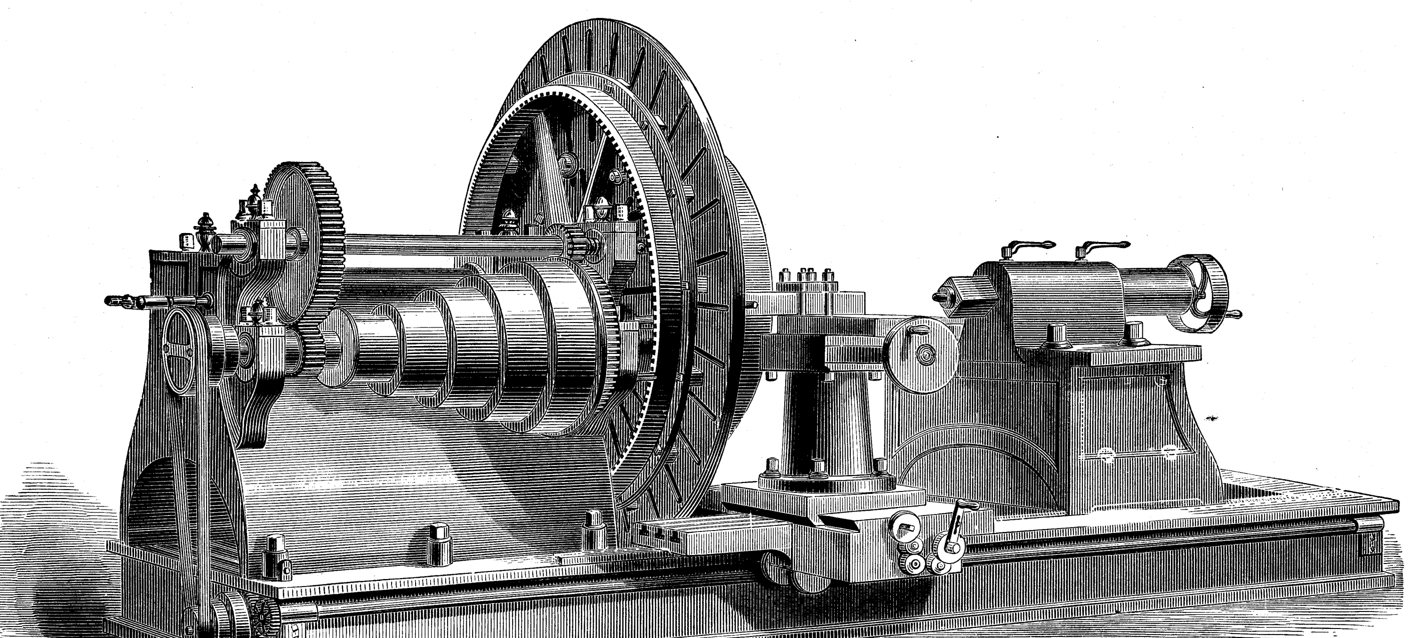

Fig. 537.

Manufacturing Company of New Haven, Connecticut. The compound rest is here provided with automatic feed so that it may be set at an angle to bore tapers with a uniform feed. The tailstock is provided with a bracket, carrying a pinion in gear with the hand-feed rack, so as to move the tailstock along the bed by means of the pinion. The feed screw is splined to give an independent feed, and the swing frame is operated by a worm as shown.

Gap Lathe or Break Lathe.

The gap lathe is one in which the bed is provided with a gap beneath the face plate, so as to enable that plate or the chucks to swing work of larger diameter, an example being given in Fig. 539.

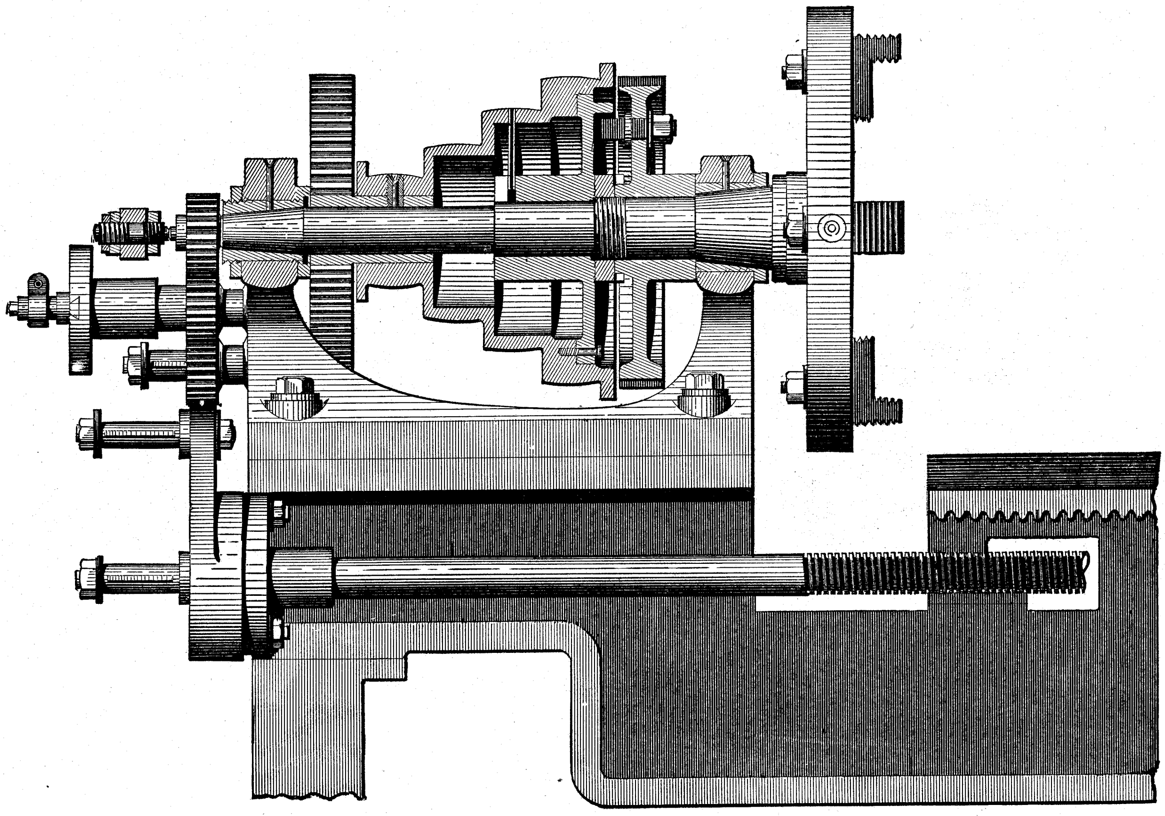

Fig. 539.

It is obvious, however, that the existence of the gap deprives the slide rest of support on one side, when it is used close to the face plate. This is obviated in some forms of gap lathes by fitting into the gap a short piece of bed that may be taken out when the use of the gap is required.

The gap lathe has not found favor in the United States, the same result being more frequently obtained by means of the extension lathe, which possesses the advantages of the gap lathe, while at the same time enabling the width of the gap to be varied to suit the length of the work. Fig. 540 represents an extension lathe by Edwin Harrington and Son, of Philadelphia. There are two beds A and B, the former sliding upon the latter when operated by the hand-wheel E, which is upon the end of a screw that passes between the two beds, has journal bearing in the upper bed, and engages a nut in the lower one, so that as the screw is operated the wheel moves longitudinally with the upper bed. C is the feed rod which communicates motion to the feeding screw D, which has journal bearing on the upper bed and therefore travels with it when it is moved or adjusted longitudinally. The cross slide has sufficient length to enable the slide rest to face work of the full diameter that will swing in the gap, and to support the slide rest when moved outwards to the full limit, it is provided with a piece F, which slides at its base upon the guideway or slide G.

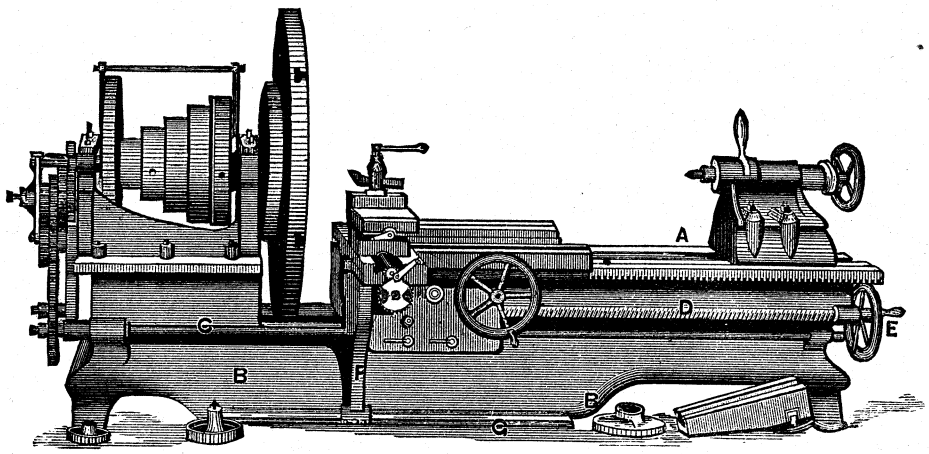

Fig. 540.

Fig. 541 represents a double face plate lathe such as is used for turning the wheels for locomotives. The circumference of both the face plates are provided with spur teeth, so that both are driven by pinions, which by being capable of moving endways into or out of gear, enable either face plate to be used singly, if required, as for boring purposes.

The slide rests are operated by ratchet arms for the self feed, these arms being operated by an overhead shaft, with arms and chains.

Fig. 542 represents a chucking lathe adapted more especially for boring purposes. Thus the cone pulley is of small diameter

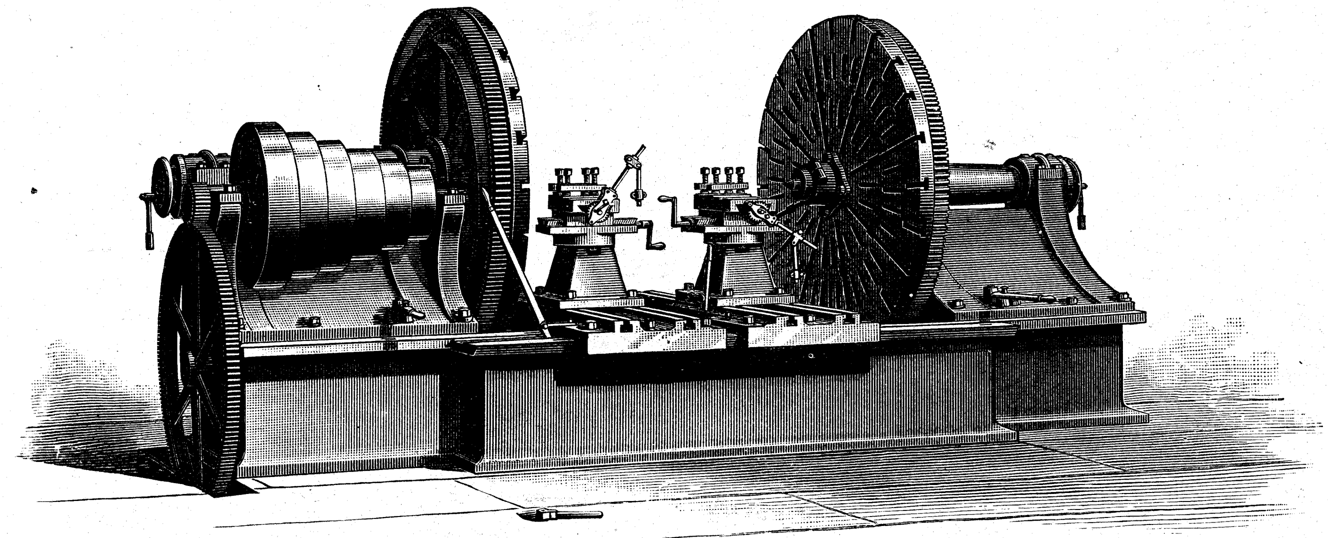

Fig. 541.

and the parts are light, so that the lathe is more handy than would be the case with a heavier built lathe, while at the same time it is sufficiently rigid for large work that is comparatively light.

The compound rest is upon a pedestal that can be bolted in any required position on the lower cross slide, and is made self-acting for the feed traverse by the change wheels and feed screw, while the self-acting cross feed is operated by a ratchet handle, actu-

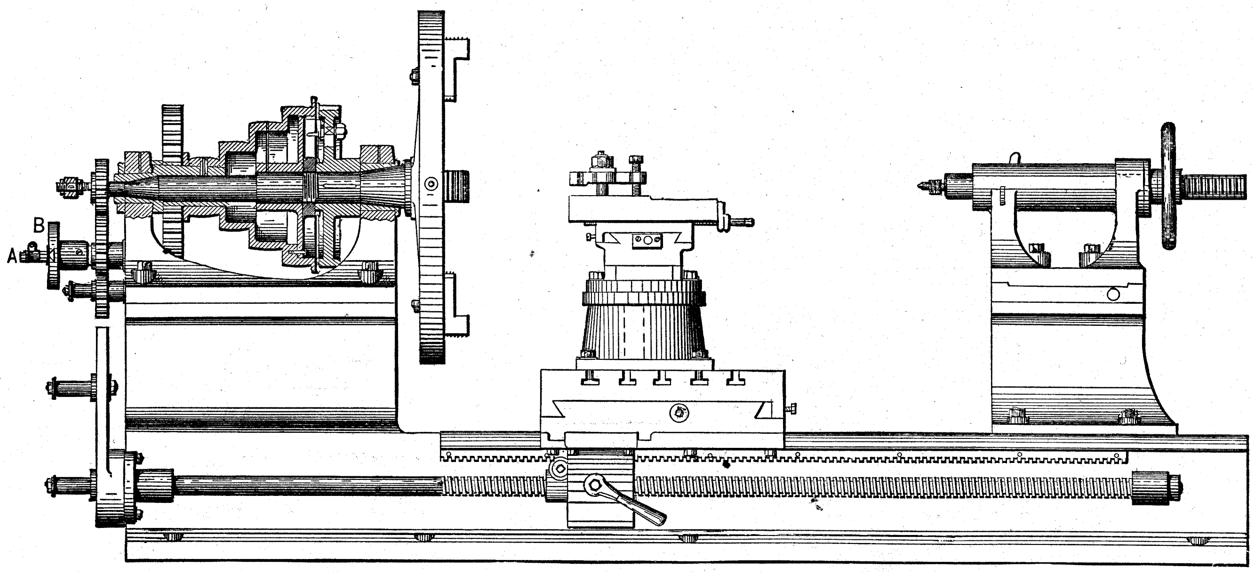

Fig. 542.

ated by a chain from an overhead reciprocating lever; the latter being actuated from the crank pin at A, which is adjustable in a slot in the crank disk B. A lathe of this kind is very suitable for brass work of unusually large diameter, because in such work the cuts and feeds are light, and the cutting speed is quick, hence a heavy construction is not essential.

Figs. 543 and 544 represent a large lathe built by Thomas Shanks and Co., of Johnstone, near Glasgow, Scotland; all the figures of this lathe being from *The American Machinist.*

Fig. 543 shows the headstock and two of the slide rests, while Fig. 544 represents the remainder of the bed, the tailstock, and two of the slide rests.

It will be seen from the figures that there are a compound rest and a column or pillar rest both at the front and at the back of the lathe, and that there is an additional rest on the front end of the tailstock which may be used for facing the ends of the work.

Fig. 545 represents a section through, and a partial plan of the headstock, and it will be seen that the live spindle is free from the cone pulley and from the gearing, the chuck plate being driven from a pinion engaging an internal gear at the back of the chuck plate. By this construction the balancing of such work as crank shafts is facilitated, because the chuck plate is not affected by the friction of the driving gears, and may therefore be easily revolved to test the balance of the work.

Fig. 546 represents a cross section through the bed, and through one of the compound rests, and one of the pillar rests, the latter rests being made thin so that they may pass between the cheeks of crank shafts, to turn their faces and the crank journals.

Fig. 547 represents a view from the back end of the headstock, and Fig. 548 a view of the lathe from the tailstock end.

Figs. 549 and 550 represent a plan and a side view of the headstock and the two slide rests nearest to it. The lathe being shown at work on the crank shaft of the steamship service, which is shown in dotted lines, and it will be seen that for turning the stem of the shaft all the rests can be used at once, those at the back of the lathe having their cutting tools turned upside down (as will be more clearly seen in the cross-sectional view of the rests in Fig. 546).

Figs. 551 and 552 represent a plan and a side view of the other

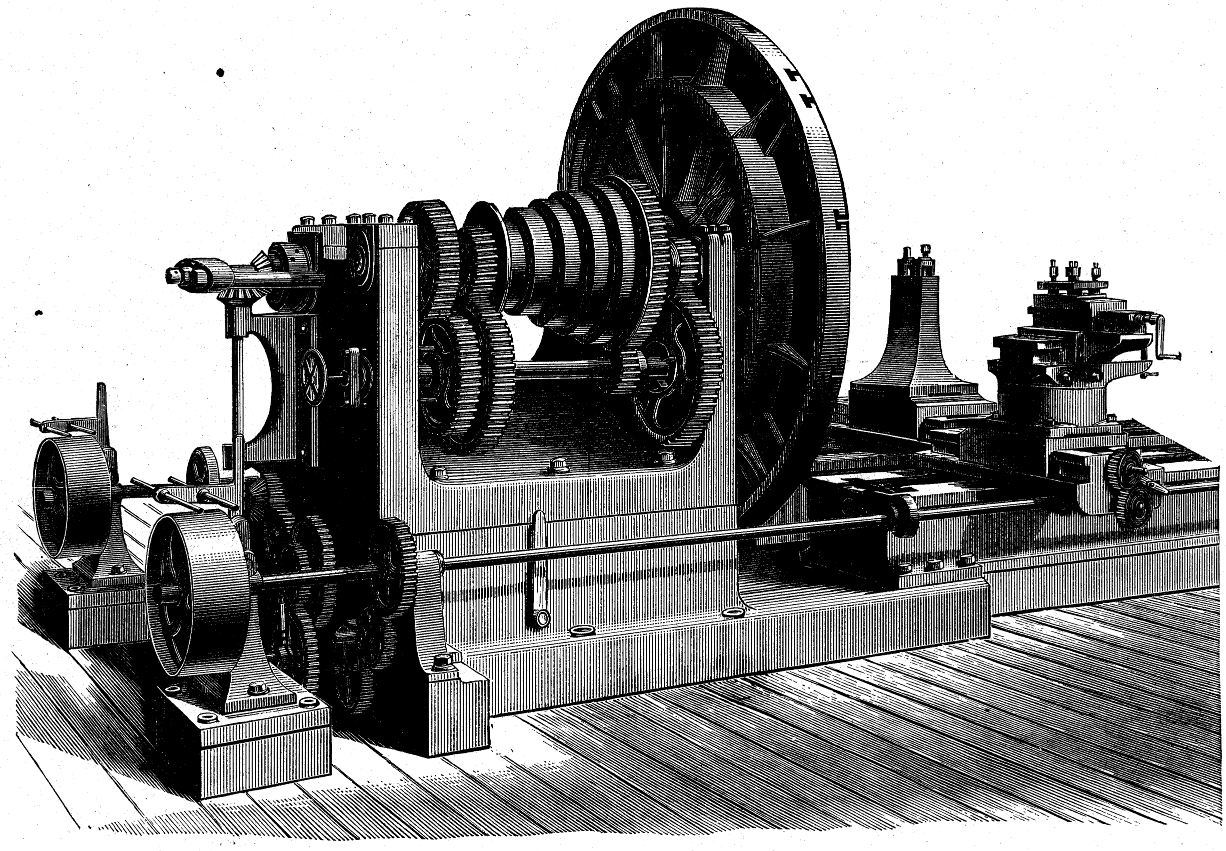

Fig. 543.

half of the lathe in operation upon the same crank shaft, which is again shown in dotted lines.

Referring now to the general construction of the lathe, the head-stock or live spindle has a front journal bearing 18 inches diameter

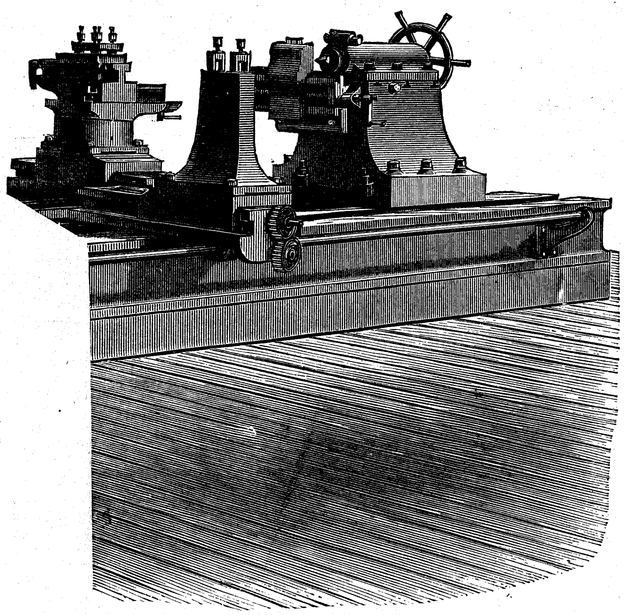

Fig. 544.

and 24 inches long, and a back bearing 12 inches diameter and 15 inches long, the bearings being parallel. The driving cone has five changes of speed for a 6-inch belt, and is carried on an independent spindle. The cone is turned inside as well as outside, so as to be in balance at high speeds.

The face plate is 12 feet diameter, cast with internal gear at the back. It is provided with T-slots and square holes for fixing work. It is bolted to a large flange in one piece with the spindle, and fitted with four steel expanding gripping jaws worked with screws and toothed blocks. These are for doing chuck work, or for gripping work to be driven, as the collars of propeller or crank shafts, or work of a similar character. By the system of gearing adopted, when desired, the face plate can be revolved almost free, which facilitates balancing for turning crank shafts, as well as

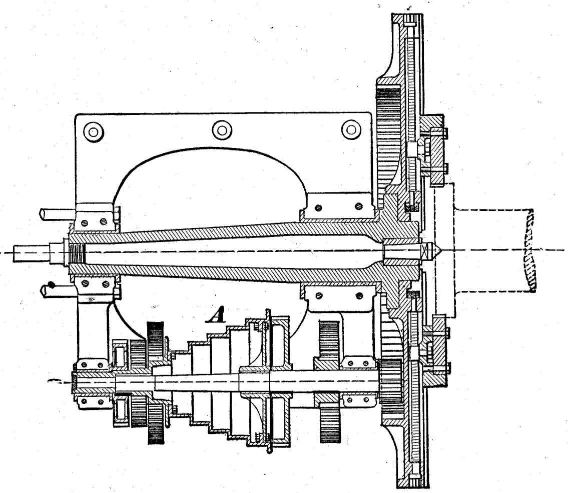

Fig. 545.

other operations. The thrust against the live spindle is taken by an adjustable steel tail piece.

The beds are double, 10 feet in width over all, the sections being joined together by massive ground plates and bolts. They are made with square lips to resist the upward strain of cutting. The

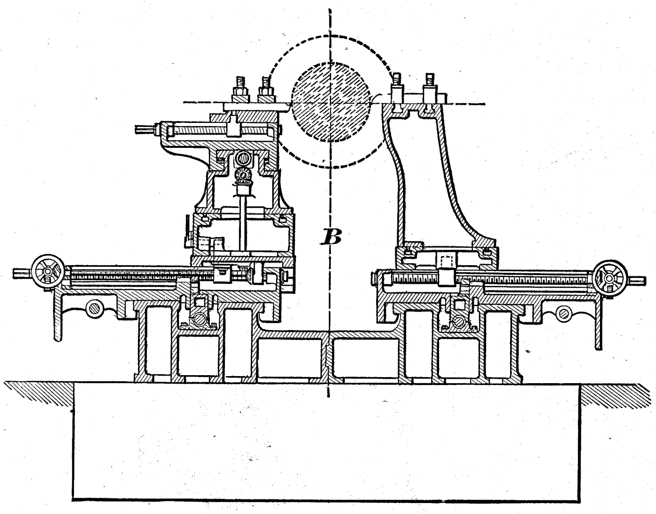

Fig. 546.

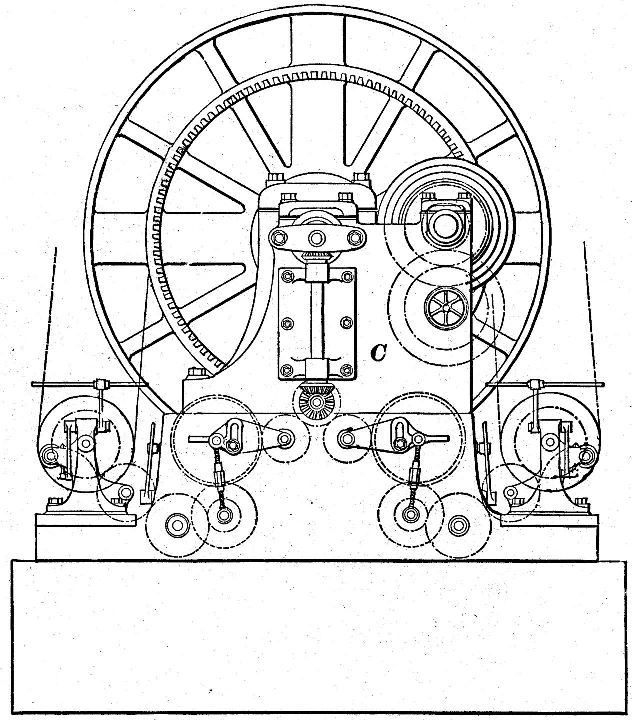

Fig. 547.

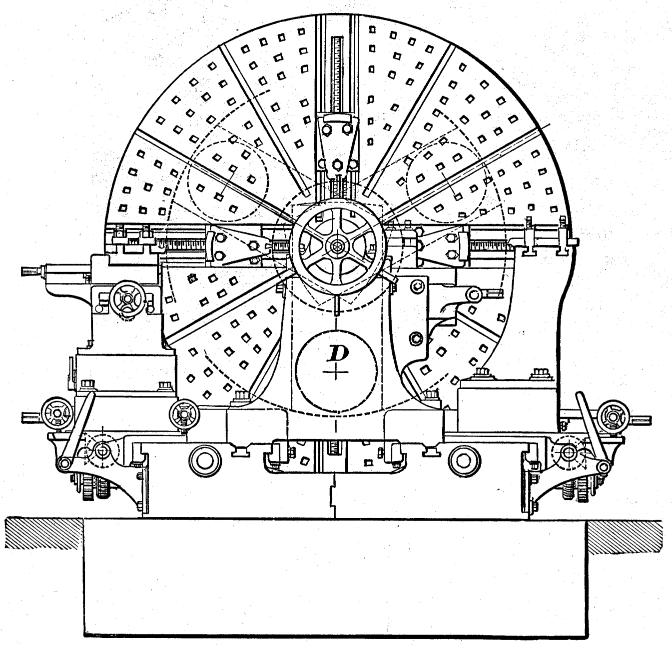

Fig. 548.

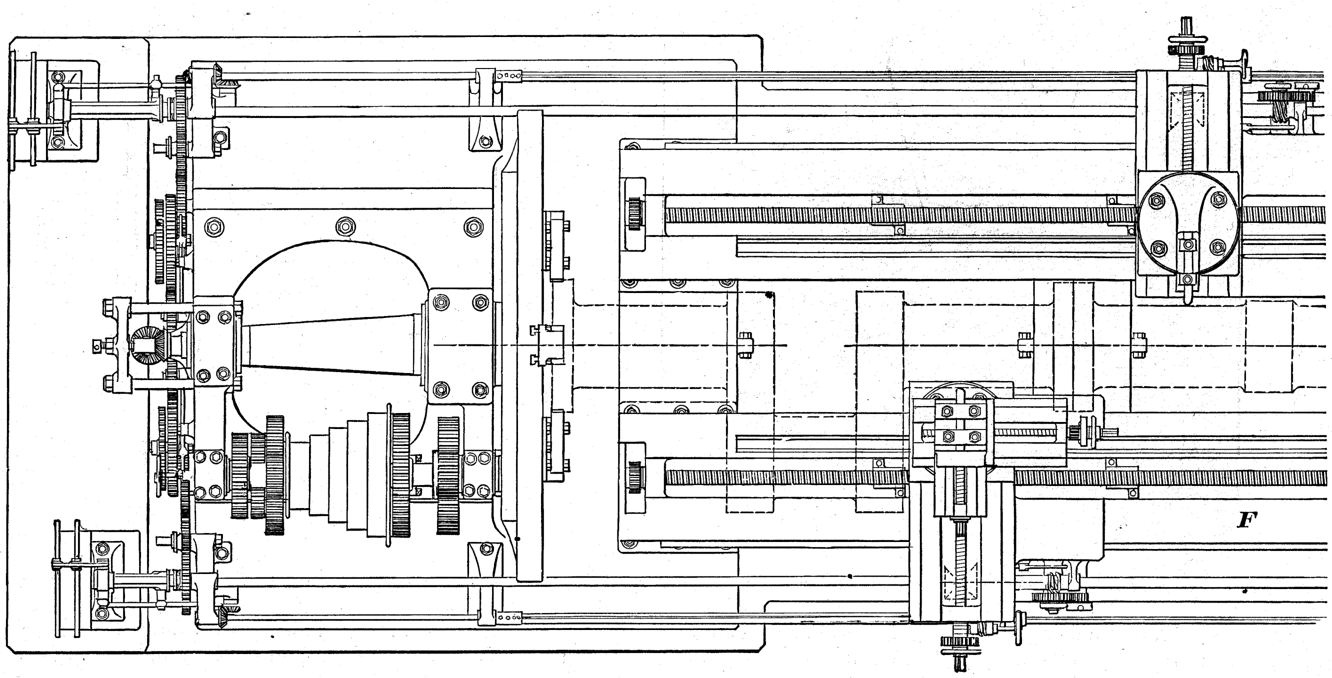

Fig. 549.

front bed is fitted with two saddles, each carrying a compound slide rest having the following movements: First, screw-cutting, by means of a leading screw, situated inside the bed, with a sliding disengaging nut and reversing motion for right or left-hand threads, or for instantaneously stopping the longitudinal movement of the saddle. This is accomplished by a set of clutch mitres placed inside the bed at headstock end, and actuated by a lever in front: Second, a self-acting surfacing motion to slide rest by means of a longitudinal shaft at the front of the bed, and clutch mitres for reversing the saddle screw.

Third, power motion for moving the saddles quickly to position along the bed. This is done through the fast and loose pulleys at the headstock end of lathe.

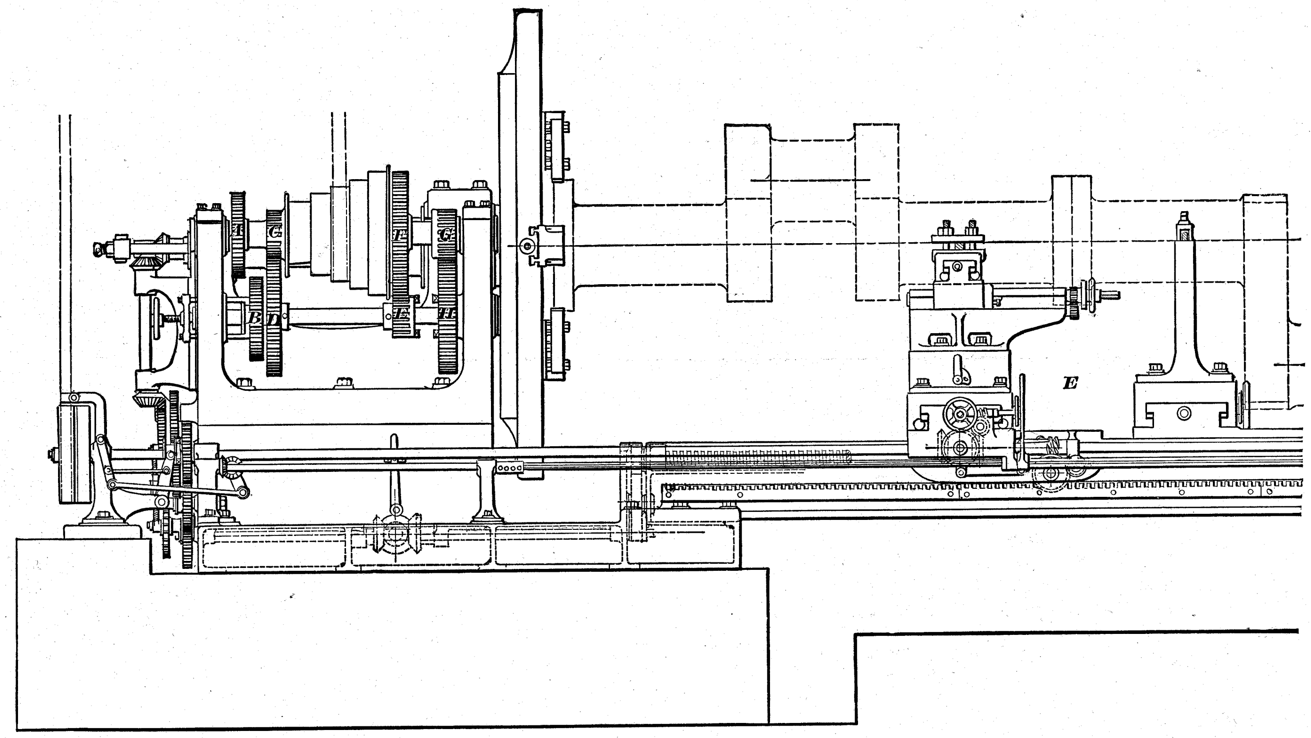

Fig. 550.

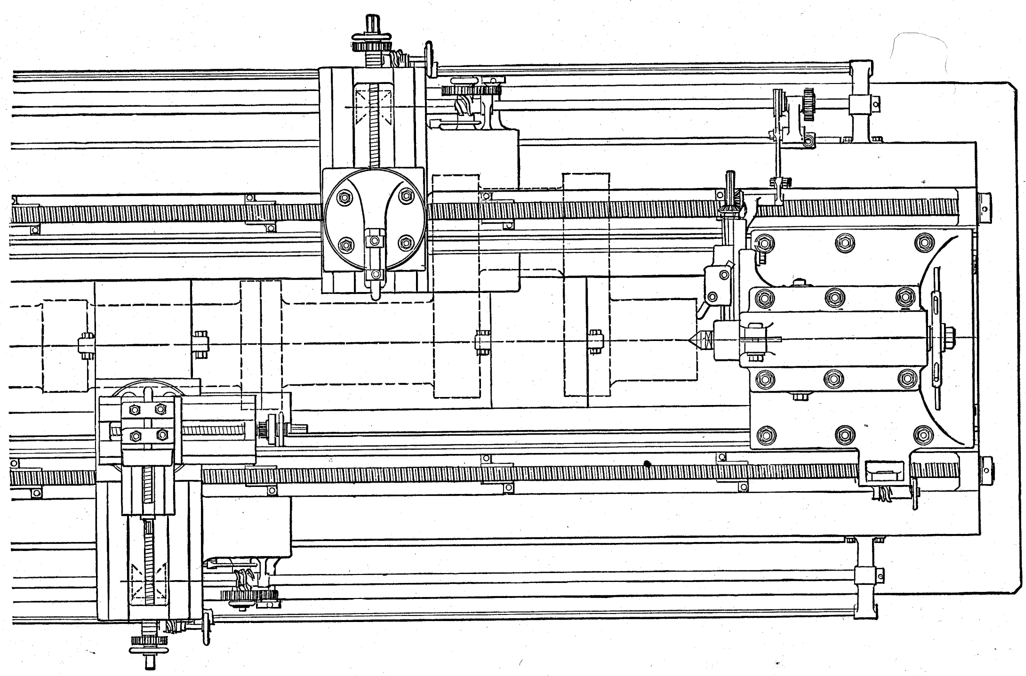

Fig. 551.

Fourth, hand rack motion to saddle. The back bed is fitted with two saddles, each carrying a pillar rest, fitted for all movements in plain turning like the front rests, and also with swiveling motion for corner turning.

The tailstock has a spindle 9 inches diameter. It is fitted in V s on the bed, and held down by three T-head bolts on each side. The top section is adjustable for turning tapers. It is moved along the ways by engaging a nut with the main screw. An end-cutting rest is fitted to the tailstock, which is adapted for operating on flanged couplings and similar work.

There is a separate set of change wheels for each saddle, so arranged as to cut standard pitches up to 3-inch pitch, and for self-acting feeds down to 50 per inch. By this means, when both tools are in operation on a piece of work, one tool may be used with coarse feed for roughing out, while the other may be taking a fine or finishing cut either on the same or a different part of the piece; or one tool may be cutting towards and the other from the face plate, always maintaining the balance of a front and back cut.

Complete counter driving motion, consisting of wall brackets, shaft, cone, and sets of fast and loose pulleys for quick reversing motion in screw cutting, also belt bar shipping motion, and full set of case-hardened wrenches are provided.

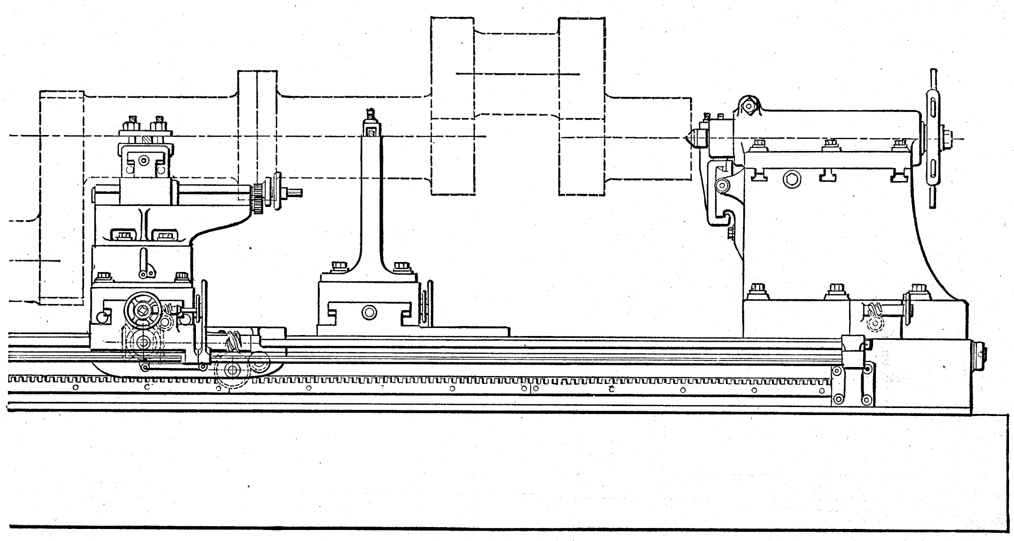

Fig. 552.