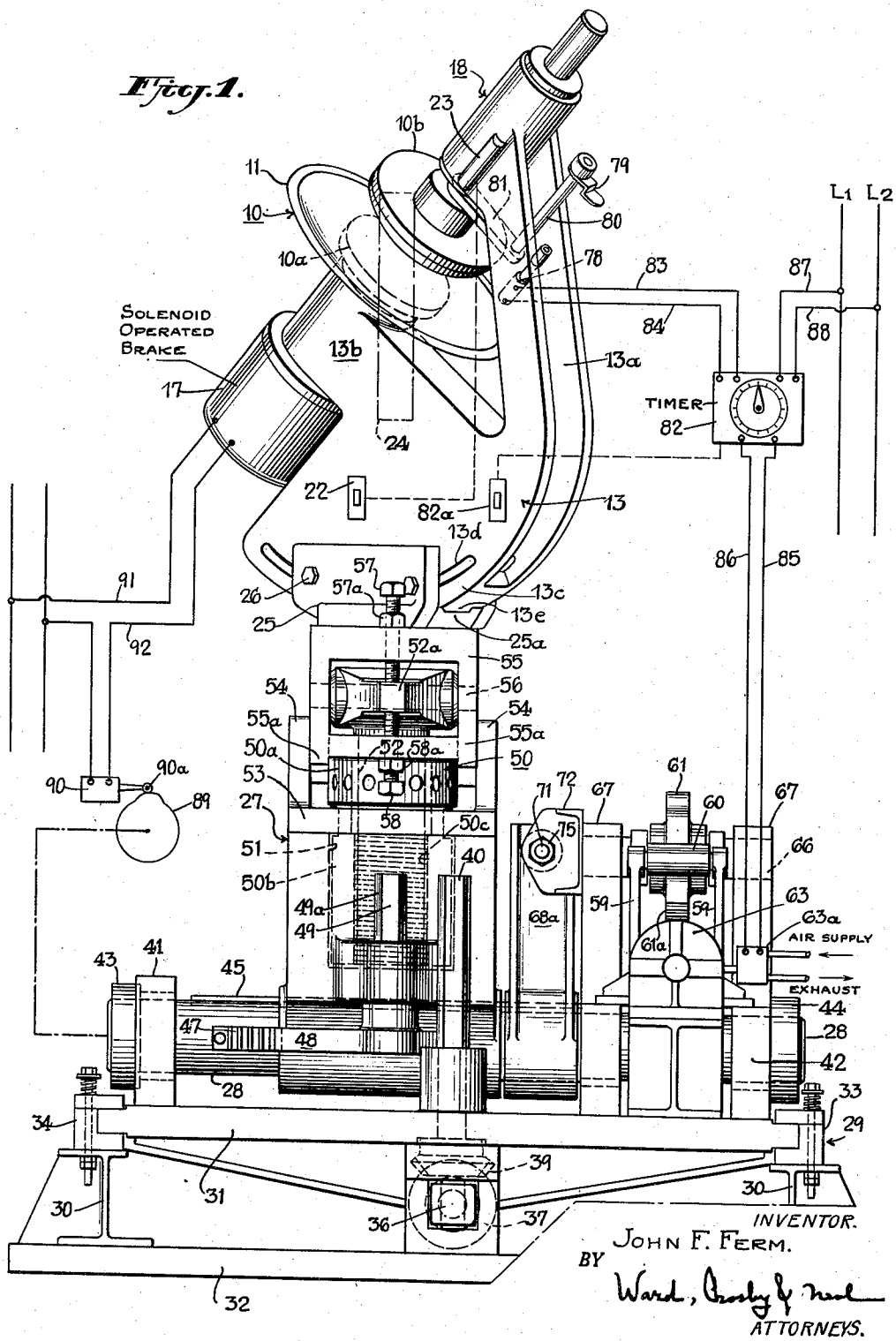
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APPARATUS FOR GRINDING DISKS

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Fig. 1.



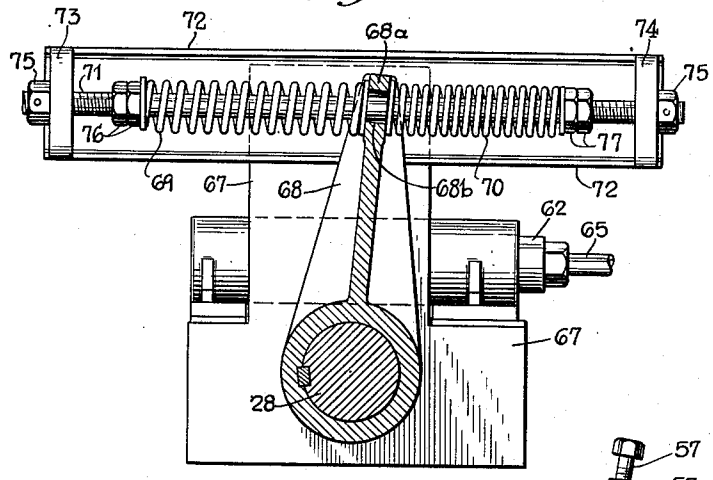
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APPARATUS FOR GRINDING DISKS

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Fig. 7.



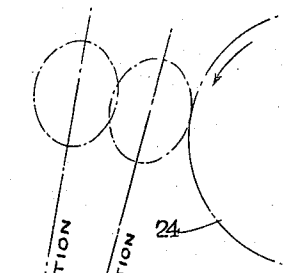
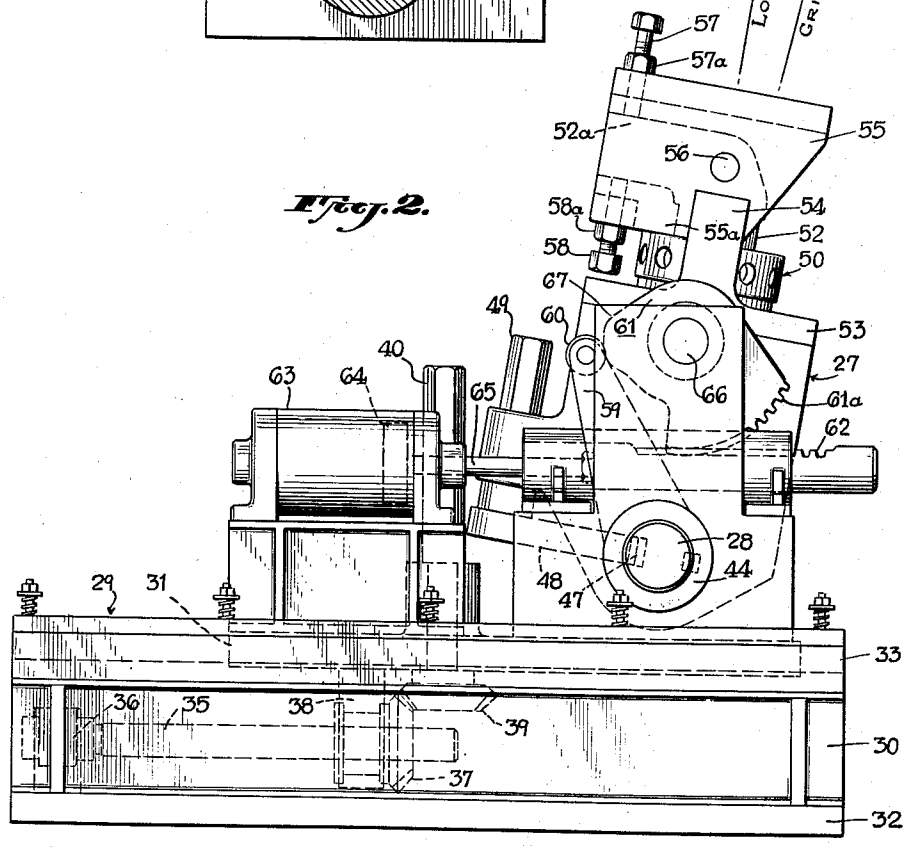


Fig. 2.



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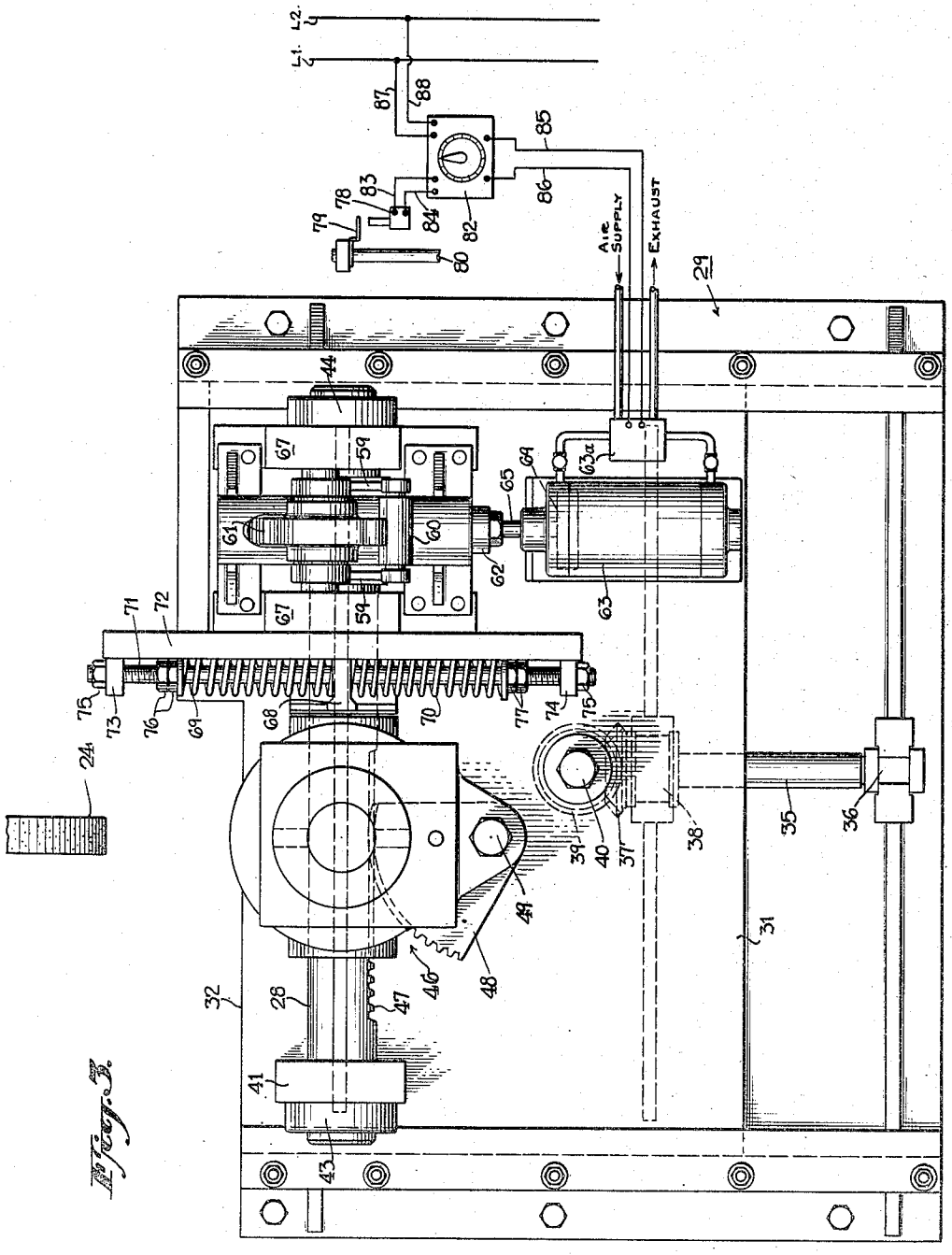


Fig. 3.

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Fig. 4.

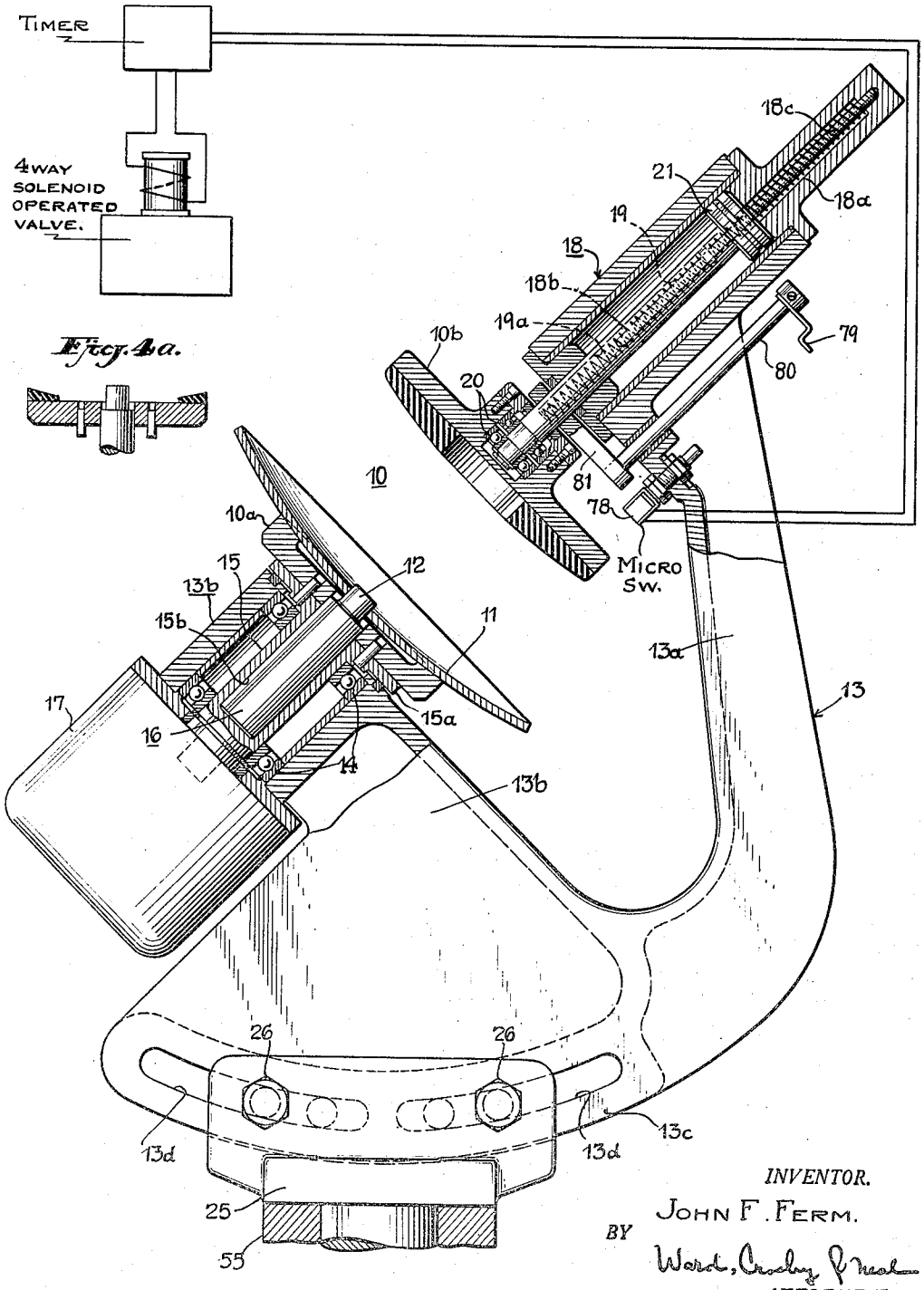


Fig. 4a.

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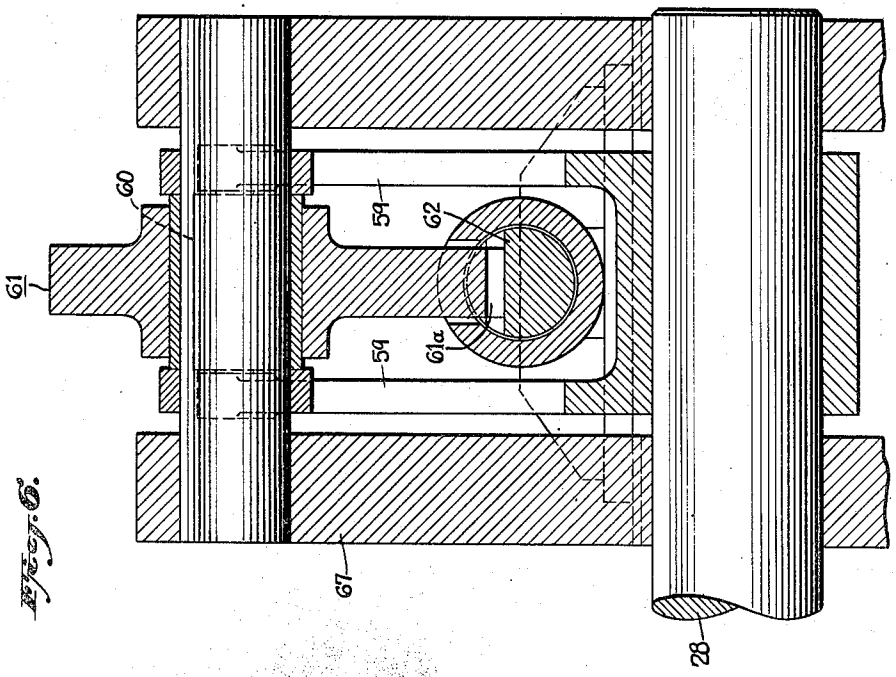


Fig. 9.

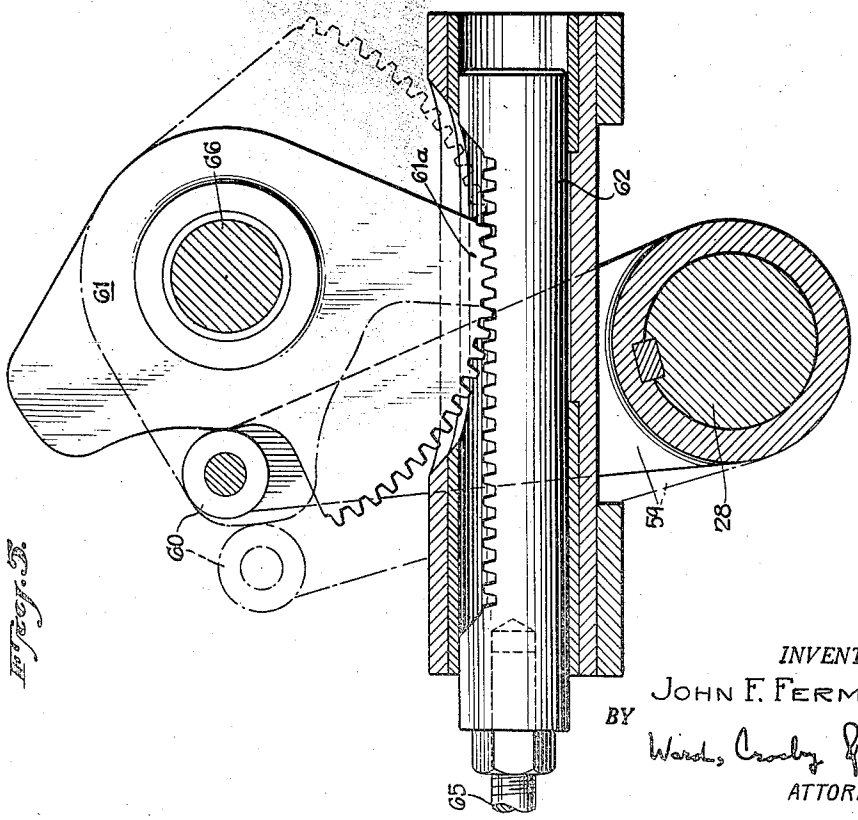


Fig. 10.

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Fig. 8.

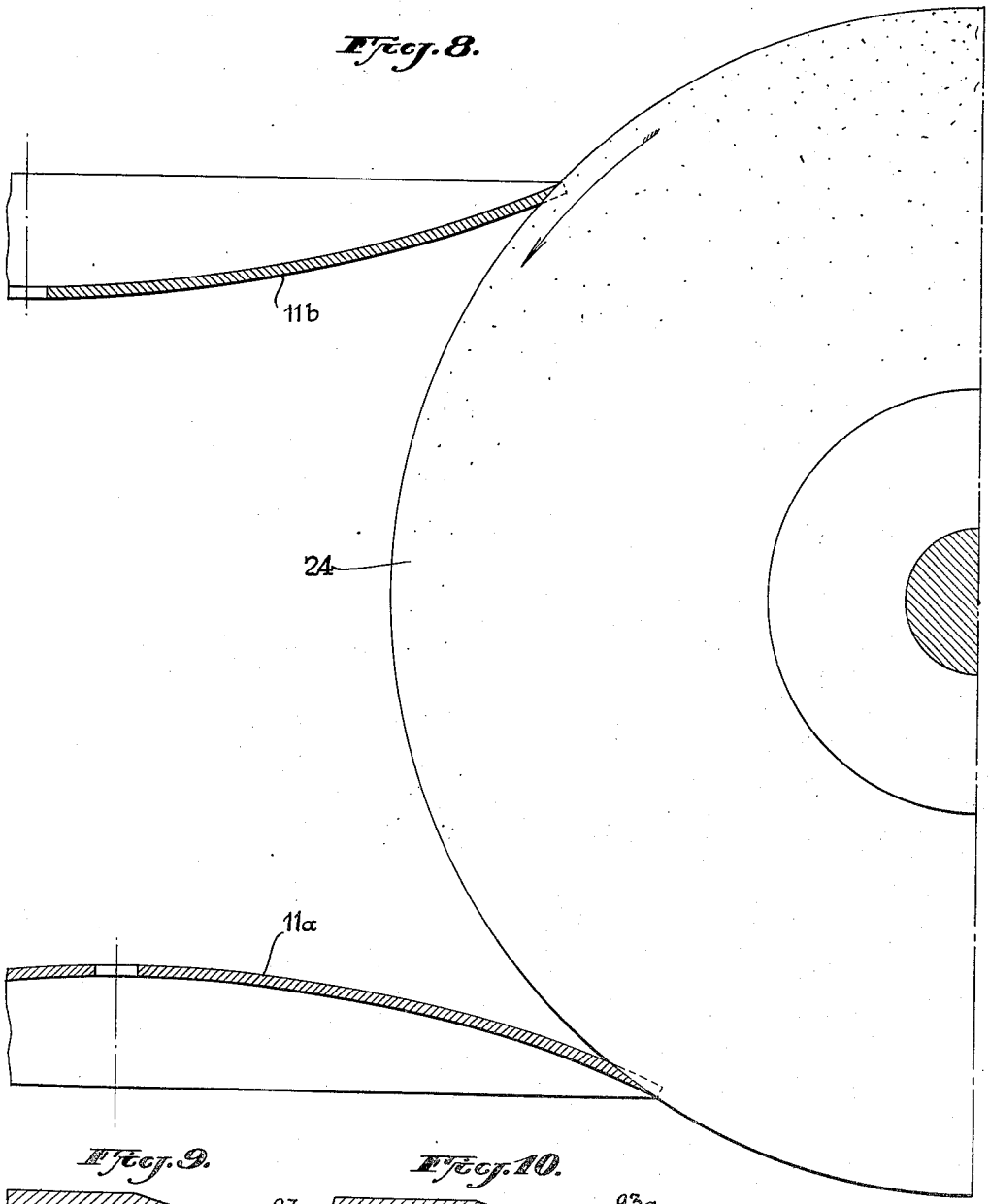


Fig. 9.



Fig. 10.

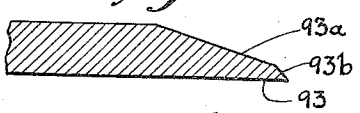


Fig. 11.

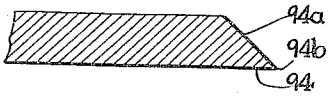
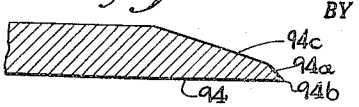


Fig. 12.



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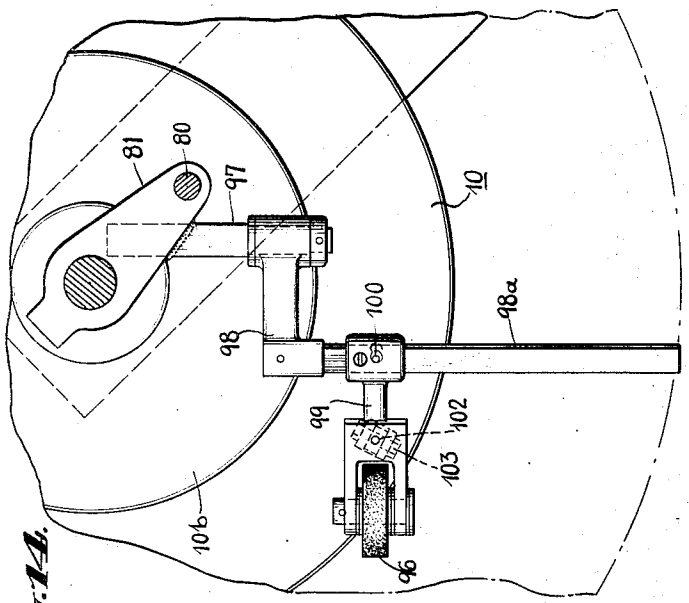


Fig. 14.

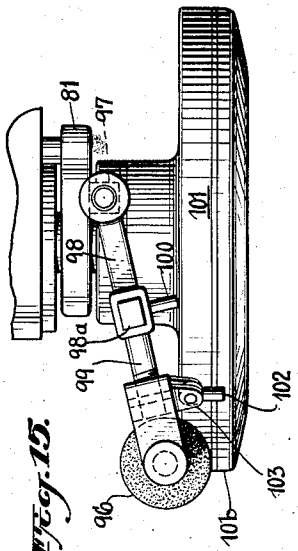


Fig. 15.

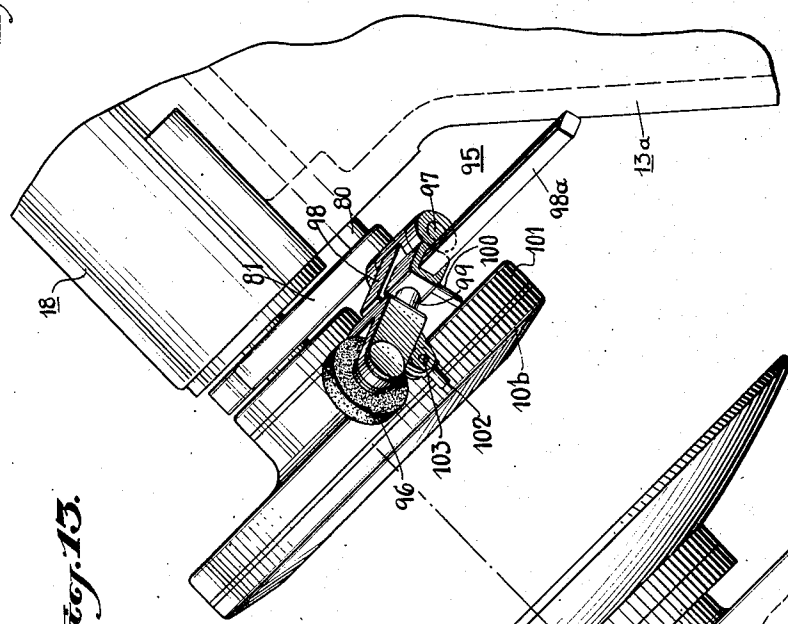
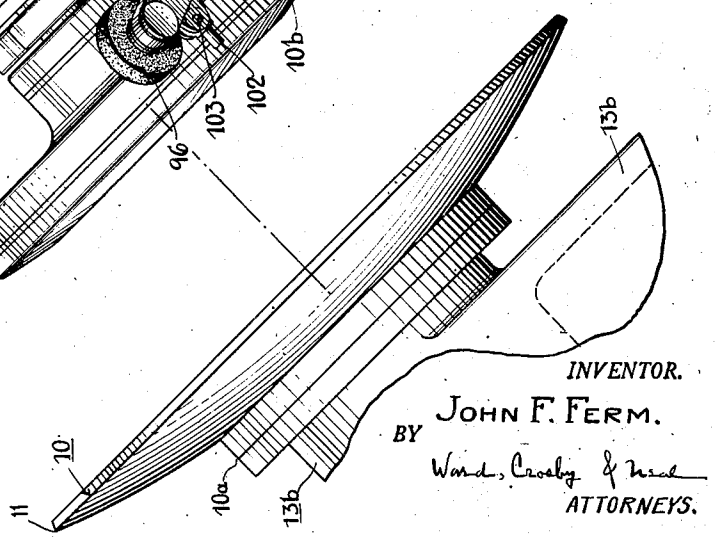


Fig. 13.



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UNITED STATES PATENT OFFICE

2,651,149

APPARATUS FOR GRINDING DISKS

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Application May 10, 1950, Serial No. 161,050

9 Claims. (Cl. 51—106)

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This invention relates to automatic grinding devices, and more particularly to means for supporting a disk workpiece and for urging same automatically into and out of engagement with an abrasive member whereby the edge region of the disk workpiece may be automatically positioned for the grinding of an edge, and, if desired, for the bevel grinding of a marginal rim region or rim surface located inwardly of such ground edge.

No satisfactory device has been heretofore suggested for the automatic grinding of the edges of disk workpieces.

Many types of apparatus of this character which have been heretofore employed for the edge grinding of disk workpieces have proved hazardous to a substantial degree to the operator because the grinding of the edge by means of a rotating abrasive member causes the disk workpiece to receive a sharp edge and usually also to rotate rapidly. Accidents of a serious nature have occurred when the operator has attempted to remove a heavy spinning, sharp-edged workpiece from a workpiece holder.

Furthermore, skilled labor has heretofore been necessary for satisfactory edge grinding of such disk workpieces.

The necessity for employing such skilled labor for the edge grinding of disks has substantially increased the unit cost of the finished product.

One of the objects of the present invention is to overcome the above difficulties or to reduce same to insignificance.

The invention, in one aspect thereof, includes in combination a pair of rotatable jaws between which a disk workpiece may be clamped and edge ground. One of such jaws preferably is fixed with respect to the other one and the latter may be reciprocatively mounted and movable under the influence of suitable reciprocative power means to aid in the loading and removal of workpieces and of course positively to hold such pieces while being ground. The jaws preferably are mounted upon a yoke member which supports such power means for the opening and closing of the jaws, said power means being responsive to a manually operable control device, such as a switch, handle or the like. The yoke is mounted for pivotal movement whereby it may be tilted from a loading position to a grinding position wherein the disk workpiece is in engagement with an abrasive member such as a rotatable wheel. The jaws and the support structure, including said yoke, normally are in the loading position with the jaws separated and ready to

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receive a disk workpiece, said loading position, of course, being removed from the grinding position by a preselected distance depending upon the relative sizes of the workpiece and the grinding wheel. Upon the placing of a disk workpiece in the open jaws, said manually operable control means are actuated for closing same. One of the jaws is situated below the other and is referred to as a disk mount member. The latter is provided with a lug or protuberance for engaging a central perforation formed in a disk to center same. The other or upper jaw has a palm-like member for holding a disk down in position upon the lower jaw and is referred to as a hold-down member. Power means are provided for controlling the angular movement of the yoke and its supporting pivotal structure, which power means are under the influence of a timer which may be adjusted to any desired period for controlling the time interval during which the workpiece undergoes grinding. Said timer is preferably actuated or started in response to the closing of said jaws and it may constitute an element of the operative interconnection between the jaws and the power means for pivoting the workpiece into grinding position.

When a disk workpiece undergoes edge grinding in a rotatable mounting it acquires a substantial angular velocity and, of course, a sharp edge, the latter constituting a hazard to an operator. In order to minimize this hazard the rotation of the disk must be arrested before the operator grasps it for removal. Operatively associated with one of the rotatable jaws or disk mount members is a brake, for example, of the solenoid variety, which functions to prevent rotation of such jaw and the workpiece thereon whenever the workpiece is out of engagement with the grinding wheel thereby making it safe to remove the disk by hand. Means are provided for actuating this brake immediately after a workpiece is disengaged from the grinding wheel and, of course, the brake is released immediately before a disk is urged into such grinding engagement.

The above and further objects and novel features of the invention will more fully appear from the detailed description given below when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for purposes of illustration only and are not intended as a definition of the limits of the invention, reference for this latter purpose being had to the appended claims.

In the drawings:

Fig. 1 is a front elevation of one embodiment of the present invention with certain parts thereof being shown schematically;

Fig. 2 is a side elevation of the apparatus shown in Fig. 1 with certain parts omitted for purposes of clarity;

Fig. 3 is a plan view of the embodiment shown in Fig. 1 with certain parts also shown schematically;

Fig. 4 is a detailed view on an enlarged scale, partly in section and with parts broken away, of the jaw structure for mounting a workpiece for grinding;

Fig. 4*a* is a fragmentary view of a modification of the disk mount member shown in Fig. 4;

Fig. 5 is a side elevation also on an enlarged scale, partly in section and with parts broken away, of a cam follower device for controlling the position of the workpiece support means relative to a grinding wheel;

Fig. 6 is an end view of the parts shown in Fig. 5;

Fig. 7 is a front elevation, partly in section, of a shock absorber mechanism associated with the pivotable workpiece holder;

Fig. 8 is a schematic representation of two disk workpieces undergoing edge grinding by a grinding wheel;

Fig. 9 is a cross-sectional view of a fragment of the marginal region of a disk which has been beveled by rolling;

Fig. 10 is a view of the portion of the disk shown in Fig. 9 but with an edge ground thereupon as by the present invention;

Fig. 11 is a cross-sectional view of a portion of the marginal region of a disk showing an edge ground thereupon at a desired angle and without being subjected to bevel rolling;

Fig. 12 shows a disk portion shown in Fig. 11 with a bevel formed thereon by grinding;

Fig. 13 is a perspective view of a deburring device which can be employed with a jaw mechanism;

Fig. 14 is a plan view of the deburring device shown in Fig. 13; and

Fig. 15 is a side elevation of the parts shown in Fig. 14.

Referring to the drawings, one form of the apparatus is shown therein comprising a pair of jaws 10, including jaws 10*a* and 10*b*, the former of which constitutes a workpiece holder or disk mount member and is best shown in Figs. 1 and 4. The latter jaw is mounted for reciprocative movement and comprises a disk hold-down member for cooperating with said disk mount member to clamp therebetween a disk workpiece as at 11. Certain types of disk workpieces, for example, as used in harrows, are dished or concave in shape, as shown. Consequently the disk mount member or jaw 10*a* is shaped to conform thereto in order to provide a firm mounting therefor. Centrally disposed in the disk mount member 10*a* is a protuberance 12 which is designed for engaging a central aperture in the disk workpiece whereby the latter may be centered and held for rotation. Said disk mount member or jaw 10*a* is rotatably supported upon a yoke 13, as shown in detail in Fig. 4. The means for so mounting the jaw 10*a* include, for example, a pair of bearings 14 secured upon the yoke 13, which bearings embrace a sleeve 15 having a flange 15*a* to which the disk mount member 10*a* per se is secured. The sleeve 15 has a central aperture therein at 15*b* which can receive a centering member 16 to which is attached the protuberance 12. Member 16 is easily removable and may be replaced manually with another member with a protuberance 12 of different size if desired.

For a purpose to be more fully set forth hereinafter, the disk mount member 10*a* is associated with a brake 17, for example, of the solenoid type, which may be secured to the yoke immediately beneath the sleeve 15 (Fig. 4), there being a suitable extension of sleeve 15 on whose surface the brake acts whereby angular movement of the former and hence of jaw 10*a* may be arrested or prevented.

In order to increase the speed of operation of the apparatus, the jaw 10*b* is reciprocatively mounted, as above mentioned, upon the yoke 13 by means of a so-called jaw power cylinder device 18 having a piston rod 19, jaw 10*b* being rotatably mounted upon such rod by means of bearings 20. Secured to the piston rod is a piston 21 which is responsive to fluid pressure in the cylinder in a conventional manner.

The jaw power means 18 is under the manual control of the operator of the apparatus, for example, by means of a suitable switch as at 22, which is operatively interconnected to a solenoid operated valve 23 which controls the flow of fluid to said cylinder device 18. Of course, if desired, instead of employing the solenoid operated valve 23, the jaw power means may be directly controlled by a hand operated valve of any conventional design.

In the event of failure of fluid pressure within the cylinder 18, when a disk workpiece is held in grinding position and is undergoing grinding, such workpiece may be thrown from the jaws while rotating rapidly and cause injury to an operator or damage to the machine. In order to prevent this, resilient means are provided for continuously urging jaw 10*b* toward the jaw 10*a*. Such resilient means, in the form shown, are constituted by a pair of springs 18*a* and 18*b* which are mounted substantially coaxially and arranged in end-to-end series. These springs are held by means of a centering rod 18*c* which extends into a cylindrical chamber within the cylinder head of the cylinder 18 and is therein fixed at its outer extremity. Such centering rod 18*c* is in telescopic engagement with a central bore 19*a* formed within the piston rod 19. Spring 18*a* surrounds the upper portion of the centering rod 18*c* and the spring 18*b* surrounds the lower portion and engages the lower or bottom surface of the bore 19*a* as viewed in Fig. 4 and urges same resiliently downwardly at all times in conjunction with the spring 18*a*. The springs 18*a* and 18*b* are, of course, in a contracted condition when the piston 21 is in the position shown in Fig. 4.

The above-mentioned yoke 13 is designed to facilitate the support of the workpiece 11 in desired adjustable angular relationship with a grinding wheel as at 24. The attitude of the disk workpiece relative to the wheel must be carefully determined in order to obtain the desired grinding action upon the edge thereof and the apparatus should be adjustable to accommodate various sizes of disk workpieces. Also the yoke 13 should be adjustable in such a manner that the speed of rotation of the disk while undergoing grinding can be preselected. The yoke 13 assists in this purpose and provides arms 13*a* and 13*b* for respectively supporting the jaw power means 18 and the disk mount member 10*a*. A lower portion of the yoke as at 13*c* is arcuately shaped and rests within a cradle 25 within which it may be adjust-

ably positioned. Said lower portion 13c is arcuately slotted as at 13d. Bolts 26 secure the yoke within the cradle 25 by passing through said cradle and slots. A groove 25a may be provided in the lower surface of the cradle for receiving a tongue 13e (Fig. 1) formed in the lower periphery of the arcuate portion 13c whereby a positive interconnection is effected between these two parts and lost motion is minimized.

The speed of rotation of the disk mounted upon the above-described means is a function of: (a) the angular relation of the plane of rotation (and hence the axis of rotation) of the disk 10 with the plane of rotation of the grinding wheel 24, assuming, of course, that the edge of the disk engages the periphery of the grinding wheel and (b) the center point offset distance, as defined below. If the disk's plane of rotation contains the wheel's axis of rotation, there will normally be no disk rotation induced by the wheel. Such angular relation in (a) may be measured in a conventional manner with respect to a three coordinate system. In this description the plane of rotation of the grinding wheel refers to a plane perpendicular to the axis of rotation of the grinding wheel and passing centrally through the peripheral area of the grinding wheel which effects the grinding. The plane of rotation of a disk workpiece refers to a plane vertical to the axis of rotation of the workpiece and passing through the peripheral disk area engaged by the grinding wheel. Also the center point of rotation of a disk refers to the point of intersection between the disk's axis of rotation and such plane of rotation of the disk. The distance between such center point of rotation of the workpiece and the plane of rotation of the grinding wheel is referred to herein as the center point offset distance.

It is clear that when the grinding wheel and disk are in peripheral engagement, with the planes of rotation thereof parallel, the two will rotate with substantially equal peripheral speed whereas if the planes of rotation thereof are truly perpendicular, no rotation will be induced in the disk workpiece by the rotation of the grinding wheel so long as the center point of rotation of the disk is in the plane of rotation of the wheel. However, if such planes remain perpendicular and if the disk center point of rotation should become offset from such plane of rotation of the wheel, rotation of the disk will be induced so long as the disk's plane of rotation does not contain the axis of rotation of the wheel. Also, when such planes of rotation move out of such perpendicular relationship, rotation of the disk workpiece will be induced, depending upon (a) the degree of obliquity of such planes; (b) the distance between the center point of rotation of the disk and the plane of rotation of the grinding wheel; (c) the force urging the wheel and workpiece into engagement. Other factors, of course, influence the speed of rotation of the disk workpiece but these are certain of the important ones. By obliquely disposing the planes of rotation of the workpiece and grinding wheel there is eliminated the necessity for positive power means for driving the workpiece, that is, power means other than that employed for driving the grinding wheel. By so obliquely disposing the planes of rotation of the grinding wheel and workpiece, the driving means of the former induces rotation at a preselected angular velocity in the latter whereby each edge portion of the workpiece is uniformly abraded.

The yoke 13 and its cradle in general are supported upon a tiltable post or yoke support generally indicated at 27, which post is angularly shiftable or pivotable about the axis of a main support shaft 28 upon which said post rests. As may be seen from Figs. 1 and 2, angular motion of the yoke and the post 27 may be effected about the axis of shaft 28 whereby a disk workpiece is moved from a loading to a grinding position and vice versa.

The shaft 28 rests upon a base 29 which is designed to permit movement of said shaft 28, the post 27, and the yoke 13 toward or away from the grinding wheel 24, in a direction parallel to the plane of the grinding wheel in order to provide an adjustment to accommodate various sizes of grinding wheels and/or workpieces. The base 29 consequently is subdivided into a so-called fixed sub-base 30 and a slidable base 31 which is movable relative to said fixed base. The latter is rigidly secured to a floor 32. The slidable base 31 rests in suitable slotted members 33 and 34 which are secured to the fixed base 30. The slidable base 31 is shiftable toward either the left or right as viewed in Fig. 2. The means for accomplishing such a shift, in the form shown, includes a threaded screw 35 which is rotatably retained by a collar at 36 against axial movement relative to the fixed base 30. A threaded bevel gear 37 embraces the adjustment screw 35 and is secured by a collar 38 to the slidable base 31. Rotation of the gear 37 will shift the slidable base 31 relative to the fixed base 30 and such rotation is effected by means of a bevel gear 39 which meshes with the gear 37 and in turn is secured to and rotatable by a shaft 40 which, for example may be of hexagonal cross-section and adapted to receive an adjustment wrench or crank.

In addition to the above-described adjustment means for shifting the mechanism from left to right (Fig. 2), that is, toward or away from the grinding wheel in a direction parallel thereto, there is also provided an adjustment mechanism for shifting the support post 27 and hence the workpiece holding apparatus laterally with respect to the grinding wheel, that is, from left to right as viewed in Fig. 1 and thus in a direction perpendicular to the plane of the wheel. Such adjustment means are best shown in Figs. 2 and 3 and constitute means for shifting the post 27 along the axis of the supporting shaft 28. The latter is held against axial movement relative to the base 29 by means of supporting journals 41 and 42 which are secured to the slidable base 31. Suitable collars as at 43 and 44 are secured to the extremities of the shaft 28 in order to prevent such axial movement. The post 27 is keyed to the shaft 28, for a purpose to appear more fully hereinafter, by means of a key as at 45 (Fig. 1).

Supporting post 27 may be shifted axially of the main supporting shaft 28 by any suitable means, and as shown such shifting is accomplished by a rack and pinion device generally shown at 46 (Fig. 3) and comprising a rack 47 which is secured to or formed in the shaft 28, and a segmental gear 48 which performs the function of the pinion and which is mounted upon an adjustment shaft 49 which extends generally vertically in such a manner that its upper extremity is exposed at 49a. The shaft 49 preferably is of hexagonal cross-section, at least adjacent the upper extremity thereof, whereby an adjustment wrench may be affixed thereto for so adjusting the position of the supporting post 27.

In addition to the above-mentioned adjustments which may be effected by turning the shafts 40 and 49, means are provided for making an adjustment of yoke 13 in a vertical direction. Such means, in the form shown, are constituted by an adjustment nut mechanism which may be turned in order to accomplish an upward or downward adjustment of said yoke. As best shown in Fig. 1, such means are constituted by an adjustment nut 50 having a head 50a and a body portion 50b, the latter extending within a central recess or bore as at 51 within the post 27. Such recess or bore is not threaded and freely receives the body portion 50b of the adjustment nut 50. The latter is provided with an internal bore as at 50c which is threaded and thus adapted to receive the threaded portion of a vertical adjustment shaft 52. The vertical adjustment nut 50 is held within the bore 51 by means of a collar 53 of the so-called split ring type, the inner surface of which is adapted for engaging a peripheral groove formed in the portion of the nut just beneath the head 50a thereof. Such collar 53 is suitably secured to the post 27 as by bolts and is provided with upstanding ear portions 54 which cooperate with the vertical adjustment mechanism in a manner to appear below whereby the vertical adjustment shaft is prevented from turning with the vertical adjustment nut 50.

The upstanding ear portions 54 cooperate with a vertical slide yoke 55 which is pivotally mounted upon a shaft 56, the latter extending through the head of the vertical adjustment shaft 52. The vertical slide yoke 55 has provided downwardly extending guides on opposite sides thereof, as at 55a, which are in close sliding engagement with the inner surfaces of the ears 54. Secured to the vertical slide yoke 55 is the main yoke cradle 25, above described, upon which there rests the yoke 13. The cradle 25, of course, is angularly shiftable and adjusted about a vertical axis as viewed in Fig. 1 by any suitable means.

It will be seen that by turning the vertical adjustment nut 50 the vertical adjustment shaft 52 will be raised or lowered as desired and without the latter shaft following the adjustment nut in the rotation by virtue of the cooperation of the guides 55a with the ears 54.

It has been found desirable to provide further means for obtaining a fine angular adjustment of the yoke 13 relative to the grinding wheel 24 which is best shown in Fig. 2. The vertical slide yoke 55 is pivotally mounted, as above described, upon the shaft 56 and supports the cradle 25 and the main yoke 13. Said vertical slide yoke 55 can be angularly adjusted to about plus or minus 5° on each side of a centerline about the axis of the shaft 56 by means of the adjustment bolts 57 and 58 (Fig. 2) which engage suitable threaded bores within said vertical slide yoke and are adapted for engaging a finger 52a which preferably is integral with the vertical adjustment shaft 52. Suitable lock nuts, as at 57a and 58a, may be employed for locking these bolts in any desired adjustment. It is, of course, understood that when the bolts 57 and 58 are in their adjusted position for operation of the machine, the vertical slide yoke is rigidly secured to the vertical adjustment shaft 52 and thus the main yoke 13 is rigidly secured to the supporting means therefor.

Referring now to Figs. 1, 2, 5 and 7, means will be described for controlling the angular position of the main supporting post 27 and hence of the disk workpiece 11 relative to the grinding wheel 24. In general, a cam and follower arrangement is employed for this purpose with the cam under the influence of a suitable power cylinder. As shown in Fig. 2, there is keyed to the main supporting shaft 28 an arm 59, to the extremity of which there is secured a cam roller 60, which is positioned for operative engagement with a cam 61. The latter preferably is provided with a portion integral therewith as at 61a which constitutes a pinion segment and which is adapted for cooperation with a rack 62. The latter is controlled by a suitable power device as at 63 which may be of the pneumatic variety having a piston as at 64 and a piston rod 65 which is rigidly secured to the rack 62. In the position of the rack and cam follower 60, as shown in Fig. 2, the supporting post 27 and hence the jaws 10, are in a loading position. It will be seen that by angularly shifting the cam 61 in a clockwise direction in response to leftward movement (Fig. 2) of the rack 62, the workpiece will be angularly shifted from a loading toward a grinding position.

The cam 61 is shaped so as to cause the post 27 to shift angularly a greater distance per degree of cam shift in the initial portion of the angular movement of the cam and a lesser distance per degree as the post approaches the grinding position. The cam 61 is preferably so designed in order to minimize the shock when the workpiece contacts the grinding wheel.

The cam 61 is angularly shiftable upon a shaft 66 which is journaled at each extremity thereof in a rigid support 67 anchored or secured to the slidable base 31.

It is desirable, as shown in Fig. 6, to employ two arms 59 and rotatably to secure upon such arms the cam follower 60 whereby a greater angular accuracy in the shifting of the workpiece holder may be attained because of a firm and positive mounting of such cam follower.

The cam follower 60 is urged toward the cam 61 by means illustrated in Figs. 3 and 7 which comprise a so-called shock absorber and performs the function of resiliently urging said follower against the cam under the influence of a differential of spring pressure. It has been found advantageous to employ a so-called spring differential device for so urging the cam follower toward the cam because it assists in angularly shifting the workpiece supporting device in a smooth manner without undue shock and further it provides a structure for resiliently yielding to thrusts which tend to force the workpiece away from the abrasive wheel. Follower 60 follows in contact with cam 61 except, as set forth below, when grinding is actively in progress.

The spring differential device, as shown in Fig. 7, is constituted by an arm 68 which is keyed to the shaft 28. The outer extremity of the arm 68, as at 68a, is positioned by means of springs 69 and 70 which act in opposite directions upon the extremity 68a. Spring 69 is preferably somewhat stronger or heavier than spring 70 but of about the same length. In the form shown, the outer extremity 68a is provided with a suitable bore 68b through which there extends a fixedly mounted spring shaft 71 about which there are coiled the springs 69 and 70. The spring shaft 71 is rigidly mounted upon a support, as at 72, having portions as at 73 and 74 which embrace the opposite extremities of said shaft and provide support therefor. The opposite extremity portions of the spring shaft 71 are threaded to receive nuts 75 which may engage portions 73, 74, and also to

receive spring adjustment nuts as at 76 and 77 which respectively are for positioning the outermost extremities of the springs 69 and 70, as viewed in Fig. 7. By adjustment of the nuts 76 and 77, it is seen that a desired spring differential pressure may be brought to bear upon the extremity 68*a* of the arm 68. Also within preselected angular limits any desired neutral position of the arm 68 may be obtained by adjusting the nuts 76 and 77. It is, of course, understood that the bore 68*b* is sufficiently large to permit angular movement of the arm 68 relative to the spring shaft 71 between the loading and grinding positions.

The spring shaft supporting member 72 is rigidly secured to the slidable base 31 by any suitable means.

It is, of course, desirable to maintain the workpiece holding mechanism in the loading position until a disk is placed upon the disk mount member or lower jaw 10*a* and the upper jaw 10*b* has been shifted to clasp the workpiece securely between such jaws. Thereafter, of course, the workpiece is prepared for grinding and the angularly shiftable mechanism above described may be moved to shift the workpiece from the loading to the grinding position. Consequently, it is desirable to maintain the power device 63 in the condition shown in Fig. 2, wherein the piston 64 and rack 62 are at the righthand extremities of their motion, until a workpiece is clasped by the jaws 10*a*, 10*b*. A preselected time can be determined for the proper edge grinding of the disk workpiece 11 depending upon the (among other factors) angular position thereof relative to the grinding wheel and the pressure placed upon the workpiece after it is urged against said wheel. It has been found desirable to control the power means 63 by a timer for urging the workpiece into engagement with the grinding wheel 24 over such a preselected time interval whereupon said power means 63 can be reversed to retract the workpiece to the loading or unloading position. An operative interconnection is provided between the power means 63 and the jaws 10*a*, 10*b* whereby said power means 63 are actuated, in response to the closing of said jaws, for a preselected time and thereafter actuated again in reverse to retract the workpiece. Said operative interconnection is shown in Figs. 1 and 3 and is constituted by a microswitch 78 which is closed in response to the closing of the jaws 10*a* and 10*b* by means of a switch finger 79 secured to a shaft 80 which is axially shifted in response to the shifting of the piston rod 19 (Fig. 4). The shaft 80 may be connected to the piston rod 19 as by means shown in Fig. 4 comprising a connecting arm 81 which at opposite ends thereof embraces said rod and shaft.

If an operator fails to center a disk workpiece properly over the protuberance 12 and thereafter operates the switch 22, the jaw 10*b* will be prevented from making its normal stroke and the switch finger 79 will be unable to contact the microswitch 78. Consequently the apparatus will remain inoperative until the operator releases the disk and centers it properly. The microswitch 78 may be adjustably positioned to accommodate a change in the length of stroke of the piston 21 and the jaw 10*b*. The stroke of such piston will vary in accordance with the thickness and concavity of a disk workpiece.

The power device 63 is under the influence of and preferably controllable by a so-called four-way valve of the solenoid type well known in the art and which is actuatable by an electric current which may be controlled by a timer above mentioned, as at 82. The latter is under the influence of the microswitch 78, that is, the timer is actuated or started by the closing of the microswitch 78 which initiates the operation of the power means 63 whereby the workpiece is urged from a loading to a grinding position and after the expiration of the predetermined time interval which is adjusted upon the timer 82, the latter is effective to return the power device to the condition shown in Fig. 2 wherein the workpiece is retracted to its initial or loading (unloading) position. The microswitch 78 is electrically connected to the timer 82 as by the leads 83, 84 and the timer is electrically connected to four-way valve 63*a* by means of leads 85 and 86. As shown, the timer is also electrically connected to a suitable power line L_1, L_2 as above leads 87 and 88. The source of electric energy preferably provides a sixty cycle A. C.

An emergency switch, as at 82*a*, is mounted upon the yoke 13 preferably near the switch 22. The emergency switch 82*a* is operatively connected to the timer 82 in such manner that the operation of the latter may be interrupted at any time by actuation of said switch 82*a*. The grinding operation thus can be interrupted and the post 27 returned to the loading position in the event of an emergency caused by, for example, a broken or cracked workpiece, a broken grinding wheel or failure of the air supply within the cylinder 18.

When a disk workpiece is mounted in the rotatable jaw members 10*a* and 10*b* which clasp same therebetween, it is clear that the workpiece, when brought in contact with the rapidly rotating grinding wheel, as at 24, will have imparted thereto a substantial angular velocity and concurrently will, by abrasion, acquire a sharp ground edge. Such a rapidly spinning workpiece, of course, constitutes a considerable hazard to an operator of the machine and serious accidents may occur if means are not provided for arresting the rotation of the workpiece immediately upon its disengagement from the grinding wheel 24. Suitable means are provided for this purpose wherein the above-described brake 17 is actuated at all times when the workpiece is out of engagement with the grinding wheel 24.

As above described the brake 17 is of the solenoid variety and is actuatable in response to electrical energization thereof. Suitable means are provided as best shown in Fig. 1 for energizing the solenoid brake 17 in response to the positioning of the workpiece holder a preselected number of minutes or degrees away from the grinding position. It is considered advantageous to apply the brake when the workpiece has been shifted at least a few minutes of arc away from the grinding position. However, if desired, the brake may be applied immediately upon disengagement of the workpiece and the grinding wheel although care should be taken not to apply the brake while the workpiece and the wheel are in engagement. As shown in Fig. 1, a cam 89 is provided which cooperates with a microswitch 90 for the control of the solenoid brake 17. The cam 89 is operatively connected to the main support shaft 28 and is so shaped that the switch 90 will be closed when the workpiece holder is positioned at a preselected point away from the grinding wheel 24. The solenoid brake 17 is connected by leads 91 and 92 to the power line L_1, L_2, the switch 90 being interposed, for example, in the lead 92 and

being provided with a suitable cam follower 90*a* for engaging the cam 89.

It has been found desirable, in order to reduce or prevent any chattering of a disk workpiece when being ground, to apply rubber pads, for example, sponge rubber, to the face of both the upper and lower disk holding jaws. The resilience of such pads can allow sufficient movement of the disk at the point of contact with the grinding member at least partially to compensate, for example, for any eccentricity in the disk.

Referring to Figs. 13–15, a deburring mechanism 95 will now be described. An abrasive wheel 96 is brought into contact with the area of the disk being ground in such a manner that any burrs which may arise during the grinding are removed by abrasive contact with such wheel. The plane of rotation of the deburring wheel 96 is obliquely disposed relative to a plane extending radially of the disk undergoing grinding as is well shown in Fig. 14. That is, the radii of the abrasive wheel 96 and a disk as at 10 situated in substantially parallel planes are obliquely disposed.

Deburring wheel 96 is pivotably mounted upon a pin 97 which may be secured as by welding to the arm 81, the latter embracing the piston rod 19. Said wheel 96 is pivotally associated with the pin 97 by means of a pivot arm 98 which is journaled upon the pin 97 and there secured by suitable means, and also by a pivot arm 99 which embraces a radial adjustment rod 98*a* secured to the pivot arm 98. The radial position of the wheel 96 may be adjusted by moving the pivot arm 99 to a desired location along the adjustment rod 98*a* and there secured in a well known manner as by adjustment screw.

The pivot arms 98 and 99, together with the deburring wheel 96, are urged downwardly, for example, by gravity. A limit-stop for such counterclockwise motion is indicated at 100 consisting of a pin secured to the pivot arm 98. It has been found desirable to hold the abrasive wheel 96 out of contact with a disk workpiece until the latter has started to rotate under the influence of the grinding wheel and such means to accomplish this are shown at 101 comprising a pin 102 which is pivotally mounted at 103 to the pivot arm 99. The axis of such pivotal mounting as at 103 extends radially with respect to the axis of rotation of the disk as is well shown in Fig. 14. Thus, when the jaw 10*b* is lowered to a holding position, the pin 102 will engage the concave surface of the disk and hold the wheel 96 out of engagement therewith until the disk commences to rotate whereupon it will pivot and allow such wheel to fall into engagement with the disk edge. Thus the pivoted pin 102 holds the abrasive wheel 96 from contact with the disk so it will not hinder or retard the start of rotation of the disk. The wheel 96 will rotate slowly due to the oblique angularity thereof with respect to the disk radius as above set forth thereby spreading the wear over the entire periphery or grinding face of the abrasive wheel. It will be seen regarding the pin 100 that it rests upon the upper face of the jaw 10*b* and causes the pivot arms 98, 99 to move with and be retracted by such upper jaw except, of course, when the latter is in a disk holding position.

The above-described apparatus is particularly directed to the grinding of edges but it also can be employed for so-called "bevel grinding" in addition to edge grinding. For example, the marginal region of a disk can be beveled by grinding, such disk being held by the apparatus above described. It has been prior practice to obtain a beveled rim surface of a disk by heating same and then passing it through bevel rolls of a well known character. Referring to Fig. 9, a disk as 93 thus may have a rim surface thereof as at 93*a* beveled by such bevel rolls. Thereafter the outer edge of the disk 93 may be edge ground by means described above to produce the surface 93*b* (Fig. 10). The heating and beveled rolling of the rim or marginal surfaces of such disks is costly and can be replaced by grinding with respect to disks of certain thicknesses and particularly the relatively thinner disks.

In order to reduce the expense of the manufacture of disks having both beveled and ground edge regions, a disk 94 having no beveling thereupon, as shown in Fig. 11, preferably is first subjected to an edge grinding operation at a desired angle thereby producing surface 94*a* and a cutting edge at 94*b*. Disk 94 may be subjected to a second grinding operation at another desired angle to produce the so-called beveled ground surface at 94*c*, such bevel grinding, of course, being in lieu of the bevel rolling above mentioned. The angular disposition of the surface 94*c* relative to the horizontal, as viewed in Fig. 12, and the width of such bevel ground surface may be controlled with substantial accuracy by means of the apparatus herein described.

In operation, the supporting post 27 and the elements associated therewith, as the yoke 13, initially are in a loading position, as shown in Fig. 2, and the jaws 10*a* and 10*b* are separated, that is, the jaw power means 18 is in the condition shown in Fig. 4. The operator places a disk workpiece upon the disk mount member or jaw 10*a* whereby the protuberance 12 engages the central perforation formed in such disk member and thereupon the manually operable switch 22 is pressed which actuates the jaw power means 18 to close the jaws and firmly clasp the workpiece therebetween.

When the jaw power means 18 has moved from the position shown in Fig. 4 to a workpiece clamping position, the microswitch 78 will be closed by virtue of the engagement therewith of the switch finger 79 whereupon the timer 82 will be energized or started for a preselected period, and the four-way solenoid valve 63*a* will be actuated which in turn will admit fluid to the right-hand side of the piston 64 (Fig. 2) whereby the rack 62 will be thrust to the left as viewed in this figure thereby angularly shifting cam 61 clockwise. The cam follower 60 will be moved from a position at or near its outermost radial position relative to the center of the shaft 66 (Fig. 5) to one at or near its innermost radial position relative thereto and the workpiece holder will be shifted angularly from the leading to the grinding position.

The post 27 and yoke 13, by means of adjustments upon the slidable base 31 and upon the post 27, must be so positioned that the disk workpiece is in contact with the grinding wheel in a desired attitude when the rack 62 and the cam 61 have reached the end of their travel to the grinding position (from the loading position). In other words, the piston 64 of the cylinder 63 always will move the rack 62 and cam 61 to the extreme end of their travel but the cam follower 60 will not follow the cam in the region near the end of the latter's travel because the disk being ground will engage the grinding wheel and hold the cam and follower separated. Thus a gap

between the cam and the follower will occur, which gap should be sufficient to allow the post **27** and the yoke **13** to move toward the grinding wheel with the disk, as metal is removed from the edge of such disk. The width of such gap is a function of the angle of the ground edge relative to the axis of the disk, the thickness of the metal, and any eccentricity of the disk. It is desirable that this gap be of such width that after grinding, to obtain the desired edge, the post **27** will not have moved forward sufficiently to cause the follower **60** to contact the cam **61**. The desired edge is obtained by the control of a combination of several factors: (*a*) grinding time, controlled by timer **82**; (*b*) the pressure of the disk workpiece upon the grinding wheel, adjustable by means of the spring adjustments as at **76**, **77** upon the shock absorber; and (*c*) by the adjustments on post **27**, for example, adjustment of bolts **57**, **58** and of cradle **25**, which effect the angle of grinding and the speed of rotation of the disk. The above-mentioned "desired attitude" of the disk and grinding wheel requires that the supporting means for the workpiece hold the latter with the plane of rotation thereof obliquely disposed relative to the plane of rotation of the grinding wheel and preferably with the plane of rotation of the workpiece intersecting the grinding wheel along the chord thereof. In order that the grinding wheel induce rotation in a desired manner in the workpiece, the center of rotation of the workpiece may be slightly spaced from the plane of rotation of the grinding wheel. The attitude of the disk workpiece relative to the grinding wheel thus is determined by the angularity of the axis of rotation of the workpiece with the plane of rotation of the grinding wheel, the distance between the center point of rotation of the workpiece and the plane of rotation of the grinding wheel.

Immediately before engagement of the workpiece with the grinding wheel **24** the cam **89** will be effective to open the switch **90** whereby the solenoid brake **17** will be deenergized and released and the workpiece thus freed for rotation during the grinding. After the expiration of the preselected grinding time, as manuallly adjusted upon the timer **82**, the power means **63** will be actuated in a reverse direction relative to that above described and the rack **62** returned to the position shown in Fig. 2 whereby the workpiece holder will be returned to the loading (unloading) position. When the workpiece has moved away from engagement with the grinding wheel by a preselected small angular increment, the cam **89** and switch **90** are effective to energize the solenoid brake **17** to arrest immediately the rotation of the spinning workpiece, thereby permitting it to be removed when it has returned to the loading or unloading position. It is, of course, understood that the loading or unloading positions are the same in this embodiment.

If desired, it is possible to reverse the cycle of energization of the solenoid brake **17** wherein it is energized only during the period when the workpiece is undergoing grinding and, of course, energization under such conditions necessitates an operative association with the brake to release the latter. Deenergization may affect the application of the brake, depending upon the adjustment of the brake element **17**.

When the workpiece holding device is retracted to the loading position, the operator may, by means of the switch **22**, open the jaws **10***a*, **10***b* and remove the workpiece which has been ground and insert a disk which is next to be acted upon by the wheel **24**.

There are thus provided novel means for automatically grinding the edge of a disk workpiece, which means largely eliminates the necessity for the employment of skilled labor whereas heretofore it has been ncessary to employ persons having special skill satisfactorily and economically to perform such edge grindings. It is, for example, possible to employ a large number of such novel edge grinding machines under the supervision of a single skilled foreman. A single unskilled operator is capable of attending two such machines, alternately loading and unloading them.

Furthermore, the apparatus is capable of producing a ground edge upon a disk workpiece with less burr and with the grinding wheel rotating toward such edge, than that obtained by so-called hand grinding wherein the workpiece is manually held against a rotating grinding wheel. The disk, as shown in Fig. 4, is positioned with the convex side placed downwardly resting in the lower mount member or jaw **10***a*. In Fig. 2, the portion of the disk edge undergoing grinding, such disk being mounted as in Fig. 4, is above the centerline or axis of the grinding wheel and such wheel is rotating toward the edge of the disk or counterclockwise (Fig. 2). Such procedure departs from the usual practice employed in "hand grinding," the latter occurring when a disk is held manually on, for example, a pin with a bracket support and is urged against a grinding wheel. In such hand grinding it is normal practice to place the disk with the convex side thereof facing up and with the edge of the disk contacting the grinding wheel considerably below the centerline of such wheel which latter rotates away from the edge. Such a relationship of disk and wheel is shown in Fig. 8 as at **11***a* and **24**. It would be unsafe to hand grind a disk workpiece with the wheel rotating toward the edge of the disk, that is, it would be unsafe to hand grind a disk workpiece positioned as at **11***b* (Fig. 8) with the grinding wheel rotating in a counterclockwise direction. The apparatus embodying the present invention is adapted for holding a disk workpiece in contact with such grinding wheel above or below the centerline of the wheel and with the latter rotating in either direction as desired. As above mentioned, an edge with less burr is obtainable with the disk in the position shown in Figs. 2 and 4 and with the grinding wheel rotating toward the edge. In Fig. 8 the axes of the disk workpieces **11***a* and **11***b* are substantially contained in or are parallel to the central plane of rotation of the grinding wheel **24**. However, such disk workpiece axes may be angularly disposed to such plane by means of the adjustable mounting therefor as disclosed above. It is necessary usually to deburr the edges of hand-ground disks by a second grinding operation. With apparatus embodying the present invention, in grinding the edges, as shown, for example, in Figs. 2 and 4, the deburring operation is greatly reduced and in some cases eliminated.

Although only one embodiment of the present invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art. For a

definition of the limits of the invention, reference will be had primarily to the appended claims.

What is claimed and is desired to be secured by Letters Patent is:

1. In apparatus for use with a grinding wheel for the edge grinding of disk workpieces, a workpiece holder constructed and arranged for angular movement between workpiece loading and grinding positions, means upon said workpiece holder for mounting such workpiece for free rotation; support means for such workpiece holder for mounting such a workpiece with the axis thereof angularly disposed relative to the plane of rotation of the grinding wheel and with the center point of rotation of such workpiece spaced from such plane of rotation of the grinding wheel by a preselected distance, such support means positioning the plane of rotation of the workpiece to intersect the grinding wheel along a chord less than a diameter thereof; power means for shifting said workpiece holder from a loading to a grinding position and return; a timer operatively connected to said power means for influencing the latter to maintain said workpiece holder in a grinding position for a preselected period which is a function of the distance between such center point and plane of rotation and the obliquity of such axis of rotation with the plane of rotation of the grinding wheel; a brake for restraining rotation of said workpiece holder; and means for applying said brake in response to the positioning of said workpiece holder a preselected distance away from the grinding position.

2. In apparatus of the class described, the combination comprising a grinding wheel; a pair of jaws for rotatably mounting a disk workpiece which is to be urged into engagement with said grinding wheel for grinding the edge of such disk, said disk when held by such jaws being rotatable about a central axis perpendicular to the plane of the disk; a yoke member for mounting said jaws; a movable yoke support for said yoke member constructed and arranged for movement toward and away from said grinding wheel; means for adjusting the position of said yoke member upon said yoke support about a primary axis; means for adjusting the position of said yoke member upon said yoke support about an axis substantially perpendicular to such primary axis; said yoke member being positioned upon said yoke support for positioning the axis of rotation of the disk in oblique angular relation relative to the plane of rotation of said grinding wheel, the plane of rotation of the workpiece intersecting said grinding wheel along a chord thereof which is less than a diameter thereof; jaw power means for opening and closing said jaws; yoke support power means for shifting said yoke member toward and away from said grinding wheel; an operative interconnection between said jaw power means and said yoke support power means for actuating the latter in response to closing of said jaws by said jaw power means, said jaws with a disk workpiece therebetween being urgable toward the grinding wheel in response to the closing of said jaws, such operative interconnection including: a timer actuatable in response to closing of said jaws; and means for operatively interconnecting said timer and said yoke support power means for urging said yoke support and disk workpiece away from said grinding wheel a preselected time after such actuation of said timer.

3. In apparatus for use with a grinding wheel for the edge grinding of disks, a disk mount member for rotatably mounting a disk the edge of which is to be ground by the grinding wheel; a disk hold-down member for engaging a disk mounted upon said disk mount member and retaining same in position for edge grinding, said hold-down member being mounted for rotation about an axis co-incident with that of the axis of rotation of said disk mount member, means for effecting reciprocative movement of said hold-down member whereby the latter is movable toward and away from said disk mount member; a yoke for mounting said disk mount member and said reciprocative means, the latter supporting said hold-down member; a device for angularly shifting said yoke through a preselected angular increment relative to the grinding wheel, a support for said yoke pivotable about a preselected axis, a cam and follower mechanism operatively connected with said yoke support for shifting the latter through said angular increment, and power mechanism operatively connected to said cam and follower mechanism for actuating same; a manually operable control device for said reciprocative means by which the position of said hold-down member is controllable relative to said disk mount member; feed control means responsive to displacement of said reciprocative means for actuating said power mechanism, said yoke support being shiftable in infeed motion from a disk loading to a disk grinding position in response to such power mechanism actuation, and shiftable in reverse in outfeed motion in response to actuation of said power mechanism in an opposite direction, said feed control means including a timer operatively connected to said power mechanism for governing the time between the initiation of the infeed and outfeed motion of said yoke support.

4. In apparatus for use with a grinding wheel for the grinding of disk workpieces, a pair of jaws for clamping therebetween a disk workpiece, said jaws including a rotatable workpiece mount member and a rotatable hold-down member; jaw power means for opening and closing said jaws; feed power means for shifting said jaws from a loading to a grinding position and return; timer means operatively connected to said feed power means for shifting said jaws away from a grinding position after a preselected period; and a deburring mechanism mounted for opening and closing movement with one of said jaws and including: an abrasive wheel, a supporting arm, the latter being pivotally mounted relative to such jaw, such abrasive wheel being positioned for engaging the edge region of a disk workpiece clamped between said jaws.

5. In apparatus of the class described for use with a grinding wheel for the edge grinding of disk workpieces, a pair of jaws for clamping a disk workpiece therebetween, said jaws being mounted for reciprocative movement; a support member for said jaws; means upon such support member for mounting such jaws for free rotation, a workpiece held in such jaws being freely rotatable; power means for moving said jaws and support member between positions at preselected limits of motion relative to the grinding wheel, such positions comprising a loading position and a grinding position; said support member including means for mounting the workpiece with the plane of rotation of the workpiece obliquely disposed relative to the plane of rotation of the grinding wheel, such plane intersecting such wheel along a chord thereof less than a diameter thereof, ro-

tation of the workpiece at a preselected angular velocity being inducible by engagement with the grinding wheel at such grinding position; and timer means operatively connected to said power means for controlling the time of engagement between the workpiece and the grinding wheel.

6. In apparatus for the edge grinding of disks, the combination comprising: a grinding wheel; a pair of jaw members for removably securing therebetween a disk workpiece; a supporting post for said jaws, the latter being rotatably mounted upon the former; means for mounting said supporting post for angular movement between a loading position and a grinding position; a spring differential device operatively connected with said supporting post for urging same toward the grinding position; cam and follower means for controlling the angular movement of said supporting post between said loading position and grinding position; power means for actuating said cam and follower means, the latter means being adjusted for providing a gap between the cam and follower thereof during grinding engagement between the workpiece and said grinding wheel; timer means for controlling said power means and operatively connected thereto for urging said cam and supporting post toward a grinding position for a preselected period of time and thereafter urging said cam and supporting post in a reverse direction; and means for mounting said rotatable jaws upon said supporting post with the axis of rotation thereof obliquely disposed relative to the plane of rotation of the grinding wheel.

7. In apparatus for use with a grinding wheel for the edge grinding of disks, a disk mount member for rotatably mounting a disk, the edge of which is to be ground by the grinding wheel; a disk hold-down member for engaging a disk upon said disk mount member and retaining same in position for edge grinding, said members being mounted for rotation about a common axis, such axis being the axis of rotation of the disk, one of said members having a protuberance for engaging a perforation formed in such a disk; a yoke member for supporting said jaws, a movable yoke support for said yoke member; means for moving said yoke support between a loading and a grinding position; means for adjusting the position of said yoke member upon said yoke support about a primary axis; means for adjusting the position of said yoke member upon said yoke support about an axis substantially vertical to such primary axis, said disk mount and hold-down members being positioned for holding said disk with the plane of rotation thereof oblique to the plane of rotation of the grinding wheel, such disk plane of rotation intersecting the wheel along a chord less than a diameter thereof; and timer means operatively connected to said yoke support moving means for controlling

the period during which said yoke support is urged toward a grinding position as a function of the angular attitude of said disk and grinding wheel.

8. In apparatus for use with a grinding wheel for the grinding of disk workpieces, a pair of jaws for clamping therebetween a disk workpiece, said jaws including a rotatable workpiece mount member and a rotatable hold-down member; jaw power means for opening and closing said jaws; and a deburring mechanism mounted for opening and closing movement with one of said jaws and including: an abrasive wheel, supporting means for such wheel, the latter being positioned for engaging the edge region of a disk workpiece clamped between said jaws.

9. In apparatus for use with a grinding wheel for the edge grinding of disks, a disk mount member for rotatably mounting a disk, the edge of which is to be ground by the grinding wheel, a disk hold-down member for engaging a disk mounted upon said disk mount member and retaining same in position for edge grinding, said hold-down member being mounted for rotation about an axis co-incident with that of the axis of rotation of said disk mount member, means for effecting reciprocative movement of one of said members relative to the other; a yoke for mounting said disk mount member and said reciprocative means; a device for angularly shifting said yoke through a preselected angular increment relative to the grinding wheel, such device including a support for said yoke pivotable about a preselected axis, a cam and follower mechanism operatively connected with said yoke support for shifting the latter through said angular increment, and power mechanism operatively connected to said cam and follower mechanism for actuating same; a manually operable control device for said reciprocative means by which the position of said hold-down member is controllable relative to said disk mount member; and feed control means responsive to displacement of said reciprocative means for actuating said power mechanism.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
723,051	Shipp	Mar. 17, 1903
799,700	Youngstrom	Sept. 19, 1905
1,455,286	Fosdick	May 15, 1923
1,877,572	Harrison et al.	Sept. 13, 1932
1,967,447	Nelson et al.	July 24, 1934
2,045,778	Huntley et al.	June 30, 1936
2,113,367	Belden et al.	Apr. 5, 1938
2,183,490	Flygare	Dec. 12, 1939
2,354,347	Peets	July 25, 1944