Nov. 22, 1932. W. ARTER ET AL 1,888,710

GRINDING MACHINE

Filed March 1, 1927 6 Sheets-Sheet 1

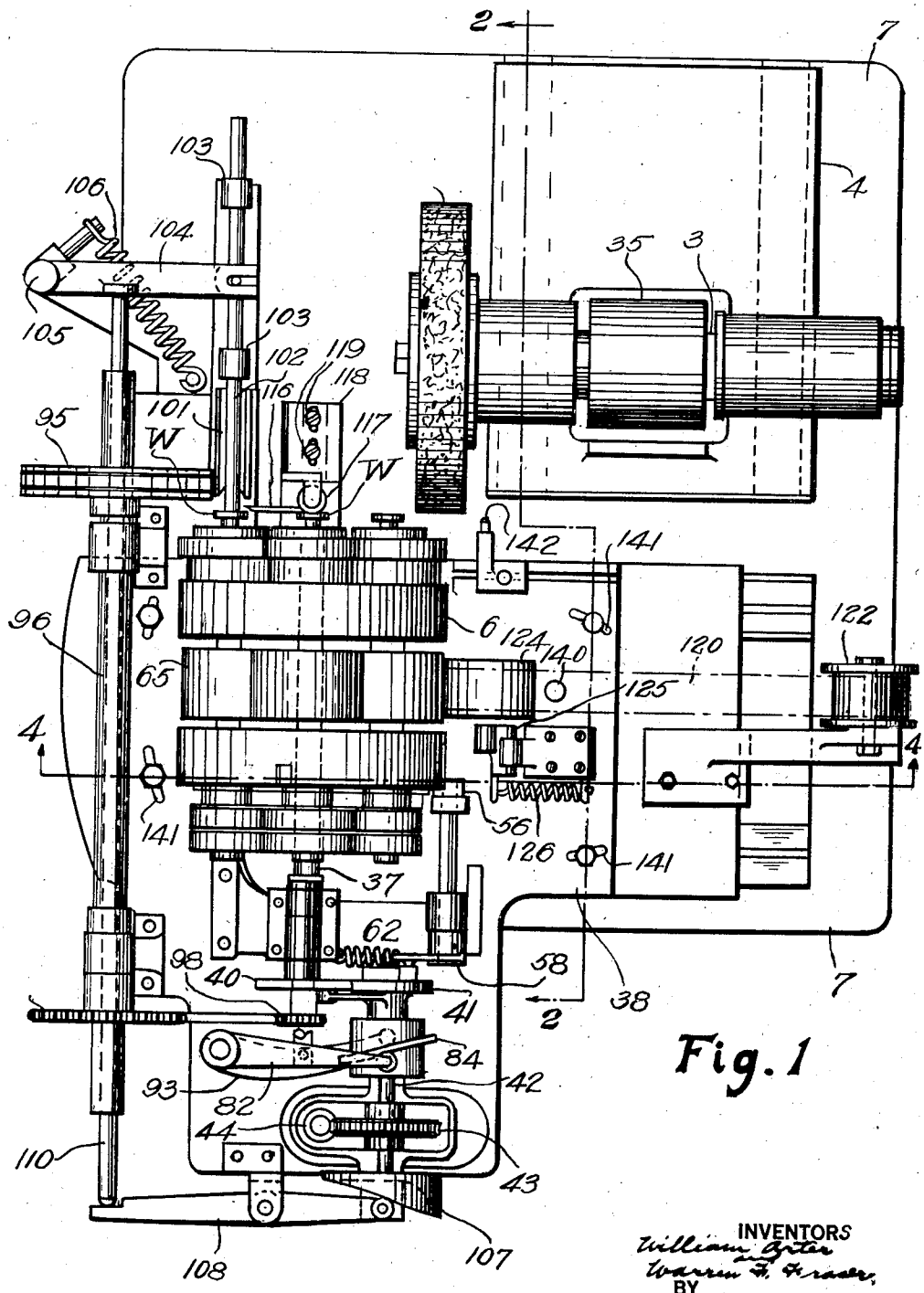

Fig. 1

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GRINDING MACHINE

Filed March 1, 1927 6 Sheets-Sheet 2

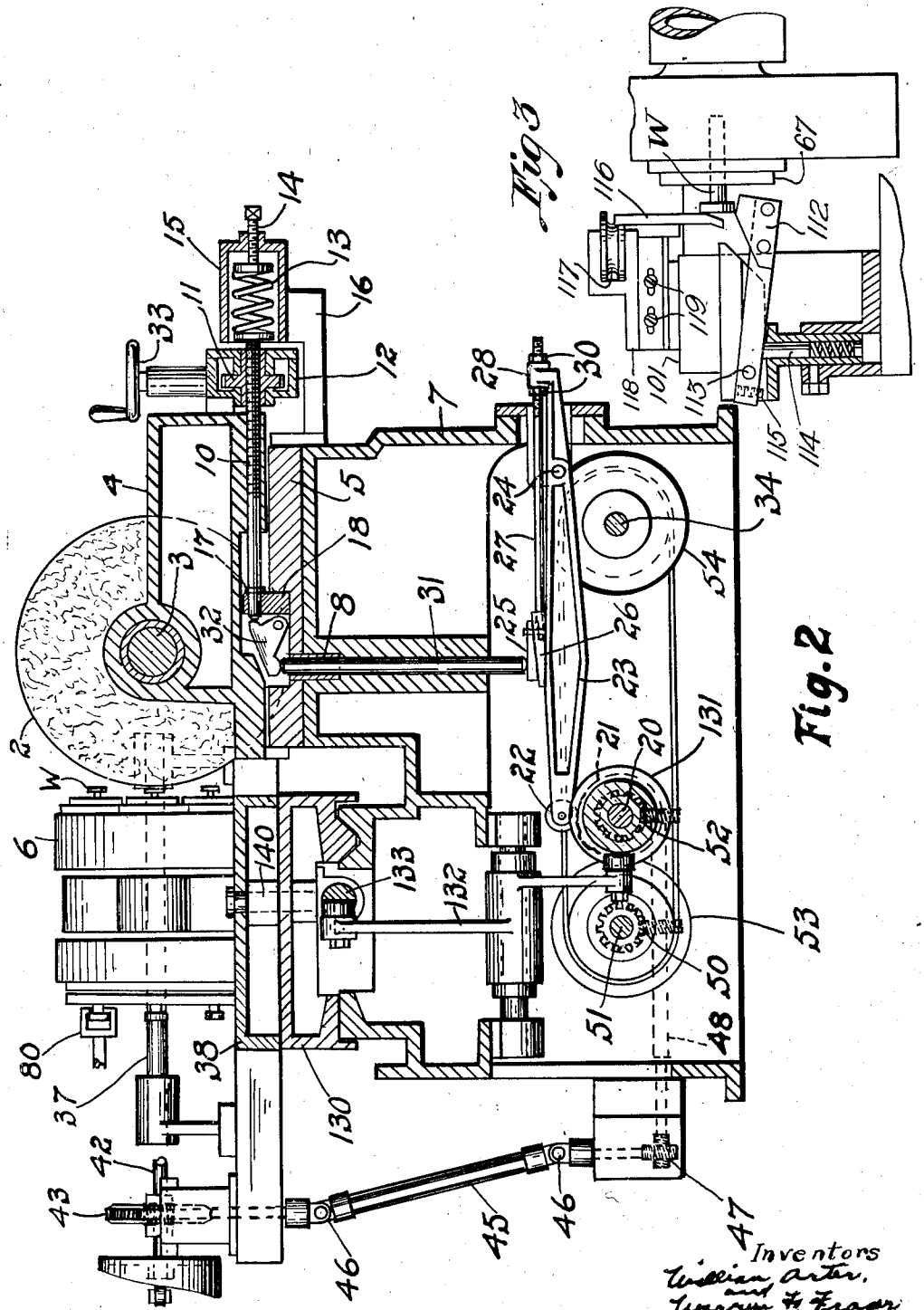

Fig. 2

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Nov. 22, 1932. W. ARTER ET AL 1,888,710

GRINDING MACHINE

Filed March 1, 1927 6 Sheets-Sheet 3

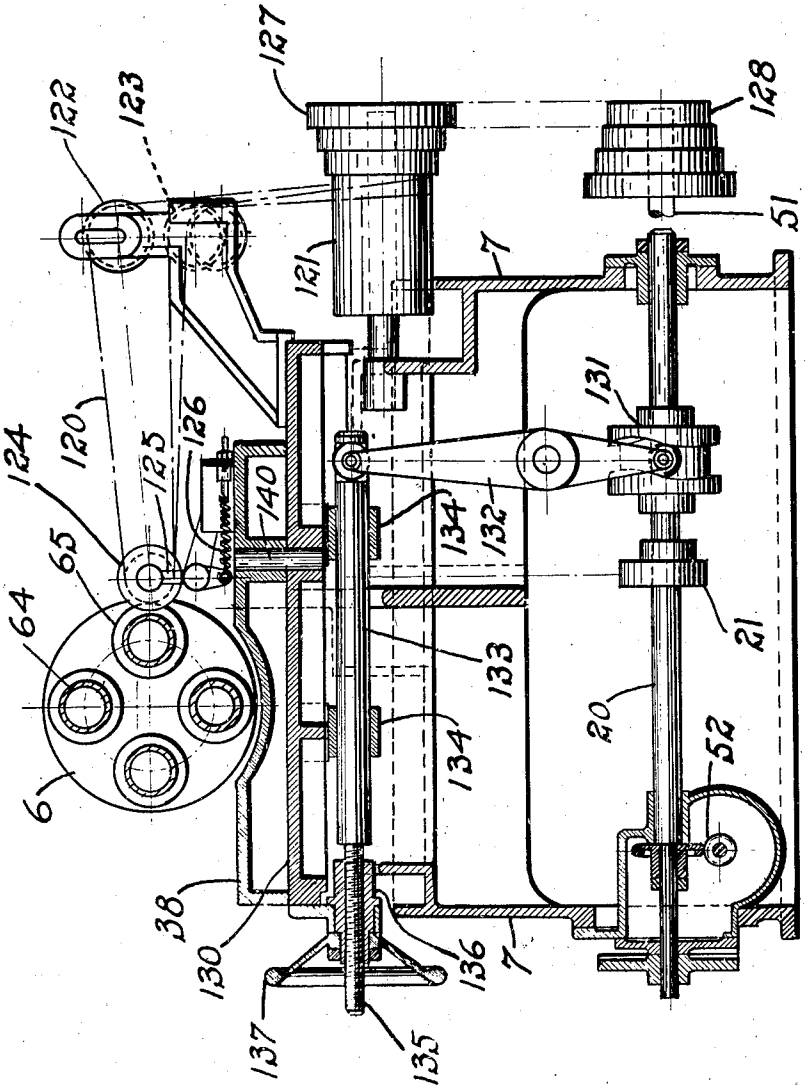

Fig.4

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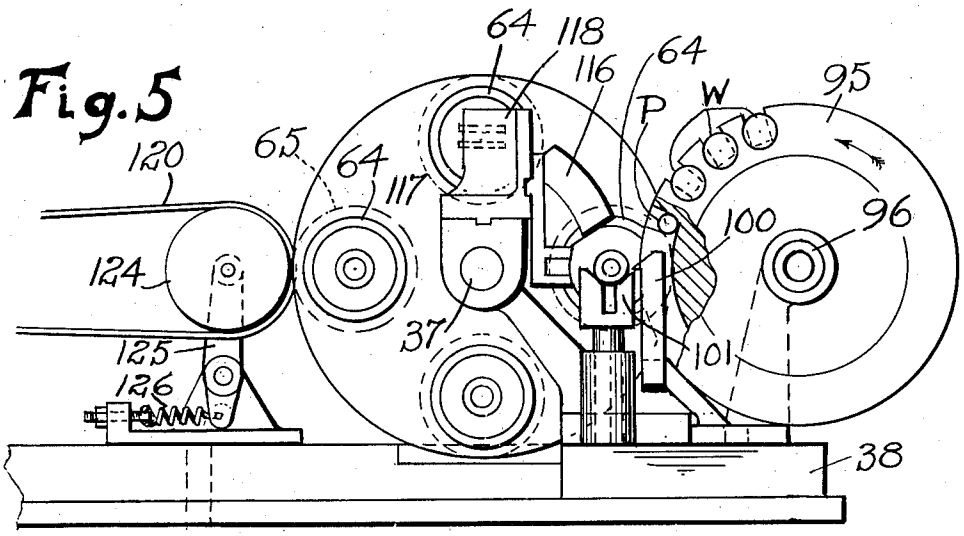
Nov. 22, 1932. W. ARTER ET AL 1,888,710

GRINDING MACHINE

Filed March 1, 1927 6 Sheets-Sheet 4

Fig.5



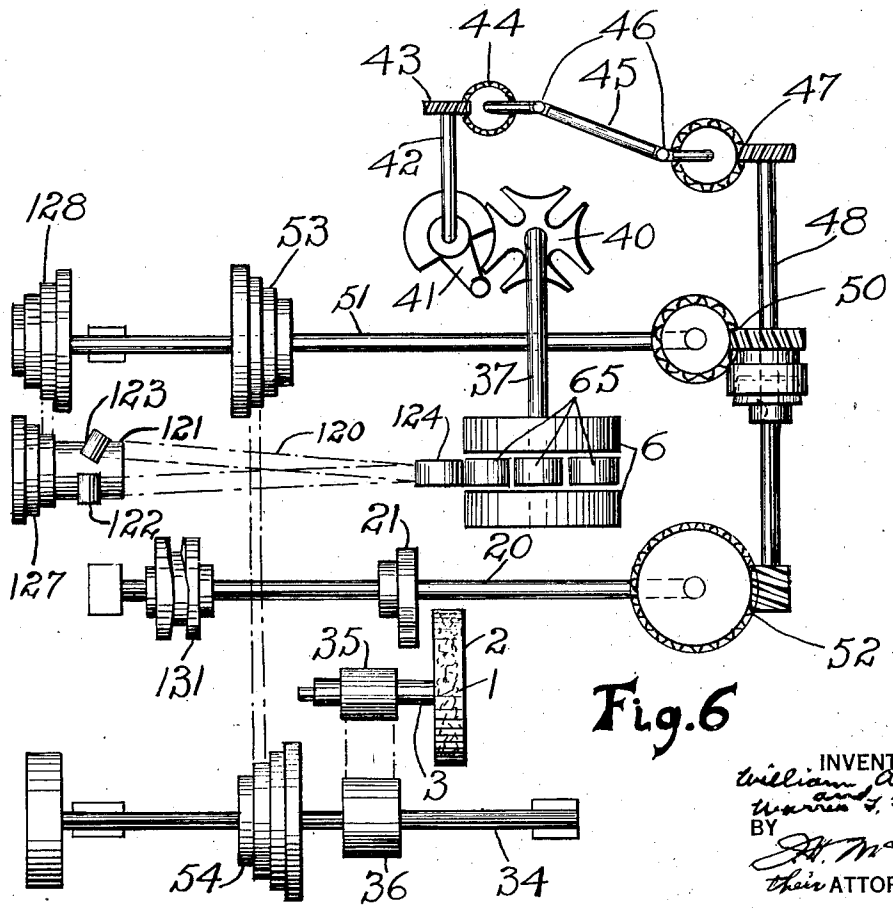


Fig.6

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Nov. 22, 1932. W. ARTER ET AL 1,888,710

GRINDING MACHINE

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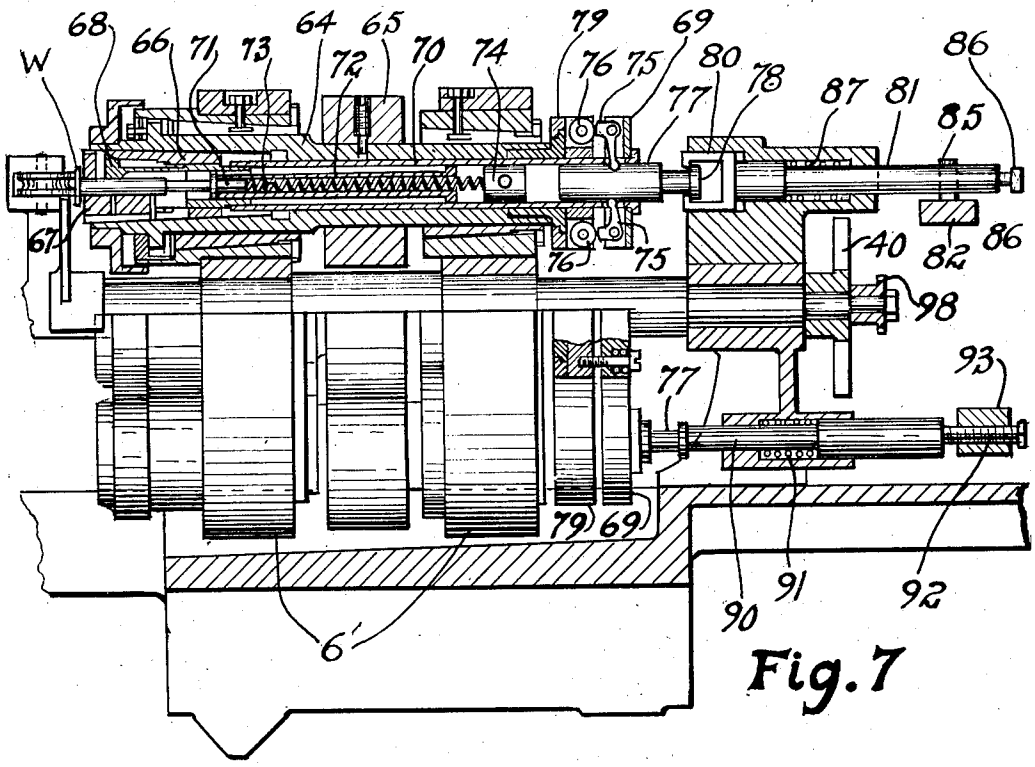

Fig. 7

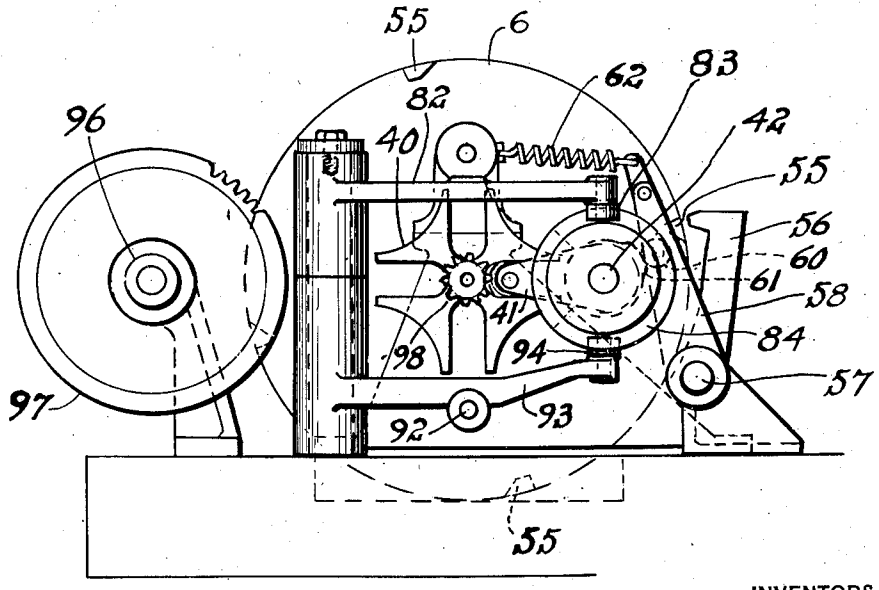

Fig. 8

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Nov. 22, 1932. W. ARTER ET AL 1,888,710

GRINDING MACHINE

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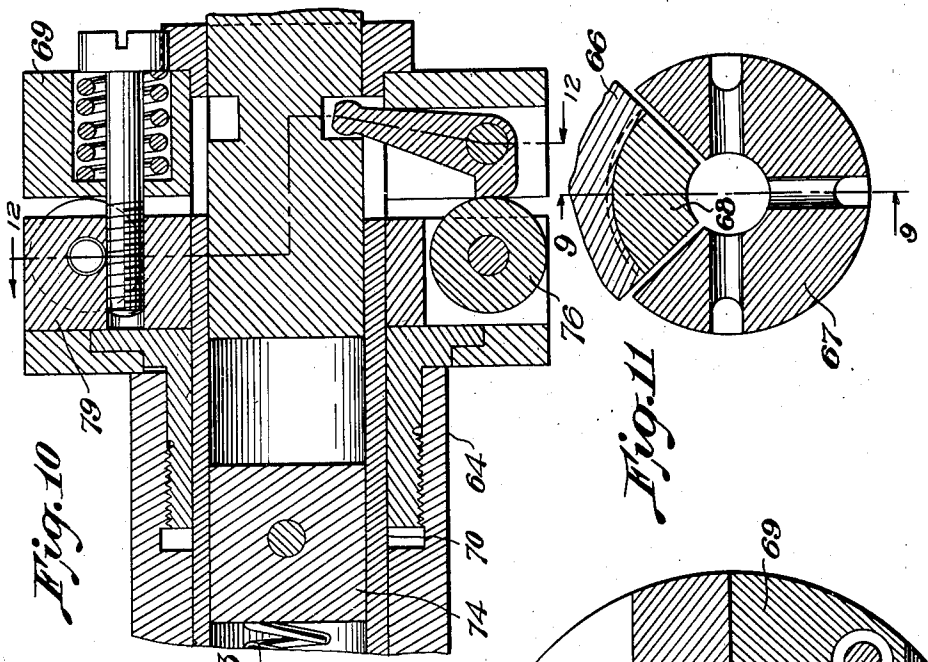

Fig. 10

Fig. 11

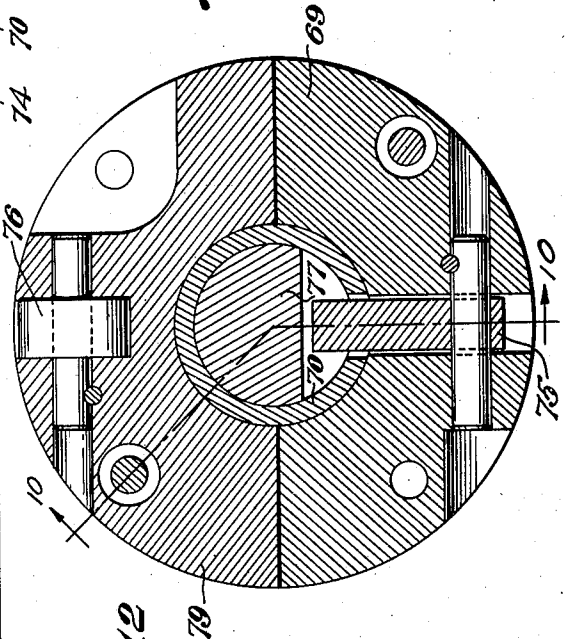

Fig. 12

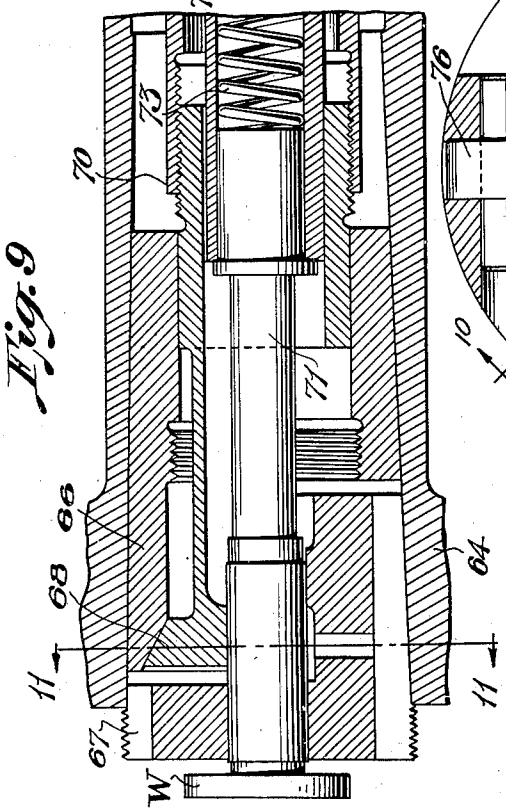

Fig. 9

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Patented Nov. 22, 1932

1,888,710

UNITED STATES PATENT OFFICE

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GRINDING MACHINE

Application filed March 1, 1927. Serial No. 171,891.

This invention relates to grinding machines and is more especially concerned with machines of this type which are adapted for acting on the end portions of various articles of work. The invention will be herein disclosed as embodied in a machine designed especially for grinding the end faces of rolls, pins, the heads of poppet valves, and the like.

It is the general object of the invention to devise a grinder of the type indicated which will be entirely automatic in operation, while still capable of handling a wide variety of work.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawings,

Figure 1 is a plan view showing the greater part of a machine embodying this invention;

Fig. 2 is a cross-sectional view substantially on the line 2—2, Fig. 1;

Fig. 3 is a view partly in side elevation and partly in cross-section, showing certain details of the mechanism for loading the work into the chucks in the turret;

Fig. 4 is a cross-sectional view substantially on the line 4—4, Fig. 1;

Fig. 5 is an end view, partly in cross-section, showing the mechanism for driving the chucks about their individual axes and also showing certain parts of the loading mechanism;

Fig. 6 is a diagrammatic view of the driving connections to the different units of the machine;

Fig. 7 is a longitudinal cross-sectional view through one of the chucks in the turret, and also shows, in elevation, some parts of the turret and the supporting mechanism therefor;

Fig. 8 is an elevation of the rear end of the turret showing certain parts of the operating mechanism;

Fig. 9 is a longitudinal cross-sectional view through the front part of one of the chucks;

Fig. 10 is a similar view through the rear portion of a chuck;

Fig. 11 is a cross-sectional view substantially on the line 11—11, Fig. 9; and

Fig. 12 is a cross-sectional view substantially on the line 12—12, Fig. 10.

The machine shown in the drawings comprises a grinding wheel mounted to have an approaching and receding movement relatively to the work, a turret carrying four chucks, each adapted to support an article of work for the action thereon of the grinding wheel, a mechanism for indexing the turret, a loading mechanism for forcing articles of work into the chuck one at a time as the chucks come into loading position, mechanism for positioning the work accurately in the chucks as they are moved into position for the grinding wheel to act on them, and means for driving the chuck which is in working position. The machine also includes certain adjustments and auxiliary parts which will be described in connection with the mechanism with which they are more especially associated. The detailed description of the various mechanisms will be taken up in substantially the order in which they have just been enumerated.

Referring more particularly to Figs. 1, 2 and 6, it will be observed that the grinding wheel is indicated at 2, and is mounted on a shaft 3 which is supported in suitable bearings provided in a wheel head 4. This wheel head is mounted in ways formed in a base 5 so that the wheel can slide toward or from the turret 6, the base 5 being mounted on the machine frame 7. Preferably the base 5 is pivoted to the frame 7 on a sleeve 8, Fig. 2, so that the entire base with the parts mounted thereon, including the wheel 2, can be adjusted into different angular relationships to the turret, the base being provided with slots (not shown) through which bolts project into the machine frame to secure the base rigidly in its adjusted position.

The particular articles of work W shown in the drawings are valve tappets of the type much used in internal combustion engines, and one important practical use of the machine illustrated is to grind the bevelled

faces on tappets of this type. In order to relatively move the grinding wheel and the work into and out of grinding relationship, an automatic mechanism is provided for giving the wheel work-approaching and receding movements. For this purpose a horizontal screw threaded rod 10, Fig. 2, is mounted loosely in the wheel head 4 but has threaded engagement with a nut 11 which is rotatably supported in a bracket 12 rigidly secured to the wheel head 4. This nut is held against movement in either direction axially of the screw 10 so that the screw and nut are compelled to move with the wheel head. A coiled spring 13 bears against the right-hand enlarged end, Fig. 2, of the screw 10 and is backed up by an adjusting screw 14, the spring being enclosed in a housing 15 which forms part of a bracket 16 that is bolted to the machine frame. Consequently, the spring 13 constantly urges the wheel toward the turret. This movement is limited, however, by a collar 17 fast on the screw 10 and arranged to abut against a fixed stop 18 which is rigid with the base 5. In the frame 7 of the machine a cam shaft 20 is mounted, this shaft carrying a cam 21, the surface of which is engaged by a roll 22 mounted in the end of a lever 23. This lever is fulcrumed on the machine frame at 24 and it carries two wedges 25 and 26 arranged one upon the other, the lower wedge being fixed while the upper wedge 25 is pinned to the end of a rod 27. The right-hand end, Fig. 2, of this rod is threaded and projects through an extension 28 of the lever 23, adjusting nuts 30 being threaded on the rod at opposite sides of the part 28 so that by properly manipulating these nuts the upper wedge 25 can be adjusted on the lower wedge. A vertical rod 31 rests on the upper wedge, and one end of a bell crank lever 32 engages the upper end of this rod, while the other end is arranged to engage the end of the screw 10 previously referred to. The cam 21 makes one complete revolution in each cycle of operations of the machine, and it acts through the connections just described to force the wheel head 4 back away from the work against the pressure of the spring 13. The wheel head thus is given one complete reciprocation in each machine cycle, being moved forward yieldingly by the spring 13 into engagement with the work and positively withdrawn from the work by the cam operated mechanism.

Adjustment of the entire wheel head relatively to this reciprocating mechanism is provided for by making the nut 11 in the form of a worm gear, and providing a worm (not shown) which meshes with this gear and is arranged to be rotated by the hand wheel 33. This permits any desired initial setting of the wheel relatively to the work.

The length of the period that the wheel operates on the work in each machine cycle may be controlled within the limits of the machine by adjusting the wedge 25 on the wedge 26, as above described. In other words, by this adjustment the entire cam rise, or any part of it, can be utilized in producing the receding movement of the wheel head.

The grinding wheel is driven by belt connections with the main shaft 34, Figs. 2 and 6, the wheel shaft 3 being provided with a pulley 35 and the shaft 34 with a pulley 36 to receive the driving belt.

The turret is rotatably supported on a shaft 37, Figs. 1, 2 and 6, which is mounted in front and rear bearings bolted to a turret base 38. For the purpose of indexing the turret to bring its chucks into the four successive positions which each chuck can occupy, the shaft 37 is equipped with a Geneva wheel 40, best shown in Figs. 6 and 8, and a Geneva driver 41 operates this wheel, the driver being mounted fast on a shaft 42. This shaft is driven through spiral gears 43 and 44 from a shaft line 45 which includes two universal joints 46—46, Fig. 2, and this shaft line is driven through a spiral gear connection 47, Fig. 2, from a shaft 48, having a spiral gear connection 50, with a counter shaft 51, and another spiral gear connection 52 with the cam shaft 20 previously referred to.

As best shown in Fig. 6, the counter shaft 51 is belt driven from the main shaft 34, these shafts carrying stepped pulleys 53 and 54, respectively, to provide for suitable changes in speed. It should be observed, however, that the cam shaft 20, counter shaft 51, and the shafts 42 and 48 are all positively connected together so that the parts driven from these shafts are held in a definite time relationship. This driving mechanism for the turret gives it a quarter turn in each machine cycle. In the periphery of the turret 6 four notches 55, Fig. 8, are formed to receive the end of a locking dog 56, this dog being fast on the rock shaft 57 to which also a cam lever 58 is secured. The lever carries a roll 60 to engage a cam 61 on the Geneva driver 41, and a spring 62 acts on the upper end of the lever 58 to hold the dog 56 normally in one of the notches 55, and thus to lock the turret against rotation. The dog is released by the cam 61 just before each turret movement is started.

While chucks of any suitable construction may be used, we prefer to use a construction like that shown in Figs. 7, 9, and 11. This chuck comprises a hollow spindle 64 rotatably mounted in suitable bearings and provided between bearings with a pulley 65 by means of which it may be revolved. The forward end of the spindle 64 is internally tapered to receive work gripping devices which consist of a collet sleeve 66 having parts 67 at its lower side provided with

curved surfaces to receive the shank of the tappet W of other article of work. Cooperating with the collet sleeve is a slidable collet 68 which is screw threaded into the forward or left-hand end, Figs. 7 and 9, of a sleeve 70 which is slidably mounted in the hollow spindle 64. It will be observed that when the sleeve 70 is drawn backwardly or toward the right, the tapered surface of the member 68 sliding along the tapered surface of the part 66 will cause the former member to clamp the stem of the valve rigidly against the part 67. This part is accurately centered in the chuck so that the backward movement of the collet rigidly secures the piece of work in the chuck notwithstanding the fact that the work has been forced into the chuck against the end of a plunger 71 which slides in a tube 72 and is backed up by a spring 73. The rearward end of this spring abuts against a plug 74 which is pinned into the sleeve 70 in a stationary relationship thereto.

In order to lock the sleeve 70 in its rearward position, in which condition the collet securely clamps the work, the rearward end of the sleeve has a disk or head 69 secured thereto in which are mounted two bell crank levers 75—75 having cam faces to engage with rolls 76—76 which are mounted in another head 79 rigid with the hollow spindle 64. The other arms of these levers 75—75 fit into sockets formed in a slide 77 which projects from the rearward end of the sleeve 70 and has an enlarged head 78 which, when the chuck is in grinding position, is located in the yoke-shaped end 80 of a plunger 81. When this plunger is drawn backwardly it retracts the slide 77 and causes the cam face of each lever 75 to move on its roll 76, thus withdrawing the sleeve 70 and locking this sleeve in its withdrawn position. This arrangement thus constitutes, to all intents and purposes, a toggle. Both toggles are locked when the slide 77 is withdrawn toward the right, Fig. 7, and they hold the sleeve 70 locked when they are in this position. When, however, the slide 77 is moved toward the left, the cam levers 75 then are moved into an unlocked position and they release the sleeve 70.

The backward or locking movement of the plunger 81 is produced by a lever 82, Figs. 1, 7 and 8, carrying a roll 83 which engages a cam 84 fast on the shaft 42 previously mentioned. This lever carries a pin 85, Fig. 7, which enters a slot in the plunger 81 and bears against a screw 86 by means of which the plunger and lever can be relatively adjusted. Normally a spring 87, Fig. 7, holds the plunger 81 toward the left.

The ejection of the work from the chuck is effected by moving the slide 77 inwardly, thus causing the collet 68 to release the work, whereupon the spring pressed plunger 71 ejects it from the chuck. This inward movement of the slide 77 is effected by a plunger 90, Fig. 7, which normally is held out of its operative position by a spring 91. It is moved against the action of said spring by a screw 92 threaded through the end of a lever 93, Figs. 1, 7 and 8, this lever carrying a roll 94 which also engages the cam 84 above mentioned.

For the purpose of loading the valves W, or other articles of work, into the chuck automatically, a magazine or carrier 95, Figs. 1 and 5, is rotatably mounted on a hollow shaft 96. This shaft extends parallel to the axis of the turret and is supported in bearings mounted on the turret base 38. The carrier wheel 95, as shown in Fig. 5, is provided with a series of slots to receive the shanks of the valves W, leaving their heads projecting at the end of the carrier wheel. The shaft 96 is provided with a sprocket 97 by means of which it may be chain driven from another sprocket 98 on the turret shaft. The ratio of this drive is such that every time the turret is moved a quarter turn the carrier wheel 95 is rotated an angular distance equal to that between the centers of the work receiving slots.

Referring to Fig. 5 it will be observed that as the wheel 95 revolves intermittently in a counter-clockwise direction, the valve positioned in the pocket P will be carried down into contact with the upper bevelled end of a stationary stripper 100 which, upon a further very slight rotation of the carrier, will force the valve out of the pocket P and cause it to roll by gravity into the V-shaped upper end of a work supporting device 101, Figs. 1 and 5. This valve now is positioned properly for the operation of the feed plunger which forces it into the chuck.

The support 101 holds the tappet W approximately in axial alinement with the chuck which is in loading position, and a plunger 102, Fig. 1, forces the valve axially into the chuck. This plunger is slidably mounted in bearings 103—103 and it is operated by a bell crank lever 104 fulcrumed on the machine frame at 105. A spring 106 gives the loading plunger 102 its operative or working stroke. The backward stroke in opposition to the spring 106 is imparted to the plunger by a cam 107, Fig. 1, mounted on the rearward end of the shaft 42 and arranged to rock a lever 108, one end of which bears against a rod 110 that extends axially through the shaft 96 and bears against one arm of the lever 104. As the tappet W rests in the holder or support 101 the head is supported by the V-shaped walls of the holder, but the shank or stem of the valve rests on a part 112, Fig. 3, which projects up above the main portion of the holder. This part is pivoted at 113 and a spring pressed plunger 114 acts on it in a direction to hold it yieldingly in its uppermost or operative position,

this position being determined by the engagement of an adjustable stop screw 115 with the main body of the holder. As the tappet is forced into the chuck by the plunger 102, the head of the tappet engages an inclined surface on the part 112 and depresses this part against the action of the plunger 114.

Immediately after a tappet has been forced into the chuck located in the loading position, the turret 6 is indexed or given a quarter revolution, and this movement is utilized to position the work accurately in the chuck. The tappet has been forced into the chuck in opposition to the spring pressed plunger 71, Fig. 7, and in order to prevent this plunger from ejecting the tappet, the loading plunger 102 remains in contact with the tappet until after the indexing movement has started. This movement immediately carries the tappet head behind a plate 116, Figs. 1, 3 and 5, having a bevelled surface at its lower end which forces the tappet still farther into the chuck. As the tappet head rides off the upper end of this plate it strikes the periphery of a positioning wheel 117 which is supported in a bracket 118, the bracket being adjustably mounted and held in its adjusted position by screws 119, Figs. 1 and 3. This wheel rotates on a fixed axis and it is accurately set so that it forces the tappet back into the chuck to exactly the desired position.

The turret comes to rest while the tappet is still held inwardly by the positioning wheel 117. The work is clamped at this station. That is, the indexing movement of the turret has brought the enlarged head 78 of the slide 77 into the open yoke-shaped end 80 of the plunger 81, and the cam 84 operates the lever 82 to withdraw this plunger and hence to move the sleeve 70 backwardly, carrying the collet 68 with it, and clamping the work securely in the chuck in the manner above described. The bell crank cam levers 75—75 lock the sleeve 70 in its retracted position. It may here be noted, however, that at the same time that the lever 82 is actuated to lock the work in one of the chucks, the lever 93 is moving the plunger 90 inwardly or toward the left, Fig. 7, to unlock the work in the diametrically opposite chuck.

The turret is next indexed another quarter turn to bring the work which has now been properly positioned and locked in the chuck into the working position; that is, the position where it is subjected to the action of the grinding wheel 2. As the chuck is swung into this position by the movement of the turret, its pulley 65 is brought into contact with the outer surface of a belt 120, Figs. 4 and 5. This belt is driven by a drum 121, Fig. 4, the belt running over guide pulleys 122 and 123 to a driven pulley 124 which is mounted immediately beside the pulley 65 of the chuck which is in working position. The pulley 124 is mounted on a lever 125 which is acted upon by a spring 126 in a direction tending to press the pulley 124 against the pulley 65. The drum 121 carries a stepped pulley 127 by means of which it may be belt driven from another stepped pulley 128 on the counter shaft 51. (See Figs. 4 and 6.) This construction permits the continuous driving of the chuck which is in working position, notwithstanding the fact that the turret is being traversed, the drum 121 permitting this traversing movement since the belt 120 simply rides backward and forward on the drum as this movement takes place. As soon as the turret is again indexed, the chuck which is in working position is moved out of said position, thus interrupting its operative relationship to the driving belt 120. The chuck stops rotating shortly and is carried into position for the action of the plunger 90, Fig. 7, which strikes the rearward end of the slide 77 and causes the collet to release the work, whereupon the plunger 71 in the chuck ejects the work.

Upon the next indexing movement of the turret, the chuck from which the work has just been ejected will again be carried into loading position and the operations above described will be repeated.

Immediately after each indexing movement has been made, the turret is given a traversing movement relatively to the grinding wheel in order to move the work across the face of the wheel. For this purpose the turret base 38 is mounted on a turret slide 130, Figs. 2 and 4, and this slide is provided with guides which travel in ways formed in the machine frame 7 so that the entire slide, with the parts mounted thereon, can move backward and forward relatively to the wheel 2. The mechanism for producing this traversing movement comprises a cam 131 fast on the cam shaft 20 and arranged to reciprocate a lever 132, the upper end of which carries a roll which is located in a slot formed in one side of a horizontal bar 133. This bar is slidably supported in bearings 134—134 formed in the upper part of the machine frame 7, and the left-hand end, Fig. 4, of this bar is reduced and screw threaded, as shown at 135. A nut 136 fits on this screw threaded portion and is provided with a hand wheel 137, the nut being supported in bearings in the turret slide which permit it to rotate but prevent it from moving axially. Consequently, as the cam 131 rotates the bar 133 will be reciprocated and thus will reciprocate the turret. The initial adjustment of the turret with reference to the grinding wheel can be changed by rotating the hand wheel 137 which moves the turret slide and the parts mounted thereon bodily with reference to the grinding wheel and also with reference to the mechanism which produces the traversing movement of the turret.

The fact has been mentioned above that

the wheel head can be angularly adjusted with reference to the turret. The turret also can be angularly adjusted relatively to the wheel, and for this purpose the turret base 38 is connected to the turret slide 130 by a pivot 140, Figs. 1, 2 and 4. Several arc-shaped slots 141 are formed through the turret base 38, as shown in Fig. 1, to receive bolts by means of which the base 38 may be clamped to the slide 130 to hold the turret in its adjusted position.

A wheel dressing tool 142, Fig. 1, is mounted on the turret base 38 where it can be reciprocated across the face of the wheel to true up the grinding wheel when necessary.

It will now be understood that in each cycle of operation of the machine the turret is indexed one step, an article of work is forced into the chuck which is in loading position, the piece of work introduced into the preceding chuck is accurately positioned in its chuck, and is locked in that position. At the same time the piece of work in the diametrically opposite chuck is ejected, the grinding operations on this piece of work having been completed. The indexing movement brings a new article of work into working position whereupon the chuck in which it is located begins to revolve rapidly, the grinding wheel is automatically advanced into contact with the work, and the grinding operation begins. The turret makes one complete reciprocation, thus traversing the work forward and backward across the face of the wheel. This completes the grinding operation and the grinding wheel thereupon moves backwardly out of contact with the work preparatory to the next indexing movement of the turret at the beginning of another cycle. It will be observed that the machine is entirely automatic in operation, it merely being necessary to keep it in proper adjustment and to place the tappets or other articles of work into the carrier wheel 95, by hand or from a hopper.

In order to enable the machine to operate on a different article of work from that shown, or another article of different dimensions, it is merely necessary to remove the collet sleeve 67 and collet 68 and replace them with other parts of similar construction but adapted to accommodate the new article of work. It may be necessary, also, to make some changes in the reciprocating movements of the grinding wheel and turret and to make other adjustments in the position or movements of the parts, as will be obvious to those skilled in this art.

Having thus described our invention, what we desire to claim as new is:

1. In a grinding machine, the combination of a turret carrying a series of work supporting chucks, a grinding wheel for acting on the work supported in said chucks, means whereby the wheel and turret may be relatively adjusted to change their angular relationship, power driven mechanism for giving said wheel an approaching and receding movement with reference to the work, mechanism for rotating said wheel, and power driven mechanism for giving said turret a traversing movement to carry the work across the face of the wheel.

2. In a grinding machine, the combination of a turret carrying a series of work supporting chucks, a grinding wheel for acting on the work supported in said chucks, means whereby the wheel and turret may be relatively adjusted to change their angular relationship, power driven mechanism for giving said wheel an approaching and receding movement with reference to the work, said mechanism including a spring for relatively moving the wheel and turret toward each other, and power driven mechanism for giving said turret a traversing movement to carry the work across the face of the wheel.

3. In a grinding machine, the combination of a turret carrying a series of work supporting chucks, a grinding wheel for acting on the work supported in said chucks, mechanism for rotating said wheel, each of said chucks being arranged to hold an article of work with the end thereof exposed for the action thereon of said wheel, power driven mechanism for giving said wheel and work a relative approaching and receding movement to move them into or out of grinding relationship, and additional power driven mechanism for giving said turret and wheel a relative traversing movement to carry the work across the face of the wheel.

4. In a grinding machine, the combination of a turret carrying a series of work supporting chucks, a grinding wheel for acting on the work supported in said chucks, a slide on which said turret is supported for angular adjustment in a horizontal plane, a support in which said slide is mounted, and power driven mechanism for reciprocating said slide to traverse the work across the face of the wheel.

5. In a grinding machine, the combination of a turret carrying a series of rotary work supporting chucks, a grinding wheel for acting on the work supported in said chucks, a slide on which said turret is supported, a support in which said slide is operatively mounted, power driven mechanism for reciprocating said slide, and hand adjusting means for moving said turret bodily with reference to said reciprocating mechanism.

6. In a grinding machine, the combination of a turret carrying a series of work supporting chucks, a grinding wheel for acting on the work, means whereby the wheel and turret may be relatively adjusted to change their angular relationship, mechanism for rotating said wheel, each of said

chucks being arranged to hold an article of work with the end thereof exposed for the action thereon of said wheel, automatic mechanism for giving said wheel and work a relative approaching and receding movement to move them into or out of grinding relationship, and additional automatic mechanism for giving said turret and wheel a relative traversing movement to carry the work across the face of the wheel in timed relationship to said relative approaching movement.

7. In a grinding machine, the combination of a grinding wheel, a turret having a plurality of chucks for supporting pieces of work for the operation thereon of said wheel, each chuck being constructed to support an article of work with the end thereof exposed for the action of the wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for forcing a piece of work endwise into each chuck while it is in loading position, a spring pressed plunger in the chuck bearing against the work and tending to eject it, and relatively stationary means for positioning the work accurately in the chuck for the grinding operation as the turret carries the chuck away from loading position and toward working position.

8. In a grinding machine, the combination of a grinding wheel, a turret having a plurality of chucks for supporting pieces of work for the operation thereon of said wheel, each chuck being constructed to support an article of work with the end thereof exposed for the action of the wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for forcing a piece of work into each chuck while it is in the loading position, additional means for accurately positioning the work in the chuck for the grinding operation, and mechanism for acting on the chuck to lock the work therein when it has been so positioned.

9. In a grinding machine, the combination of a grinding wheel, a turret carrying a plurality of chucks, each adapted to support a piece of work for the operation thereon of said wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for revolving each chuck about its own axis when it is in working position, a movable carrier for holding a series of articles of work, means for moving said carrier to cause it to deliver an article held thereby into loading relationship to the chuck in loading position, and means for forcing the article so positioned into the chuck.

10. In a grinding machine, the combination of a grinding wheel, a turret carrying a plurality of chucks, each adapted to support a piece of work for the operation thereon of said wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for revolving each chuck about its own axis when it is in working position, a rotary carrier wheel constructed to hold a series of articles of work, means for rotating said carrier wheel intermittently in a definite time relationship to the movements of said turret to cause the carrier to deliver articles of work one at a time in loading relationship to the chuck in loading position, and means for forcing an article of work so delivered into the chuck in loading position.

11. In a grinding machine, the combination of a grinding wheel, a turret carrying a plurality of chucks, each adapted to support a piece of work for the operation thereon of said wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for revolving each chuck about its own axis when it is in working position, a holder for supporting an article of work in loading position, means for delivering such articles one at a time to said holder, said means including a movable device for carrying a series of said articles, and a plunger for forcing an article positioned in said holder into the chuck which is in loading position.

12. In a grinding machine, the combination of a grinding wheel, a turret having a plurality of chucks for supporting pieces of work for the operation thereon of said wheel, mechanism for indexing said turret to carry each chuck successively into different operative positions including a working position and a loading position, means for revolving each chuck about its own axis when it is in working position, mechanism cooperating with the chucks for forcing articles of work into them one at a time at the loading position, said turret acting thereafter to carry each chuck so loaded into working relationship to said grinding wheel, means for acting on the work between the loading and working positions to position the work accurately in the chuck for grinding, means for locking the work when it has been so positioned and means for causing the automatic ejection of the work from each chuck after it has been moved away from the working position and before it arrives again in loading position.

13. In a grinding machine, the combination of a base, two slides mounted on said base

for sliding movement in horizontal planes but in directions transverse to each other, a grinding wheel mounted on one of said slides, power driven mechanism for reciprocating the latter slide and said wheel, a turret carried by the second slide, power driven mechanism for reciprocating said turret, a plurality of chucks rotatively mounted in said turret, each of said chucks being adapted to support a piece of work for the operation thereon of said grinding wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into working position, and mechanism for rotating each chuck while it is in its working position.

14. In a grinding machine, the combination of a base, two slides mounted on said base for sliding movement in horizontal planes but in directions transverse to each other, a grinding wheel mounted on one of said slides, power driven mechanism for reciprocating the latter slide and said wheel, a turret carried by the second slide, a turret base supported by the second slide and on which the turret is mounted, said base being angularly adjustable in a horizontal plane with reference to said second slide, power driven mechanism for reciprocating said second slide, a plurality of chucks rotatably mounted in said turret, each chuck being adapted to support a piece of work for the operation thereon of said grinding wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into working position, and means for rotating each chuck while it is in its working position.

15. In a grinding machine, the combination of a base, two slides mounted on said base for sliding movement in horizontal planes but in directions transverse to each other, a grinding wheel mounted on one of said slides, power driven mechanism for reciprocating the latter slide and said wheel, means for adjusting said wheel relatively to the slide which supports it, a turret carried by the second slide, power driven mechanism for reciprocating said second slide, means for adjusting the relationship between said second slide and the mechanism for reciprocating it, a plurality of chucks rotatively mounted in said turret, each of said chucks being adapted to support a piece of work for the operation thereon of said grinding wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into working position, and mechanism for rotating each chuck while it is in its working position.

16. In a grinding machine, the combination of a grinding wheel, a turret having a plurality of chucks for supporting pieces of work for the operation thereon of said wheel, each chuck being constructed to support an article of work with the end thereof exposed to the action of the wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position where the wheel acts on the work, additional power driven mechanism for giving said wheel and turret a relative approaching and receding movement to bring the work and wheel into and out of grinding relationship, means for rotating each chuck while in its working position to revolve the work while the wheel grinds it, means for forcing the work into the chuck in a predetermined relationship thereto, and means for acting on the chuck to lock the work in the chuck in said relationship.

17. In a grinding machine, the combination of a grinding wheel, a turret having a plurality of chucks for supporting pieces of work for the operation thereon of said wheel, each chuck being constructed to support an article of work with the end thereof exposed for the action of the wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, means for rotating each chuck while in its working position to revolve the work while the wheel grinds it, power driven mechanism for producing a relative traverse of said wheel and work while the wheel grinds the work, and means for forcing a piece of work endwise into each chuck while it is in loading position.

18. In a grinding machine, the combination of a grinding wheel, a turret carrying a plurality of chucks, each adapted to support a piece of work for the operation thereupon of said wheel, mechanism for giving said turret a step by step rotative movement to carry the chucks successively into different operative positions including a working position and a loading position, mechanism for revolving each chuck while it is in its working position to rotate the work while the wheel grinds it, automatic means for presenting an article of work in loading relationship to any chuck in loading position, means for forcing an article so presented into the chuck, automatic mechanism for giving said wheel and work a relative approaching and receding movement to carry them into or out of grinding relationship, and additional automatic mechanism for giving said turret and wheel a relative traversing movement to carry the work across the face of the wheel while the wheel grinds the work.

In testimony whereof we have signed our names to this specification.

WILLIAM ARTER.
WARREN F. FRASER.