This invention relates to automatically controlled abrading machines, and more particularly to an automatic control mechanism for controlling the extent of the abrading action and producing work pieces of predetermined sizes. It is particularly applicable to machines, herein termed abrading machines, in which a flat or radial face of one abrading element or of two opposed abrading disks or laps is utilized for sizing one or a plurality of flat or cylindrical pieces of work. This mechanism is applicable to lapping machines of the type shown in the patent to Indge et al. No. 1,831,958 or to the rotary type surface grinding machine in which the flat face of a rotary abrading disk grinds work on one side while it is supported on a rotary chuck, as well as to the double opposed disk grinding machines of the Gardner type, such as shown in the Gardner Patent No. 1,589,593. In a lapping machine, a plurality of flat or cylindrical work pieces are mounted in a work carrying cage between two opposed laps or disks, the upper one of which is movable downwardly to engage and cause the work pieces to be lapped. The laps or disks and the cage are so moved relatively that the work pieces are caused to travel through irregular ever changing paths between the opposed faces of two disks, either or both of which may be rotated or be held stationary.

It has been proposed, as shown in the patent to Belden and Cole No. 1,911,552 dated May 30, 1933, to employ an electrical control device in a grinding machine which serves to remove the wheel from the work when the latter has reached a measured size. It has also been proposed to stop the downward movement of the upper lap of a lapping machine when it has reached a stop, but this has not served to stop the cage rotation, which goes on until the operator stops the machine. Also a device has been suggested for stopping the cage rotation when the work has been moved through a predetermined number of revolutions, but this has not reduced cutting the work to a predetermined size.

The primary object of this invention is to provide such an abrading machine in which the work is automatically sized, and in which the relative movement of the work and abrading disk or disks is so controlled as to produce not only the desired finish but also accuracy in dimensions.

A further object is to provide such a machine with a control mechanism which not only controls the movement of the abrading disk towards the work, in that it automatically causes their separation, but also stops the relative movement of the disk and work after the abrading operation has proceeded to a predetermined extent.

It is another object of this invention to provide a control mechanism including a time delay device actuated by the relative movement of the work and abrading lapsing disks to separate them after a predetermined lapping operation.

Other objects will be apparent from the following disclosure. One embodiment of this invention has been illustrated in the drawings, in which like reference numerals indicate like parts.

Fig. 1 is a side elevation of an improved abrading machine embodying this invention, having parts broken away to more clearly show the construction;

Fig. 2 is a diagrammatic view, showing diagrammatically the driving mechanism for the abrading disk elements and the cage, as well as the wiring diagram for the electrical control system;

Fig. 3 is a cross-sectional view, on an enlarged scale, taken approximately on the line 3—3 of Fig. 1, showing the manually operable and the electrically actuated power and manual control mechanism for raising and lowering the movable abrading element;

Fig. 4 is a fragmentary elevation, on an enlarged scale, of the reversing switch for controlling the reversible motor for raising and lowering the upper abrading disk;

Fig. 5 is a fragmentary elevation of the mercury switch, which serves to break the circuit and thereby render ineffective the electrical control apparatus when the abrading disks are in a separated position;

Fig. 6 is a fragmentary sectional view, on an enlarged scale, of the contact mechanism in the electrical control system for governing the extent of the abrading operation; and

Fig. 7 is a fragmentary side elevation of the upper part of Fig. 6, on an enlarged scale, to show the support and adjustment for the movable contact member.

The embodiment of this invention illustrated in the drawings comprises two opposed rotatable abrasive disks or laps and a work cage having a plurality of work receiving apertures therein which is supported between the disks and arranged to simultaneously abrade a plurality of work pieces therebetween. The work carrying cage is arranged to be simultaneously rotated and revolved by a power operated mechanism to carry the pieces of work through irregular paths. The abrading disks are mounted so that they...
may be moved relatively toward and from each other by a power actuated mechanism. In accordance with this invention, I provide such a machine with a control device, preferably electrically operated, and suitable mechanism which serves when a control member is actuated by the relative approaching movement of the disks to stop the abrading operation. This mechanism serves to separate the disks automatically when a predetermined work size has been attained and it preferably acts to stop the relative movement of the cage and disk. In the specific form illustrated, a time delay device which is preferably set in motion by the approaching movement of the disks or disks towards the work causes the work to be abraded for a predetermined period after the control device has been rendered effective. The preferred embodiment illustrated in the drawings comprises two opposed rotatable disks and a work cage therebetween which is arranged to be simultaneously rotated and revolved by a power operated mechanism to carry the work pieces through irregular paths. The two abrading disks are so mounted that they may be moved relatively toward and from each other by a power actuated mechanism. An electrical control apparatus is provided which is rendered effective by the relative approaching movement between said disks and serves to actuate a time delay device which in turn causes the power mechanism to automatically separate the disks after a predetermined abrading period and to simultaneously stop the rotation of the disks and the cage.

As illustrated in the drawings, the improved grinding or abrading machine comprises a base 10 which rotatably supports a lower abrasive wheel 11 for rotation upon a vertical spindle 12. The base is provided with an upwardly extending projection 13 which supports an abrasive disk 14 on a vertically mounted rotatable spindle 15. To facilitate a relative approaching and receding movement between the abrading members 11 and 14, the spindle is preferably supported in a vertically movable slide 16 which is supported in a dovetailed slide 17 in the upwardly extending projection 13 of the base 10. By movement of the slide 16 in a vertical direction, the upper abrading element may be caused to move toward and from the lower abrading element 11 to reduce the work pieces to the required size.

Feeding device

It is desirable to provide a suitable mechanism for raising and lowering the movable abrading disk to bring the disk into engagement with the work and to remove it therefrom after the operation has been completed, as well as to provide a suitable means for feeding the abrading disk with the desired pressure to produce the desired abrading action between the abrading disks and the opposed faces of the work piece. As illustrated in the drawings, the slide 16 is provided with a rack 20 meshing with a pinion 21 on a shaft 22 which is rotatably mounted in the projection 13 of the base 10. The shaft 22 carries a worm gear 23 meshing with a worm 24. The worm 24 is slidably keyed to a shaft 25 and is held in position by the enal at 26 and 27 which surround the shaft and are interposed between the ends of the worm 24 and a bearing 28 and an enlarged portion 29 on the other end of the shaft 25. The other end of the shaft 25 is provided with a hand wheel 30, by means of which the worm 24, worm wheel 23, shaft 25 and pinion 21, may be turned to move the rack 20, slide 16, and thereby transmit a vertical motion to the upper disk 14, either relatively toward or from the lower lap, as desired.

It is desirable to provide a suitable power actuated mechanism for rapidly raising and lowering the upper abrading disk with the minimum amount of exertion required on the part of the operator. Such a mechanism, as illustrated in the drawings, may comprise an electric motor 32 mounted on or secured within the base. The motor is provided with a pinion 34 which is connected by a link chain 35 with a sprocket 36 on the end of the shaft 25. In the preferred construction, the sprocket 36 is mounted as one element of a centrifugal clutch, which serves to connect the sprocket 36 to rotate the shaft 25. By utilizing a centrifugal clutch, for the power drive, it eliminates the necessity of rotating the power driven mechanism when the upper abrading disk is in contact with the work. The motor 32 is preferably of the reversible type so that the direction of movement of the upper disk may be readily varied by means of a reversing switch 38 which is controlled by a manually operable lever 39. Movement of the lever 39 into position 39a serves to connect the centrifugal clutch to raise the upper abrading disk to cause the separation or receding movement between the two abrading disks. Similarly, moving the lever 39 into position 39b serves to lower the upper abrading disk and to cause an approaching movement between the two abrading disks and also relative to the work pieces 40.

Work carrying cage and driving mechanism

A plurality of work pieces 40 are mounted in a work carrying cage 41 which is carried by driving pins 42 which are rotated and revolved by means of a gear mechanism 43. See, for example, the cage operating mechanism in the prior patent of Ingde No. 1,610,527, dated December 14, 1926. This cage operating mechanism is not a part of the present invention, and consequently has not been illustrated in detail. Further reference is had to the above-mentioned patent.

Lap rotating mechanism

In the operation of the improved or abrading machine, the abrading disks 11 and 14 are arranged for rotation relative to each other. Either one or both of the abrading disks may be rotated, as desired, depending upon the nature of the work to be finished on the machine. In the preferred construction, both of the abrading disks 11 and 14 are simultaneously rotated in the opposite direction and at suitable speeds to produce the desired operating action. As illustrated in the drawings, the motor 50 is provided to serve as a prime mover for rotating the upper abrading disk and also for controlling the movement of the cage 41 to produce the desired abrading action. The motor 50 is provided with a pulley 51 which in turn drives a belt 52 which passes over a pulley 53 on a cross shaft 54. The pulley 53 is freely rotatable on the shaft 54 and is integrally connected with a clutch member 55 which is also free to rotate on the shaft 54. A movable clutch member 56 is slidably keyed to the shaft 54 and is engaged or disengaged with the member 55, by means of a manually operable lever 57 which is connected by a link 58 to move the clutch shifting rod 59 which is connected at its other end by a suitable clutch shifting member 60 to the movable clutch mem-
ber 55. The lever 57 is pivotally supported on a stud 61 which is fixed to the base 16. The shaft 54 is provided with a worm gear segment 40 which meshes with a worm gear 64 to rotate the lever 55 and the lower abrading disk, 11. The shaft 54 is also provided with a pulley 66 which drives a belt 67 passing around a pulley 68 on a shaft 69. The shaft 69 is provided with a worm 78 meshing with a gear 79 on the vertical spindle 41 to transmit a rotary motion to the spindle 15 to rotate the abrading disk 14.

Reversing switch

The reversing switch 38 is preferably provided with a suitable actuating mechanism which may be automatically actuated by the vertical movement of the slide 16. As illustrated in the drawings, the switch 38 is provided with a lever 75 which is connected to a gear segment 76, gear 77 and gear segment 78 on the manually operable lever 39. By utilizing the gearing above mentioned, the lever 75 will be moved in timed relation with and in the same direction as the lever 39. Thus, if it is desired to move the upper abrading disk toward the lower abrading disk, the lever 39 is moved into position 39b which in turn serves to move the lever 75 into position 75b. Similarly, when it is desired to move the upper disk in an upward direction, the lever 39 is moved into position 39a which in turn through the gear train serves to move lever 75 into position 75a. In order that the power driving mechanism may be automatically disconnected to stop the vertical movement of the slide 16, either when approaching or receding from the lower disk, a suitable adjustable dog mechanism is provided comprising a lower adjustable dog 80 and an upper adjustable dog 81 which are mounted on a projection 82 of the base. It will be readily apparent from the foregoing description that when the slide 16 is moved downwardly by manually moving the lever 39 into position 39b, the slide 16 and reversing switch 38 will move downwardly until the lever 15b engages the dog 80 which serves upon continued downward movement of the slide to rock the reversing switch into a neutral position, as shown in full lines in Fig. 4. Similarly, when the upper disk is moved in an upward direction, the adjustable dog 81 is arranged to engage the lever 16 when in position 16a, and similarly move the reverse switch into a neutral position and thereby stop the upward movement of the disk 14.

Pressure device

In the operation of a machine of this type, it has been found desirable to provide a suitable pressure device which is arranged to exert a predetermined adjustable but predetermined pressure between the abrading disks and the work so as to produce the desired abrading action. This feature is not a part of the present invention and, consequently, has been illustrated only as incidental to the main features of the invention. For further data regarding this pressure device, reference may be had to the prior patent to Indge et al. No. 1,931,908, dated November 17, 1931. As illustrated in the drawings, a slightly different type of pressure device has been illustrated which is more readily adaptable to an improved abrading machine. As illustrated in Fig. 3, the worm 24 is held in its central or normal position by means of the opposed springs 26 and 27 which surround the shaft 25. The slide 16 may be moved downwardly into operative relation with the work to cause an abrading action, either by means of the motor 32 which moves the slide rapidly into position, but is preferably moved into contact with the work by the manually operable wheel 30. Rotation of the hand wheel 30 rotates the shaft 25, the worm 24, worm gear 23, shaft 22, gear 21, to move the rack 20 and slide 16 in the desired direction. After the upper disk 14 engages the surface of the work, the operator continues to rotate the manually operable wheel 30, during which movement the worm gear 23 is relatively stationary due to engagement of disk 14 with the work, and worm 24 serves as a screw threaded member and rotates and moves axially relative to the worm gear, compressing the spring 28 to the desired extent to give the required pressure for the abrading operation. In order that the operator may readily turn the wheel 30 to duplicate the pressure on successive operations, a dial indicator 85 is provided mounted on the projection 13 of the base 10. A collar 86 is slidably mounted on the shaft 25 and is held against the end of the worm 24 by means of a spring 27. A pivotally mounted lever 87 has one end 88 arranged to engage the end of the sleeve 65 and its other end connected to a plunger 89 which is connected to operate the dial indicator 85. During the normal vertical movement of the slide 16 in a downward direction, the sleeve 85, lever 87, plunger 89 and dial indicator 85 are stationary and inoperative. When the upper abrading disk 14 engages the upper surface of the work and continued rotation of the hand wheel 30 serves to tension the spring 28 to exert a pressure between the abrading elements and the work, the dial indicator and its actuating lever and plunger are operative to register or indicate the tension of the spring 28. On successive abrading operations, the hand wheel 30 is turned until the dial indicator reads a predetermined pressure which has been found by experience to be suitable for the operation being performed.

Electrical control

In order to attain one of the primary objects of this invention, a suitable control apparatus is provided for regulating the extent of the abrading operation so that duplicate pieces of work may be produced on successive operations with a minimum amount of attention on the part of the operator. In the preferred construction, a suitable electrical control apparatus is provided which serves to regulate the extent of the abrading action after the abrading disks are brought into operative engagement with the work to be abraded. It is not only desirable but essential that the abrading disks be automatically separated after a predetermined abrading operation has been completed, and also that the relative rotation of the abrading elements and the cage be automatically stopped when the abrading disks recede to an inoperative position. One form of this control system is illustrated in the drawings, in which the downward movement of the slide 16 serves to either make or break a circuit to actuate the time delay device which permits a predetermined abrading operation with the abrading disks engaging the work at the desired predetermined pressure before automatically separating them from engagement with the work. If desirable, a visible indicating device, such as a dial indicator 50, may be provided to indicate when the upper abrading disk has approached the lower abrading disk and work to a predetermined pressure.
mined extent. The dial indicator 99 is carried by the vertically movable slide 16 and is arranged to be actuated by a slidable plunger 91 which is journaled in suitable bearings 92 and 93 in the slide 16. When the slide 16 moves downwardly, a head 94 on plunger 91 engages a stop 95 which is fixed to the base of the machine. As the slide continues moving in a downward direction, the plunger 91 moves upwardly and actuates the dial indicator 100 which indicates the approaches of the upper abrading disk toward the lower element during the abrading operation. In the preferred construction, a suitable automatic control is provided which is independent of the dial indicator and serves to automatically control an electrical system for automatically terminating the abrading action after the work has been reduced to a predetermined extent.

The dial indicator is preferably adjustably positioned above the slide 16 so that the mechanism may be readily adapted to set the machine up for abrading various sizes of work. As illustrated in Fig. 6, the bearings 92 and 93 as well as the indicator 99 are supported by a cylindrical sleeve 90. The sleeve 90 has a thread 101 on its periphery meshing with an internally threaded sleeve 102 which is supported within an aperture in the slide 16. To facilitate vertical adjustment of the dial indicator and its actuating mechanism, the periphery of the sleeve 102 is provided with a worm gear 103 meshing with a worm 104 which is mounted on a shaft 105. The shaft 105 is also provided with a manually adjustable wheel 106 which serves to rotate the sleeve 102 and thereby adjust the position of the sleeve 90 and thereby position the dial indicator in setting up the machine for a given operation.

The sleeve 105 carries a bracket 108 which supports an electrical control head 109. The head 109 is provided with a central vertically movable plunger 110 which engages and operates with the plunger 111 of the dial indicator. The upper end of the plunger 110 engages the end of an adjustable screw 112 in a bell crank lever 113 which is supported by a knife edge support 114. As illustrated in the drawings, the electrical control head is illustrated for use in a break circuit, the long arm 115 serving as one of the contact members and the control head 116 serving as a fixed contact member which is supported within the head 109. The arm 115 is held in contact with the member 116 by means of a spring 117 exerting a pressure on a short arm 118 of the bell crank 113 so as to hold the contact points in engagement with each other. It will be readily apparent from the foregoing disclosure that the head 109 is carried by and moves with the vertical slide 16 on which the slide moves downwardly to bring the upper abrading disk into engagement with the work to abrade a plurality of work pieces, the gage head 119 also moves downwardly until the plunger head 94 engages the fixed stop 95 on the base and continued movement raises the plunger 91, the dial indicator plunger 111, and the control head plunger 110, so as to rock the bell crank 113 and break the circuit between the contact members 115 and 116.

In order to overcome in a consequent pitting of the contact points during continued operation, it is desirable to provide a low energy current at the make and break point in the control head. This feature is not part of the present invention, but is clearly defined and covered by the prior patent to Cole et al. No. 1,911,552, dated May 30, 1933. A suitable adjusting screw 118 is provided to adjust the position of the contact member 116 relative to the contact arm 115. As illustrated in the drawings, power is provided from the source 125 by the power lines 125. This source may be either of a direct or alternating current, but for the sake of illustration, an alternating current source has been indicated. The current from the alternating current source 125 passes through a rectifier 127 which changes the current from an alternating to a direct current for application to the electric control head.

It is desirable that no current be flowing through the head when the upper abrading disk is in a raised position. To accomplish this, a mercury switch 130 is mounted on a rotatable support 131 pivoted on a laterally adjustable member 128 and fixed to the upwardly extending portion 13 of the base 10. The member 131 is provided with an outwardly extending stud 132 arranged in the path of an adjustable stop 134 carried by the vertically movable plunger 110. The stud 132 is arranged to be operable under manual control, and the upper abrading disk fed manually by means of the hand wheel 30, or the upper 75

2,088,923
 disk may be raised or lowered by power under manual control of the reverse switch 38.

The operation of this mechanism will be readily apparent from the following disclosure.

Assuming the adjustments of the various mechanisms to have been previously made, and that the parts are in the position as illustrated in Figs. 1, 2 and 6, the manually operable control lever 57 is moved in a clockwise direction (Figs. 1 and 2) to engage the clutch member 58 so as to cause a relative rotation between the abrading disks and to cause an irregular motion of the cage therebetween. The reverse switch control lever 38 is moved into position 39b to start the movement 32 and cause a downward movement of the upper abrading disk. The downward movement of the abrading disk 14 continues until the adjustable dog 88 strikes the lever 13b and moves the reverse switch into a neutral position to stop the downward feed under power just prior to the upper abrading disk 14 engaging the surface of the work. The hand wheel 30 is then rotated to move the abrading disk 14 into operative engagement with the work, and the rotation of the wheel 30 continues until the worm 24 compresses the spring 26 so that the dial indicator 86 shows that the pressure exerted by the lower abrading disk is sufficient for the abrading operation. The abrading operation continues, and the abrading disk 14 moves downwardly under the tension of the spring 26 until the head 94 of the electrical control apparatus engages the fixed stop 95 on the base and upward movement of the plunger 91 serves to break the contact between the contact members 115 and 116 in the control head 108. Breaking of the contact serves to deenergize the relay 140 and allows the pivotally mounted member 141 to move into the position as illustrated in full line in Fig. 2 so as to close the high energy circuit and thereby start actuation of the time delay relay 142, the time delay relay having been previously set to trip in a predetermined number of seconds or minutes after the contacts 115 and 116 have been broken. When the relay 142 operates after the prescribed abrading period, electric circuit including relay 143 is energized, thereby closing the circuit and energizing the solenoid 144 which serves to throw the reverse switch lever 38 to position 39a to cause a relative separating movement between the abrading disks, and at the same time energizes the solenoid 145 to swing the main control lever 57 into the position illustrated in Fig. 2 to disengage the clutch 56 and thereby stop the relative rotation of the abrading disks 41 and 44 and the motion of the cage 41. The upward or receding movement of the abrading disks 14 continues until the adjustable pin 134 on the slide 16 engages the stud 133 and rocks the member 131 and the mercury tube switch 130 into the position illustrated in Fig. 5, breaking the circuit to the transformer 126, thereby rendering ineffective the electric size control head 109.

When the downward movement of the abrading disk 14 is started by manipulation of the reverse switch lever 38, the electric size control head is ineffective until the pin 134 moves downwardly from the position indicated in Fig. 5, allowing the member 131 and the mercury tube switch 130 to rock until the circuit is closed, permitting current to flow through the transformer 126, rectifier 127 and to the electric size control head 108 so as to energize the magnet 140 and swing the contactor 141 into position 141a. The contactor 141 remains in position 141a under the influence of the electromagnet 140 until the continued downward movement of the upper abrading disk 14 breaks the circuit by separating contacts 115 and 116.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. An abrading machine comprising a rotatable abrading disk having a flat operative surface and an opposed rotatable abrading disk and means for raising and lowering said disk, means to rotate said abrading disk and work carrier, means to cause a relative approaching and receding movement between said abrading disk and work carrier, and a control device actuated in timed relation with the approaching movement of said abrading disk to automatically separate said disk and carrier and to stop the rotation of the abrading disk and the work carrier after a predetermined abrading operation.

2. An abrading machine comprising a rotatable abrading disk, an opposed rotatable work support, means to rotate the disk and the work support for an abrading operation, means whereby the disk and the work may move relatively towards each other, means including a measuring device which controls the movement of the work support to automatically stop the relative approach of the disk towards the work at a predetermined position, and means actuated in timed relation with the operation of the measuring device which serves to stop the rotations of the disk and the work support automatically after the stoppage of the disk approaching movement.

3. A machine of the type covered by claim 2 in which a time delay device serves to permit an abrading operation after the stoppage of the disk feed and before the work and disk rotations are stopped.

4. An abrading machine having a rotatable abrading disk and a work carrier opposed there to which is arranged to support a plurality of work pieces in operative relation with said abrading disk, mechanism to cause a relative approaching movement between said abrading disk and carrier to bring said disk into operative relation with said work to be abraded, means to apply a predetermined pressure between said abrading disk and the work, and means automatically actuated when said disk and carrier have reached a predetermined relative position which serves to automatically separate said disk and carrier after a further predetermined period of abrading.

5. An abrading machine having a rotatable abrading disk and a work carrier opposed there to which is arranged to support a plurality of work pieces in operative relation with said abrading disk, power actuated mechanism to cause a relative approaching movement between said abrading disk and carrier to bring said disk into operative relation with said work to be abraded, means to apply a predetermined pressure between said abrading disk and the work, and means automatically actuated when said disk and carrier have reached a predetermined relative position which serves to automatically separate said disk and carrier after a further predetermined period of abrading.

6. An abrading machine comprising two opposed disks movable relatively towards and from each other, a carrier for a plurality of work pieces therebetween, means for holding the carrier and the disks relatively so as to cause the work pieces to travel through irregular paths while being abraded by the opposed disks, means 75
to cause said disks to relatively approach each other and engage the work, mechanism to cause a separation of the disks and a control device operated automatically in response to movement of the disks to a predetermined distance from each other which causes said mechanism to separate the disks and stop the relative movement of the disks and carrier after a predetermined lapping operation.

7. A machine of the type covered by claim 6, in which a time delay device operates when the disks have reached predetermined positions to cause the work to be abraded for a predetermined period thereafter and before the disks are separated.

8. An abrading machine having two opposed abrading disks which are relatively movable towards and from each other, and a cage for a multiplicity of work pieces therebetween comprising means for moving the cage and disks relatively to cause the work pieces to travel through irregular paths between said disks, power actuated means to cause a relatively approaching movement between said disks to move the disks into and out of operative engagement with the work pieces, and an electrically operated sizing device to cause the power actuated means to separate said disks after a predetermined period of abrading.

9. An abrading machine having a rotatable abrading disk and a work carrier opposed thereto which is arranged to support a plurality of work pieces in operative relation with said abrading disk, power actuated mechanism to cause a relative approaching movement between said abrading disk and carrier to bring said carrier into operative relation with the work to be abraded, means to apply a predetermined pressure between said abrading disk and the work, and automatically actuated means controlled by the approaching movement between said disk and carrier to automatically separate said disk and carrier after a predetermined period of abrading.

10. An abrading machine having a rotatable abrading disk and a rotatable work carrier opposed thereto comprising means to relatively rotate said abrading disk and work carrier, a power actuated means to cause a relative approaching and receding movement between the abrading disk and work carrier, an electrically actuated control device to control the movement of said abrading disk, means including a pair of contact members actuated by the relative approaching movement between said disk and the carrier to actuate said control device after the abrading operation has continued to a predetermined extent, means actuated by the control device to cause a receding movement between the carrier and the disk and to stop the relative rotation of the disk carrier.

11. An abrading machine having a rotatable abrading disk and a work carrier opposed thereto comprising means to relatively rotate said abrading element and work carrier, mechanism to cause a relative approaching and receding movement between said abrading disk and work carrier, and an electrical control device including a time delay relay which is actuated by the relative approaching movement between said disk and carrier to automatically cause a separation of said disk and work carrier and to stop the rotation thereof when the abrading operation has continued to the desired extent.

12. An abrading machine having a pair of opposed abrading disks and a work cage therebetween which is arranged to support a plurality of pieces of work, means to rotate said disks and cage relative to each other, a power actuated mechanism to cause a relative approaching movement between said disks to bring said elements into operative relation with the work to be abraded, means to cause a relative separation of said disks and the work, and electrically actuated means controlled by the approaching movement between said disks to automatically separate said disks after a predetermined period of abrading.

13. An abrading machine having a rotatable abrading disk and a work carrier comprising means to relatively rotate said disk and carrier, power actuated means to cause a relative approaching and receding movement between said disk and carrier, means including a manually engageable clutch to cause a rotation of said abrading disk and carrier, means including a manually operable control mechanism to cause an approaching movement between said abrading disk and carrier, a control device for said mechanism including a time delay device to cause the relative approaching movement between said abrading disk and carrier to actuate said time delay device, and means actuated by said time delay device including a solenoid which is operatively connected to reverse the direction of movement of the power actuated means to cause a predetermined separation between the abrading disk and the carrier, and a second solenoid operated simultaneously with the first to disengage the clutch and stop the movement of the abrading disk and the carrier.

14. An abrading machine having a rotatable abrading disk and a work carrier comprising means to rotate said abrading disk and carrier relative to each other, means including a manually controlled, power actuated mechanism to raise and lower said abrading disk relative to said carrier to position the disk in operative contact with the surface of the work, means to apply a predetermined pressure between said abrading disk and carrier to cause the desired abrading action, an electrically controlled mechanism including contact members and said relay to cause said relay to become effective after a predetermined approaching movement between said disk and carrier, and electrically controlled means actuated by said relay after a predetermined period of abrading to automatically separate the abrading disk and the carrier.

15. A lapping machine comprising two opposed laps which are relatively rotatable, a work cage therebetween arranged to hold a multiplicity of work pieces in lapping contact with the laps, means to cause a relative rotary movement between the work cage and laps to lap the work pieces, and mechanism actuated automatically to stop the relative rotary lapping movement of the laps and cage after the laps have reached a predetermined distance apart.

16. A lapping machine of the type covered by claim 15 comprising a time delay mechanism controlled thereby which serves after the laps have reached a predetermined distance apart to cause a predetermined lapping operation and thereby separate the laps.

17. An abrading machine having a pair of opposed abrading disks and a work cage for supporting a plurality of work pieces therebetween.
comprising means for relatively rotating said disks, means for moving said cage to carry the work pieces through an irregular path between said disks, means whereby the disks may approach each other and abrade the work pieces, an electrical control system including a time delay device, and means actuated by the relative approaching movement of said disks to actuate said timing device when the laps are a predetermined distance apart which serves after a predetermined time interval to cause a relative separation of the disks and to stop the rotation of the disks and the cage.

18. An abrading machine having a pair of opposed abrading disks and a work cage for supporting a plurality of work pieces therebetween comprising means for relatively rotating said disks, means for moving said cage to carry the work pieces through an irregular path between said disks, power actuated means to cause a relative approaching movement between said disks, an electrical control system including a time delay device, and means actuated by the relative approaching movement of said disks to actuate said timing device which serves after a predetermined time interval to cause a relative separation of the disks and to stop the rotation of the disks and the cage.

19. An abrading machine comprising a pair of opposed abrading disks and a work cage therebetween which is arranged to support a plurality of pieces of work in operative relation with said opposed disks comprising means to rotate said disks, means to move said cage so as to carry said work pieces through an irregular path between the opposed disks, power actuated means to cause a relative approaching movement between said disks to bring them into abrading engagement with the work pieces, means to apply a predetermined pressure between said disks to cause the desired abrading action, an electrical control system including a time delay device and contact members actuated by the approaching movement between said disks to actuate said timing device and automatically separate the disks after a predetermined abrading period.

20. An abrading machine having a pair of opposed abrading disks and a work holding cage therebetween comprising means to rotate said disks relative to each other, means to move the cage through an irregular path between the opposed faces of said disks, means including a manually controlled, power actuated mechanism to raise and lower one of said disks to position the disk in operative contact with the surface of the work, means to apply a predetermined pressure between said disks to cause the desired abrading action, an electrically controlled mechanism including contact members actuated by the approaching movement between said disks, a time delay relay, connections between said contact members and said relay to cause said relay to become effective after a predetermined approaching movement between said disks, and electrically controlled means actuated by said relay after a predetermined period of abrading to automatically separate the disks.

21. An abrading machine having a pair of opposed abrading disks and a work cage therebetween which is arranged to carry a plurality of work pieces between said disks, means including a clutch to rotate said abrading disks relative to each other and to move said cage between the disks to carry the work pieces through an irregular path on the abrading disks, a motor driven mechanism to cause a relative approaching and separating movement between said disks, manually operable means to initiate an approaching movement thereof to bring the disks into abrading engagement with the work pieces, a solenoid arranged to reverse the motor driven mechanism for separating the disks, a second solenoid operatively connected to disconnect the clutch, an electrical circuit including a time delay device and contact members actuated by the relative approaching movement between said disks which is operative after a predetermined abrading period to energize said solenoid and thereby cause a separating movement between the disks and to stop the rotation of the disks after the motion of the work carrying cage.

22. An abrading machine having a pair of opposed, relatively rotatable abrading disks and a work cage therebetween comprising power actuated means to cause a relative approaching and receding movement between said disks, means including a manually engageable clutch to cause a rotation of said abrading disks and cage, means including a manually operable control mechanism to cause an approaching movement between said disks, a control device for said mechanism including a time delay device, means actuated by the relative approaching movement between said disks to actuate said time delay device, and means actuated by said timing device including a solenoid which is operatively connected to reverse the direction of movement of said power actuated means to cause a relative separation between said abrading disks and a second solenoid operated simultaneously with the first to disengage said clutch and stop the movement of the disks and the cage.

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