(No Model.) 5 Sheets—Sheet 1.

G. M. GRISWOLD.

AUTOMATIC METAL GRINDING MACHINE.

No. 344,777. Patented June 29, 1886.

Fig. 1.

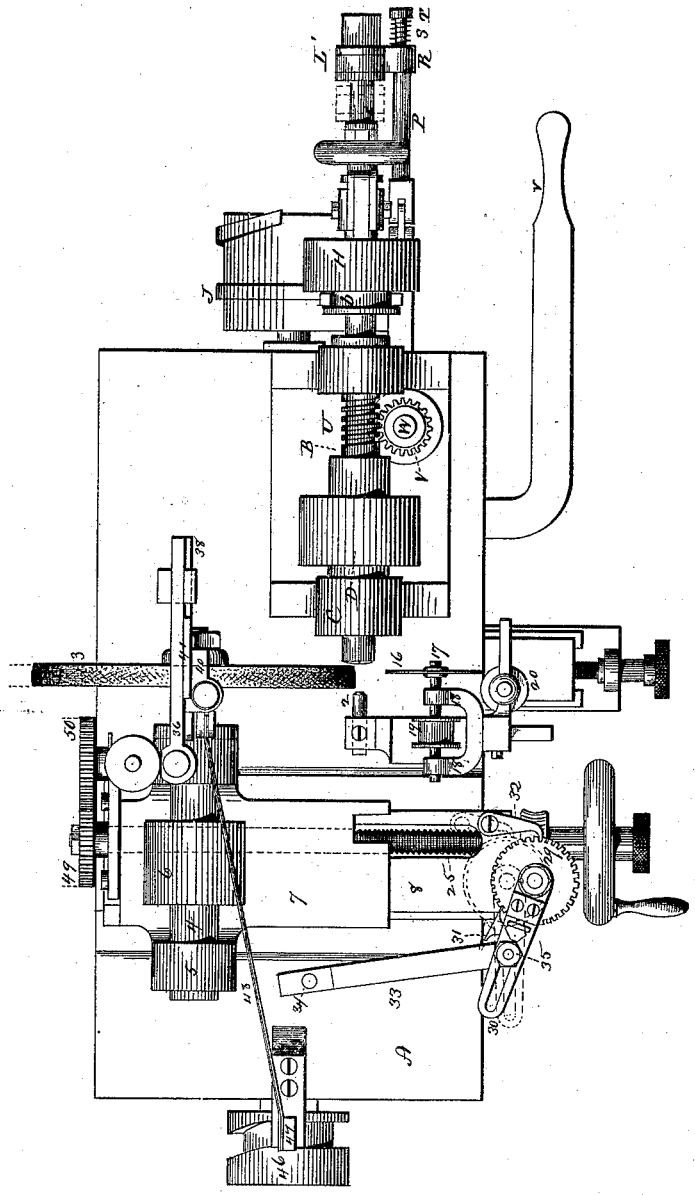

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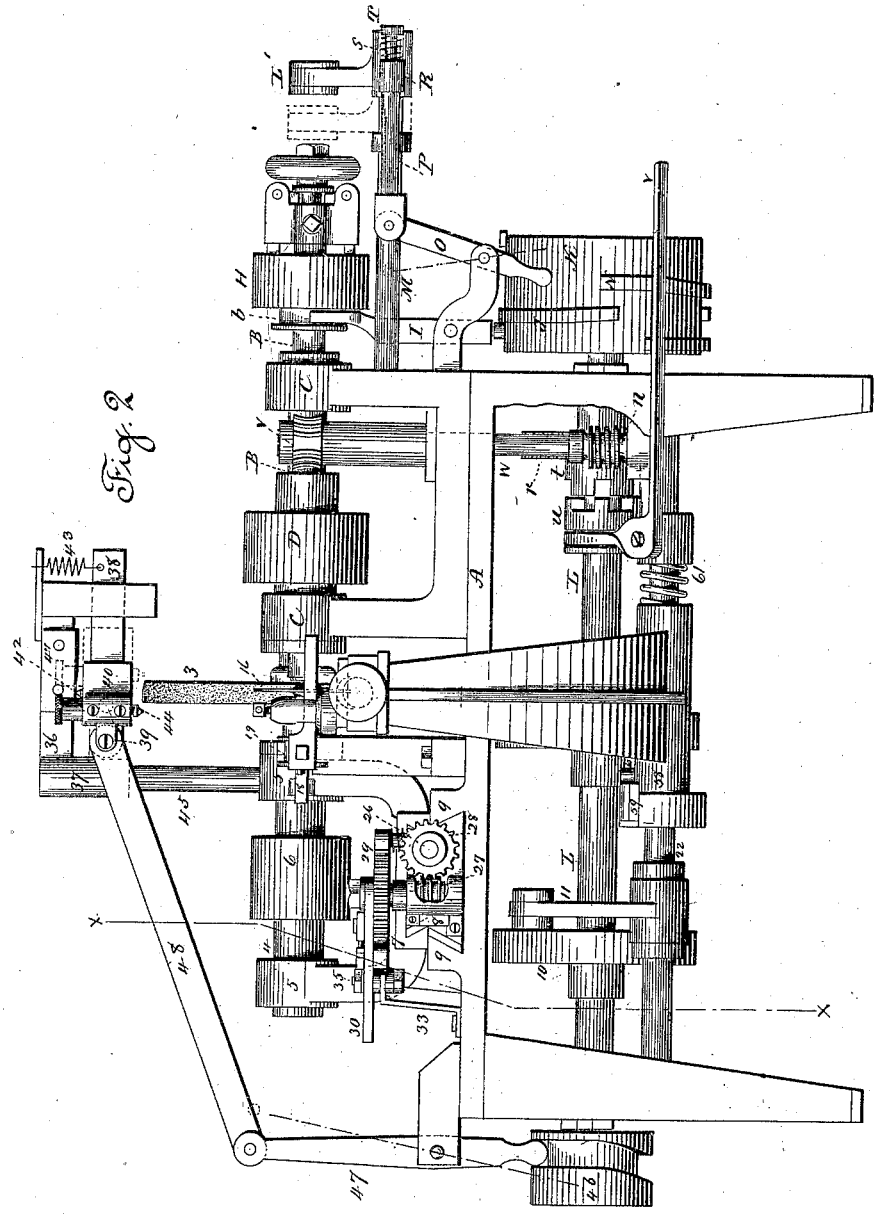
Fig. 2.



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G. M. GRISWOLD.

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Fig 3.

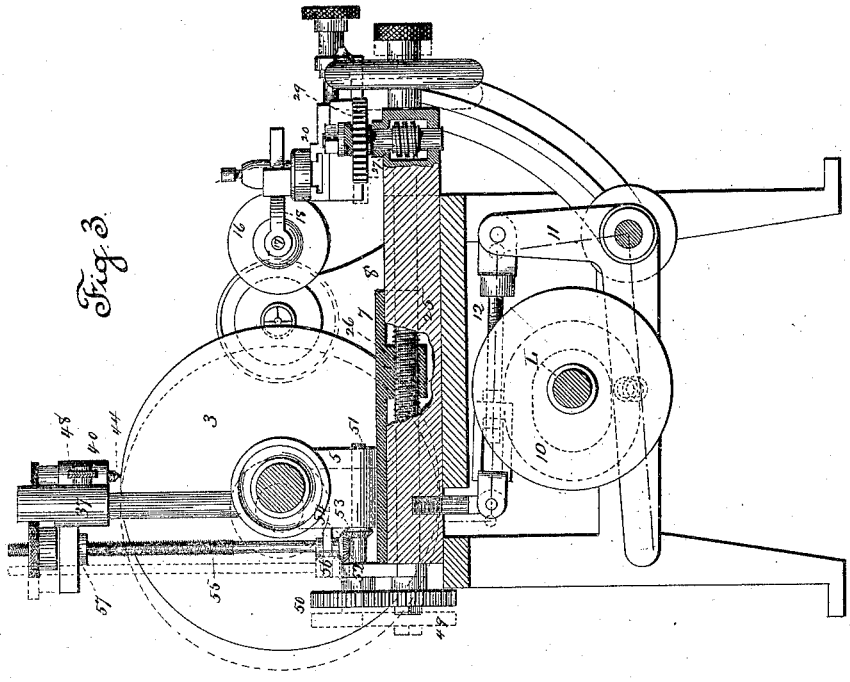
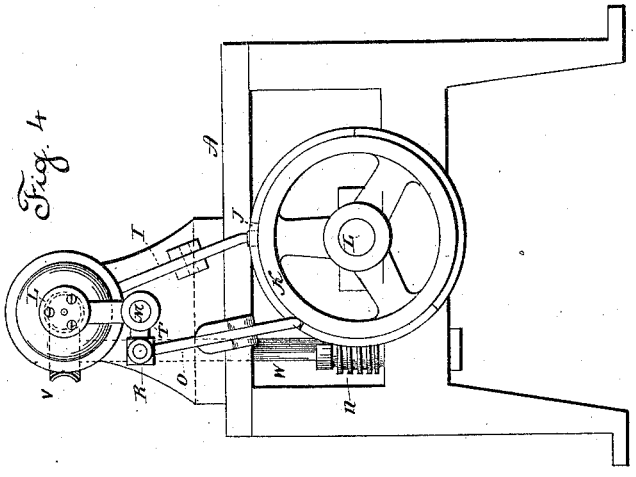


Fig 5.

Fig 4.



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(No Model.) 5 Sheets—Sheet 4.

G. M. GRISWOLD.

AUTOMATIC METAL GRINDING MACHINE.

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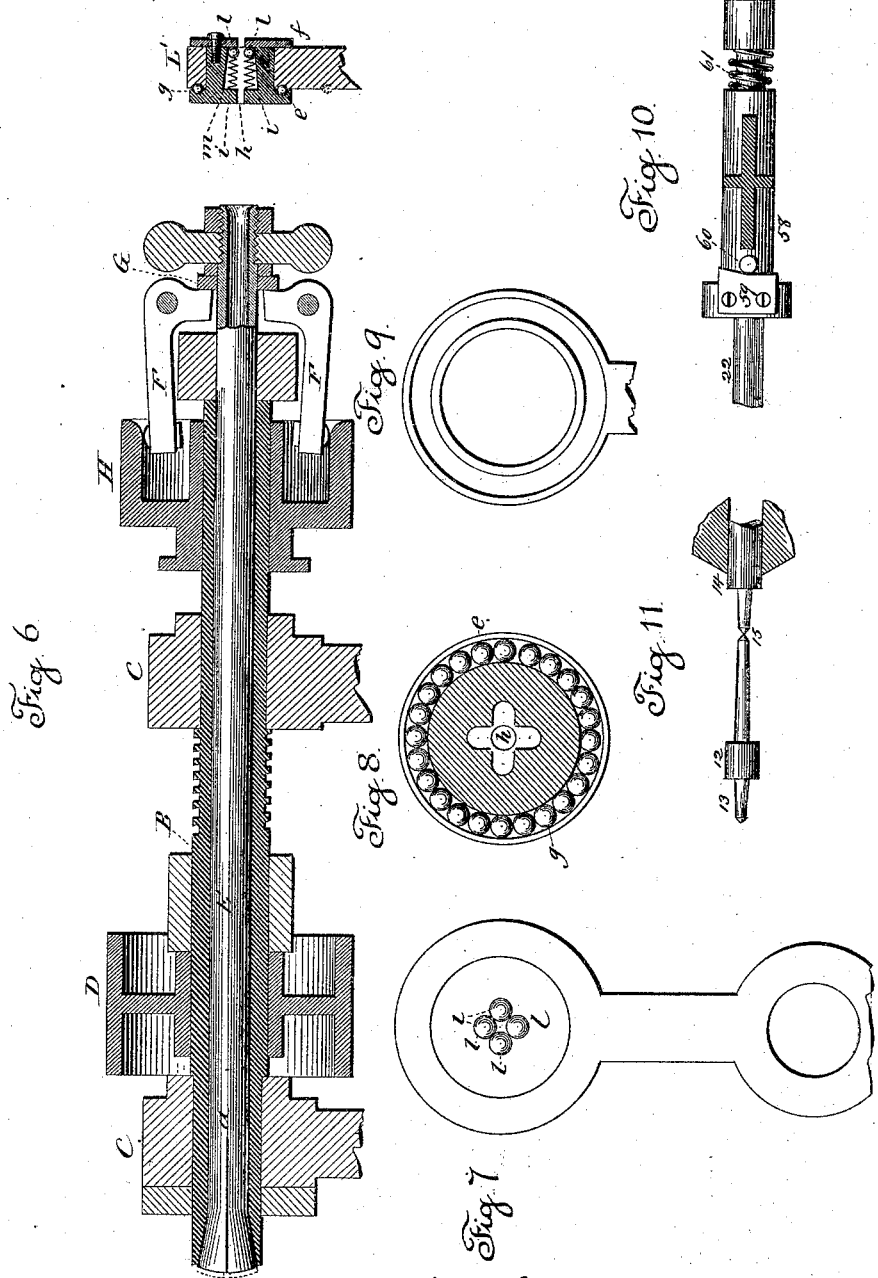

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G. M. GRISWOLD.

AUTOMATIC METAL GRINDING MACHINE.

No. 344,777. Patented June 29, 1886.

Fig. 12.

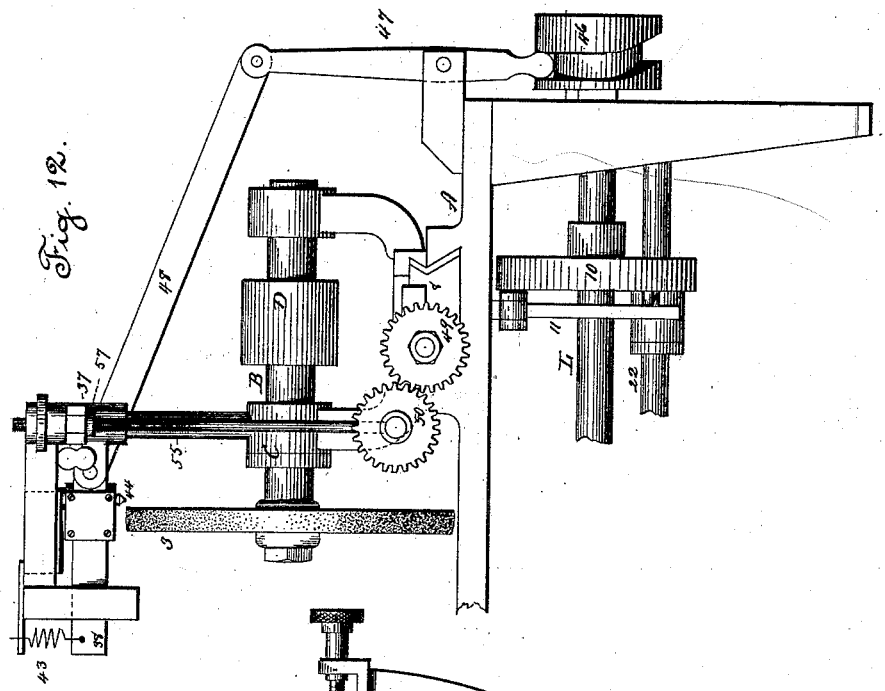
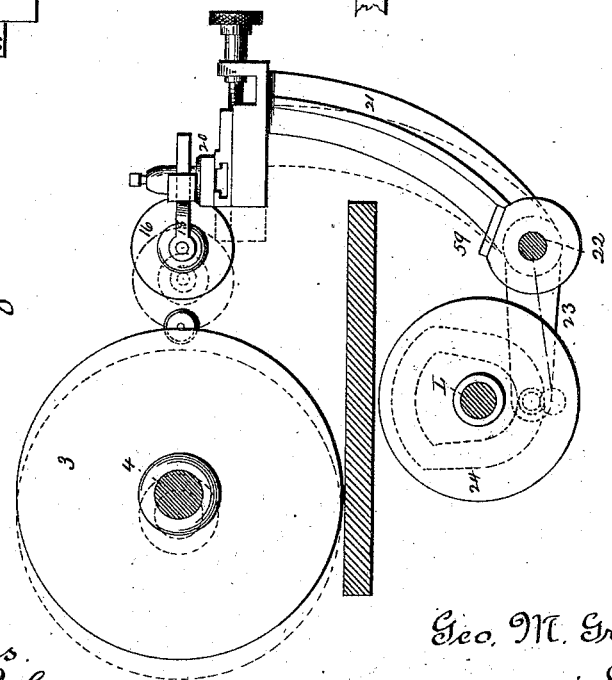


Fig. 13.



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UNITED STATES PATENT OFFICE.

GEORGE M. GRISWOLD, OF NEW HAVEN, CONNECTICUT.

AUTOMATIC METAL-GRINDING MACHINE.

SPECIFICATION forming part of Letters Patent No. 344,777, dated June 29, 1886.

Application filed February 23, 1886. Serial No. 192,781. (No model.)

To all whom it may concern:

Be it known that I, GEORGE M. GRISWOLD, of New Haven, in the county of New Haven and State of Connecticut, have invented a new Improvement in Automatic Metal-Grinding Machines; and I do hereby declare the following, when taken in connection with accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a top or plan view of the machine complete; Fig. 2, a front side view of the same; Fig. 3, a transverse section on line *x x*, parts broken away to better illustrate the invention; Fig. 4, an end view from the right of Fig. 2; Fig. 5, a pinion-blank such as may be produced by this machine; Fig. 6, a longitudinal section through the mandrel and feeding-head, enlarged; Fig. 7, a rear end view of the feeding-head, the rear flange removed to show the balls; Fig. 8, a vertical section of the feed-cylinder cutting just in rear of the forward flange, *e*, and showing the groove and anti-frictions balls therein; Fig. 9, a forward face of the feeding-head, showing the groove corresponding to the groove in the flange, Fig. 8, Figs. 7, 8, and 9 being still further enlarged; Fig. 10, a detached view of the hub of the cutter-lever, showing a modification of the cutting device; Fig. 11, a portion of the rod to illustrate the operation of the machine; Fig. 12, a rear view of a part of the machine, to illustrate the downward feed of the grinding-wheel cutter; Fig. 13, a transverse section showing the cutting-off mechanism.

This invention relates to a machine for cutting down metal surfaces by a grinding operation, and with special reference to such cutting upon a cylindrical surface, as upon a rod, such work being technically termed "breaking down," the machine being specially adapted to the manufacture of clock-pinions from wire—that is to say, the smaller class of pinions in which the pinion and arbor are integral—such pinions being formed from wire in diameter sufficient to form the blank for the pinion, and the wire reduced each side the pinion to form the arbor, as seen in Fig. 5 enlarged. After being thus formed the teeth are cut in the pinions in gear-cutting apparatus. Heretofore in general practice these pinions have been formed by cutting down the wire in a suitable machine for the purpose, the machine receiving a length of wire which is intermittently fed into the machine as each blank is finished, so that blanks are produced successively from the wire rod.

The object of my invention is to reduce the wire by a grinding operation. The invention, however, is applicable to the production of other articles, and parts of the invention to the grinding of other than cylindrical metal surfaces; and the invention consists in the construction and combination of parts, as fully hereinafter described, and more particularly recited in the claims.

A represents the bed of the machine, supported on suitable legs, which carries the operative mechanism of the machine.

B is a mandrel arranged in bearings C C, and so as to revolve freely therein, power being applied to cause such revolution through a pulley, D, on the mandrel or otherwise. The mandrel B is shown enlarged in Fig. 6. It is tubular, and does not differ materially from the mandrel usually employed in similar machines. Within the mandrel a tube, E, is longitudinally arranged, through which the wire passes. The inner tube is adapted for a certain amount of longitudinal movement. At the forward end the mandrel B, with that end of the tube E, forms what may be called a "chuck." The mandrel has an expanding mouth at its forward end, and the tube E is correspondingly expanding in shape, and is longitudinally slit, as at *a*, so as to permit a certain amount of contraction or expansion to that end of the tube, thereby forming jaws to grasp the wire. As the tube is moved forward, as indicated in broken lines, Fig. 6, the jaws open to permit the movement of the wire through the tube, and then as the tube is drawn into the mandrel the flaring mouth of the mandrel and corresponding shape of the jaws cause them to approach each other and firmly grasp the wire—a common and well-known chuck, and for which any of the known chucks may be substituted. The longitudinal movement above referred to is imparted to the tube E through bell-crank levers F F, hung in the mandrel, the shorter arm arranged to bear against a collar, G, on the tube, while the

longer arm extends forward within a collar, H, which is arranged to slide longitudinally on the mandrel, and so that as the said collar H is moved rearward it will force the longer arms of the levers inward toward the mandrel, and thereby cause the shorter arms to move rearward and draw the tube into the mandrel. At the proper time the collar H is thus moved by means of a cam acting through a lever, I. As here represented, this cam consists of a rib, J, on a cylinder, K, the said cylinder being arranged upon a shaft, L, below and parallel with the mandrel. The lever I is forked at its upper end, and works in an annular groove, *b*, on the collar H, so that vibratory movement imparted to the lever I will impart longitudinal movement to the collar H to permit the longer arm of the levers F to separate for the advance or forward movement of the tube E, or to be forced inward to cause the tube E to retreat—a mechanism common in this class of machinery, and for which any of the known mechanisms may be substituted. The wire extends longitudinally through the tube E, and when grasped by the tube, as before described, will partake of the revolution of the mandrel. Intermittently a longitudinal feeding movement is imparted to the wire, such feeding movement occurring when the tube E is moved forward to open the jaws or chuck. The feeding device by which the wire is so intermittently advanced consists of a grasping-head, L′, concentric with the mandrel, and in rear of its rear end, the said head arranged to slide upon a bar, M, below, parallel with the mandrel. To this head a reciprocating movement is imparted by means of a cam (here represented as a rib, N,) on the cylinder K, through a lever, O, and rod P, connecting the said lever O with the head L′. The rod P works through a projection, R, from the body of the head L′. (See Fig. 1.) The rod P extends through the projection R, and on the rear side of the projection a spring, S, is arranged around the rod, one end bearing against the projection R and the other against a collar, T, on the rod P, the tendency of the spring being to draw the rod to a bearing against the forward side of the projection R, as seen in Fig. 1, and so that as the rod P is forced forward its movement will be communicated to the head L′ through the said spring S, and thus produce a yielding force to move the head L′; so that if, perchance, anything should interfere with the advance of the feeding-head L′, the spring S will yield, and thereby prevent a possible break or injury to the feeding apparatus.

The feeding-head is of peculiar construction, and is illustrated in Figs. 6, 7, 8, and 9. The head L′ consists of a cylinder, *d*, arranged in the head L′, and so that it may revolve freely therein. This cylinder is constructed with an annular flange, *e*, on the forward side, and a similar flange, *f*, on the rear side, so that the cylinder is held in its place in the head, yet free to revolve. In the forward side of the head, and between it and the flange *e*, in concentric grooves, (see Figs. 8 and 9,) I arrange a series of spherical balls, *g*, (see Figs. 6 and 8,) which produce an anti-friction bearing between the flange *e* and the head.

Concentrically through the cylinder *d* is an opening, *h*, somewhat larger than the wire to be fed. In the cylinder surrounding this aperture several longitudinal grooves *i* are formed, the grooves deepening radially from the rear forward. I prefer four such grooves, and in each I arrange a spherical ball, *l*, and forward of each ball I introduce a spring, *m*, one end of the spring taking its bearing at the forward end of the groove and the other against the ball, so that the tendency of the spring is to force the balls rearward. In their normal condition they are at the extreme rear position, as seen in Fig. 6, and as also seen in Fig. 7, where the balls lie substantially in contact with each other. Opposite balls are distant from each other less than the diameter of the wire to be used. The wire is introduced through the opening in the cylinder from the rear side forward and between the balls. In such advance movement of the wire the springs yield and the balls move forward under the action of the wire, and so as not to interfere with such forward movement of the wire. When the wire is properly introduced through the mandrel, the feeding device is ready for operation. It is moved rearward, as indicated in Fig. 1, to its extreme point, then in due time advances. The balls lie in close contact with the wire and forward of their extreme rear position, and also in contact upon their opposite side with the bottom of their inclined grooves *i*, and so that as the head advances the balls, owing to the inclination of the grooves, are forced hard upon the wire to produce a grasping effect, which will cause the wire to advance with the head until the feed is completed, as indicated in broken lines, Fig. 1. Then the head retreating, the springs readily yield, to permit the balls to fall back in their grooves, away from forcible contact with the wires, and ready for a grasp upon the wire at the next advance. The grasping-balls yield instantly upon the commencement of the return of the head, and because of their spherical shape, permitting them to roll in any direction, they move over the wire with little or no friction, but are always in position for instantaneous grasp upon the movement of the head in the forward or advancing direction. This feeding device is applicable in many classes of machinery where wires or rods are to be fed in the direction of the length of the wire. The rotation of the cam-cylinder K is timed so that the chuck opens so soon as the work shall have been performed upon the wire, the feed there advanced to present a new length of wire, and the chuck regrasp the wire before a second operation commences. As here represented such rotation is imparted to the cam by a worm, U, on the mandrel B, (see Fig. 1,) working into a corresponding worm-pinion, V, on a vertical shaft, W,

which carries a worm, *n*, working into a corresponding worm-gear, *r*, on the shaft L. This makes the rotation of the shaft L and the cylinder K so slow that a very considerable portion of the time may be given to the work upon the wire, and the shape of the ribs J N such that the action to produce the grasp upon the chuck and of the feed are quick, and occupy but a fractional portion of a revolution of the cam K.

It is many times desirable to stop the feed without stopping the revolution of the mandrel. To this end I form the screw-gear *r* as a part of a hub, *t*, loose on the shaft L, and on the shaft L is a clutch, *u*, arranged to slide longitudinally on the shaft and engage or disengage the hub *t*. This clutch is provided with the usual spline between it and the shaft L, (not shown,) so that the shaft L must partake of the movement of the clutch *u*. If the clutch be disengaged, as seen in Fig. 2, then the gear R will simply turn loosely on the shaft; but if the chuck be thrown into engagement with the hub *t*, then the shaft L, with its cam-cylinder K, will partake of the revolution of the hub *t*.

A hand-lever, *v*, is provided by which the clutch may be readily thrown into or out of engagement at the convenience of the operator.

As a support for the end of that portion of the wire which projects from the chuck, I provide an adjustable center, 2, concentric with the chuck, (see Fig. 1,) which corresponds to and operates substantially like the back center in a lathe.

The cutting down of the wire is made by means of a grinding-wheel, 3. This wheel is arranged upon an arbor, 4, supported in bearings 5, and to which revolution is imparted by means of a pulley, 6, on the said arbor, the axis of the said arbor and grinding-wheel, as here represented, being parallel with the axis of the mandrel carrying the wire. The bearings 5 are formed as a part of a transverse slide, 7, arranged on a second slide, 8, which in its turn is arranged in transverse guides 9, the guides being of dovetail form, as seen in Fig. 2, so that the slide 7 may move on the slide 8, while the slide 8 may be moved in guides 9, one independent of the other, or both together, as the case may be. The slide 7 is advanced and retreated to bring the grinding-wheel up to and take it from its work, and such reciprocating movement is produced by a cam, 10, on the shaft L, (see Fig. 3,) this cam working through a bell-crank lever, 11, and an adjustable connecting-rod, 12, which connects the one arm of the bell-crank lever directly to the slide 8, on which the slide 7 is arranged. Thus as the shaft L revolves a single forward-and-back movement will be imparted to the slide 8 and the grinding-wheel 3, the said cam 10 being timed to make the advance and retreat of the grinding-wheel while the chuck holds the wire, so that a length of wire having been been properly presented and supported in front of the grinding-wheel, the grinding-wheel will be gradually advanced to the wire. The wire revolving rapidly, and the wheel also revolving, the wheel will reduce the wire as it advances, and then, when reduced to the required extent, the wheel will retreat, leaving the wire free to be cut off and advanced for the next operation. The shape of the periphery of the wheel transversely must be according to the shape required to be produced upon the wire.

In making clock-pinions such as seen in Fig. 5, the work on the wheel is best performed as indicated in Fig. 11, the wheel being in width corresponding to the length between one end of one pinion-blank and the opposite end of the next. In Fig. 11, 12 represents the pinion-blank; 13, the portion of the arbor at one end which has been previously formed. 14 represents the end of the next pinion, the space between 12 and 14 being the work of the wheel. As before described, the wheel advances and reduces the wire between 12 and 14, and this space is in length equal to the portion of the arbor on the side of the pinion-blank opposite 13, and to the portion of the arbor of the next pinion corresponding to the portion 13 of the first. The wire thus reduced between 12 and 14 is then cut, as indicated at 15, separating the completed pinion-blank from the body of the wire and leaving the forward end of the arbor of the next pinion projecting. Then the wire advances the length of one arbor to the back center, and then the wheel again advances to reduce the wire as before. The grinding-wheel is thus working on two arbors at the same time. After the grinding-wheel has done its work it becomes necessary to cut the finished portion or blank from the body of the wire. To do this I preferably employ a grinding-wheel, 16. This grinding-wheel is hung upon an arbor, 17, in bearings 18, and rapid revolution imparted thereto through a pulley, 19, on the cutter-arbor 17. The cutter-bearings, as here represented, are arranged in a tool-post, 20, similar to that employed for carrying a tool in metal lathes. This tool-post is fixed to the upper end of one arm, 21, of a lever hung upon a shaft, 22, below the bed of the machine. (See Fig. 13.) The second arm, 23, of the said lever extends into engagement with a cam, 24, on the shaft L, and so that by the rotation of the shaft L a vibratory movement is imparted to the arm 21 at right angles to the axis of the wire, and so as to advance the cutting-wheel 16, as seen in broken lines, Fig. 13, and withdraw it. The shape of the periphery of the cutting-wheel should be made corresponding to the cut required. As indicated in Fig. 11, the edge should be of inverted-V shape, so as to produce a pointed termination at both ends of the arbor. The advance of the cutting-wheel 16 occurs after the grinding-wheel shall have finished its work. The cutting-wheel, so advancing, cuts off the finished blank, then retreats, and the wire then fed, the grinding-wheel 3 advances to

repeat its work, the cutting-wheel then advancing as the grinding-wheel retreats, and then the grinding-wheel retreats, as before described. The surface of the grinding-wheel will necessarily wear away in performing the work upon the wire. It becomes necessary therefore to provide an adjustment of the grinding-wheel, so that its periphery will advance to the same point with relation to the wire, in order that the reduction on successive blanks may be constant. In making such adjustment of the wheel I have found the best results attained by a gradual advance of the wheel toward the axis of the mandrel between each operation of the grinding-wheel, such advance being to the extent of the wear of the grinding-wheel, and as in different wheels, or in different parts of the same wheel, the wear will vary, I provide a device which will travel across the face of the grinding-wheel and take therefrom a predetermined depth equal, at least, to the greatest possible wear in a single operation, and then advance the grinding-wheel between successive operations to the extent of this reduction of the wheel; but before describing the device for positively reducing the wheel I will describe the advance of the grinding-wheel, presupposing a constant or uniform wear of the wheel. In the slide 8 a leading-screw, 25, is arranged parallel with the guides on which it, as also on which the slide 7, moves, and this leading-screw works through a nut, 26, on the slide 7, so that a rotation of the leading-screw will impart to the slide 7 a movement in the direction of the axis of the screw independent of the slide 8, and to the extent of such rotation of the leading-screw. The leading-screw is fixed in bearings in the slide 8, and so as to partake of the longitudinal movement of the said slide 8. At the front end of the slide 8, and in bearings therein, is a vertical worm, 27, which works into a worm-pinion, 28, on the leading-screw 25. (See Fig. 2.) This worm also moves with the slide 8, and on the shaft of the worm 27 is a toothed ratchet, 29. Loosely on the axis of the ratchet 29 a lever, 30, is hung, (see Fig. 1,) and so as to swing in a horizontal plane concentric with the ratchet 29. Upon the lever 30 is a pawl, 31, adapted to work into the teeth of the ratchet 29, and on the slide 8 is a stop-dog, 32, adapted to engage the teeth of the ratchet. To the bed of the machine a rod, 33, is hung by one end, as at 34, the other end hung to the lever 30, as at 35. The rod 33 being fixed, it follows that as the slide 8 moves in one direction—say inward—as seen in broken lines, Fig. 1, the dog 32 will hold the ratchet 29, while the pawl 31 will fall back over the teeth of the ratchet and make a new hold upon the ratchet. Then as the slide returns the pawl 31 will hold the teeth it has engaged, and impart corresponding rotation to the wheel 29, and that rotation will be communicated to the leading-screw 25 through the worm 27 and the gear 28 on the leading-screw. This leading-screw being engaged with the slide which carries the grinding-wheel, will therefore impart an advance movement to the grinding-wheel slide to the extent of the rotation of the leading-screw, and the extent to which the grinding-wheel is thus advanced may be varied by adjusting the connection between the rod 33 and the lever 30, a slide in the lever being provided for this purpose, and is a well-known adjustment; but when once set this adjustment would be constant and the wheel would advance to the same extent after each operation, and this would be sufficient adjustment were the extent of wear upon the grinding-wheel radially the same at each operation; but inasmuch as such wear will vary to a considerable extent, I provide a device to work across the face of the wheel and remove therefrom a portion radially equal to the extent of the greatest possible wear. This device I will now proceed to describe. Above the grinding-wheel 3 is a horizontal arm, 36, parallel with the axis of the grinding-wheel. The arm extends from a sleeve, 37, arranged as a slide on a vertical post, 45, rigidly fixed to the carriage which carries the grinding-wheel. Beneath the arm 36 is a lever, 38, hung upon a fulcrum at 39, and so as to swing in a vertical plane parallel with the arm 36. On the lever 38 is a slide, 40, adapted to be moved back and forward thereon. On the bar 36 is a guide, 41, the lower edge of which corresponds to the shape which is required for the periphery of the wheel, and on the upper side of the slide is a point, 42, which works against the under edge of the guide 41, and so that as the slide moves back and forth on the lever 38 the lever and the slide will be depressed or rise, as the case may be, to conform to the shape of the working-edge of the guide 41. The free end of the lever 38 is supported by a spring, 43, to hold it up against the guide, but yield for the depression of the guide. In the under side of the slide 40 a carbon, or what is commonly called "black diamond," is fixed, as at 44, and so that as the slide moves over the periphery of the wheel the carbon will come in contact with the surface of the wheel and cut therefrom to the extent required. A reciprocating movement is imparted to the slide 40 by means of a cam, 46, on the shaft L, working through a lever, 47, and connecting-rod 48, so that at the proper time in the operation of the machine—say while the grinding-wheel is retreating, and before it has advanced—the slide 40 is moved across the face of the wheel, as indicated in broken lines, and returned. The carbon working upon the surface of the grinding-wheel cuts therefrom to the extent for which the carbon may be set, and in a shape corresponding to the guide 41. In order that the carbon may dress the grinding-wheel after each operation of the grinding-wheel on the wire, a downward feed is given to the arm 36 and the carbon to the extent required for each operation of the carbon upon the wheel. This downward feed is produced

from the leading-screw 25 by means of a gear, 49, on the leading-screw at the back of the machine, which works into a corresponding gear, 50, hung upon the slide 8, in which the leading-screw is fixed. The gear 50 is fixed upon the shaft 51, which extends through the arm 52, which supports the gear 50, and forward through a portion of the slide which carries the grinding-wheel, and on the shaft 51 is a bevel-pinion, 53, engaged with the shaft 51 by a common spline arrangement, so that the pinion 53 is free to move longitudinally on the shaft 51, yet so engaged as to partake of the revolution of the shaft 51. The pinion 53 works into a corresponding bevel-pinion, 54, on the lower end of a vertical leading-screw, 55. This leading-screw is supported at its lower end in a bearing, 56, extending from the grinding-wheel slide, and at its upper end works through a nut, 57, fixed to the sleeve 37, that carries the carbon-holder, so that the rotation of the leading-screw 55 will raise or lower the sleeve 37, according to the direction in which the leading-screw is turned.

In the working of the machine the leading-screw is turned, through the gearing described, so as to lower the sleeve 37 and the carbon-holder connected therewith. The gearing and the leading-screw 55 are such with relation to the leading-screw 25 that the carbon will be forced downward to the same extent that the slide carrying the grinding-wheel is moved forward, so that, suppose, for illustration, the maximum wear upon the grinding-wheel at each operation to be one ten-thousandth of an inch, the advance movement of the slide 7, carrying the grinding-wheel, will be one ten-thousandth of an inch, and the descent of the carbon will be also one ten-thousandth of an inch; hence as the carbon travels across the face of the grinding-wheel it will reduce the surface of the grinding-wheel to the extent of one ten-thousandth of an inch, minus, of course, the depth which shall have been removed in the grinding operation, and thus the periphery of the grinding-wheel will always bear the same relation to the surface to be ground. If the surface of the grinding-wheel is to be straight across the face of the wheel, so that no up or down movement is required for the carbon, the arm or lever which serves as a guide for the movement of the carbon may be fixed and stationary. This device for gradually advancing the grinding-wheel and for correspondingly dressing its face may be employed in other grinding-machines where the work of the grinding-wheel is intermittent—that is to say, where there is a lapse of time between successive operations of the grinding-wheel sufficient to give time for the travel of the carbon across the face of the grinding-wheel. I do not therefore wish to be understood as limiting this part of my invention to the breaking down or reducing of metal wire or rods.

I have represented the cutting-off device as a revolving cutting or grinding wheel, 16; but it will be readily seen by those skilled in this class of machinery that a cutting-tool may be substituted for the grinding-wheel in the same tool-post, and in like manner as a cutting-tool is introduced into the tool-post of a lathe, and in like manner adjustable; but in the use of such a cutter it is desirable that it have also a longitudinal movement. To this end the lever 21 23, which carries the tool-stock, is arranged upon the shaft 22, so that it may receive a certain amount of longitudinal movement. The shaft 22 is fixed and rigid, the lever rocking thereon, 58, Fig. 10, representing the hub of the lever. On the shaft is a fixed cam, 59, against which a stud, 60, on the hub of the lever works, and so that as the lever is rocked upon the shaft to advance the cutter the cam will force the lever longitudinally on the shaft 22 to the extent of the pitch of the cam and against the pressure of a spring, 61. The extent of movement of the cam gives the longitudinal movement required for the operation of the cutter. The spring 61 returns the lever as the cutter retreats.

While I prefer the feed which I have described to advance the wire or rod, it will be understood that any of the intermittent feeds may be substituted therefor.

I claim—

1. The herein-described feed for wire or rods, consisting of a head arranged for longitudinal movement, and constructed with an opening longitudinally through it for the passage of the wire or rod, and also constructed with longitudinal grooves in said opening, the grooves deepening radially in the direction of the advance movement of the head, and a ball arranged in each of the said grooves, substantially as described, the said balls adapted, under the advance movement of the head, to impinge upon the rod, and to release the rod on the retreat of the head.

2. In a machine for producing articles from wire or rods, the combination of a revolving mandrel, through which the said rod or wire passes, the said mandrel provided with a chuck adapted to grasp and release the said rod, a reciprocating feeding-head arranged in axial line with the said mandrel, a cylinder in said head, arranged to revolve therein concentric with the axis of said mandrel, the said cylinder having an axial opening through it corresponding to the axis of the mandrel, the said cylinder constructed with longitudinal grooves in the opening through the head, the said grooves deepening radially from the rear end forward, and a ball in each of said grooves, substantially as and for the purpose described.

3. In a feeding-head for wire or rods, the cylinder *d*, arranged for free revolution, and constructed with an opening concentrically through it for the passage of the wire, the cylinder constructed with an annular flange upon its forward end against that side of the head, the head and flange each constructed with a corresponding concentric groove, a se-

ries of balls, *g*, in said groove, the said head provided with a gripping device to engage and release the rod to be fed, substantially as described.

4. In a feeding-head for wire or rods, the cylinder *d*, arranged for free revolution, and constructed with an opening concentrically through it for the passage of the wire, the cylinder constructed with an annular flange upon its forward end against that side of the head, the head and flange each constructed with a corresponding concentric groove, a series of balls, *g*, in said groove, the said cylinder constructed with longitudinal grooves in the opening through the said cylinder deepening radially from the rear toward the forward end, a ball, *l*, in each of said grooves, and a spring in the said grooves forward of the balls, substantially as described.

5. In a machine for grinding metal surfaces, the combination of a revolving grinding-wheel, a slide carrying said grinding-wheel, arranged upon a second slide, said second slide arranged to reciprocate in a path at right angles to the axis of the grinding-wheel, the said grinding-wheel slide arranged upon the second slide to move in a path parallel with the path of said second slide, a leading-screw in said second slide working through a nut on the grinding-wheel slide, and mechanism, substantially such as described, to impart rotation to said leading-screw, substantially as specified, and whereby the said grinding-wheel and its slide may receive a certain extent of advance movement independent of the advance and retreating movement imparted to it by the movement of said second slide.

6. In a machine for grinding metal surfaces, the combination of a grinding-wheel, a slide arranged in guides substantially parallel with the face of said grinding-wheel, the said slide provided with a cutter adapted to operate upon the face of the wheel, the slide carrying the cutter also adapted to receive an intermittent movement toward the grinding-wheel, and mechanism, substantially such as described, to automatically impart reciprocating movement to said slide, whereby said cutter will be caused to pass across the face of the grinding-wheel, and also to impart an intermittent movement to the said slide, carrying the cutter toward the face of the grinding-wheel, substantially as described.

7. In a machine for grinding metal surfaces, the combination of a grinding-wheel, a reciprocating slide arranged on a guide across the face of the said grinding-wheel, said slide carrying a cutter adapted to bear upon the face of said wheel, and mechanism, substantially such as described, to impart an intermittent feed to said cutter-carrying slide toward the said wheel, the said guide constructed to permit its radial movement toward and from said grinding-wheel, and a cam over said cutter-carrying slide, substantially as described, and whereby the said cutter will be advanced toward or drawn from the said wheel, according to the shape of the said cam.

8. In a machine for grinding metal surfaces, the combination of the reciprocating slide 8, arranged in guides, the slide 7, arranged on said slide 8 and in guides parallel with the movement of said slide, a revolving grinding-wheel, 3, arranged in bearings on said slide 7, the axis of the said grinding-wheel at right angles to the path of the said two slides, a leading-screw, 25, in said slide 8, a worm-gear, 28, on said leading-screw, a vertical worm, 27, working into said gear 28, a ratchet, 29, on said worm-shaft, a lever, 30, hung upon the axis of said ratchet 29, a pawl, 31, on said lever, and a rod, 33, one end hung in a fixed position, the other to the said lever, substantially as described.

9. In a machine for grinding metal surfaces, the combination of the reciprocating slide 8, the slide 7, arranged on said slide 8 in guides parallel with the movement of said slide 8, an intermittently-rotating leading-screw, 26, in said slide 8, the said screw engaged with the said slide 7, whereby the intermittent rotation of such screw will be imparted to said slide 7 independent of the slide 8, a revolving grinding-wheel, 3, arranged on said slide 7, the axis of the said wheel being at right angles to the path of movement of the said slides 7and 8, a slide, 40, arranged above said grinding-wheel, on a guide substantially parallel with the axis of the said grinding-wheel, and the said guide arranged upon a vertically-guided slide, and a vertical leading-screw, 55, in connection with said leading-screw 25, whereby the intermittent rotation of said leading-screw 25 will be imparted to said leading-screw 55, the said vertical leading-screw 55 in threaded connection with the vertically-movable slide carrying the slide 40, and the said slide 40 provided with a cutter adapted to operate upon the surface of the said grinding-wheel, substantially as described.

10. The combination of a constantly-revolving tubular mandrel, a chuck in said mandrel adapted to engage and release a wire or rod fed through said mandrel, a reciprocating slide, 8, at right angles to the axis of said mandrel, a grinding-wheel arranged upon said slide with its axis parallel with the axis of the mandrel, and whereby the said grinding-wheel is adapted to be moved toward or from the axial line of the said mandrel, an intermittently-reciprocating cutter adapted to reciprocate in a path at substantially right angles to the axis of the mandrel, and an intermittently-reciprocating feed adapted to engage the wire or rod which runs through the mandrel and intermittently advance the said rod, substantially as described.

GEO. M. GRISWOLD.

Witnesses:
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