April 7, 1942. J. H. HOERN ET AL 2,278,784

GRINDING MACHINE

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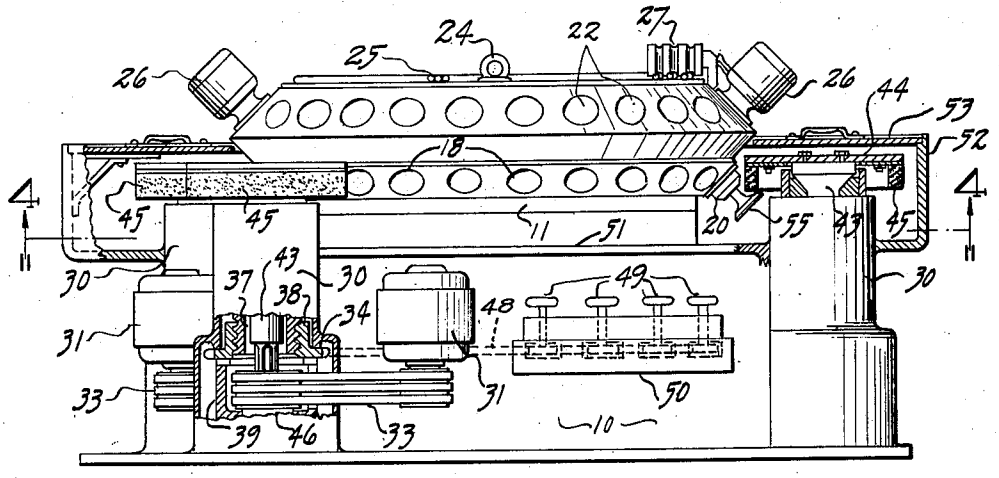


FIG. 1.

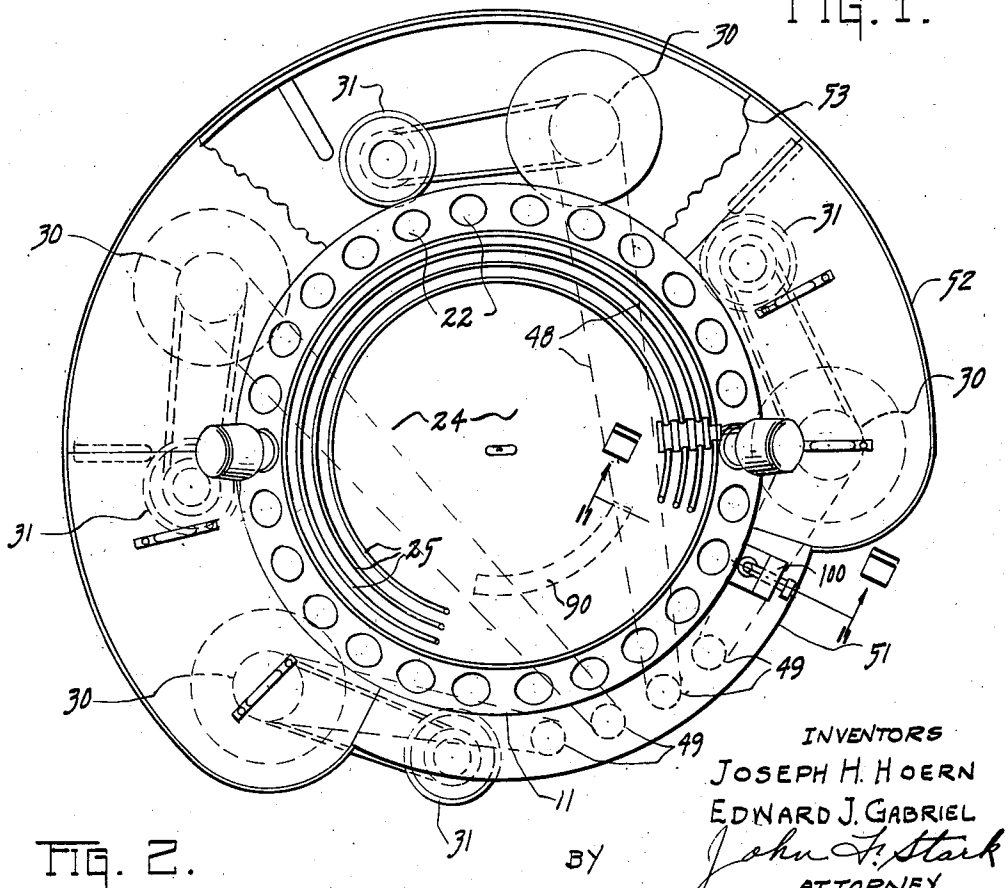


FIG. 2.

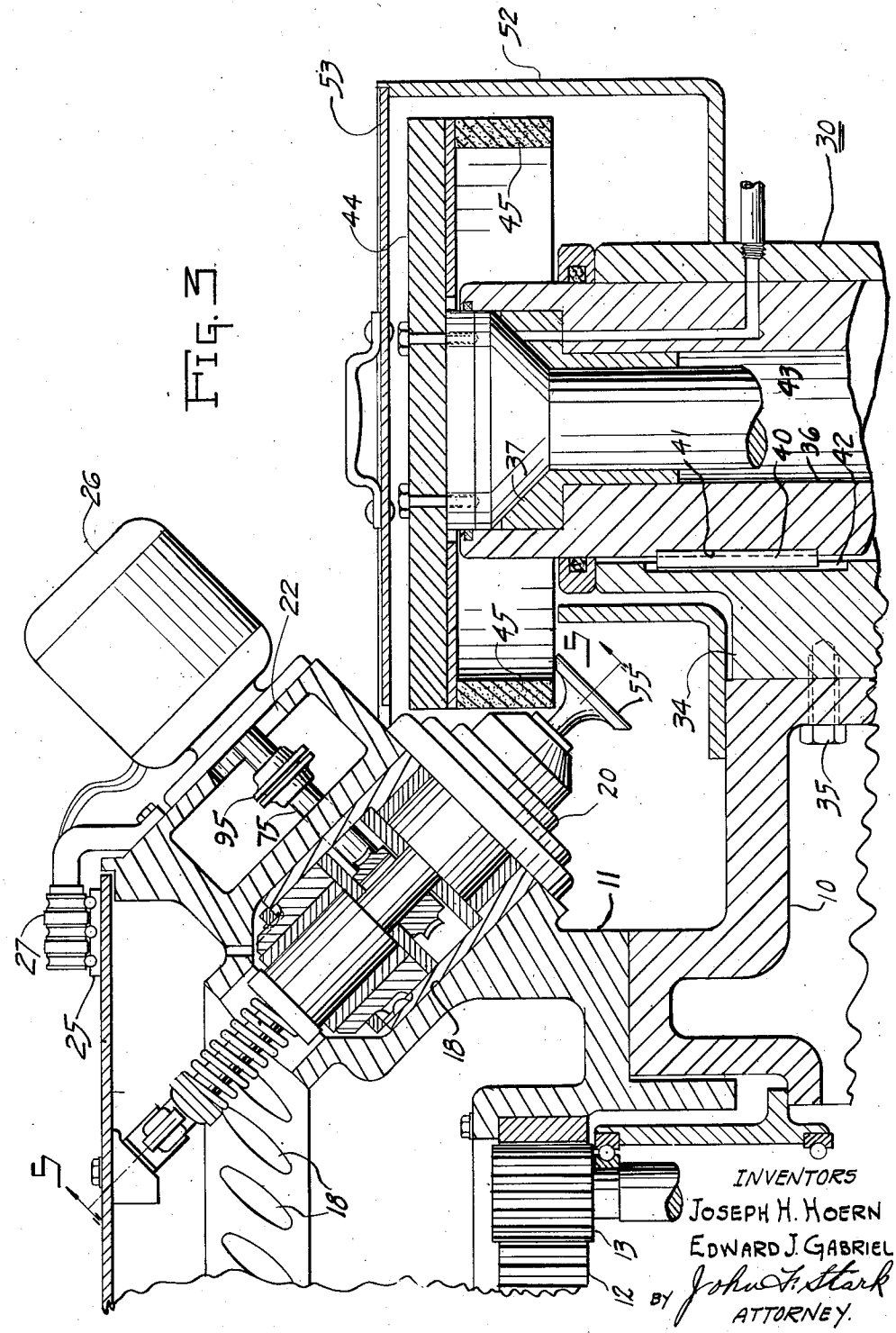
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GRINDING MACHINE

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FIG. 3



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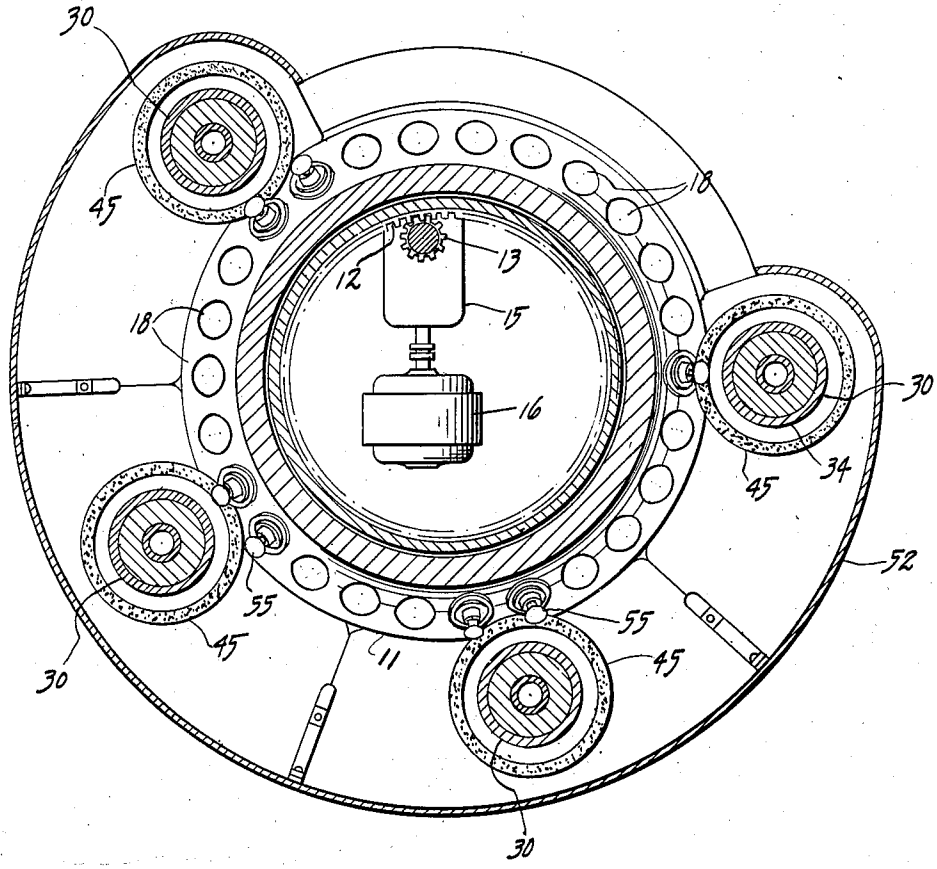


FIG. 4.

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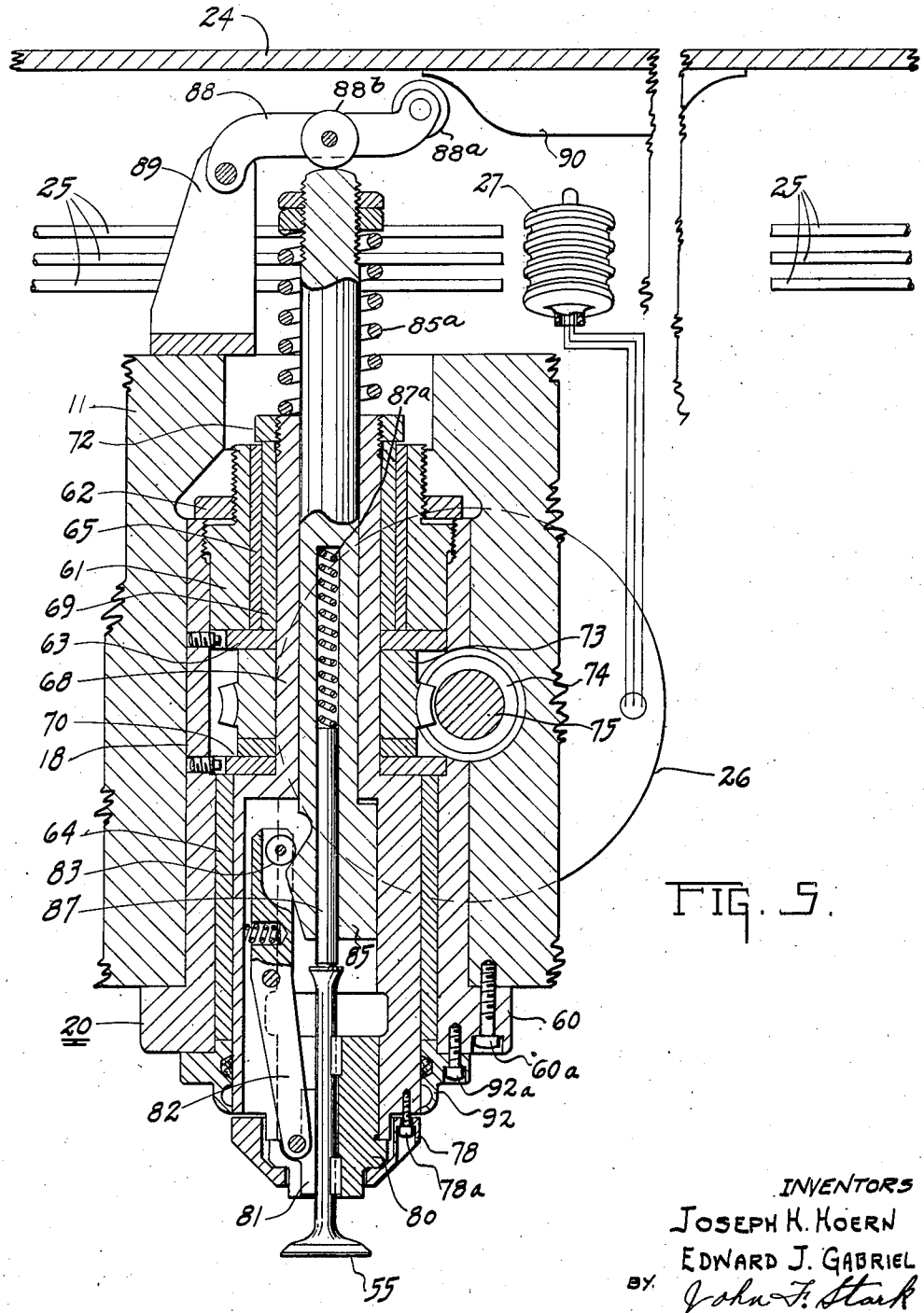


FIG. 5.

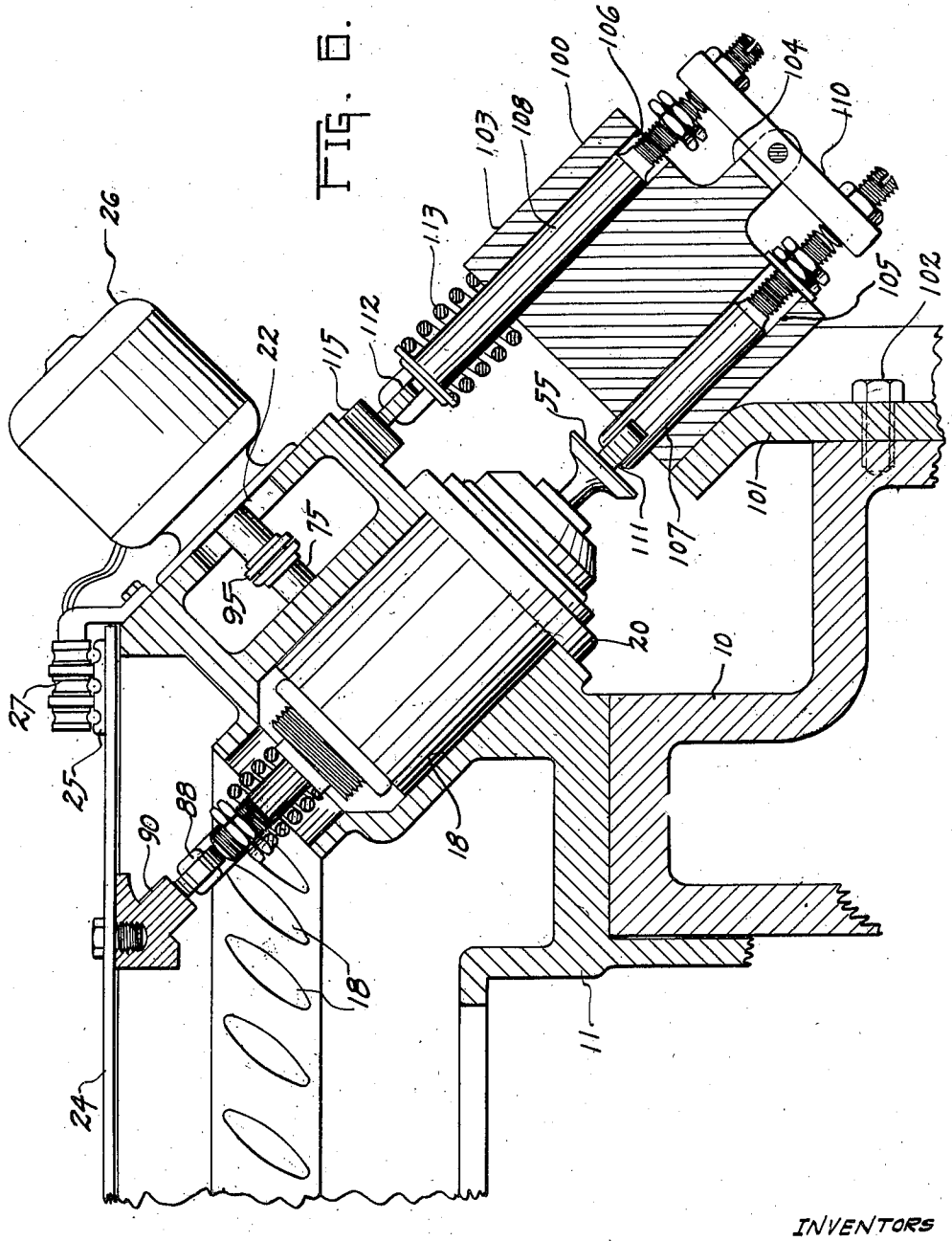
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FIG. 6.



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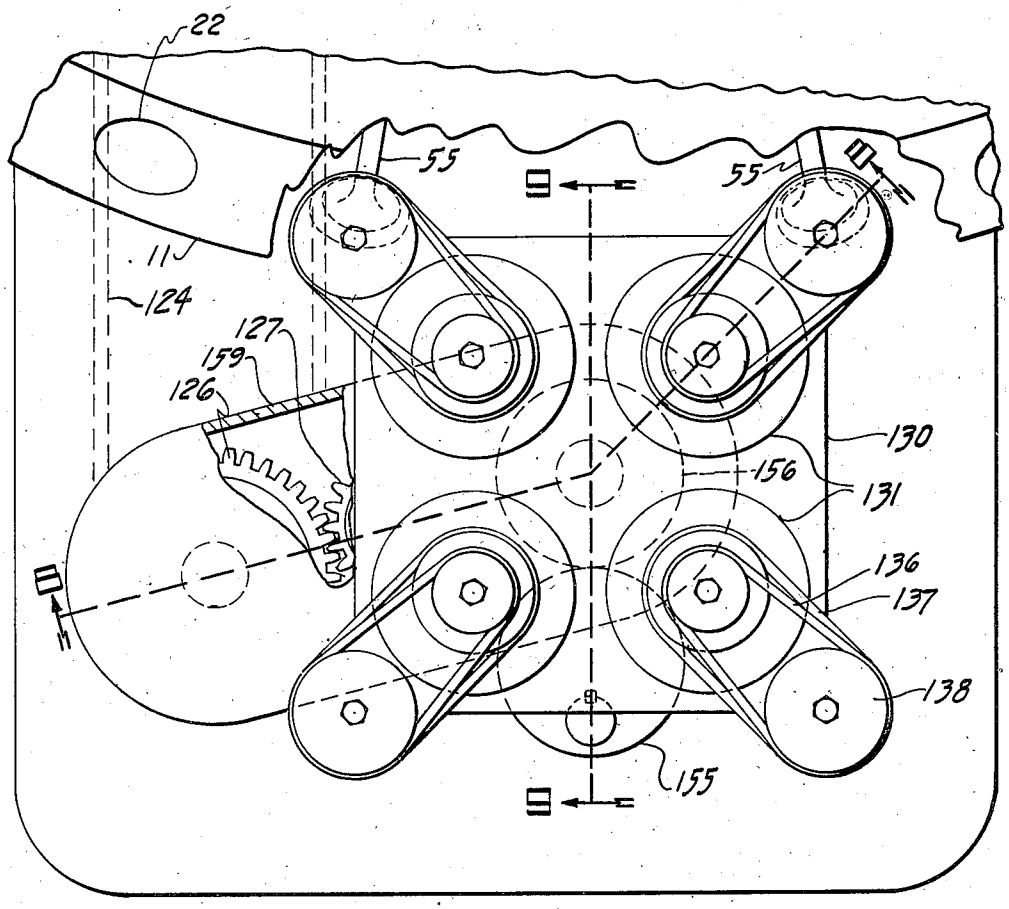


FIG 7

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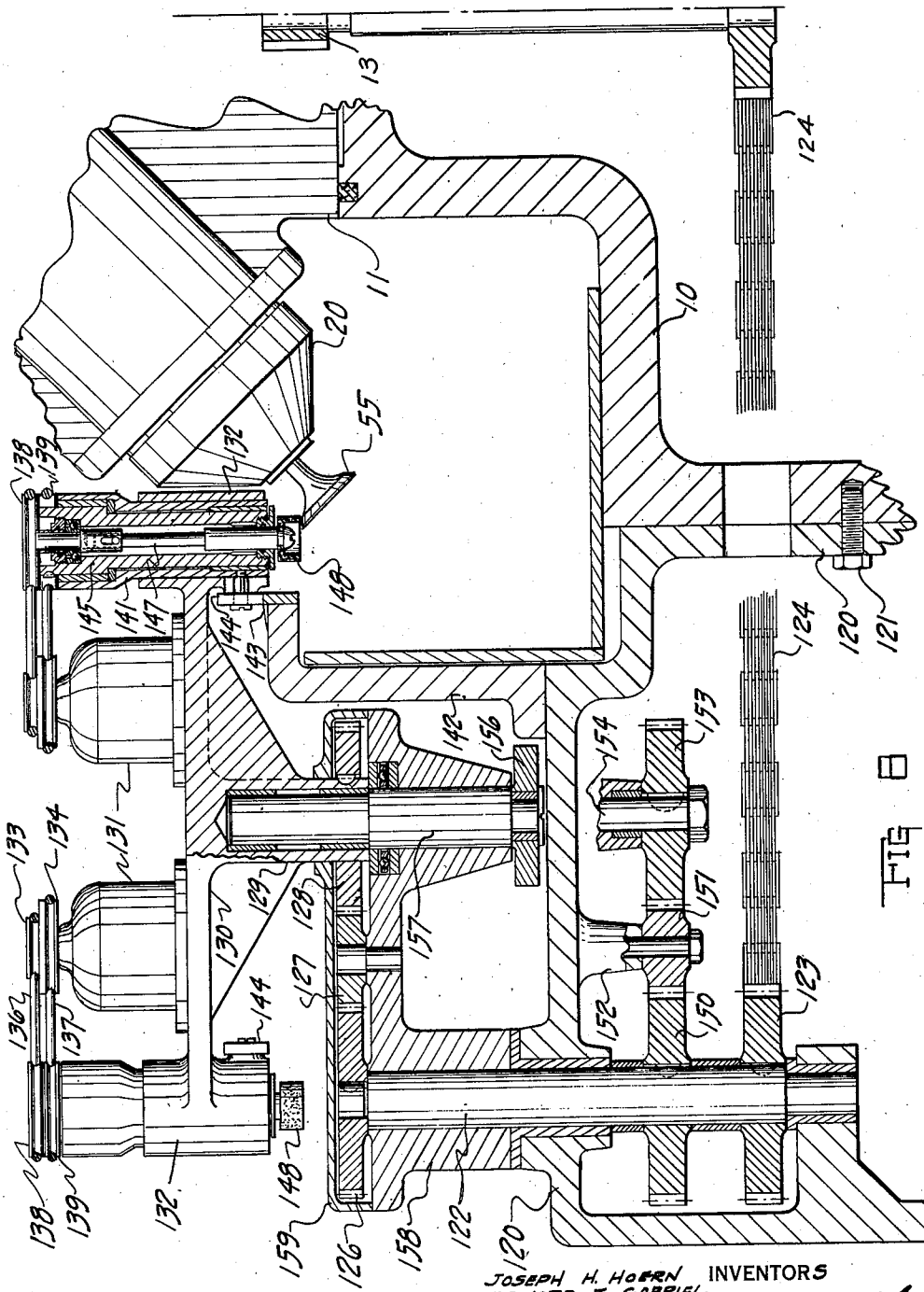


FIG. 8

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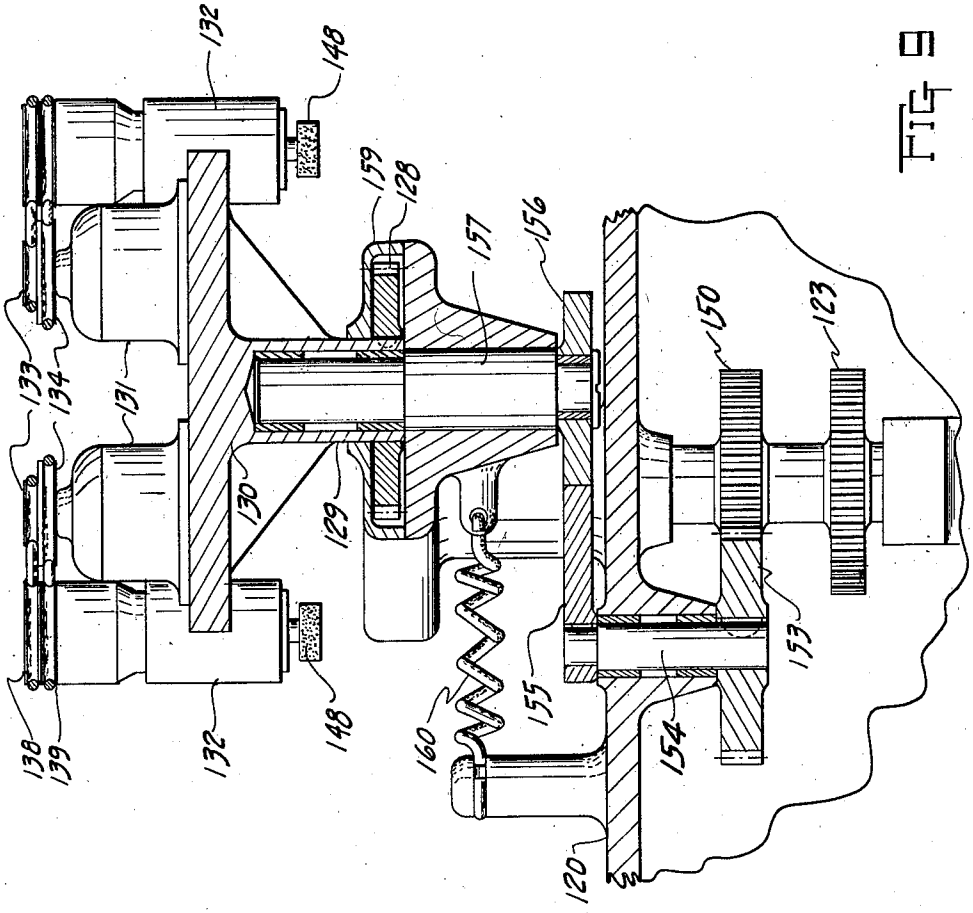


FIG. 8

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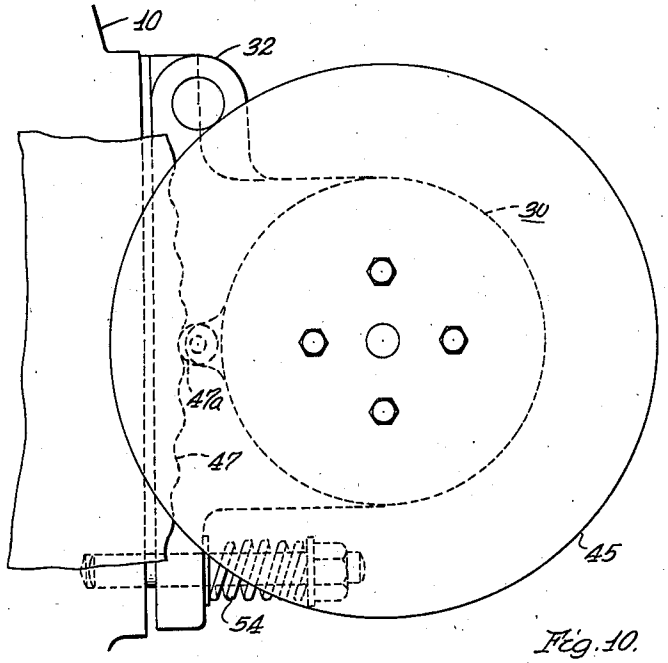


Fig. 10.

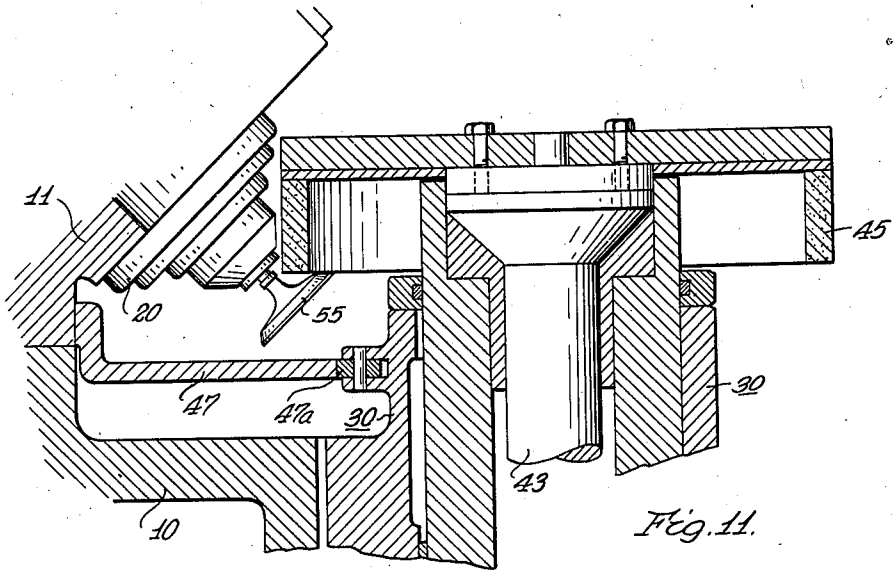


Fig. 11.

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Patented Apr. 7, 1942 2,278,784

UNITED STATES PATENT OFFICE

2,278,784

GRINDING MACHINE

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Application February 13, 1939, Serial No. 256,120

15 Claims. (Cl. 51—134)

The present invention relates to grinding machines and more particularly concerns a machine for grinding the seats of poppet valves as used in internal combustion engines and the like.

The primary object of this invention is to provide a valve grinding machine incorporating a continuous sequence of grinding operations on a circular drum mechanism that presents the work to the several grinding means; that requires no manual operations from the initial to the final grind; and that includes novel chucking means for rotating the work pieces during the path of travel around the several grinding means.

A further object of this invention is to provide a valve seat grinding machine in which a plurality of work pieces are chucked in individual spindles in a rotatable drum, the individual spindles rotated by unitary power means, and conveyed across the full width of the working face of suitably spaced rotative grinding wheels, thereby evenly removing the abrading material and obtaining the full wearing qualities therefrom without requiring frequent truing of the grinding wheels.

A still further object of this invention is to provide a valve grinding machine incorporating a plurality of work holding chucks, and means automatically cooperative therewith in timed relation to the travel of the work pieces for properly axially spacing the work pieces in the chucks for presentation to the grinding wheels, and further automatic means for releasing the chuck holding the finished valve and maintaining the chuck in released position until a new work piece is inserted therein and properly axially spaced, to secure a predetermined valve seat margin.

A further object of this invention is to provide in a valve grinding machine of the character described, individually adjustable grinding wheel spindles to compensate for wear of the abrading material carried thereby, the said abrading material being graduated from a rough grind on the initial grinding wheel to a finish grind on the final wheel.

A further object of this invention is to provide in a grinding machine of the character described, in which powered work gripping means are rotated around a path of travel overlapping that of a plurality of powered grinding means, a honing or finishing means secured to said grinder, synchronously driven therewith, and effecting a compound movement over said work.

A still further object of this invention is the provision in a grinding machine of the character described, in which powered work gripping means are rotated around a path of travel overlapping that of a plurality of powered grinding means, of one or more of said grinding means being pivotally mounted and including an attached cam follower resiliently pressed to a sinuous cam plate, to impart a movement transverse to said grinding means whereby to increase the grinding period for a given time interval.

This invention is further featured and characterized by a unitary set of operating controls that enables a single operator from a central operating point to operate the apparatus through its cycle in proper sequence, thereby rendering the apparatus in its grinding operations automatic from such centralized controls and substantially reducing the skill and judgment required from an operator.

A secondary feature of this invention is to provide in a valve grinding machine of the character described having individual power driven units for rotating each driving chuck, means whereby if one power unit becomes disabled it may be quickly dismounted and a spare power unit replaced therefor without substantially disassembling the machine or holding up the remaining production.

The above being among the objects and advantages of this invention, the same consists in certain novel combinations and arrangement of parts as will be hereinafter apparent from a study of the accompanying drawings and specification.

With reference to the drawings wherein like parts are designated by similar reference characters throughout the several views and wherein:

Fig. 1 is a general elevational view of the machine forming the subject matter of this invention with portions broken away to disclose certain parts thereof; and

Fig. 2 is a plan view of the grinder shown in Fig. 1; and

Fig. 3 is a sectional view on an enlarged scale of a portion of a work-holding spindle adjacent one of the grinding wheels; and

Fig. 4 is a horizontal sectional view showing the overlapping paths of travel of the work pieces and the grinding wheels as on the line 4—4 of Fig. 1; and

Fig. 5 is an enlarged sectional view through a work-holding spindle, and is somewhat diagrammatically illustrated with associated structure as on the line 5—5 of Fig. 3; and

Fig. 6, is a sectional view through a work-holding spindle and adjacent means for axially locating the work in the spindle as on the line 6—6 of Fig. 2; and

Fig. 7 is a plan view of a honing attachment for insertion in place of the final grinding operation; and

Fig. 8 is a partial vertical section on the broken line 8—8 of Fig. 7;

Fig. 9 is a further vertical section on the line 9—9 of Fig. 7;

Fig. 10 is a plan view of a detail showing a grinding wheel pivotally mounted to the stationary drum; and

Fig. 11 is a sectional elevational view of the detail of Fig. 10.

Referring now to Figs. 1 and 2 there is shown a general elevational and plan view of the complete grinder. A fixed base 10 comprising a circular drum-like member upon which is rotatably mounted a powered drum 11, driven through a suitable ring gear 12 secured to the drum 11, and a pinion gear 13 operatively journalled through a reduction gear or a variable speed transmission 15, to a motor 16 as best shown in Figs. 3 and 4, for effecting the desired rotational speed of the drum 11, constitutes the basic structure of this machine. The rotatable drum 11 comprises a large circular casting with a plurality of equally spaced peripheral openings 18, angularly disposed with relation to the axis of the drum, for reception of a plurality of powered spindles generally designated 20, and which will be more fully described hereinafter. Obviously the openings 18 may be made at any angle at which it is desired, for example, to have a valve seat ground, and in the present case this angle is shown as 45° to the vertical axis of the machine, which in turn results in a 45° angle seat on the valve. A second series of similarly spaced peripheral openings 22 in the drum 11, are also angularly spaced with relation to the axis of the drum and are normal to the openings 18 and in communication therewith to serve as a means for reception of the driving shafts 75 of the spindles 20, as shown in Figs. 3 and 6, and which will be more fully described hereinafter. A stationary cover member 24 overlies the upper axial opening of the powered drum 11, and serves as a support for an electric track 25 to transfer power through a plurality of associated trolley members 27 to individual electric motors 26 which drive the individual valve spindles 20, all of which are mounted upon the rotatable drum 11.

Now making reference again to Figs. 1, 2 and 3 it will be seen that a plurality of grinding wheel spindles, generally designated 30, are shown spaced around a portion of the periphery of the powered drum 11, and suspended or supported from the stationary table 10. Individual electric motors 31, also secured to the stationary table 10, are geared to the spindles 30 by multiple belts 33. The spindles 30, described more in detail each comprise a retaining case 34, having the hollow longitudinal axis thereof disposed parallel to the major axis of rotatable drum 11, and secured to the stationary table 10 by fastening means 35. The fastening means 35 may include an elongated slotted portion either on the table 10 or on the case 34 to enable the whole spindle mechanism 30 to be tilted slightly from the vertical so as to provide a gradual or progressive presentation of the work pieces to the grinding wheel. For certain grinding operations or operating on various types of metal alloys it may be necessary to increase the grinding time on the rough or intermediate polishing wheels, and to this end, a suitable hinged or pivotal means 32 may be used to mount the spindle mechanism 30 to the table 10, so as to be movable radially toward and away therefrom through a predetermined arcuate path cooperatively associated with said pivotal means, and a cam follower or roller 47a pressed thereto, an arcuate serpentine or wave-like cam plate 47 is secured to the periphery of the rotating table 11. In this hookup, as best shown in Figs. 10 and 11, the pivotal spindle 30 would be spring pressed, as at 54, to the cam plate 47 and caused to move in and out as it followed the sinuous face thereof at the same time as it was normally rotated. Thus for a given time interval, as the overlapping relationship of the path of travel of the grinding wheel and work pieces was increased, the length of grinding time would be increased. A sleeve member 36 slidably fitted into case 34 is shouldered at its upper end for reception of a bearing member 37 and contains a threaded portion adjacent the lower end thereof for threadably receiving a bevel gear or sprocket wheel 38. A suitable thrust member 39 and cooperating flanges on case 34 provides for the journalling and thrust of the sprocket 38. The sleeve 36 is provided with a key 40 and keyway 41, for retaining said sleeve non-rotatably in the elongated slot 42, in the casing 34, but permits a limited range of longitudinal movement therein. Rotatably journalled within the bearing 37 and sleeve 36, a driving shaft 43 carries at its upper end a removable driven disc 44, to which may be secured the grinding wheel ring 45. The lower end of shaft 43 is fitted with a grooved pulley wheel 46 over which the multiple belts 33 are trained.

The sprocket wheel 38 has a chain or link belt 48 trained over the peripheral teeth thereof that extends to a series of centralized operating controls 49, journalled in a housing 50 secured to the table 10; that is to say, there is one control 49 for each spindle 30. It will now be apparent that an operator positioned adjacent the loading and unloading station or platform 51 may separately adjust the individual grinding wheel spindles to compensate for loss of abrading material therefrom, or to cause a greater cut at any individual wheel, without moving from his central operating position. It should be noted now that the several grinding wheels 45 are progressively graduated around the path of work travel from an initial rough cutting wheel to a final finishing polish wheel. Obviously, dependent upon the work and character of the metal removed, the number of grinding wheels may be increased or decreased to the necessary amount, however, in this instance, for grinding valve seats four spindles as shown are preferable. In conjunction with the grinding wheel spindles 30 an annular trough 52 and cover member 53 is secured to the casing 34 and surrounds the several spindles for collection of the ground-off metal and the cooling fluid sprayed on the cutting wheel or work piece, if used.

One of the important features of this machine is the overlapping relationship of the rotated work pieces 55, carried on the rotatable drum 11, and the periphery of the grinding wheels 45 rotatably supported by the spindles 30. That is to say, since the grinding elements 45 constitute a relatively narrow annular ring, the work pieces 55 are presented first to the outer peripheral edge of the grinding ring, then caused to pass com-

pletely across the working face thereof and leave the ring at another peripheral section thereof, as best shown in Fig. 4. This relative spacing of the grinding spindles and the work pieces accomplishes two important results. First, should the annular wheel 45 have a localized high or low spot on its working surface, the oscillating path of the work piece across the full working surface of the wheel will obviate the possibility of an annular ridge or depression being imparted to the ground surface of the work piece. Secondly, the movement of the work piece across the full working surface of the abrading annulus provides for an automatic, continuous, and even dressing-down or truing of the working surface of the grinding wheel, whereby no localized groove is worn therein as from the repeated travel of a work piece over a concentrically located grinding wheel, and further insures the utilization of the full grinding qualities of the abrading material resulting in an economical use thereof.

The work holding chuck or spindle generally designated 20 is shown in detail in Fig. 5, and is diagrammatically connected to associated structure. Each spindle 20 comprises a shouldered sleeve 60, secured in the bore 18 of the drum 11 by fastening means 60*a*, and contains an internally threaded portion at its inner end for reception of a cooperatively threaded and shouldered member 61, having a second threaded portion axially inward therefrom for reception of a locknut 62, to secure the annular member 61 in adjusted position against thrust washer 63. A pair of axially spaced bearing members 64 and 65 are pressed into the sleeve members 60 and 61, respectively, for journalling the internally bored driven shaft 68. An annular sleeve member 69, slidably received within the bearing 65, serves to remove end play from the stationary thrust washers 63 and 70, by means of an adjusting nut 72 threaded to the driven shaft 68. A worm wheel 73, pinned to shaft 68, and worm 74 associated therewith and secured on driving shaft 75, which is operatively joined to an electric motor 26, provides the power for rotation of the individual chucks. Within the counter-bored outer end of the hollow driven shaft 68, the chucking mechanism is supported by an apertured ring member 78 secured by suitable fastening means 78*a* thereto. This chucking means comprises a collet member 80 having a pair of axially spaced angularly disposed V-blocks, which may be formed of a wear-resisting alloy, and a complementary shaped clamping member 81, including an attached spring pressed pivotal lever 82, for frictionally clamping the valve stem of work piece 55 therebetween. The opposite end of lever 82 includes a journalled roller portion 83, associated with a cooperating cam portion on a plunger member 85 which is pressed by a spring 85*a*, for positively locking the work piece 55 in the chuck. Extending from a blind aperture in the outer axial end of the plunger 85, a spring 87*a* acting against ejector rod 87 provides a means for automatically ejecting the work piece 55 when the collet members 80 and 81 are in released position. Associated with the inner end of plunger member 85 is a lever member 88, pivoted at one end on a support 89 secured to drum 11, which has at the opposite end thereof a roller portion 88*a* arranged to be intermittently actuated by a cam member 90 secured to cover member 24. Intermediate the ends of lever 88 a second roller 88*b* is fulcrumed upon the inner end of plunger 85 and acts against the compression spring 85*a* thereof upon being actuated by the cam 90, whereby to release the work piece 55 through the associated clamping means. An annular apertured plate member 92, provided with an internal annular groove and packing gland in the aperture thereof, is secured to sleeve 60 by suitable fastening means 92*a*, providing a retainer for bearing 64 and an oil seal for lubricant supplied to the friction surfaces of the spindle.

It will now be apparent from the above detailed description of spindle or chuck 20 that various size valve stems can be readily accommodated in the collet members 80 and 81, by removing the fastening means 78*a* and replacing the stationary collet member 80 with one having the proper size V-blocks for the selected valve stem so that when the valve is secured in the chuck 20 its axis will coincide with the major axis of driven shaft 68. It will also be evident that by means of a readily releasable coupling 95 on the driving shaft 75, any one of the individual work holding spindles 20 may be easily removed for repair or replacement without stopping the remaining production of the machine for more than a minimum amount of time. In addition, the use of individual motors 26 for each spindle 20 provides for easy access thereto for repair, adjustment, or removal without hindering the production of the remaining spindles.

In conjunction with the work holding spindles 20, a locater generally designated 100, for axially spacing the work in the spindles to secure the proper length or seat margin on the valve 55 is shown in Fig. 6 secured to the stationary table 10, by a bracket 101 and fastening means 102, adjacent the cam 90 and ahead of the initial rough grinding wheel 45, as in Fig. 2, that is to say, in timed relation of the travel of the spindles to the initial grinding means. Locater 100 described in detail comprises a housing portion 103 having a fulcrum arm 104 and spaced parallel bores 105 and 106 extending through said housing. Within the bores 105 and 106 are slidable plungers 107 and 108 respectively, having a threaded portion on their outer ends. Adjustably associated, by threaded means to the outer ends of plungers 107 and 108 is a lever member 110, having abutment screws at each end for engagement therewith, and which is fulcrumed on the arm 104 of housing 103. Upon the inner end of plunger 107 a journalled roller member 111 is adapted to contact the end of work piece 55. The inner end of plunger 108 contains a similarly journalled roller member 112, backed by a compression spring 113 adapted to maintain the roller in contact with a cam 115 adjacently secured to the powered drum 11. Therefore, as the spring pressed roller 112 follows the contour of cam 115 the fulcrumed lever 110, spring pressed by the outer end of plunger 108, will actuate plunger 107, and attached roller 111, to properly locate valve 55 in the chuck. The somewhat elongated cam 90 secured to cover member 24, is so located and contoured, that after a finished work piece is released and ejected, the chuck 20 is only permitted to partially close for a short interval of rotation of the drum 11, whereby the operator is afforded an opportunity to temporarily position a new work piece 55 in the chuck before it is accurately positioned therein by valve locater 100 stationarily disposed in the path of the work pieces on the periphery of table 10, prior to the initial grinding operation, as best seen in Fig. 2. It should also be noted that the

powered track member 25 is discontinued for a portion of its peripheral path, as shown in Figs. 2 and 5, from the source of electric power, so that after the final grinding operation has been performed and when the work piece is in position to be released and ejected by the cam 90, and associated chucking means, that power has been interrupted to an individual motor 26 so that the individual spindle is no longer rotating. This interruption of power to the work holding spindle is continued until after the work piece is accurately located in the chuck and securely locked and just prior to initiating the first grinding operation, that is to say, there is no power supplied to any of the work holding spindles during their travel through the unloading and loading positions.

In keeping with the present trend toward finer finishes and closer tolerances between working surfaces of engine parts there has been provided, as shown in Figs. 7, 8 and 9, a means for finish honing the working surface of the work pieces 55, in this case a valve seat. In this finishing operation in place of the final grinding wheel spindle generally designated 30 and including the retaining case 34, the last spindle next to the unloading station 51 reading counter-clockwise as in Fig. 2, a housing member 120 is secured to the stationary table 10 by any suitable fastening means 121. Within the housing 120 an upstanding main drive shaft 122 is rotatably mounted as shown in Fig. 8. Adjacent the lower end of shaft 122 a driving gear 123 is keyed thereon and over which is trained a link belt or chain 124 driven from the shaft of pinion gear 13, shown in Fig. 2, whereby the shaft 122 is driven at the same speed as rotatable drum 11 and synchronized therewith. Upon the upper end of shaft 122 is keyed another gear 126 which is included in a gear train comprising an intermediate idler gear 127 and therethrough to an outer gear 128, keyed to hub 129 of a webbed plate 130, which is driven thereby and supports a plurality of abrading wheels and individual electric motors, to be presently described. Upon the upper side of the plate 130, which is substantially square or rectangular, a plurality of electric motors 131, in this instance four, are suitably mounted on diagonal lines thereof. At the four corners of plate 130 are four integral hollow cylindrical casings 132 having their longitudinal axes parallel to hub 129 and parallel to the major axis of rotatable drum 11. Each motor 131 has two pulley wheels 133 and 134 of unequal size on the shaft thereof and around which are stretched belts 136 and 137 to frictionally drive pulley wheels 138 and 139 of equal size.

Each hollow cylindrical casing 132, of plate 130, rotatably receives a hollow sleeve member 141 which is also longitudinally reciprocable therein. An upstanding frame member 142 supported on an upper wall of housing member 120 serves as a base for a stationary cam plate 143 against which cam follower 144, secured to sleeve 141, bears and thereby longitudinally reciprocates the same through a predetermined distance during movement thereover. The hollow sleeve member 141 has an internal shouldered surface upon which is concentrically seated an annular shouldered rotatable member 145 and within which is eccentrically journalled a rotatable spindle 147. Upon the upper end of the rotatable member 145 is pinned the pulley wheel 139 driven through belt 137 by pulley wheel 134 from the shaft of electric motor 131. The pulley wheel 138 is keyed to the upper end of spindle 147 and is driven through belt 136 by pulley wheel 133 from the shaft of motor 131. Depending from the lower end of spindle 147 is secured a removable grinding wheel annulus 148 of relatively small size in relation to the area of the surface of the work piece operated upon, or the remaining grinding wheels.

At an intermediate portion of the upstanding shaft 122, longitudinally between the lower gear 123 and upper gear 126 thereon, is keyed a gear 150 which is included in a second gear train comprising in part a meshed intermediate idler gear 151 journalled on stub shaft 152 secured to an upper wall of the housing member 120. This intermediate idler gear 151 is in turn meshed with an outer gear 153 keyed to a driven shaft 154, upon the upper end of which is secured a cam 155, which acts upon a cam roller or follower 156 rotatably journalled on a shaft 157 extended through a movable gear housing 158, and hub 129 of the plate 130. An apertured cover member 159 closes the upper end of gear housing 158 and the gear train 126, 127, and 128 therein. An anchor spring 160 secured at one end to an upper wall of the housing 120, and at the other end to the pivotal gear housing 158 adjacent shaft 157, maintains the cam follower 156 in spring pressed engagement with cam 155, as shown in Fig. 9.

It will now be apparent that once the main drive shaft 122 is synchronized in speed with the rotatable drum 11, and the grinding wheels 148 contact the work pieces 55 in timed relation during their overlapping paths of travel, an abrading operation will be performed thereon. Further, since the gear train 126, 127 and 128 causes the plate 130, mounting the grinding wheels 148, to rotate and thereby index the series of grinding means for presentation of successive grinding wheels in timed relation to the spacing of successive work pieces and to follow the path of travel of the work pieces 55 so long as their paths overlap, and the cam and cam follower 155 and 156 effects a predetermined transverse movement of a grinding wheel 148 across a work piece 55, a combined reciprocation and translatory movement will be produced. Additionally, the rotary movement imparted to the grinding wheels 148, by the individual electric motors 131, and the concurrent oscillatory movement of the grinding wheels 148, induced by the eccentric mounting of the journals thereof, and the difference in pulley wheel sizes 133 and 134 provides a compound movement of the abrading wheel over the work piece at different speeds in several directions. Obviously the stationary cam 143 and cam follower 144 will effect a raising and lowering of the grinding wheel 148 at the proper timed interval to provide for a gradual presentation and removal of the abrading wheel to and from the work so as to obviate an annular depression being ground therein. In recapitulation, due to the relative size of the abrading surface of the grinding wheels 148 and the surface area of the work pieces 55 operated upon and the rotary, oscillatory, translatory, and indexing movement imparted to the grinding wheels, successive abrading wheels will be presented to the work in timed relation during their overlapping paths of travel and effect a multiple or compound movement thereon, whereby the relative advantages of grinding, lapping and/or honing are combined to produce a very accurate and smoothly finished surface with the elimination of "fuzz" from

the surface of the work operated on. The word "fuzz" as just used means the many closely grouped pinnacle-like peaks of the end structure of the surface metal not apparent to the naked eye but clearly visible through a magnifying lens and which gives an indication of the degree of smoothness of the finish of the metal surface.

From the foregoing it will be apparent to those skilled in the art to which the present invention is related that a novel grinding machine has been disclosed wherein a plurality of individually powered work holding chucks are caused to rotate within the path of travel of a series of individually powered grinding wheels whereby the grinding wheels are evenly dressed and the full abrading qualities thereof utilized in an economical and efficient manner; it provides a work holding spindle for use in conjunction therewith, but which may be employed singly, if desired, and which because of its novel arrangement for loading and unloading the work permits unusual rapidity in continuous grinding operations; it provides a locater for axially positioning the work pieces in a grinding machine; and provides a novel compound movement finishing means operable in timed relation to the path of work travel to produce an unusually smooth accurate surface thereon together with numerous novel details of construction throughout the same.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What we claim is:

1. In combination with a grinding machine of the character described, a rotatable spindle, a pair of spaced work-gripping means carried by said spindle and located at one end thereof, an associated cam and roller member disposed at the opposite end of said spindle, spindle rotating means located intermediate said work-gripping means and said cam and roller member, an axial spring pressed plunger interposed between said work-gripping means and said cam and roller member for actuating said gripping means to grip or release said work, and separate means extending from said plunger to said work gripping means whereby to hold said plunger closed when work is gripped and to hold said plunger released when said gripping means are open.

2. In combination with a grinding machine of the character described, a unit powered work holding chuck means, said chuck means comprising an axially apertured cylindrical body carrying at one end thereof two pairs of angularly disposed and axially spaced V-blocks, spring pressed means for frictionally clutching a work piece in said V-blocks, a cooperative spring pressed plunger extending axially rearward of the work piece arranged to actuate said work clutching means, and associated cam and roller members axially disposed adjacent the opposite end of said cylindrical body arranged to intermittently actuate said axial plunger.

3. In combination with a grinding machine of the character described, a unit powered work holding chuck means, said chuck means comprising an axially apertured cylindrical body carrying at one end thereof two pairs of angularly disposed and axially spaced V-blocks, spring pressed means for frictionally clutching a work piece in said V-blocks, a cooperative spring pressed plunger extending axially rearward of the work piece arranged to actuate said work clutching means, associated cam and roller members axially disposed adjacent the opposite end of said cylindrical body arranged to intermittently actuate said axial plunger, and a spring backed rod partially extending from said axial plunger to eject said work piece upon release thereof by said plunger and said spring pressed means.

4. In a valve grinding machine, a fixed support, a circular drum rotatably mounted thereon, a stationary cover concentrically overlying the upper axial end of said drum including a cam suitably located on the underside thereof, a plurality of individually powered work carrying chucks angularly supported by said drum having means extending from said chucks to said cam and adapted to be progressively actuated to an open position by said cam, and locating means secured to said support for axially spacing said work in said chucks when in a partially open position under said cam.

5. In a valve grinding machine, a fixed support, a circular drum rotatably mounted thereon, a stationary cover concentrically overlying the upper axial end of said drum including a cam suitably located on the underside thereof, a plurality of individually powered work carrying chucks angularly supported by said drum having means extending from said chucks to said cam and adapted to be progressively actuated to an open position by said cam, locating means secured to said support for axially spacing said work in the chucks when in a partially open position under said cam, said locating means comprising actuating and actuated plungers disposed in spaced parallel relation in a fixed mounting block, one of the ends of said plungers joined by a lever member fulcrumed intermediate thereof, and having the opposite ends of the actuating and actuated plungers adapted to contact a cam secured to said rotatable drum and said work pieces, respectively.

6. In a grinding machine, a fixed support, a circular drum rotatably mounted thereon, a stationary cover overlying a portion of said drum including a cam suitably located on the underside thereof, a plurality of individually powered work carrying chucks angularly supported by said drum having means extending from said chucks to said cam and adapted to be actuated to an open position by said cam, locating means secured to said support for axially spacing said work in said chucks when in a partially open position under said cam, and automatic means carried by each of said spindles for frictionally locking said work in the spindles subsequent thereto.

7. In a grinding machine for angularly grinding a valve seat, a plurality of grinding means arranged along a circular path of work travel, means for mounting one or more of said grinding means pivotally, a work holder, means for moving said work holder in said path of travel, means for rotating said holder so as to rotate work held therein during said travel, and means for moving one or more of said grinding means in a path normal to the axis of rotation thereof whereby to increase the grinding period for a given time interval.

8. In a grinding machine for angularly grinding a valve seat, a plurality of grinding means arranged along a circular path of work travel, means for mounting one or more of said grinding means pivotally, a work holder, means for moving said work holder in said path of travel,

means for rotating said holder so as to rotate work held therein during said travel, and means for moving one or more of said grinding means in a path normal to the axis of rotation thereof whereby to increase the grinding period for a given time interval, said means comprising a stationary wave-like cam plate and a cam follower pressed thereto attached to said pivotally mounted grinding means.

9. The combination with a grinding machine of the class described having a base, a powered drum rotatably mounted thereon, a plurality of individually powered work carrying spindles rotatably carried by said drum, a plurality of individually powered grinding wheels carried by said base and having the axes thereof disposed in spaced parallel relation around the periphery of said drum and work carrying spindles thereon, of unit powered honing means synchronously driven by said powered drum, and means imparting a compound working movement to said hones thereon whereby to accurately and smoothly finish work presented thereto.

10. The combination with a grinding machine of the class described having a base, a powered drum rotatably mounted thereon, a plurality of individually powered work carrying spindles rotatably carried by said drum for rotation about the longitudinal axis of said work and the axis of rotation of the drum, a plurality of individually powered grinding wheels carried by said base and having the axes thereof disposed in spaced parallel relation around the periphery of said drum and work carrying spindles thereon, of unit powered honing means including means for synchronously driving the same by said powered drum, means imparting a compound working movement to said hones thereon, said last named means comprising a first gear train driven from said synchronous drive to rotate said grinding means in timed relation to said rotating and rotated work, and a second train of gears also driven from said synchronous drive effecting movement transverse to said work.

11. The combination with a grinding machine of the class described having a base, a powered drum rotatably mounted thereon, a plurality of individually powered work carrying spindles rotatably carried by said drum for rotation about the longitudinal axis of said work and the axis of rotation of the drum, a plurality of individually powered grinding wheels carried by said base and having the axes thereof disposed in spaced parallel relation around the periphery of said drum and work carrying spindles thereon, of unit powered honing means including means for synchronously driving the same by said powered drum, means imparting a compound working movement to said hones thereon, said last named means comprising a first gear train driven from said synchronous drive to rotate and index said grinding means in timed relation to said rotating and rotated work, a second train of gears also driven from said synchronous drive effecting movement transverse to said work, and a combined two-speed, two-directional unit power means for driving each of said honing means simultaneously with said compound movement.

12. In a machine for grinding poppet valves, powered work holders, a plurality of powered grinding means arranged around a circular path of work travel, said grinding means comprising roughing, intermediate, and finishing wheels, means for moving said work holders in said path of travel, means for rotating work held therein during said travel, means supporting said finishing wheels for a compound movement on successive work pieces, and means for causing said movement in timed relation to said work travel.

13. In a machine for grinding poppet valves, powered work holders, a plurality of powered grinding means arranged around a circular path of work travel for rotation about the longitudinal axis of said work and the axis of rotation of the drum, said grinding means comprising roughing, intermediate, and finishing wheels, means for moving said work holders in said path of travel, means for rotating work held therein during said travel, means supporting said finishing wheels for a compound movement on successive work pieces, means for causing said movement in timed relation to said rotating and rotated work travel, and cam means for elevating and lowering said finishing wheels, respectively, as they are presented to and leave said work pieces whereby an annular depression will not be formed thereon.

14. In a machine for grinding poppet valves, powered work holders, a plurality of powered grinding means arranged around a circular path of work travel, said grinding means comprising roughing, intermediate, and finishing wheels, means for moving said work holders in said path of travel, means for rotating work held therein during said travel, means supporting said finishing wheels for a compound movement on successive work pieces, means for causing said movement in timed relation to said work travel, and said rotatable finishing wheels being mounted in concentric and eccentric driven journals whereby in addition to the above compound movement an added movement angular to said work is produced.

15. In a machine for grinding poppet valves, powered work holders, a plurality of powered grinding means arranged around a circular path of work travel, said grinding means comprising roughing, intermediate, and finishing wheels, means for moving said work holders in said path of travel, means for rotating work held therein during said travel, means supporting said finishing wheels for a compound movement on successive work pieces, and means for causing said movement in timed relation to said work travel, said finishing wheels being mounted in concentric and eccentric driven journals whereby in addition to the above compound working movement an added movement angular to said work is produced, and the driven speed of said eccentrically mounted finishing wheels being different from that of the overlying concentrically mounted driven journals in which said wheels operate.

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