Nov. 24, 1959 C. G. EKHOLM 2,913,854

CENTERLESS GRINDING MACHINE

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FIG. 1.

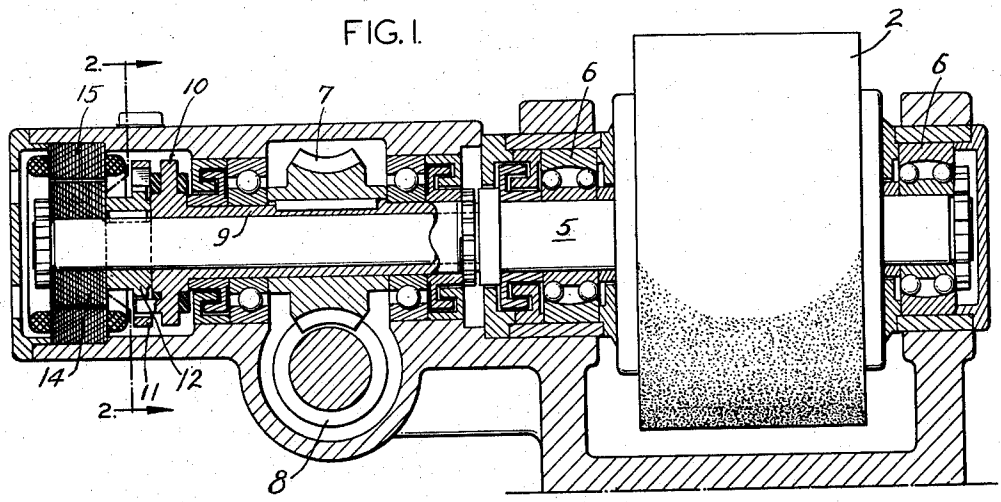


FIG. 2.

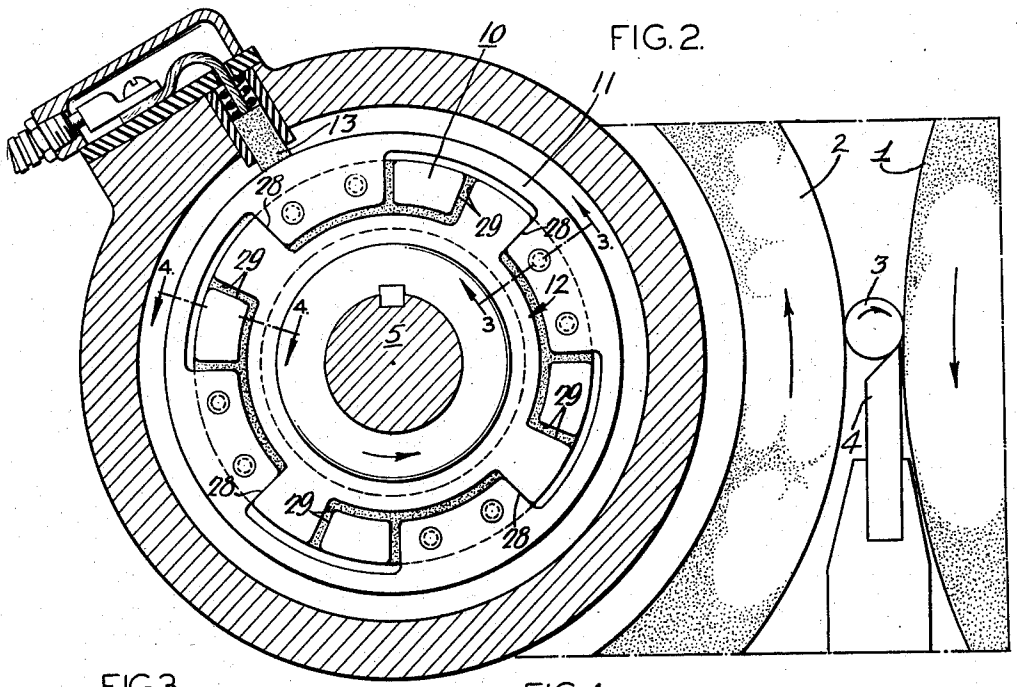


FIG. 3.

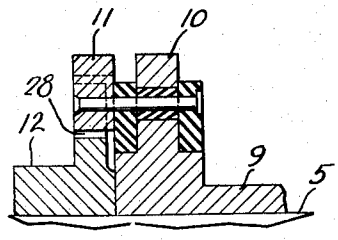
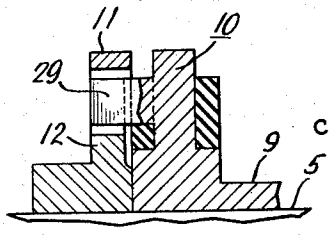


FIG. 4.



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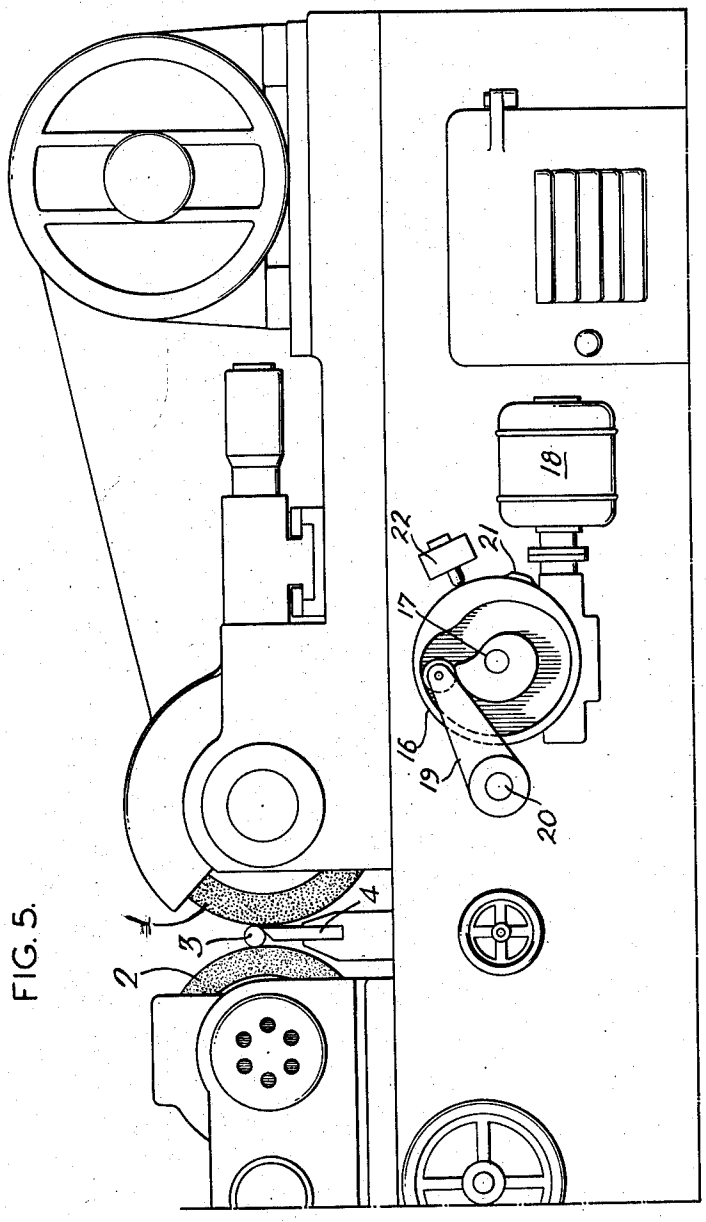


FIG. 5.

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FIG.8.

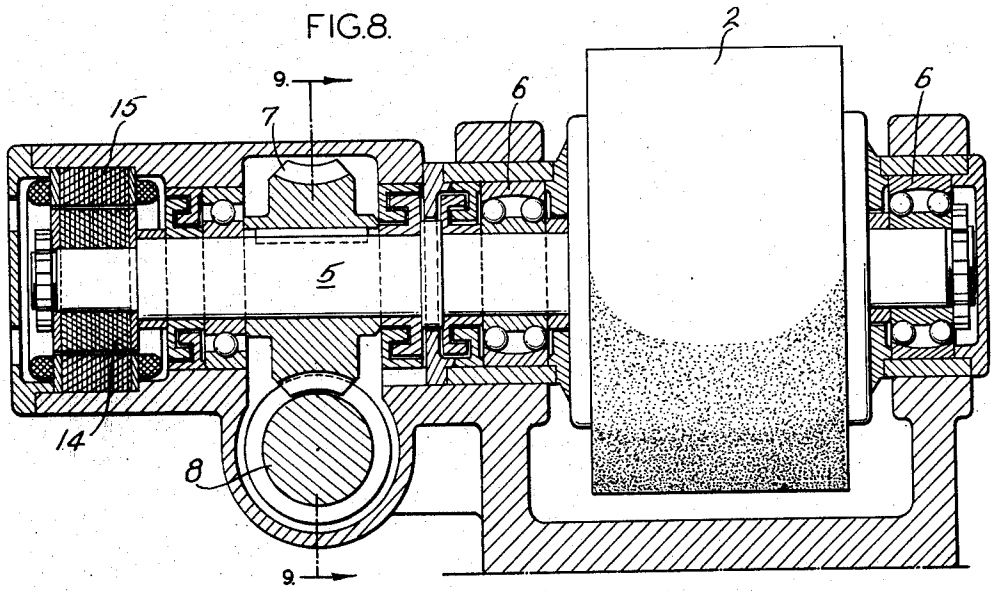


FIG.6.

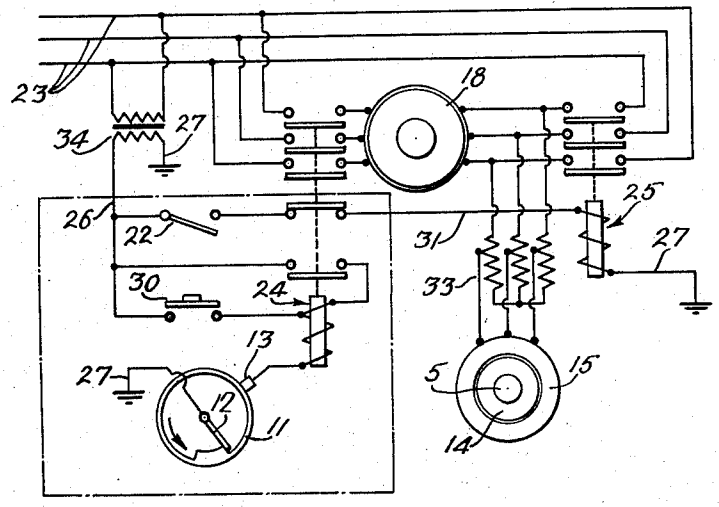
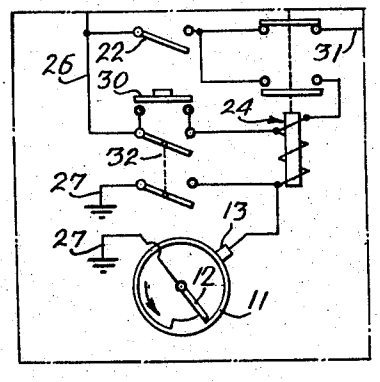


FIG.7.



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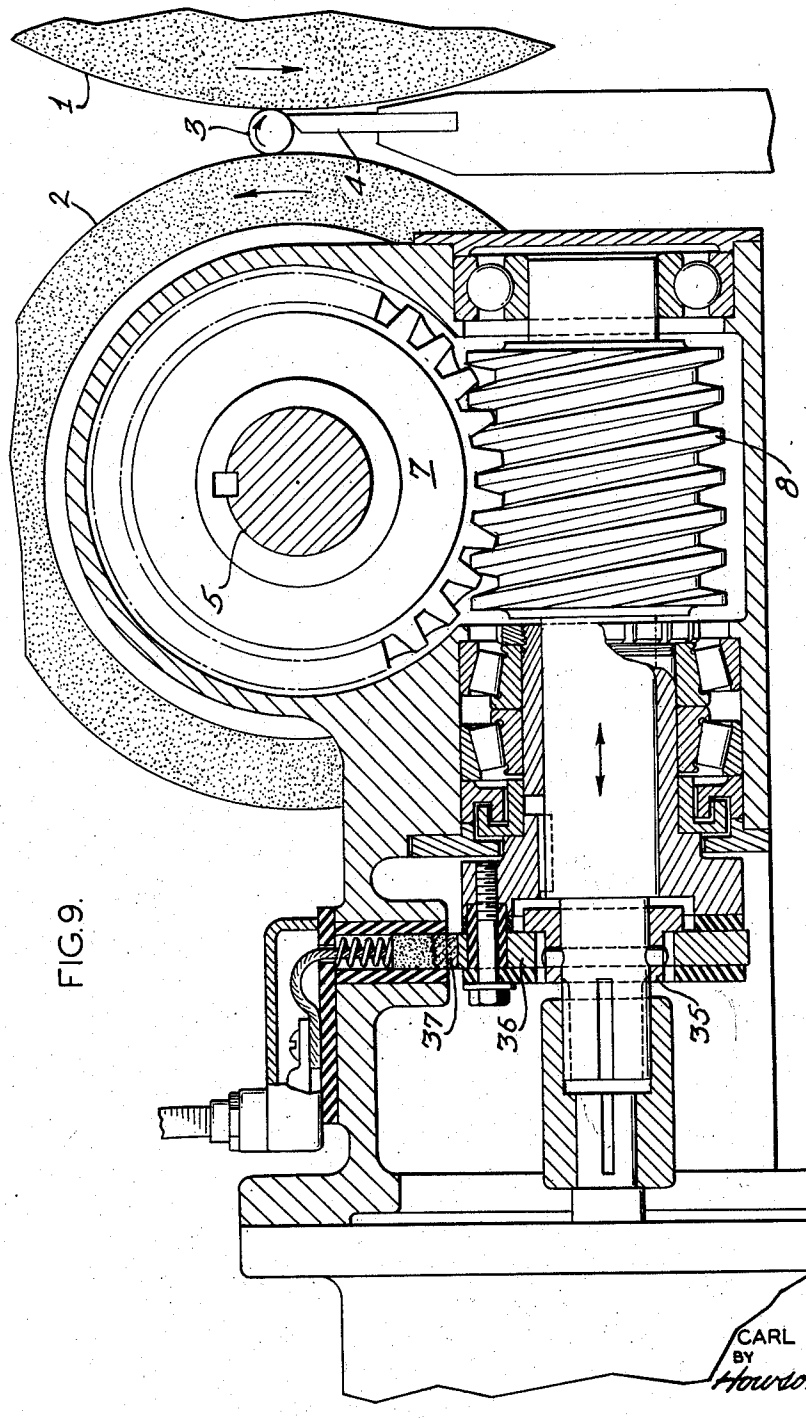


FIG. 9.

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United States Patent Office 2,913,854 Patented Nov. 24, 1959

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CENTERLESS GRINDING MACHINE

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Application May 21, 1957, Serial No. 660,566

Claims priority, application Sweden May 23, 1956

7 Claims. (Cl. 51—103)

In certain grinding operations, for instance plunge-grinding in centerless grinding machines, the grinding wheel must be moved away from the work to enable the work piece to be inserted in working position without coming into contact with the grinding wheel. Since the relative feeding movement between the grinding wheel and the work piece during the grinding operation must take place comparatively slowly a considerable amount of time would be wasted if the work and the grinding wheel were advanced towards each other at the same low speed at which the feed takes place during the actual grinding operation. In order to save time it has therefore been common to arrange the feed so that the first part of the movement takes place at high speed, preferably until the grinding wheel contacts the work or comes into its immediate vicinity. Since the grinding allowance, especially on work of large diameter, can vary within comparatively great limits it is therefore necessary with mechanical feed to change over from high speed approach feed to working feed at different positions of the grinding wheel, depending on the magnitude of the grinding allowance of the work piece being ground. In order to change over automatically from one feed to another at the moment at which the grinding wheel comes into contact with the work it has been suggested among other things to actuate the changeover of the feed mechanism by the change in the grinding wheel driving torque which occurs when the grinding wheel comes into contact with the work. It is however necessary that this changeover occurs with sufficient rapidity to prevent damage to the work piece or the grinding wheel due to the grinding wheel running into the work piece at the higher speed.

In centerless grinding machines for plunge-grinding of cylindrical, tapered or profiled work pieces, which are freely supported on a rest between two disks of which one, the grinding wheel, grinds the work while the other, the regulating wheel, serves to regulate the speed of rotation of the work, the grinding wheel as a rule has considerable kinetic energy due to the fact that it is usually of considerable diameter and width and rotates at great speed. For this reason it does not react with sufficient promptitude to changes in torque. According to the present invention, which relates to a device in centerless grinding machines for plunge-grinding, the mechanism for changing the feed is therefore actuated by changes in the torque of the regulating wheel which is of less mass and always has a considerably lower speed than the grinding wheel and thus much less kinetic energy and therefore reacts more rapidly to changes in torque.

The regulating wheel spindle is usually driven through a worm gear. When the grinding wheel comes into contact with the work piece, a force component is created, which through the work piece tends to drive the regulating wheel at an increased peripheral speed and the worm gear will therefore have a retarding effect on the spindle instead of driving it, thereby determining the

speed of rotation of the work. The worm gear is therefore usually made self-locking.

According to one form of the invention the reversal of the direction of the force, which occurs when the regulating wheel instead of being driven by the worm gear begins to exert a retarding action upon contact between grinding wheel and work piece, is utilized to accomplish the change from rapid feed to working feed and also includes means for accomplishing this change.

The invention is illustrated on the accompanying drawings as applied to a centerless grinding machine, in which the grinding wheel carriage is moveable towards and from the work piece, but can be applied also to other types of machines. Centerless grinding machines are well known in the art and only those parts necessary to an explanation of the invention are shown in the drawings.

Fig. 1 shows a regulating wheel spindle mounting in axial section adapted to function according to the invention.

Fig. 2 shows on a larger scale a section through a spindle along the line A—B in Fig. 1. In order to indicate the directions of the forces and of rotation, the grinding wheel, work piece, work rest and regulating wheel are shown.

Figs. 3 and 4 show sections through certain of the coupling elements along the lines C—D and E—F in Fig. 2.

Fig. 5 shows a side view of a centerless grinding machine having a cam shaft driven by a two-speed motor, which serves to move the grinding wheel carriage towards and from the work piece.

Figs. 6 and 7 are wiring diagrams showing how the operating cycle is controlled electrically.

Fig. 8 shows an axial section of a regulating wheel spindle mounting, in which the worm of the worm gear is displaceably mounted on its shaft and Fig. 9 shows on a larger scale a cross section through the same spindle.

Figs. 1 and 2 show the grinding wheel **1**, the regulating wheel **2**, the work piece **3** and the work rest **4**, on which latter the work is supported. The regulating wheel is mounted on a spindle **5** rotatable in bearings **6**. A worm gear **7** and **8** drives, or retards, respectively, the regulating wheel spindle. The worm **8** is driven by an electric motor, not shown. The worm wheel **7** is mounted on a sleeve **9**. This sleeve is freely rotatable on the spindle **5** and one end thereof is formed as a toothed coupling member **10** and is provided with a metal ring **11**, isolated from the sleeve by an electrically nonconductive material. The ring **11** is also in the form of a toothed coupling member. Another toothed coupling member **12** is mounted on the spindle **5** and engages with the members **10** and **11**. A brush **13** is arranged to slide on the ring **11**. A rotor **14** is further mounted on the spindle **5** to coact with a stator **13** fixed to the housing of the spindle. The stator and the rotor together form an electric motor, the function of which is described in the following.

A cam **16** (Fig. 5) is mounted on a shaft **17** in the frame of the machine. This cam is driven through a worm gear (not shown) by a two-speed motor **18**. An arm **19**, mounted on a shaft **20**, is actuated by the cam **16**. At the other end of the shaft **20** is a gear (not shown) which actuates the carriage of the grinding wheel and moves it backwards and forwards as the cam rotates. At the periphery of the cam is a projection **21**, which operates a switch **22**. As is apparent in Fig. 6 a three-phase line **23** leads current to the two-speed motor **18** and to the special motor **14—15** on the regulating wheel spindle. Relays for connecting and disconnecting the current to these motors are shown at **24** and **25**. Wires

26 and 27 lead current from a transformer 34 to the relays 24 and 25. One of the poles is shown as being grounded to the machine frame but double lines may be used if desired. In that case the spindle housing is provided with a further brush to engage the sleeve 9.

The device functions as follows, the directions of rotation of the grinding wheel and the regulating wheel being indicated by arrows in Fig. 2. During the grinding operation the work piece will also be caused to rotate in the direction of the arrow. As long as the grinding wheel is not in contact with the work, the sleeve 9 will be driven by the worm gear 8—7 and the spindle 5, on which the regulating wheel is mounted, is driven through the coupling 10—11. As is shown in Fig. 2, there is a certain amount of play between the claws of the members of the coupling 10, 11, 12. When the regulating wheel spindle is driven through the worm gear, the surfaces 28 on the coupling members 10 and 11 will contact each other and close a circuit through wires 26—27 when a push button switch 30 is closed. Current then passes through the magnetic coil of the relay 24 and the relay closes the three-phase current to the stator windings for the higher speed of the motor 18 and the grinding wheel is advanced rapidly towards the work piece. When the grinding wheel comes into contact with the work piece the latter is caused to rotate. The friction between the grinding wheel, the work piece and the regulating wheel creates a force, which strives to turn the latter. The pressure perpendicular to the contact between work piece and regulating wheel is augmented due to the fact that surface of the work rest 4 slopes towards the regulating wheel. The speed of the work is retarded by the regulating wheel and is determined by the speed at which the worm gear is driven through the reversal of the direction of the forces, which takes place when the worm gear ceases to drive the regulating wheel and instead counteracts the forces from the grinding wheel, the contact between the surfaces 28 is broken and contact is established between the surfaces 29. Hereby the circuit to the relay 24, and consequently also the three-phase circuit to the motor, are broken. When the switch 22 is operated by the projection 21 on the cam during the rapid advance of the grinding wheel carriage, a circuit to the relay 25 through wires 26, 31 and 27 is closed, thereby closing the three-phase circuit to the stator winding for the lower speed of the motor 18, whereby a suitable feed for grinding will be imparted to the grinding wheel carriage. The motor 18 continues to be driven at this lower speed until the grinding operation is completed and the grinding wheel carriage is returned to its original position through the action of the cam mechanism. In this position the circuit to the relay 25 is broken through the action of the projection 21 on the switch 22 and the motor 18 stops. The working cycle can, if desired, be combined with means for rapidly retracting the grinding wheel when the grinding operation is finished, in which case the relay 24 is again connected through a double switch 32 actuated through a projection on the cam 16. The part of the wiring relating to the relay 24 can then be done as shown in Fig. 7.

The push button switch 30 operates either manually or automatically. In automatic machines, i.e. when work pieces are automatically fed in sequence to the machine from a magazine, the switch is actuated by a member connected to the magazine, which is caused to function when the work piece assumes its grinding position.

When the circuit to the relay 25 is closed not only the motor 18 but also the special motor 14—15 will receive current through the transformer 33. This motor is designed to exert a relatively small torque and its purpose is to provide an additional torque supplementary to that exerted upon the regulating wheel from the work and great enough to maintain the surfaces 29 of the coupling in engagement with each other, so that the speed of rotation of the regulating wheel and the work will be kept at an even and steady speed determined by the speed of the worm gear only and will not be influenced by uneveness of the surface of the work piece.

The invention is not limited to the form described above. Other means and mechanisms may be used to attain the desired result. Thus, instead of mechanism formed by the coupling members 10 and 11 it is possible to use a mechanism in which the worm of the worm gear is axially displaceable on its shaft and the circuit is closed and broken respectively through the displacement of the worm.

This form of the invention is shown in Figs. 8 and 9, in which Fig. 8 is an axial section through the mountings for the regulating wheel spindle and Fig. 9 an axial section through the bearings of the worm of the worm gear. The circuit closing mechanism in this form of the invention comprises the members 35, 36 and 37, which correspond to the members 10, 11 and 13 of the previous form. The member 35 is mounted on the worm 8. The member 36 is a metal ring, isolated by an electrically non-conductive material from the worm 8. A brush 37 is provided to engage the ring 36. This brush is connected to the wire 26, shown in Fig. 6. When the worm drives the regulating wheel spindle, i.e. when the grinding wheel is not in contact with the work, the worm 8 is displaced towards the left in its bearings as shown in Fig. 9 through the action of the force required to turn the regulating wheel spindle working through the gear. Hereby the members 35 and 36 will contact each other and close the circuit through the wires 26 and 27 when the push button switch 30 is closed. When the grinding wheel comes into contact with the work and the worm gear consequently acts to retard the force generated by the grinding wheel, the worm 8 will be displaced toward the right and the contact between the members 35 and 36 will be broken whereby the grinding wheel carriage will assume the lower rate of feed.

The two-speed motor 18, described above, may be replaced with two motors having the same or different speeds connected to the cam mechanism with different gear ratios. It is also possible to use a gear box provided with electro-magnetically actuated couplings to provide different speeds to the grinding wheel carriage. Further, instead of the special motor 14—15, a normal motor provided with a maximum-torque slip coupling may be used, the motor being connected by a belt or other suitable transmission member to the regulating wheel spindle to transmit the torque necessary to augment that exerted by the grinding wheel. It is also possible to use hydraulically or pneumatically driven members, e.g. a hydraulic or pneumatic motor combined with electric operating means.

I claim:

1. A centerless grinding machine for plunge-grinding comprising opposed grinding and regulating wheels between which a work piece is confined in the grinding operation, rotary drive means for said grinding wheel, rotary drive means for said regulating wheel, feed means for effecting a relative approach of said grinding wheel and work piece in said operation, control means for said feed means operable in one position to effect approach movement at a rapid rate and in a second position to effect approach movement at a lower rate, and mechanism connecting said regulating wheel and its drive means responsive to the change in torque exerted on the regulating wheel upon contact between the grinding wheel and the work piece automatically operating said control means from said one position to said second position to change the said relative approach movement to the lower rate.

2. A centerless grinding machine according to claim 1 wherein said mechanism includes a spindle for the regulating wheel and worm gear means connected to said regulating wheel drive means and driving said wheel at a speed and in a direction such that the torque exerted

on the wheel by the work piece when contacted by the grinding wheel tends to overrun the worm gear so that the latter begins to act as a brake on the wheel, and wherein the mechanism for changing the said rate of approach is responsive to the reversal in the direction of the forces thus resulting from contact of the grinding wheel with the work piece.

3. A centerless grinding machine according to claim 2 including means mounting the worm element of the worm gear for axial displacement, said worm being displaceable in one direction under the action of the forces created when the regulating wheel is driven through the worm gear, and axially displaceable in the other direction when the regulating wheel is subjected to a braking action from the worm gear, and wherein the said rate-changing control means comprises an electric control circuit including a contact device operatively connected to the worm element for actuation by the said axial displacement of the element.

4. A centerless grinding machine according to claim 2 wherein the said control means comprises an electric control circuit including a pair of electric contacts operatively associated with the regulating wheel spindle, at least one of said contacts being mounted for movement relative to the other, together with means holding said contacts together when the grinding wheel is out of engagement with the work piece, and separating the contacts when the grinding wheel comes into engagement with the work piece.

5. A centerless grinding machine according to claim 4 wherein said mechanism includes a claw coupling connecting the spindle with the said driving means for the regulating wheel and comprising relatively movable members, and wherein the said electric contacts are mounted respectively on said members.

6. A centerless grinding machine according to claim 4 including means for exerting on the regulating wheel spindle a torque which augments the torque exerted by the grinding wheel through contact with the work piece, and means automatically causing the said torque-exerting means to function when the said electric contacts are separated.

7. A centerless grinding machine according to claim 6 wherein the said torque-exerting means comprises motor means connected directly to the spindle of the regulating wheel.

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