

Nov. 4, 1947.

L. R. HEIM

2,430,423

INTERNAL GRINDING MACHINE

Filed Jan. 8, 1945

6 Sheets-Sheet 1

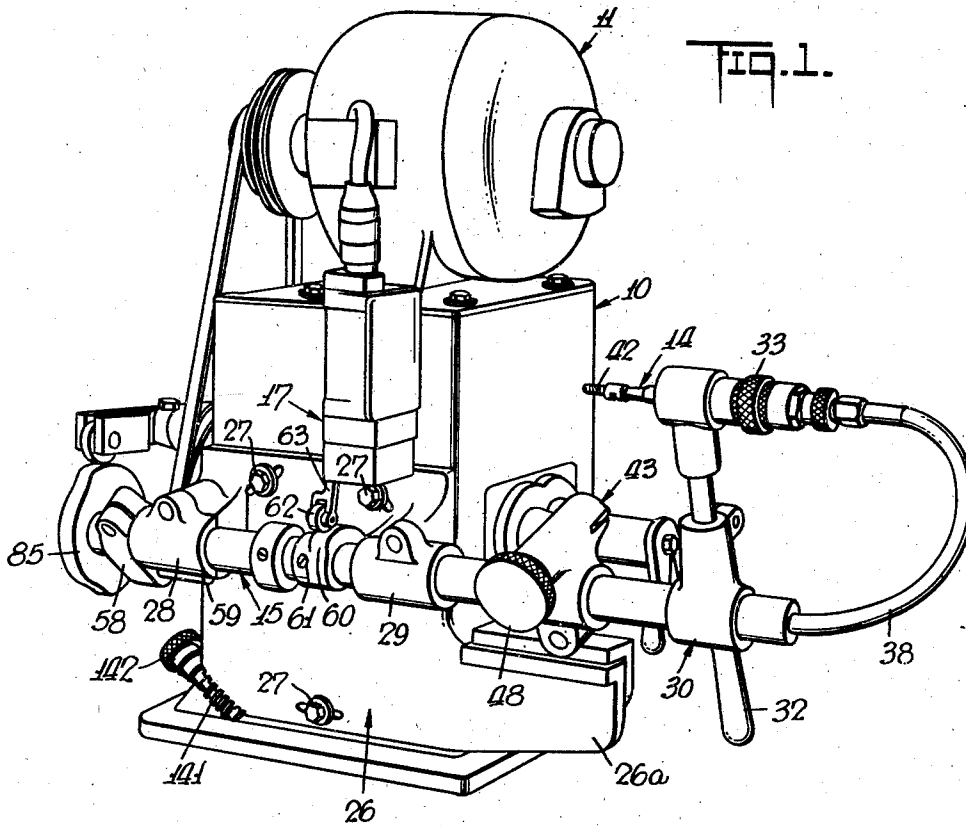


FIG. 1.

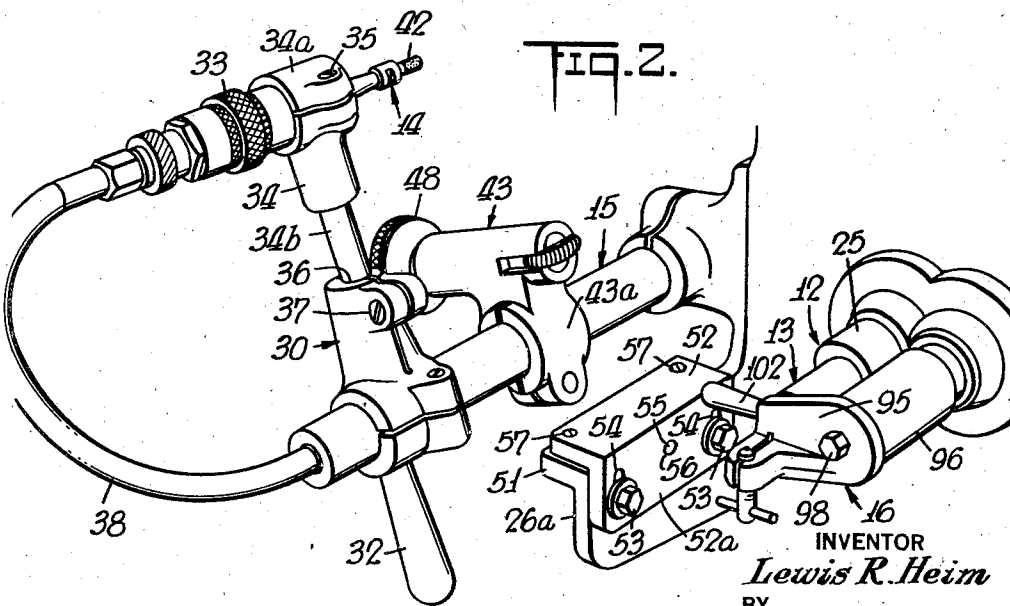


FIG. 2.

INVENTOR
Lewis R. Heim
BY
Blair, Curtis + Hayward
ATTORNEYS
4-101 6-1

Nov. 4, 1947.

L. R. HEIM

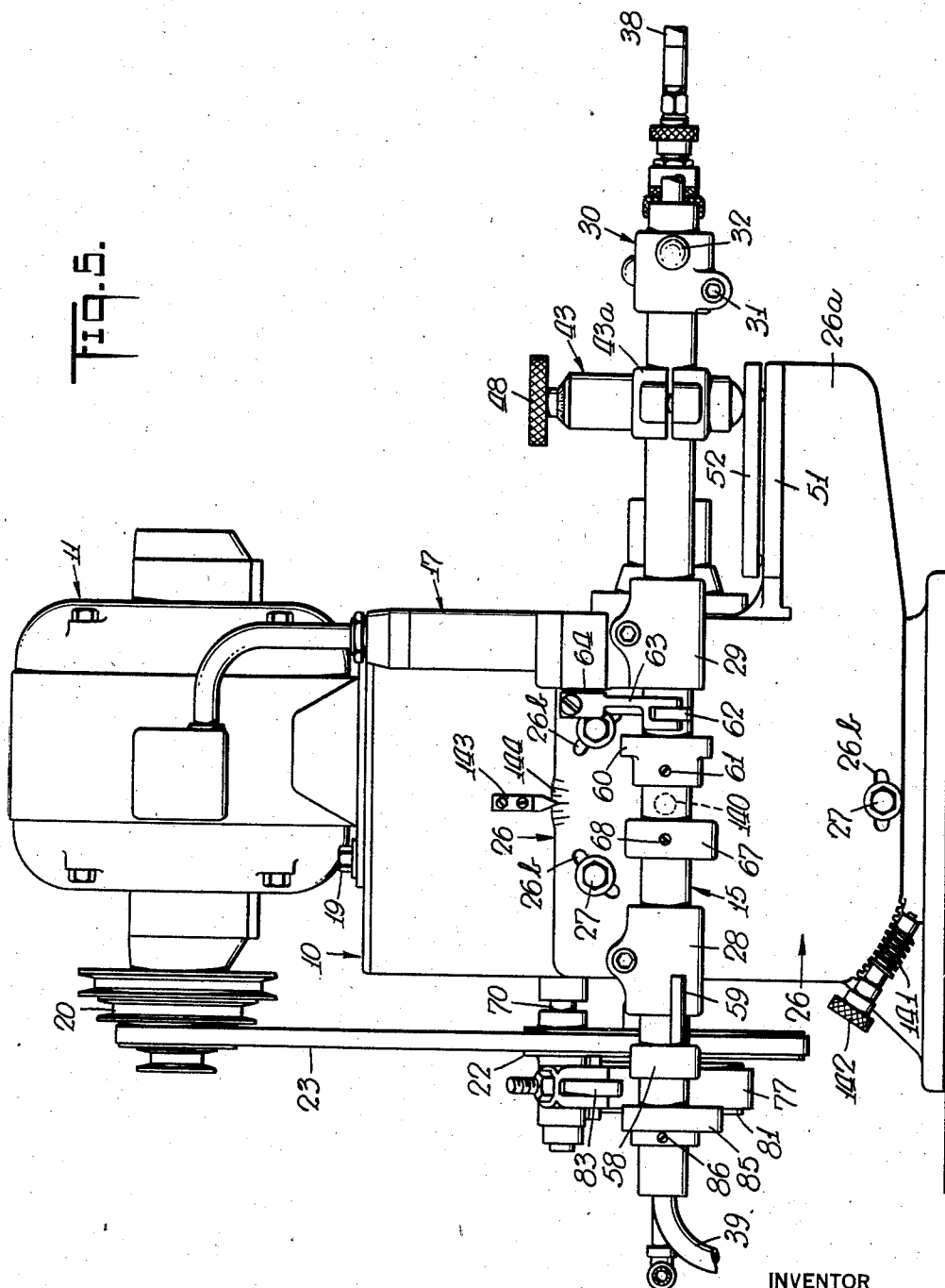
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Fig. 5.



INVENTOR
Lewis R. Heim
BY
Blair, Curtis & Hayward
ATTORNEYS

Nov. 4, 1947.

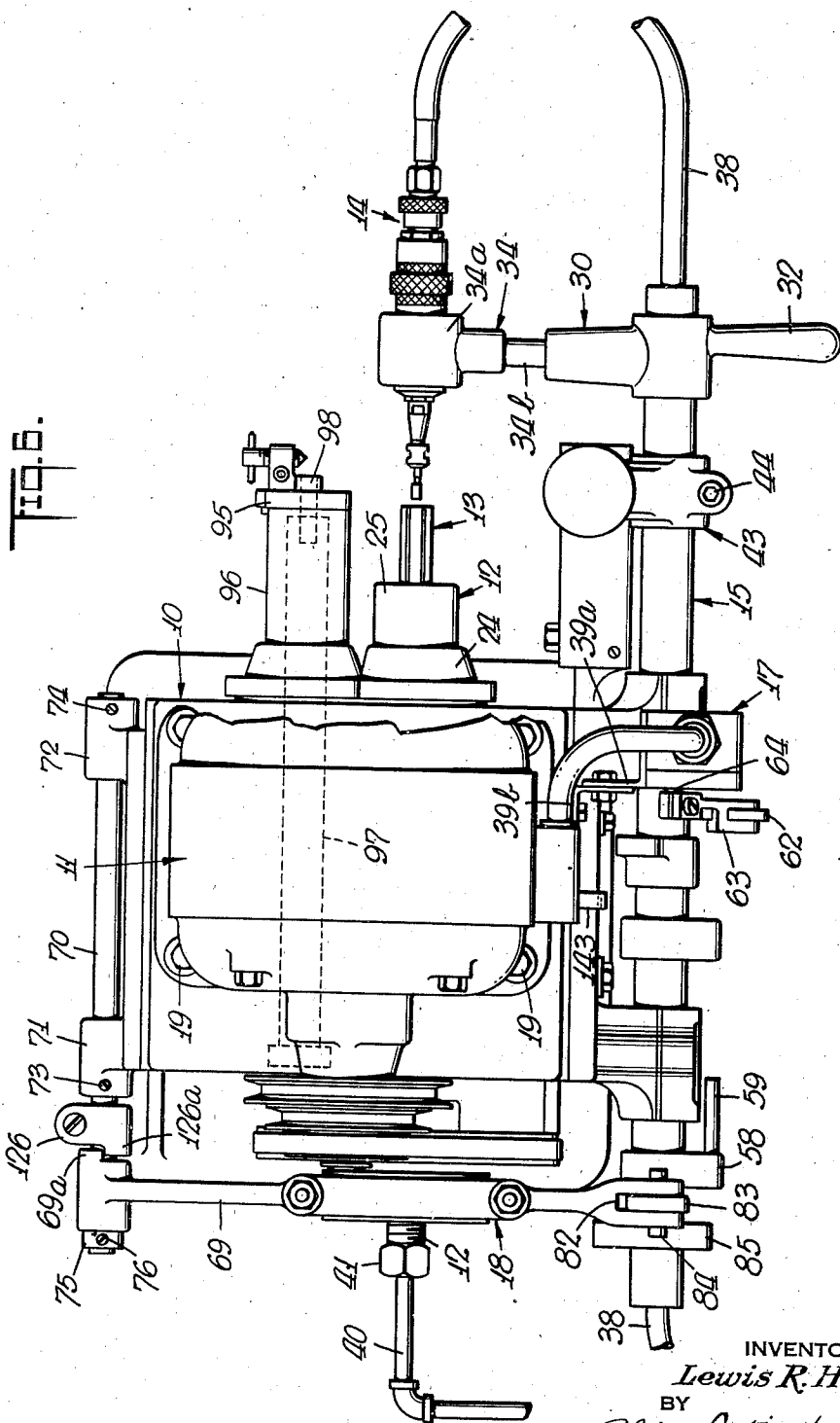
L. R. HEIM

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INTERNAL GRINDING MACHINE

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INVENTOR
Lewis R. Heim
BY
Blair, Furtie & Hayward
ATTORNEYS
4-101 6-4

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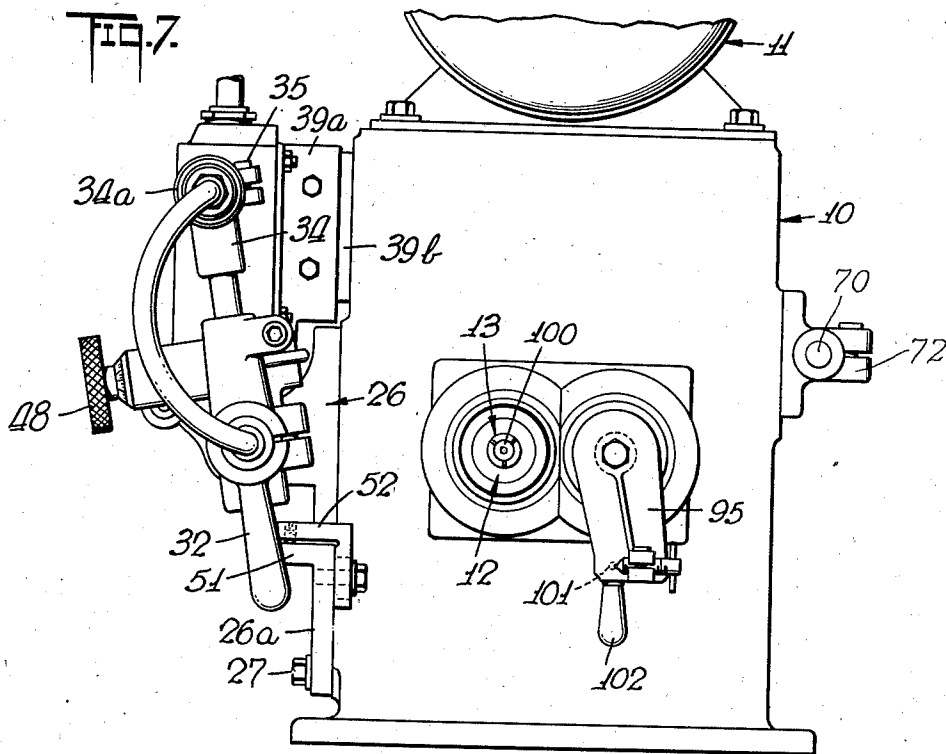
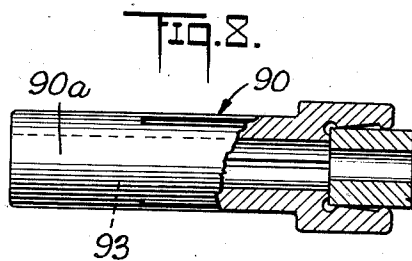
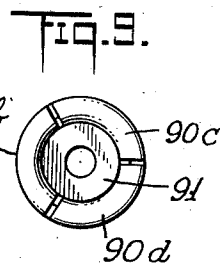
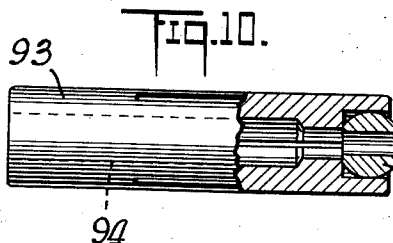
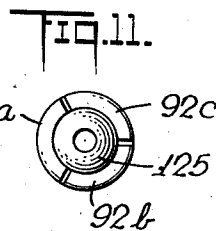
L. R. HEIM

2,430,423

INTERNAL GRINDING MACHINE

Filed Jan. 8, 1945

6 Sheets-Sheet 5



INVENTOR

Lewis R. Heim

BY

Blair, Curtis & Hayward
ATTORNEYS

ATTORNEYS.

4-101 6-4

Nov. 4, 1947.

L. R. HEIM

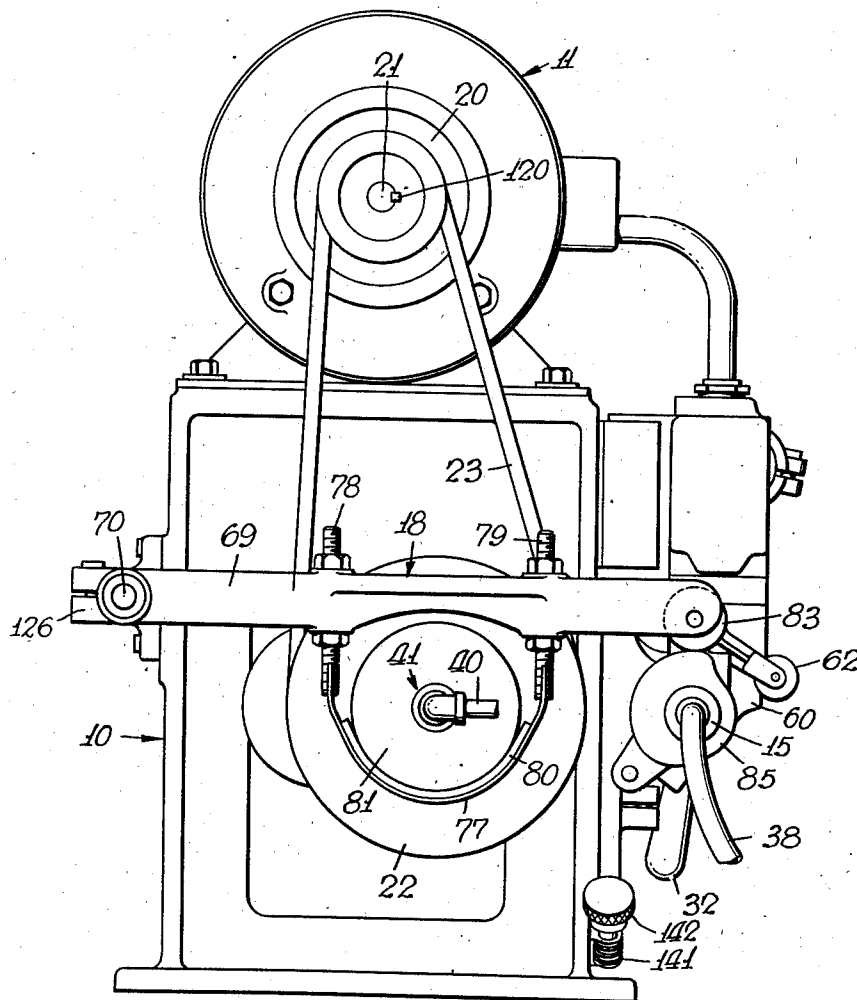
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Fig. 12.



INVENTOR
Lewis R. Heim
BY
Blair, Curtis & Hayward
ATTORNEYS
4-101 6-6

UNITED STATES PATENT OFFICE

2,430,423

INTERNAL GRINDING MACHINE

Lewis R. Heim, Fairfield, Conn., assignor of twenty-five per cent to Anna E. Heim, twenty-five per cent to Charles R. Heim, and twenty-five per cent to Florence H. Van Etten, all of Fairfield, Conn.

Application January 8, 1945, Serial No. 571,777

12 Claims. (Cl. 51—50)

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This invention relates to grinding machines and to a method of grinding.

One of the objects of this invention is to provide a new and improved grinding machine. Another object is to provide a machine of the above character which is simple, thoroughly practical, and durable in construction. Another object is to provide a machine of the above character by means of which a maximum of articles may be ground in a minimum of time. Another object is to provide a machine of the above character which is accurate in operation. A further object is to provide a machine of the above character which is well adapted to withstand continual hard usage. Another object is to provide a machine of the above character which is capable of accurately and efficiently grinding tapered holes. Still another object is to provide a new and improved method of grinding. Another object is to provide a method of grinding which is economical and efficient. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists, in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of the various possible embodiments of this invention,

Figure 1 is a perspective view of the internal grinding machine;

Figure 2 is a perspective view on an enlarged scale of a portion of the machine shown in Figure 1;

Figure 3 is a view similar to Figure 2 with certain parts of the machine in different relative positions;

Figure 4 is a view similar to Figure 2 with certain parts of the machine in different relative positions;

Figure 5 is a side elevation on an enlarged scale of the grinding machine shown in Figure 1;

Figure 6 is a top plan view on an enlarged scale of the grinding machine shown in Figure 1;

Figure 7 is a front elevation of the grinding machine shown in Figure 1 on an enlarged scale;

Figure 8 is a plan view partly in section of a collet which may be used in the machine shown in Figure 1 and having a bushing mounted therein;

Figure 9 is an end view of the collet and bushing shown in Figure 8;

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Figure 10 is a plan view partly in section of a collet which may be used in the machine shown in Figure 1 and having a ball mounted therein;

Figure 11 is an end view of the collet and ball shown in Figure 10; and,

Figure 12 is a rear elevation on an enlarged scale of the machine shown in Figure 1.

Similar reference characters refer to similar parts throughout the several views of the drawings.

In general, the machine includes a frame 10 (Figure 1) having an electric motor 11 mounted thereon. Motor 11 is operatively connected to and drives a spindle, generally indicated at 12 (Figures 6 and 12), which has a work holding member, generally indicated at 13, mounted on its forward end. A grinding wheel 42 mounted on a grinding spindle 14 is driven by a motor 33 at grinding speed. Spindle 14 and motor 33 are mounted on a shaft, generally indicated at 15, which is movable about its axis radially and may also be moved axially. This permits the grinding spindle to be moved into and out of contact with the work in member 13 (Figure 3) and also permits the grinding spindle to be pivoted with shaft 15 out of operative position to the position it occupies in Figures 2 and 7. A loader, generally indicated at 16, is provided for placing and aligning the work in work holding member 13. Loader 16 may also be used to true the grinding wheel 42 mounted on grinding spindle 14 (Figure 4). Shaft 15 operates a switch, generally indicated at 17, to break or make the circuit to motor 11 and also operates a brake, generally indicated at 18, to stop or permit rotation of spindle 12 when the grinding spindle is moved out of or into operating position (Figures 2 and 3).

Referring now to the drawings in detail, electric motor 11 is securely mounted on the top of frame 10 by screws 19 (Figures 5 and 6). A step cone pulley 20 (Figures 1 and 5) is keyed to the shaft 21 (Figure 12) of motor 11 by key 120. Pulley 20 is operatively connected by a belt 23 to a pulley 22 keyed to the rear end of the work driving spindle 12 (Figure 6). Spindle 12 is rotatably mounted in a pair of bearings, such as bearing 24 on frame 10. The forward end of spindle 12 is provided with a suitable chuck 25 for mounting a work supporting collet, such as collet 13, and holding it axially aligned with respect to the axis of spindle 12. Thus motor 11 is operatively connected to and rotates the work mounted in collet 13.

Spindle 12 is preferably hollow in order that a coolant may be supplied to the work during

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the grinding operation. To supply the coolant to spindle 12 a pipe 40 is connected by a stuffing box, generally indicated at 41, to the rear end of spindle 12 and the collets used, such as collet 13, with spindle 12 are preferably axially bored so the coolant may flow through them and through the hole being ground in the work supported by the collet. Suitable means (not shown) is preferably provided to collect the coolant after it has passed over the work and return it to the source of the supply of pipe 40.

A supporting plate, generally indicated at 26 (Figure 5) is mounted on the side of frame 10 by screws 27. The surface of frame 10 against which plate 26 is held is in a plane parallel to the axis of main spindle 12. A stay pin 140 (Figure 5) extends outwardly from frame 10 through a hole in plate 26 and screws 27, which are connected to frame 10, extend through slots 26a in plate 26. Thus for purposes to be disclosed hereinafter, when screws 27 are loosened, plate 26 may be pivoted about pin 140 as an axis, and then when it has been adjusted to the desired position, bolts 27 are tightened. To facilitate the adjustment of plate 26, a worm gear 141 is mounted on frame 10. This gear is turned by hand wheel 142 and meshes with a rack cut into the edge of plate 26. Thus, when screws 27 are loosened, the operator can adjust the position of plate 26 with respect to the frame of the machine by pivoting plate 26 about stay pin 140 and is guided in his adjustment by the relative positions of the indicating finger 143 mounted on frame 10 and the scale 144 on plate 26. By changing the position of plate 26 with respect to the frame, the grinding wheel 42 may be positioned so that tapered holes may be ground in the work, all as will be more fully pointed out hereinafter.

Plate 26 has a pair of bearings 28 and 29 thereon in which shaft 15 is mounted both for movement longitudinally of the machine and about the shaft's axis radially. The axis of shaft 15 is parallel to the axis of work supporting spindle 12. Shaft 15, which is hollow, has a supporting bracket, generally indicated at 30 (Figures 2 and 6) mounted thereon and held in a set position by a screw 31 (Figure 5). Supporting bracket 30 is provided with a handle 32 (Figure 2) by which the operator moves the grinding spindle between operative (Figure 3) and "rest" (Figure 2) positions. Grinding wheel 42, which is driven at grinding speed by an air or electric motor 33, is mounted on bracket 30 by a support 34. Support 34 has a clamp 34a (Figures 2 and 7) formed on its outer end, which, when screw 35 (Figure 2) is tightened, mounts motor 33 on shaft 15. Support 34 has a cylindrically shaped portion 34b (Figure 2) which extends into a bore 36 in bracket 30. The portion of bracket 30 into which the portion 34b of support 34 extends is split longitudinally to form a clamp and is provided with a screw 37, which, when tightened, holds support 34 in adjusted relationship with respect to bracket 30. By loosening screw 37, support 34 may be adjusted with respect to shaft 15 so as to align the axis of grinding wheel 42 with the axis of spindle 12. As shaft 15 is parallel to spindle 12, this insures that the axis of the grinding wheel will be parallel to the axis of the spindle 12 at all times during grinding (Figure 3).

Air motor 33 (Figures 1 and 3) is connected to a flexible air supply hose 38. This hose passes through hollow shaft 15 and is connected to a

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source of compressed air (not shown). If an electric motor is used in place of motor 33, the electric cable also passes through hollow shaft 15. With the hose or cable in this position, it does not interfere in any way with the operation of the machine and furthermore it is efficiently protected from wear.

To permit vertical adjustment of the grinding wheel 42 (Figure 3) with respect to the axis of the grinding spindle when it is in operating position and thus to accurately grind the hole within the work to a preselected diameter, an adjusting head, generally indicated at 43, is provided. This head has a split clamp portion 43a (Figure 2) formed thereon by which, when screw 44 (Figure 4) is tightened, the head is rigidly connected to shaft 15. Head 43 has a vertical bore 43b therein within which a cylindrically shaped supporting member 45 is mounted for vertical movement with respect to head 43, as viewed in Figure 4. The lower end of member 45 has a slot 45a therein which a roller 46 is rotatably mounted on member 45 by a shaft 47. An adjusting wheel 48 is operatively connected to member 45 by a screw 49 which threads into a hole in member 45 having threads complementary to the threads on screw 49. A collar 50 connected to screw 49 prevents upward movement of screw 49 and thus wheel 48. Accordingly, as adjusting wheel 48 is turned, member 45 and thus roller 46 may be adjusted upwardly and downwardly with respect to head 43. Pivotal movement of supporting member 45 is prevented by the portions of roller 46 which extend into the slots 43c in the lower portion of head 43.

Plate 26 has a bracket 26a (Figure 1) formed thereon and extending forwardly therefrom. This bracket has a flange portion 51 extending to the left from its upper edge, as viewed in Figure 7. A supporting plate 52 (Figure 2) having a hardened flat top surface and having a downwardly extending flange portion 52a is mounted on bracket 26a and its flange portion 51 by a pair of screws 53 which extend through slots 54 in flange portion 52a and thread into bracket 26a. A pin 55 extends outwardly from the side of bracket 26a through a hole 56 in flange 52a and thus mounts plate 52 for adjusting movement with respect to bracket 26a when screws 53 are loosened. Thus plate 52 may be adjusted by tilting it about pin 55 as a fulcrum point so that its upper surface is horizontal. After it has been adjusted, screws 54 are tightened and a pair of set screws 57 extending through plate 52 are screwed down until their lower ends abut against the top of flange portion 51 thus assisting screws 53 in maintaining plate 52 in its adjusted position.

When the grinding wheel is moved into operative position, as shown in Figure 3, roller 46 limits the downward movement of the grinding wheel 42 when it contacts the surface of plate 52. If it is desired to raise or lower the grinding wheel and thus adjust it to grind a hole to a predetermined size, adjusting wheel 48 is turned. This wheel acts through screw 49 (Figure 4), bracket 43, and roller 46 to raise or lower the grinding wheel 42 (Figure 3) when it is in operative position. During grinding, when the operator is moving the grinding wheel with a reciprocating action in the hole in the work by means of handle 32, the roller 46 (Figure 3) supports the weight of the grinding wheel and mechanism associated therewith as the roller rolls back and forth on the top surface of the plate 52.

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To limit the inward movement of the grinding wheel during grinding, a stop 67 (Figure 5) is provided. This stop, which is in the form of a collar on shaft 15, is connected to shaft 15 by a set screw 68 which permits the adjustment of the collar longitudinally of shaft 15. Thus a stop is provided which, when it abuts against the front surface of bearing 28, limits the degree of movement of the grinding wheel inwardly.

At the end of a grinding operation, the operator grasps handle 32 and moves the spindle and shaft 15 outwardly away from the front of the machine until a limit stop 58 securely connected to shaft 15 (Figure 5) contacts the rear end of bearing 23. Next the operator moves the grinding spindle from operative position to the position it occupies in Figure 7. Movement in this direction is limited by pin 59 (Figures 1 and 5) which extends forwardly from stop 58 and which contacts the outer face of plate 26 (Figure 1). During the time that the grinding spindle is being moved from operating to rest position, as shown in Figure 2, a cam 60, the hub of which is connected to shaft 15 by set screw 61 (Figure 1), acts upon a roller 62 mounted upon the lower end of switch arm 63. The upper end of switch arm 63 (Figure 5) is connected to a shaft 64 which operates motor switch 17, which is mounted on frame 10 by brackets 39a and 39b. Cam 60 (Figure 1) is of such shape that when the shaft 15 (Figure 1) is turned, arm 63 is moved outwardly, thus turning the shaft 64 (Figure 5) opening the switch 17 to cut off the power to motor 11. Cam 60 is aligned with roller 62 by moving spindle 42 and shaft 15 outwardly prior to the pivoting of the spindle to its rest position.

As described hereinabove, a brake 18 is provided for the main spindle 12 (Figure 6) of the machine. This brake is automatically operated immediately after motor switch 17 is actuated by cam 60 to cut off the current to motor 11. Brake 18 includes a brake lever 69 which is pivotally mounted on a shaft 70 at its left end, as viewed in Figure 12. Shaft 70 is mounted in a pair of brackets 71 and 72 (Figure 6) extending outwardly from the side wall of frame 10. Shaft 70 is rigidly held with respect to brackets 71 and 72 by a pair of set screws 73 and 74. A collar 75 is provided to hold lever 18b on shaft 70, the collar being held in position by a set screw 76.

A brake band 77 having lining 80 (Figure 12) is mounted on brake lever 69 by a pair of adjusting screws 78 and 79 and this band coacts with a brake drum 81 mounted on and keyed to spindle 12 when the brake is operated. The right-hand end of brake lever 69, as viewed in Figure 12, has a slot 82 (Figure 6) therein in which a cam roller 83 is rotatably mounted on a shaft 84. As described hereinabove, immediately prior to moving the grinding wheel from its operating to its rest position, the shaft 15 is moved outwardly until stop 58 (Figure 5) abuts against the rear end of bearing 28 (Figure 1). At this time a cam 85, the hub of which is connected to shaft 15 by set screw 86, is aligned with roller 83 on the end of brake 18 (Figure 12). Thus, as the shaft 15 is turned in a clockwise direction, as viewed in Figure 12, cam 85 acts upon roller 83 to move brake lever 69 upwardly and thus moves the brake lining 80 into contact with drum 81 to stop rotation of both the spindle and motor. Cams 85 (Figure 12) and 60 (Figure 1) are set with respect to each other so that switch 17 is operated before brake 18 when the grinding wheel is moved to a non-operating position.

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Thus, the motor 11 is off when the brake is operated and when the grinding wheel is moved into operating position, the brake is released before the motor is turned on. In place of the brake described hereinabove, a type of switch might be used in place of switch 17 which in conjunction with motor 11 would employ the well-known principle of dynamic braking by shorting the armature of motor 11 when the grinding wheel is moved to non-operative position, thus utilizing motor 11 as the brake for spindle 12.

To limit the downward movement of brake lever 69, as viewed in Figure 12, shaft 70 has a split collar 126 (Figure 6) thereon having a rearwardly extending portion 126a which coacts with a forwardly extending portion 69a on the hub of lever 69. When the grinding wheel is moved out of contact with roller 83, then portions 126a and 69a abut against each other to hold lever 69 out of contact with drum 81 (Figure 12) and to hold roller 83 in a raised position. This permits cam 85 to be moved into operative position with respect to roller 85 as the grinding wheel is being returned to its rest position.

The holes in a variety of different types of work may be ground in this machine, being mounted on spindle 12 by any suitable type of work holding member such as draw in, key, or magnetic chucks. For internally grinding the holes in balls and small bushings, collects shown in Figures 8, 9, 10, and 11 are preferably used. The collet generally indicated at 90 has a shank 90a which fits within and is connected to the chuck 25 (Figure 6) on main spindle 12. Collet 90 has three spring sections 90b, 90c, and 90d, (Figure 3), which, when a bushing 91 is pressed between them, firmly grip the bushing and hold it so that the hole extending through it is axially aligned with the axis of the main spindle. After the bushing has been mounted in the collet 90, the grinding wheel 42 is moved into operative position (Figure 3) and the hole in the bushing is ground by moving the grinding wheel longitudinally of the hole in the bushing with a reciprocating action. During this time the hole is accurately ground to a predetermined size depending upon the setting which is made by adjusting wheel 46. In Figure 10 a collet is shown, generally indicated at 92, for holding balls, such as ball 125, as the hole in the ball being held is internally ground. This collet is substantially similar to the collet shown in Figure 8 and includes three spring sections 92a, 92b, and 92c which firmly grip the ball when it is placed in the collet. It will be noted that collets 90 and 92 are provided with internal bores 93 and 94 through which the coolant flows to the work after it has passed through the main spindle 12 as described hereinabove.

To place the work in collets 90 and 92, loader 16 (Figure 2) is used. This loader includes an arm 95 having a hub 96 mounted on the forward end of a shaft 97 (Figure 6) and held thereon by a screw 98 which threads into the forward end of shaft 97. Shaft 97 is mounted on bearings on frame 10 of the machine so that it is movable about its axis radially and is also movable axially. The axis of shaft 97 is parallel to the axis of spindle 12. Thus arm 95 (Figure 3) may be moved toward and from the front of the machine and also pivoted using the axis of shaft 97 as its axis of rotation.

Arm 95 has a pin 101 (Figures 3 and 7) thereon which extends rearwardly therefrom. This

pin is so positioned on arm 95 that when arm 95 is swung in a clockwise direction from the position it occupies in Figure 7 by handle 102, the axis of pin 101 may be longitudinally aligned with the axis of the main spindle 12. Pin 101 (Figure 3) preferably has a diameter slightly smaller than the diameter of the hole in a bushing or ball 100 prior to the hole in the bushing or ball being ground. To mount a ball in the collet 13 a ball is placed on pin 101, then arm 95 is swung from the position it occupies in Figure 2 to the position it occupies in Figure 3 by means of handle 102. Next the arm 95 is pushed inwardly and then the operator presses downwardly upon handle 102. This seats the ball in the spring collet and the downward pressure acts through pin 101 to axially align the hole in the ball with the axis of the spindle. Next arm 95 is moved outwardly leaving the ball in collet 13 and then moved downwardly to the position it occupies in Figure 7.

To grind the hole in ball 100, the grinding wheel is swung downwardly into operative position and then moved with a reciprocating action with the grinding wheel within the hole of the ball. The hole in the ball is accurately ground to a predetermined size because the adjustment of setting wheel 48 limits the degree that the grinding wheel 42 can move downwardly. During grinding it will be noted that the grinding wheel which is cylindrically shaped maintains the hole in the ball in axial alignment with the axis of spindle 12.

Arm 95 also has the additional function that it may be used to true the grinding wheel. Arm 95 has a bracket portion 107 on which an adjustable screw 105 having a diamond 106 on its upper end is mounted. To dress wheel 42, arm 95 is placed in the position it occupies in Figure 4 with pin 101 still within the hole in the work piece it inserted in the collet 13. By adjusting screw 105 and then moving the grinding wheel 42 backwardly and forwardly across the diamond, the surface of the wheel may be dressed. After dressing, the grinding wheel is swung out of operative position into its rest position, arm 95 is pulled outwardly and then pivoted downwardly to the position it occupies in Figure 3, the grinding wheel is moved into operative position, and then the hole in work piece 100 is ground.

In operation, starting from the rest position of the grinding spindle 14, as shown in Figure 1, a ball is placed in the collet 13 by means of the loader 16. By pressing downwardly and inwardly upon loader 16, the hole in the ball is axially aligned with the axis of the main spindle 12. Next the loader is pulled outwardly, then moved downwardly to the position it occupies in Figure 3 where it is out of the path of the grinding wheel 42. If the adjusting wheel 48 has been set, the grinding spindle is then moved to operative position, as shown in Figure 2. This causes the brake 18 (Figure 12) to be released and motor switch 17 (Figure 1) to complete the circuit to motor 11. This causes the ball to be rotated in a direction opposite to the direction of rotation of the grinding wheel 42, and the grinding wheel, which is driven at grinding speed, is then moved longitudinally of the hole in the work piece mounted in the collet 13 (Figure 3) with a reciprocating action, producing relative movement between the lines of contact of the grinding wheel and the surface being ground. After grinding has been completed, the grinding spindle 14 is moved out of operative position to rest position, as shown

in Figure 2, and the work is removed from collet 13. When the grinding spindle 14 is pivoted out of operative position, switch 17 is opened to break the circuit to motor 11 (Figure 1) and brake 18 (Figure 12) is applied to stop rotation of spindle 12. After this the work is removed from the collet.

If it is desired to grind a tapered hole, then plate 26 (Figure 5) by means of hand wheel 42 is adjusted so that the grinding wheel 42 is moved out of axial alignment with respect to the hole in the work mounted on spindle 12. Next a piece of work is placed in work holding member 13, loader 16 moved out of the operating path of grinding wheel 42, the grinding wheel moved into operative position, and reciprocated to grind the work. Because of the angular position of the surface of the grinding wheel, holes having a taper are ground in the work mounted in the work holding member 13. By adjusting plate 26, tapers of different degrees may be obtained.

It will thus be seen that a machine has been described by means of which relatively small holes in balls, bushings, and like work pieces may be efficiently and accurately internally ground. Furthermore, the machine is so constructed that it may be operated by an operator seated at a bench as the machine is small and compact and all parts of the machine which the operator uses during grinding are readily accessible to an operator when he is seated. Furthermore, by means of the loader, work may be rapidly and accurately loaded into the machine in position for grinding. Also it will be noted that this machine may be readily set to grind holes of different sizes. Furthermore, mechanism is disclosed by means of which the grinding wheel may be readily and accurately dressed whenever it is necessary. Thus, a practical and efficient grinding machine has been disclosed which has accomplished the objects set forth hereinabove as well as many others. Furthermore, an efficient and practical method of grinding relatively small holes in balls, bushings, and like work pieces has been disclosed. Also it will be clear that some of the advantages of this machine are applicable to external grinding as well as to internal grinding.

As many possible embodiments may be made of the mechanical features of the above invention, and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an internal grinding machine, in combination, a frame, a spindle mounted on said frame, a motor for driving said spindle, means for mounting a work piece having a hole therein on one end of said spindle, a member rotatably mounted on said frame and also being longitudinally movable with respect to said frame, the axis of said member being parallel to the axis of the hole in said work piece, a grinding wheel, means driving said grinding wheel at grinding speed, a member mounting said grinding wheel on said first-mentioned member, whereby said grinding wheel may be moved into and out of operative position and when in operative position may be moved into grinding relationship with respect to the hole in said work piece, means for limiting the movement of said grinding wheel in the direction it is moved when it is moved into operative position, switch means operated by said first-men-

tioned member for breaking the circuit to said motor when said grinding wheel is moved out of operative position, brake means operatively associated with said spindle, and means on said first-mentioned member for operating said brake means to stop rotation of said spindle when said grinding wheel is moved from operative into inoperative position.

2. In an internal grinding machine, in combination, a frame, means for supporting a work piece having a hole therein on said frame, a grinding wheel, driving means for driving said grinding wheel, said grinding wheel being movable into and out of grinding relationship with respect to the hole in said work piece, a loading arm, said loading arm being mounted for both pivotal and longitudinal movement with respect to said frame, and a pin extending rearwardly from said arm, said pin being capable of axial alignment with the means for supporting said work piece, whereby a piece of work may be mounted on said first-mentioned means by inserting said pin in the hole in said work piece, pivoting said arm until said pin is aligned with the means for supporting said work piece, and then inserting said work piece in said last-mentioned means by pressing inwardly on said arm.

3. In an internal grinding machine, in combination, a frame, a spring collet for supporting a ball having a hole therein on said frame, a grinding wheel, means for driving said grinding wheel at grinding speed, said grinding wheel being movable into and out of grinding relationship with respect to the hole in said ball, a loading arm, said loading arm being mounted for both pivotal and longitudinal movement with respect to said frame, and a pin extending rearwardly from said arm, the axis of said pin being parallel to the axis of said spring collet, said pin being capable of axial alignment with the axis of said spring collet, whereby said ball may be mounted on said collet by inserting said pin into the hole in said ball, pivoting said arm until said pin is aligned with said spring collet and then inserting said ball into said spring collet by moving said arm inwardly toward said spring collet.

4. In an internal grinding machine, in combination, a frame, a spring collet for supporting a ball having a hole therein mounted on said frame, a grinding wheel, means for driving said grinding wheel at grinding speed, means pivotally mounting said grinding wheel on said frame, whereby said grinding wheel may be pivoted into and out of operative position, a loading arm, said loading arm being mounted for both pivotal and longitudinal movement with respect to said frame, and a pin extending rearwardly from said arm, said pin being capable of axial alignment with the axis of said spring collet, whereby a piece of work may be mounted on said collet by inserting said pin in the hole in said ball after said grinding wheel has been moved out of operative position, then pivoting said arm until said pin is axially aligned with said spring collet and the inserting said ball in said spring collet by pressing inwardly upon said loading arm.

5. In an internal grinding machine, in combination, a frame, a spindle mounted on said frame, means for mounting a work piece having a hole therein on one end of said spindle, a motor for driving said spindle, a grinding wheel, means for driving said grinding wheel at grinding speed, a supporting member, said grinding wheel being mounted on said supporting member, said supporting member being pivotally mounted on said

frame, whereby said grinding wheel may be pivoted with said supporting member into and out of operative position, and switch means operated by said supporting member to cut off the source of current to said motor whenever said grinding wheel is moved to inoperative position.

6. In an internal grinding machine, in combination, a frame, a spindle mounted on said frame, means for mounting a work piece having a hole therein on one end of said spindle, a motor for driving said spindle, a grinding wheel, means for driving said grinding wheel at grinding speed, a supporting member, said grinding wheel being mounted on said supporting member, means pivotally mounting said supporting member on said frame, whereby said grinding wheel may be pivoted with said supporting member into and out of operative position, switch means for said motor operatively associated with said supporting member, brake means operatively associated with said spindle, and means operatively connecting said brake means to said supporting member, whereby when said grinding wheel is moved to an inoperative position, said supporting member acts through said switch means to cut off the current to said motor and operates said brake to stop rotation of said spindle.

7. In an internal grinding machine, in combination, a frame, means mounted on said frame for holding a workpiece having a hole therein, a cylindrically shaped grinding wheel, means for driving said grinding wheel at grinding speed, a supporting member, said grinding wheel being mounted on said supporting member, means mounting said supporting member for movement toward and from the workpiece, means pivotally mounting said supporting member on a second supporting member, whereby said grinding wheel may be pivoted with said first-mentioned supporting member into and out of operative position, and means adjustably mounting said second-mentioned supporting member on said frame, whereby the axis of said grinding wheel may be adjusted relative to the hole in said workpiece to permit the grinding of tapered holes in the workpiece.

8. In an internal grinding machine, in combination, a frame, means mounting a workpiece having a bore therein on said frame, a grinding wheel, means for driving said grinding wheel, means positioned at one side of said first-mentioned means for pivotally mounting said grinding wheel and associated mechanism on said frame to permit said grinding wheel and its associated mechanism to be manually swung upwardly and outwardly from a position in front of said workpiece to a position where it is held against a stop by means of gravity, a loading arm for loading workpieces into said first-mentioned means, said loading arm being mounted on said frame for pivotal and longitudinal movement with respect thereto, and a pin mounted on said arm capable of being axially aligned with the bore of a workpiece mounted on said first-mentioned means, the point at which said loading arm is mounted on said frame being on the opposite side of said frame with respect to said first-mentioned means from that on which the means for mounting the grinding wheel is positioned, whereby when the machine is in inoperative position the workpiece is readily accessible to an operator positioned in front of the workpiece.

9. In an internal grinding machine, in com-

ination, a frame, means for mounting a workpiece on said frame, a grinding wheel, means for driving said grinding wheel, means mounting said grinding wheel on said frame to one side of said workpiece mounting means, said last-mentioned means being substantially horizontally positioned with respect to said first-mentioned means, said grinding wheel mounting means permitting said grinding wheel to be pivoted into and out of operative position and also move longitudinally with respect to said workpiece, means permitting relative adjustment of said grinding wheel with respect to said workpiece when said grinding wheel is in operative position, means for guiding said grinding wheel as it moves into and out of grinding relationship with respect to said workpiece, said grinding wheel and related mechanism being held in contact with said last-mentioned means by the force of gravity, and stop means, said grinding wheel when being moved to an inoperative position being moved upwardly and outwardly past the balance point over said mounting means to a position against said stop means, whereby gravity is utilized to hold the grinding wheel and associated mechanism against said stop means and said workpiece is readily accessible to an operator positioned in front of said workpiece.

10. In an internal grinding machine, in combination, a frame, a spindle mounted on said frame, means for mounting a workpiece having a hole therein on one end of said spindle, a motor for driving said spindle, a grinding wheel, means for driving said grinding wheel at grinding speed, a supporting member, said grinding wheel being mounted on said supporting member, means pivotally mounting said supporting member on said frame, means permitting said supporting member to be moved longitudinally with respect to its pivotal axis, whereby said grinding wheel may be pivoted with said supporting member into and out of operative position and when in operative position may be moved axially with respect to the hole in said workpiece, switch means for said motor, means on said supporting member for actuating said switch means when said supporting member is pivoted into inoperative position, brake means associated with said spindle, said brake means including a lever, and cam means mounted on said supporting member, said cam means actuating said brake means through said lever to stop said spindle when said grinding wheel is moved to an inoperative position.

11. In an internal grinding machine, in combination, a frame, means mounted on said frame for holding a workpiece having a hole therein, a cylindrically shaped grinding wheel, means for driving said grinding wheel at grinding speed, a supporting member, said grinding wheel being mounted on said supporting member, means mounting said supporting member for movement toward and from the workpiece, means pivotally mounting said supporting member on a second supporting member, whereby said grinding wheel

may be pivoted with said first-mentioned supporting member into and out of operative position, means adjustably mounting said second-mentioned supporting member on said frame, whereby the axis of said grinding wheel may be adjusted relative to the hole in said workpiece to permit the grinding of tapered holes in the workpiece, guide means for said first mentioned supporting member, and adjustable means on said first mentioned supporting member coacting with said guide means for adjusting the position of said grinding wheel with respect to the hole in said workpiece when said grinding wheel is in operative position.

12. In an internal grinding machine, in combination, a frame, a spindle mounted on said frame, means for mounting a workpiece having a hole therein on said spindle, means for driving said spindle, a member rotatably mounted on said frame and also being longitudinally movable with respect to said frame, the axis of said member being parallel to the axis of said spindle, a grinding wheel, means for driving said grinding wheel at grinding speed, a member mounting said grinding wheel on said first-mentioned member, whereby said grinding wheel may be pivoted into and out of operative position and when in operative position may be moved longitudinally into grinding relationship with respect to the hole in said workpiece, the axis of rotation of said grinding wheel being parallel to the axis of rotation of said spindle, a loading arm, means mounting said loading arm on said frame for both pivotal and longitudinal movement with respect to said frame, the pivotal axis of said arm being parallel to the axis of said spindle, and a pin extending rearwardly from said arm, the axis of said pin being parallel to the axis of said spindle, whereby a workpiece may be mounted on said pin, said arm pivoted until said pin is aligned with said first-mentioned means and said workpiece inserted in said first-mentioned means by pressing inwardly on said arm, whereby the axis of the hole in said workpiece is axially aligned with the axis of said grinding wheel.

LEWIS R. HEIM.

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