(No Model.)

4 Sheets—Sheet 1.

F. G. ECHOLS.

METAL WORKING MACHINE.

No. 602,062. Patented Apr. 12, 1898.

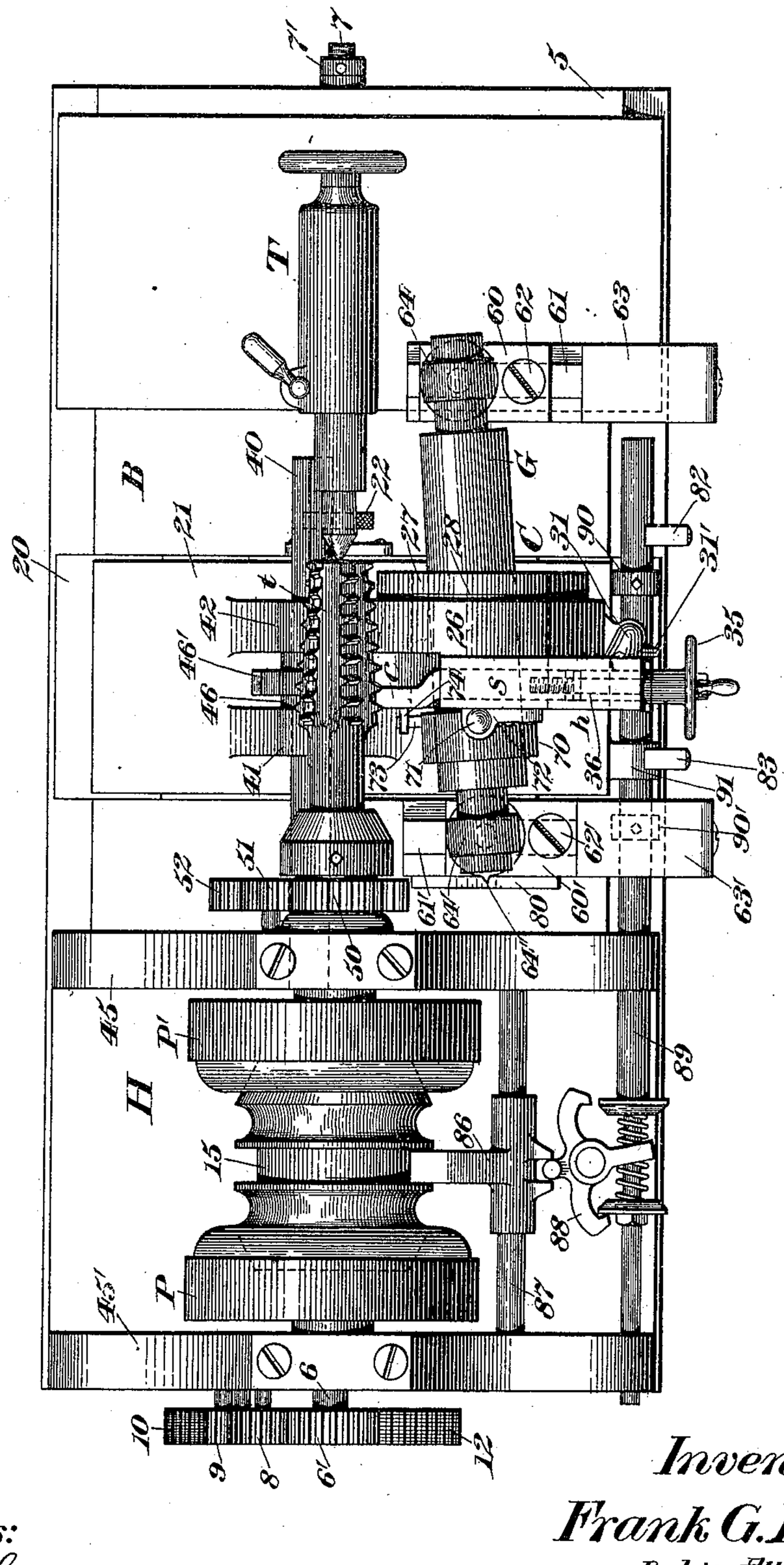

Fig. 1.

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Inventor;
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By his Attorney,
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(No Model.) 4 Sheets—Sheet 2.

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METAL WORKING MACHINE.

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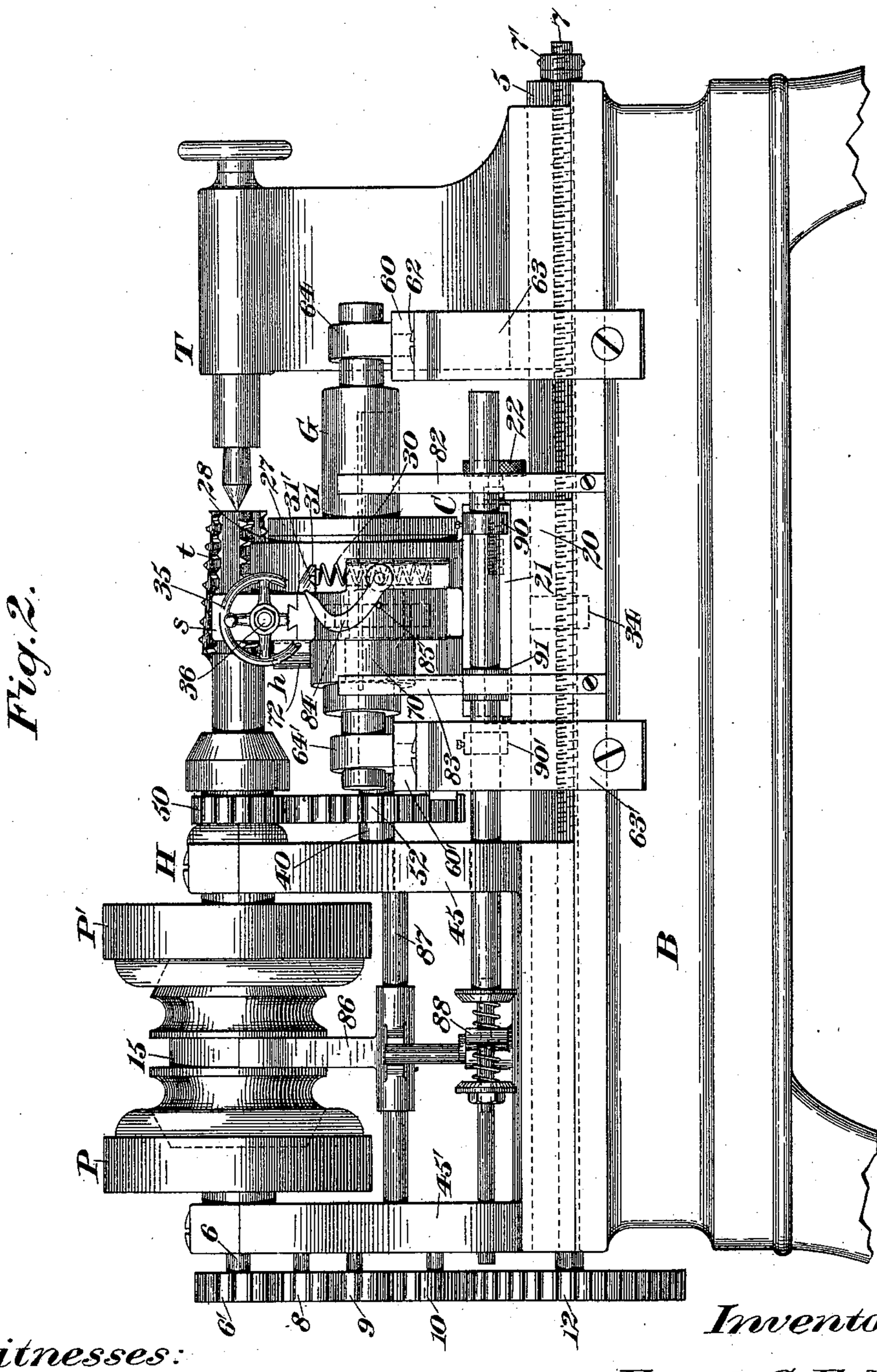

Fig. 2.

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(No Model.)

4 Sheets—Sheet 3.

F. G. ECHOLS.

METAL WORKING MACHINE.

No. 602,062. Patented Apr. 12, 1898.

Fig. 3.

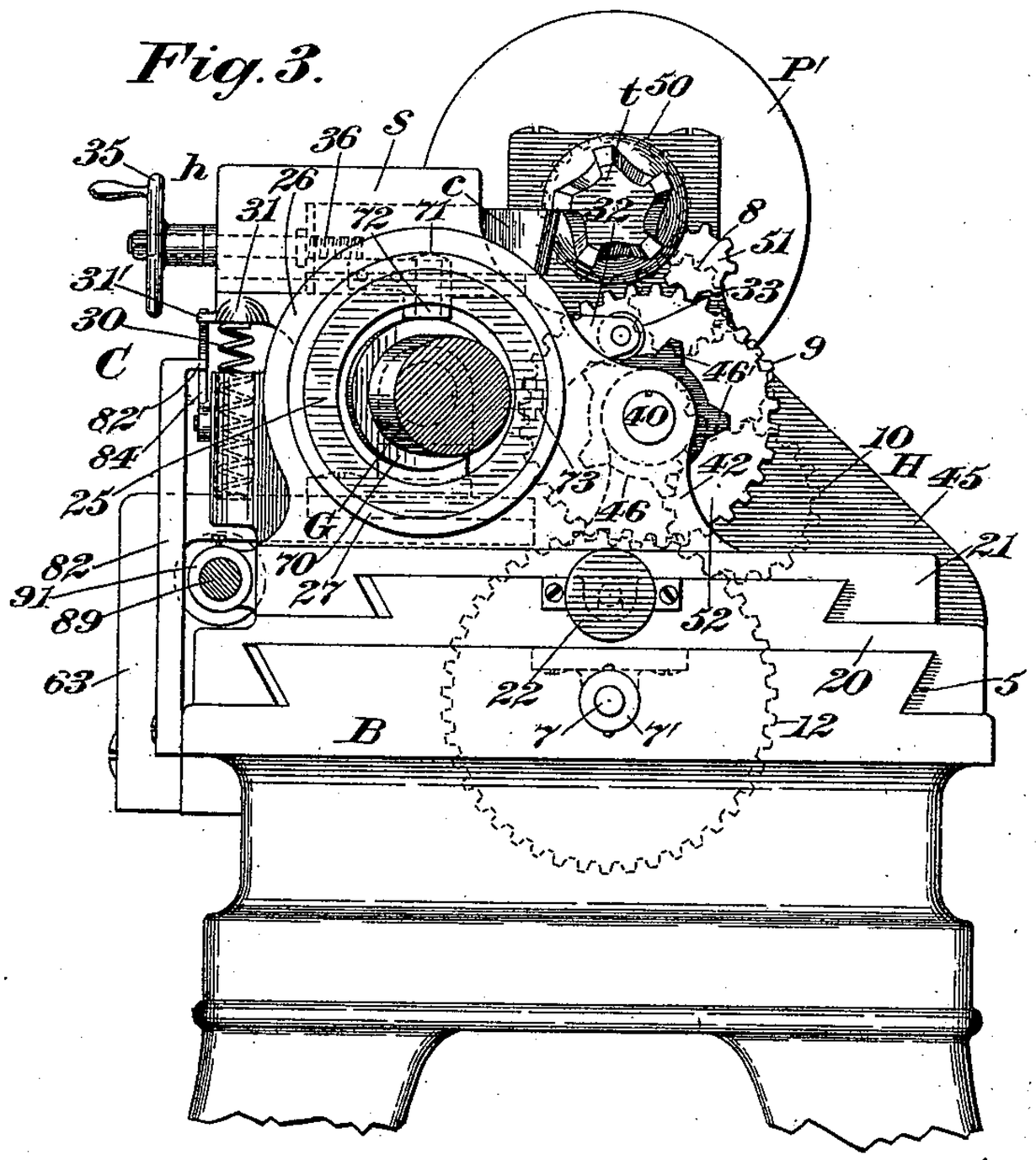
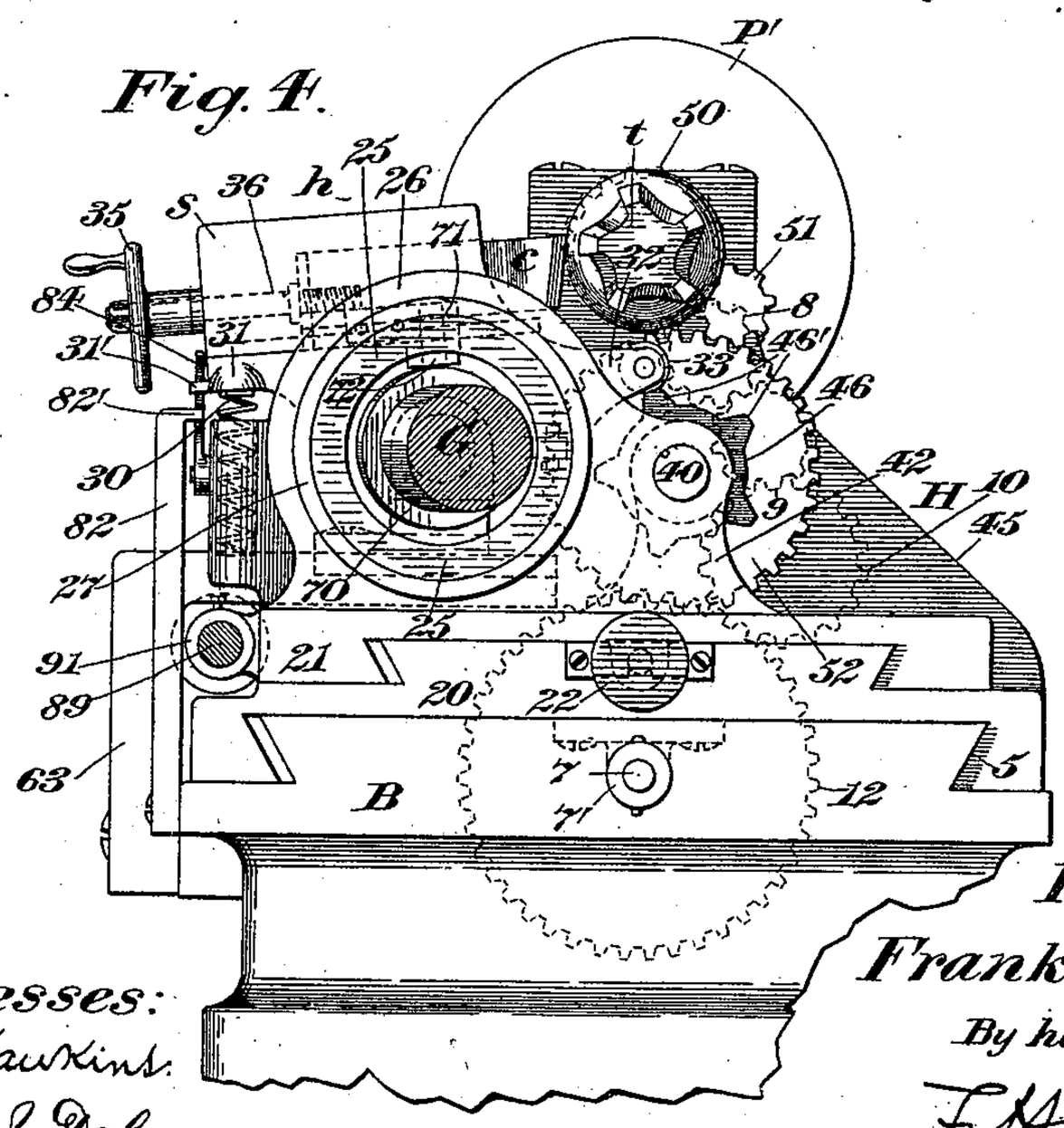


Fig. 4.



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(No Model.) 4 Sheets—Sheet 4.

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METAL WORKING MACHINE.

No. 602,062. Patented Apr. 12, 1898.

Fig. 5.

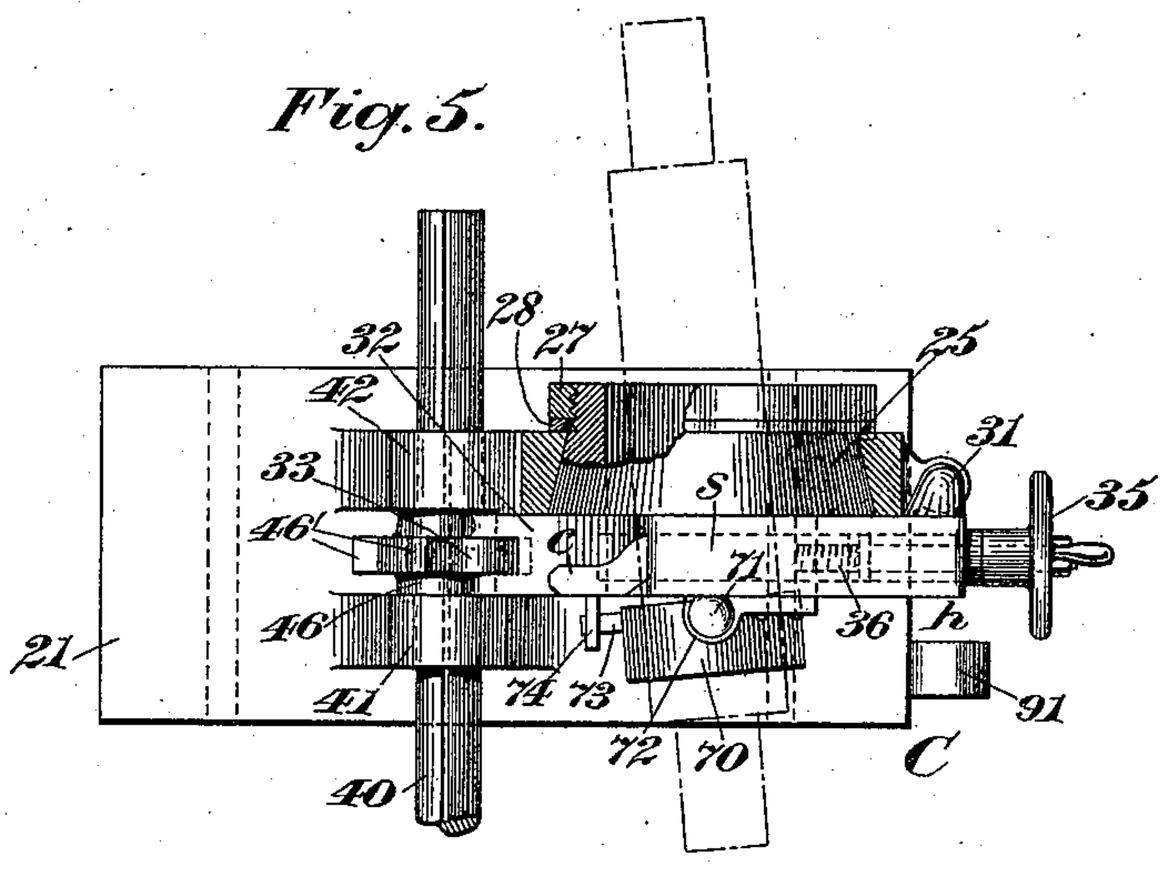
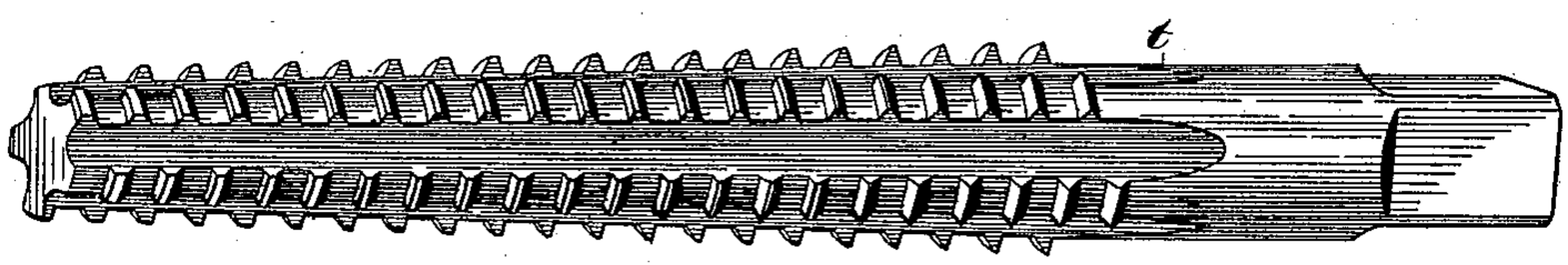


Fig. 6.

Fig. 7.



Witnesses:
D. S. Hawkins.
Fred. J. Dole.

Inventor:
Frank G. Echols.
By his Attorney,
F. A. Richards.

UNITED STATES PATENT OFFICE.

FRANK G. ECHOLS, OF HARTFORD, CONNECTICUT.

METAL-WORKING MACHINE.

SPECIFICATION forming part of Letters Patent No. 602,062, dated April 12, 1898.

Application filed September 20, 1897. Serial No. 652,225. (No model.)

To all whom it may concern:

Be it known that I, FRANK G. ECHOLS, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Metal-Working Machines, of which the following is a specification.

This invention relates to improvements in metal-working machines, and especially to automatic turning-lathes; and it has for its main object the provision of a machine of this type especially adapted for cutting away a portion of the teeth of an ordinary screw-cutting tap to form the improved tap described and claimed in Patent No. 588,056, granted to me August 10, 1897. In the tap described in this patent the tool has an odd number of wings, and each wing has half the usual number of teeth, one-half of all the teeth of the tap being entirely removed, preferably by cutting out alternating peripheral teeth, all of the teeth being located in a single spiral from end to end of the tool.

For the purpose of forming my improved tap from a tap of the ordinary construction I make use of a machine in the form of a turning-lathe, the principal features of which are a work-holder and a tool-holder, one of which is rotatable preferably continuously, an intermittently-effective cutting-tool which is carried by the tool-holder and will usually be in the form of a chaser, and suitable means for automatically shifting one of the holders toward and from the other a plurality of times during each rotation of the rotary holder in order that the tool may be brought intermittently into position to operate upon the work and cut the latter at separated points in its periphery. In connection with these mechanisms I employ also feeding means for imparting a traveling feed movement to one of the holders in the direction of the longitudinal axis of the work-holder, so that the tool may cut not only at separated points in the periphery of the work, but also at different points in the length of the latter and follow the spiral in which the teeth of the tap are located.

In cutting plain taps having straight sides the work-holder and the tool-holder will of course maintain the same relative distance between them at all points in the movement of the traveling holder; but in cutting taper-taps this interval should vary in accordance with the taper of the tool. Hence in cutting away the teeth of taper-taps I make use, in connection with the instrumentalities hereinbefore mentioned, of a guide disposed at an angle to the longitudinal axis of the work-holder, the angle of inclination of the guide corresponding, of course, to the angle of taper of the tap. In the preferred construction of the machine the work-holder will usually travel along this guide, so as to operate upon the tool at progressively-varying distances from the longitudinal axis of the latter. In the preferred form thereof this guide will be adjustable in order that it may be shifted to any desired angular position and locked when set to correspond to the taper of the tap upon which the tool or chaser may be operating.

For the purpose of rendering the machine automatic in its action I may employ, in connection with the devices previously described, means for automatically throwing the tool into and out of action at the beginning and at the end of the range of travel of the traveling holder and for also reversing the direction of travel of such holder.

In the drawings accompanying and forming part of this specification, Figure 1 is a plan view of a metal-working machine constructed in accordance with my improvements. Fig. 2 is a side elevation of the same. Fig. 3 is a sectional end elevation of the same with the tail-stock removed and shows the cutter in its operative position. Fig. 4 is a similar view illustrating the cutter and the tool-holder thrown out of operation to permit alternate teeth in the periphery of the tap to pass by the tool without being cut. Figs. 5 and 6 are detail views of the tool-holder and slide-rest, and Fig. 7 is a view of the tap as completed by the machine.

Similar characters designate like parts in all the figures of the drawings.

The several operative parts of my improved machine will be mounted ordinarily upon the usual bed B, and many of these working parts are substantially similar to those found in metal-working lathes in common use. Among these may be mentioned the tail-stock T, which slides on the ways 5 in the usual

manner, the head-stock H, the work-spindle 6, and the lead-screw 7, supported for rotation in the bed of the machine and connected in the usual manner with the tool-carriage for imparting to the latter a traveling movement longitudinally of the bed of the machine. The lead-screw receives its movement from the spindle 6 through the spur-gear 6′, secured to said spindle, which gear meshes with an idler-pinion 8, from which movement is transmitted through an idler-pinion 9 and an idler-gear 10 to a large spur-gear 12, secured to one end of the lead-screw. At the other end thereof of the lead-screw is maintained in proper position and held against longitudinal movement by the usual nut 7′. The devices just described constitute the feeding means or feed mechanism for actuating the tool-holder longitudinally of the machine.

For the purpose of rotating the work-spindle 6 I prefer to make use of a pair of pulleys P and P′, loosely mounted on the work-spindle and normally continuously rotated in opposite directions in the usual manner by means of belts. (Not shown.) For the purpose of bringing either of these pulleys into operative relation with the work-spindle to drive the latter I have shown herein a friction-clutch 15, splined to the work-spindle and adapted to slide thereon and having conical ends adapted to be received in corresponding openings in the inner faces of the loose pulleys P and P′, it being obvious that when this friction-clutch is moved in the one direction or the other it may be brought into engagement with one or the other of said loose pulleys to turn the work-spindle in a direction corresponding to the direction of rotation of said pulley.

The tool-carriage is designated in a general way by C and is supported in the usual manner on the ways 5 for traveling movement longitudinally of the machine. The body portion of this tool-carriage is preferably composed of two members, the lower of which is shown at 20 and embodies ways similar to those shown at 5 for carrying the upper or movable member 21 of said carriage. This upper member 21 is adjustable relatively to the lower member 20 by means of an adjusting-screw 22 for the purpose of properly regulating the position of the cutter at the beginning of the operation of the machine.

The tool-holder may be of any suitable construction, and it will be so mounted as to have a movement for shifting the cutting tool or chaser toward and from the work-holder, the movements of the tool-holder being so timed that said tool will be shifted back and forth a plurality of times during a single rotation of the rotary holder, which will be usually, and is in this case, the work-holder. The movement of the tool-holder for carrying the cutter toward and from the work-holder and into and out of engagement with the work may be advantageously a reciprocating one, the tool-holder being mounted for oscillation on the upper member 21 of the tool-carriage in the construction shown in the drawings. This tool-holder is designated in a general way by *h* and embodies an annular member or ring 25, supported for oscillation in a fixed annulus 26, forming part of the upper member 21 of the tool-carriage. The bearing-faces of these two annular members are preferably conical, as shown in dotted lines in Fig. 1 and as will be evident by reference to Figs. 5 and 6, and the movable annulus may be retained in its proper position by holding means at the reduced end of the annulus—as, for instance, by a screw-cap 27, a washer or retaining-ring 28 being interposed between the screw-cap and the end of the fixed ring 26. In the construction shown the oscillatory tool-holder will be held normally by means of a spring—as, for instance, the coil-spring 30—in the position shown in Fig. 3, with the cutter or chaser in its working position. This spring is seated in a vertical aperture or recess in the adjustable member 21 of the tool-carriage, its upper end engaging the walls of a corresponding recess in the underside of a boss 31, projecting from the tool-holder. The tool-holder also has at its opposite side an arm 32, carrying an anti-friction-roll 33, which coöperates with a cam-shaft by means of which the tool-holder is oscillated, and which cam-shaft will be hereinafter described. The connection between the tool-holder and the lead-screw by means of which traveling movement is imparted to said holder is obtained in this case by passing the lead-screw through a nut 34, formed as a fixed part of the member 20 of the tool-carriage.

As before stated, the cutting-tool which I prefer to employ is in the form of a chaser, and this will usually be carried by a tool-slide movable transversely of and mounted on the tool-holder. The tool-slide is designated herein by *s* and is supported by the usual transverse way on the tool-holder for reciprocation toward and from the longitudinal axis of the work-holder or work-spindle of the machine. The cutting-tool will of course be adjustable longitudinally of this slide in order to position it properly with respect to the work, especially at the beginning of each cut. This cutting-tool or chaser is designated herein by *c*, and its adjustment may be obtained in any suitable manner. In the present instance I have illustrated a hand-wheel 35 and an adjusting-screw 36 for this purpose, the adjusting-screw being supported by the slide and having a suitable connection with the chaser—such, for example, as that shown in Figs. 1, 3, and 4.

For the purpose of oscillating the tool-holder to carry the cutter into and out of its operative position with respect to the tap supported by the work-spindle or tap-holder I make use of a cam-shaft carrying a circuit of wipers, preferably equidistant from each other and corresponding in number to the

number of wings of the tap being formed. This cam-shaft is illustrated at 40 and is supported for rotation in suitable bearings on the machine, two of these bearings being on the tool-carriage, as shown at 41 and 42, and the third in the standard 45. In the preferred construction this shaft is free to rotate, but has no longitudinal movement, and the wipers, by means of which the tool-holder is oscillated, are formed on a sleeve splined to the shaft 40, so as to move longitudinally thereof while rotating therewith, this sleeve being suitably guided between the cheeks of the bearings 41 and 42. (See Figs. 1 and 5.) The cam-sleeve is designated by 46 and the wipers projecting therefrom by 46′. It will be obvious that this mounting of the cam-sleeve and wipers is necessary in order to maintain them in the proper relation with the work-holder longitudinally of the machine, as the position of such holder will of course be constantly changing during its traveling movement.

In the construction shown the cam-shaft 40 derives its movement from the work-spindle, the latter having thereon a spur-gear 50, the teeth of which mesh with those of an idler-pinion 51, (see Fig. 1,) which drives in turn a spur-gear 52, secured to the cam-shaft 40. This gear-train is a two-to-one train in order that the tap may be rotated twice as fast as the cam-sleeve carrying the wipers, this being necessary for the purpose of permitting the tap to be rotated at such a rate as will carry alternate wings of the tool past the cutter and leave uncut alternate teeth in every turn of the tap, it being obvious, of course, that the cutting-teeth and the interdental spaces formed by the removal of a portion of the teeth will alternate from end to end of the spiral in which the teeth of the tap are located.

For the purpose of cutting the teeth of ordinary taper-taps to form taps of the construction shown in the drawings, and more particularly described in my patent hereinbefore referred to, I employ, in connection with the devices just described, a guide cooperative with the tool-slide to permit transverse movement of the latter in accordance with the taper of the tap as the tool-carriage travels along the bed of the machine. This guide, which is designated in a general way by G, is preferably adjustable to different angles relatively to the axis of the work-holder or tap-holder, and may be in the form of a cylindrical member or roll having reduced ends pivotally connected with the bed of the machine. These connections are preferably adjustable in such a manner as to permit angular adjustment of the guide. Said connections embody in the present instance a pair of slides 60 and 60′, mounted for sliding movement on parallel guides or ways 61 and 61′, disposed at right angles to the longitudinal axis of the work-holder, suitable means, such as binding-screws 62 and 62′, being employed for locking the slides to their ways. These ways may be formed on standards 63 and 63′, bolted to the bed of the machine. The connections between the slides and the guide are preferably swivel-joints, two swivel-pins being shown at 64 and 64′, respectively, in the eyes of which the reduced ends of the guide have a free sliding movement. The swivel-pins of course turn freely in the slides 60 and 60′.

As before stated, the tool-slide is intended to be guided in its movements by the roll G, and for the purpose of controlling positively the position of the tool-slide the latter is preferably pivotally connected with a member slidable on the guide. In the present case this member is in the form of a sleeve 70, encircling the guide and free to turn thereon, and it has rising therefrom a round pin or stud 71, which passes through an aperture in a boss 72, projecting from one side of the tool-slide. This pin may be headed up so as to form in vertical direction a rather tight joint. It will be seen that, no matter what may be the angle to which the guide G is adjusted, the sleeve 70, through its pin 71, will turn freely in the boss of the tool-slide and will carry the tool-slide with it as it recedes from and approaches the longitudinal axis of the tap-holder. The sleeve 70 preferably has a second boss 73, projecting therefrom substantially in the horizontal plane of the longitudinal axis of the guide, and this boss works in a recessed guideway 74′ in a guide-arm 74, projecting laterally from the oscillatory tool-holder. By means of this connection of the tool-holder with the sleeve 70 the latter is not only turned positively by the former, but is also guided positively while it is being moved toward and from the axis of the tap.

In order to locate the guide G at the proper angle relatively to the work, I prefer to employ a taper-indicating scale, such as 80, adjacent to the inner end of the guide, this scale being intended to coöperate with a pointer 64″ on the swivel-pin 64′. The indications on this scale show different angles of taper for different kinds of taps, and the guide may be set for any desired angle by loosening the binding-screw 62′ and bringing the pointer 64″ opposite the proper indication on the scale, it being understood that this binding-screw, as well as the screw 62, should be screwed fast before the machine is operated.

As it is intended that this machine shall be automatic in its action, I also make use of some suitable means for throwing the tool-holder to the position shown in Fig. 4 and holding it there when the tool-holder reaches the end of its travel to the left, as seen in Fig. 1. Two stops are shown at 82 and 83 for this purpose, both being bolted to the bed of the machine, the former at the beginning of the range of movement and the latter at the end thereof. These two stops have inwardly-projecting fixed actuating members, one of which is shown at 82′ and is adapted to coöperate with suitable means on the tool-carriage

for oscillating the tool-holder from its operative to its inoperative position. I employ for this purpose a swinging hook in the form of a deadlock-cam 84, having a cam-shaped working face adapted to engage a bevel-faced stop 31′, projecting from the boss 31 into the path of the cam 84. (See Figs. 2, 3, and 4.) The hook 84 is pivoted on the upper portion 21 of the tool-carriage and may be held with its end adjacent to the stop 31′ by means of a fixed stop 85.

In order to reverse automatically the direction of rotation of the lead-screw at the beginning and at the end of the range of travel of the tool-carriage, I make use of any suitable automatic reversing means controlling the friction-clutch 15. A sliding shifter is shown at 86 for the purpose of operating this friction-clutch, said shifter being carried by a rod 87, supported by the standards 45 and 45′. This shifter is actuated by an oscillating shifting lever 88, controlled in its movements by a slide-rod 89, having a pair of adjustable stops 90 and 90′, with which a stop 91 on the upper portion 21 of the tool-carriage is intended to engage at each end of the travel of the tool-carriage to shift the slide-rod 89 in the one direction or the other, and thereby through the intermediate connections clutch the member 15 to one or the other of the loose pulleys P and P′.

The operation of a machine constructed in accordance with my present invention as shown herein is as follows: A tap of ordinary construction, which is to be changed into a tap of the type shown in my patent hereinbefore referred to, is first clamped in place in the usual manner between the head-stock and the tail-stock. The guide G is then adjusted at the proper angle and also secured firmly in place by the binding-screws 62 and 62′. It being understood that the tool-carriage is at the beginning of its range of travel, the cutting-tool or chaser *c* is then adjusted by means of the screw 22 to bring it to its exact position longitudinally of the tap, and its lateral position for taking the first cut is determined by means of the hand-wheel 35. As soon as the tool and the tap are in their proper positions relatively to each other the machine is started in operation by the pulley P, and as the tap rotates the tool *c* takes the first cut in substantially the manner shown in Fig. 3, except that in that view the tool is shown cutting a tooth near the inner end of the tap and at the end of the range of travel of the tool-carriage instead of at the beginning of such movement. As the tap rotates and the tool cuts through the first tooth thereof the cam-sleeve carrying the wipers 46′ is also rotated slowly by the two-to-one train of gears connecting it with the work-spindle, the antifriction-roll 33 riding over the corresponding rest of the cam-sleeve until the cut is finished, when the tool-holder will be operated by the proper wiper 46′ and the antifriction-roll 33 will ride up said wiper, and hence throw the chaser out of the path of the next succeeding tooth of the tap. As the tap rotates twice as fast as the cam-shaft, such next succeeding tooth will pass by the cutting edge of the tool *c* and will not be cut by the latter, but instead the tap will turn far enough to skip one tooth and present the next one to the action of the chaser, it being obvious that as such third tooth is brought into position the antifriction-roll 33 will ride down the opposite face of the wiper by which it was actuated and will lie on the next succeeding rest of the cam-sleeve, whereupon the operation just described will be repeated. While the cutting-tool, the cam-shaft, and the work-holder are operating in the manner just described, the lead-screw is being continuously rotated by the gear-train connecting it with the work-spindle, and the tool-carriage is progressively actuated toward the left-hand end of the machine, as seen in Fig. 1. It should be understood, of course, that the movement of the feed-screw will be so timed as to cause the cutting-tool to come to the proper position as successive alternate teeth in the continuous spiral of the tap are presented to the action of its cutting edge. This action just described will be repeated and a cut taken for every other tooth of the tap until the end of the spiral in which the teeth are located is reached, it being apparent that as the tool-carriage continues its movement the cutter will be alternately oscillated into and out of engagement with the teeth of the tap, it operating to cut alternate teeth and to skip the intermediate teeth. Moreover, as the carriage moves, the sleeve 70 will gradually recede from the longitudinal axis of the tap to an extent previously determined by the taper of the tap and the angular position of the guide G and will carry the tool-slide, and hence the tool, with it, thereby assuring a uniform cut for each tooth operated upon by the chaser. As soon as the last tooth of the tap is cut by the tool *c* the hook 84 comes into engagement with the inwardly-projecting actuating member on the stop 83, and the cam-face of said hook rides up the bevel-face of the stop 31′ of the tool-holder and engaging the upper side of said stop 31′ shifts the tool-holder to the position shown in Fig. 4 and assumes a dead-lock position, in which it will lock the tool-holder, so as to maintain the latter and its tool out of operative relation with the tap. At the same time the stop 91 on the tool-carriage strikes the stop 90′ on the slide-rod 89 and shifts the lever 88 to the opposite position from that shown in Fig. 1, and the pulley P is unclutched from the work-spindle, and the pulley P′ is clutched thereto. The direction of rotation of the parts being reversed, the tool-carriage will be carried back to its original position by the lead-screw, and as soon as it reaches its extreme right-hand position the actuating member 82′ on the stop 82 will unhook the dead-lock cam 84 and permit the tool-holder to return the chaser to its effective position. At the same time the stop

90 is struck by the stop 91 and the slide-rod 89 shifted to the position shown in Fig. 1 to unclutch the pulley P and clutch the pulley P′, whereupon the direction of rotation of the parts will be reversed again and the several devices will be in position for a new series of movements. The cutting-tool should now be adjusted by means of the hand-wheel 35, so as to bring the point of the chaser nearer to the tap to permit the chaser to take another cut from the teeth which are to be removed, the several series of operations just described being continued until every other tooth in the tap is entirely cut away and the tap *t* presents the appearance shown in Figs. 1, 2, and 7.

Having described my invention, I claim—

1. The herein-described machine comprising a work-holder; a tool-holder; automatically-operative mechanism for rotating one of said holders; an intermittently-effective cutting-tool carried by the tool-holder; and means for automatically oscillating one of said holders toward and from the other a plurality of times during each rotation of the rotary holder and for maintaining a fixed interval between the holders while they are in their working positions, the parts being combined substantially as and for the purpose specified.

2. The herein-described machine comprising a work-holder; a tool-holder; automatically-operative mechanism for rotating one of said holders; means for imparting a feed movement to one of said holders; an intermittently-effective cutting-tool carried by the tool-holder; and means for automatically oscillating one of said holders toward and from the other a plurality of times during each rotation of the rotary holder and for maintaining a fixed interval between the holders while they are in their working positions, the parts being combined substantially as and for the purpose specified.

3. The herein-described machine comprising a tool-holder; a tap-holder; automatically-operative mechanism for continuously rotating the tap-holder; an intermittently-effective cutting-tool carried by the tool-holder; and means for automatically oscillating the tool-holder to carry said tool into engagement with alternate wings of the tap and maintaining it at a fixed distance from the axis of the tap while in its working position and for withdrawing said tool from engagement with intermediate wings of said tap, the parts being combined substantially as and for the purpose specified.

4. The combination, with a work-holder and with a tool-holder, of means for rotating one of said holders; means for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; a tool-holder guide disposed at an angle to the longitudinal axis of the work-holder, and means for automatically shifting one of said holders toward and from the other a plurality of times during each rotation of the rotary holder.

5. The combination, with a work-holder and with a tool-holder, of means for rotating one of said holders; means for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; a tool-holder guide adjustable at an angle to the longitudinal axis of the work-holder; and means for automatically shifting one of said holders toward and from the other a plurality of times during each rotation of the rotary holder and for maintaining a fixed interval between the holders while they are in their working positions.

6. The combination, with a tool-holder guide, of a work-holder; a tool-holder carried by said guide for oscillation toward and from the work-holder; work-holder-rotating means; means for imparting a feed movement to the tool-holder; a cutting-tool carried by the tool-holder; and automatic rotary tool-holder-oscillating means.

7. The combination, with a tool-holder guide, of a work-holder; a tool-holder carried by said guide for oscillation toward and from the work-holder; work-holder-rotating means; means for imparting a feed movement to the tool-holder; a tool-slide carried by, and movable transversely of, the tool-holder; a cutting-tool carried by the tool-slide; and automatic rotary tool-holder-oscillating means.

8. The combination, with a tool-holder guide, of a work-holder; an oscillatory tool-holder embodying a sleeve mounted to slide on said guide and pivoted to the main portion of the tool-holder; work-holder-rotating means; means for imparting a feed movement to the tool-holder; a cutting-tool carried by the tool-holder; and automatic tool-holder-oscillating means.

9. The combination, with a work-holder, of automatically-operative work-holder-rotating means; a tool-carriage; mechanism for imparting a feed movement to the tool-carriage; a tool-holder supported on the tool-carriage for oscillation transversely to the longitudinal axis of the work-holder; a cutting-tool carried by the tool-holder; and means for automatically oscillating said tool-holder toward and from the work-holder a plurality of times during each rotation of the work-holder and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position.

10. The combination, with a work-holder, of work-holder-rotating means; a guide adapted to be set at an angle to the longitudinal axis of the work-holder; a tool-carriage; mechanism for imparting a feed movement to the tool-carriage; a tool-holder carried by the tool-carriage; a tool-slide supported on the tool-holder to slide transversely thereof and guided by said guide; a cutting-tool carried by the tool-slide; and means for shifting said tool-holder toward and from the work-holder.

11. The combination, with a work-holder, of

work-holder-rotating means; a guide adapted to be set at an angle to the longitudinal axis of the work-holder; a tool-carriage; mechanism for imparting a feed movement to the tool-carriage; a tool-holder carried by the tool-carriage; a tool-slide supported on the tool-holder to slide transversely thereof; a sleeve slidable on said guide and movably connected with the tool-slide; a cutting-tool carried by the tool-slide; and means for shifting said tool-holder toward and from the work-holder.

12. The combination, with a work-holder and means for rotating the same, of a guide adapted to be set at an angle to the longitudinal axis of the work-holder; a tool-carriage; mechanism for imparting a feed movement to the tool-carriage; a tool-holder supported on the tool-carriage for oscillation transversely to the longitudinal axis of the work-holder; a tool-slide supported on the work-holder to slide transversely thereof and guided by said guide; a cutting-tool carried by the tool-slide; and means for oscillating said tool-holder toward and from the work-holder.

13. The combination, with a work-holder and with a tool-holder, of work-holder-rotating means; means for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; means for automatically shifting said tool-holder toward and from the work-holder a plurality of times during each rotation of the work-holder; and throw-out mechanism for automatically shifting the tool-holder out of action at a predetermined point in the operation of the machine.

14. The combination, with a work-holder and with a tool-holder, of work-holder-rotating means; mechanism for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; means for automatically shifting said tool-holder toward and from the work-holder a plurality of times during each rotation of the work-holder; and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position and means controlled by the feed movements of the tool-holder for automatically reversing the operation of the feed mechanism.

15. The combination, with a work-holder and with a tool-holder, of work-holder-rotating means; mechanism for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; means for automatically shifting said tool-holder toward and from the work-holder a plurality of times during each rotation of the work-holder; and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position and means controlled by the feed movements of the tool-holder for automatically reversing the operation of the feed mechanism at opposite ends of the range of travel of the tool-holder.

16. The combination, with a work-holder and with a tool-holder, of work-holder-rotating means; mechanism for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; means for automatically shifting said tool-holder toward and from the work-holder a plurality of times during each rotation of the work-holder; means for automatically reversing the operation of the feed mechanism; and mechanism for automatically throwing the tool-holder into and out of action alternately at the beginning and at the end of its range of travel.

17. The combination, with a work-holder and with an oscillatory tool-holder, of means for continuously rotating the work-holder; an intermittently-effective cutting-tool carried by the tool-holder; and a rotary shaft carrying a plurality of wipers coöperative with the tool-holder for intermittently oscillating the latter away from the work-holder during the rotation of said work-holder and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position.

18. The combination, with an oscillatory tool-holder and with a work-holder, of means for continuously rotating the work-holder; an intermittently-effective cutting-tool carried by the tool-holder; and a rotary shaft carrying a plurality of equidistant wipers coöperative with the tool-holder for intermittently oscillating the latter away from the work-holder during the rotation of said work-holder and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position.

19. The combination, with a tool-holder and with a tap-holder adapted to carry a tap having equidistant wings, of means for continuously rotating the tap-holder; an intermittently-effective cutting-tool carried by the tool-holder; a rotary shaft carrying a plurality of equidistant wipers, one for each wing of the tap, and coöperative with the tool-holder for intermittently shifting the latter away from the work-holder during the rotation of said work-holder; and a two-to-one gear-train between the work-holder and said shaft.

20. The combination, with a work-holder and with a tool-holder, of work-holder-rotating means; means for imparting a feed movement to the tool-holder; an intermittently-effective cutting-tool carried by the tool-holder; a tool-holder guide adjustable at an angle to the longitudinal axis of the work-holder; a taper-indicating device for determining the angular position of said guide; and means for shifting the tool-holder toward and from the work-holder and for maintaining the tool at a fixed distance from the axis of the work-holder while in its working position.

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Witnesses:
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