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CONTROL APPARATUS FOR GRINDING MACHINES

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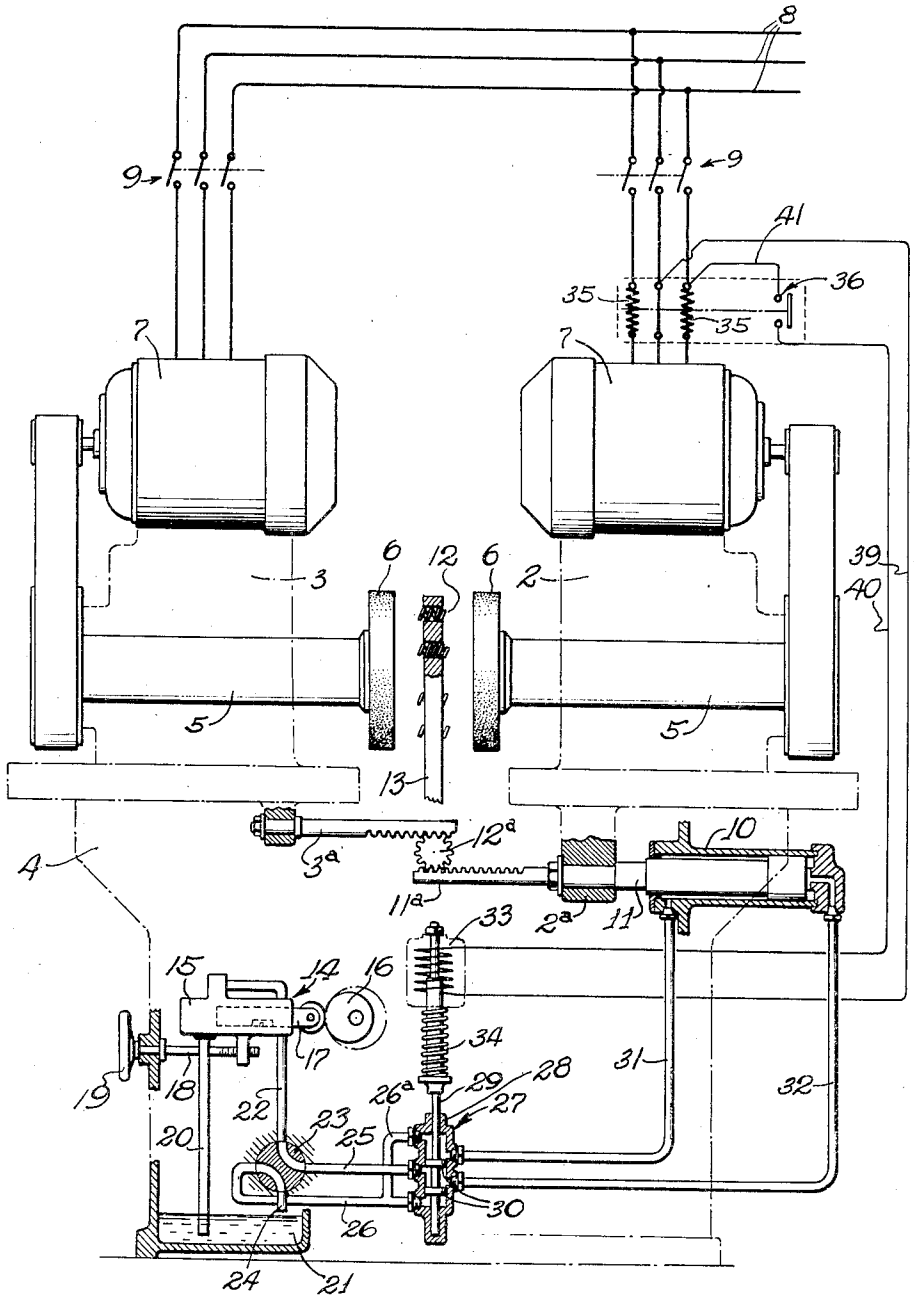

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CONTROL APPARATUS FOR GRINDING MACHINES

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This invention relates to improved control apparatus for grinding machines and more particularly to control apparatus for grinding machines in which the tool or grinding wheel is rotated and simultaneously moved into engagement with the work by power actuated means.

The primary object of the invention is to provide improved control apparatus for grinding machines of the above general character by which the overloading of the driving motor or motors of the machine is effectually prevented.

Another object is to provide improved control apparatus which permits the full capacity of the driving motors to be utilized throughout the complete grinding cycle of the machine.

Another object is to provide an improved control apparatus for opposed disk grinding machines whereby the pressure for closing the heads together may be set for most efficient operation without danger of overloading the driving motors.

Still another object is to provide control means for opposed disk grinding machines whereby the grinding disks are automatically momentarily retracted from the work during the grinding cycle to enable the disks to free themselves of grinding chips.

Other objects and advantages will become apparent from the following detailed description taken in connection with the accompanying single figure of drawings which shows a grinding machine embodying the features of the invention.

By way of illustration, the invention is shown and will be described hereinafter as embodied in a grinding machine in which the work is yieldably held between two opposed, rotatable grinding disks or wheels which are adapted to be closed together to operate simultaneously on opposite ends of the work. It will be understood, of course, that this is not intended as a limitation of the invention to this particular type of machine, it being contemplated that various changes may be made by those skilled in the art to adapt the invention to other types of machines without departing from the spirit and scope of the invention as defined by the appended claims.

In the exemplary embodiment shown in the drawing, the grinding machine comprises generally a pair of grinding heads 2 and 3, mounted on a suitable frame or base 4 for axial movement toward and from each other. Each grinding head is equipped with a rotatable spindle 5 carrying on its inner end a grinding disk or wheel 6. The spindles are preferably driven by individual electric motors 7 mounted on the respective grinding heads. Current for operating the motors is supplied over a power circuit 8, and through suitable switches 9 individual to the respective motors.

Movement of the grinding heads 2 and 3 toward and from each other is effected by a hydraulic motor, preferably comprising a hydraulic cylinder 10 mounted on the base 4 and having a reciprocable plunger 11 operatively associated with the grinding heads. As shown herein, the projecting end of the plunger 11 is secured to a depending lug 2a on the grinding head 2, and is provided with an extension in the form of a rack 11a adapted to engage a pinion 12a, rotatably mounted on the base 4. A similar rack 3a secured to the grinding head 3 also engages the pinion 12a so that simultaneous, uniform movement of the two grinding heads may be effected by the single driving means.

Upon the movement of the heads 2 and 3 toward each other, the grinding wheels are closed together to engage with and operate upon opposite ends of a work piece 12 held in position intermediate the grinding wheels by a suitable work support 13. When the size of the work piece permits, the work support may conveniently be arranged to hold a plurality of work pieces for simultaneous grinding. In any event, the work pieces 12 are desirably held in a manner to permit their free endwise movement so that the work may equalize itself between the two grinding wheels.

Pressure fluid from any suitable source may be employed for reciprocating the plunger 11 in the cylinder 10 to move the grinding wheels 6 toward and from the work. As shown herein, the source of pressure fluid comprises a variable displacement pump 14 of well known construction mounted on the base 4 of the grinding machine and having a cylinder 15 and a spring pressed piston 17 reciprocable therein through a limited range of movement. For varying the rate at which the pump delivers pressure fluid, the pump cylinder 15 may be slidably mounted whereby the entire pump assembly is movable toward and from a driven eccentric 16 adapted to reciprocate the piston 17. The positioning of the pump cylinder 15 and piston 17 may be conveniently effected by means of a screw 18 which is provided with a hand wheel 19 and which is rotatably anchored in the base and in threaded engagement with the cylinder. It will be apparent that by shifting the position of the cylinder 15 and piston 17 relative to the eccentric 16, the point at which the eccentric engages the piston and hence, the length of the stroke of piston 17 may be varied as desired with a consequent variation in the rate at which pres-

sure fluid is delivered by the pump. This may be advantageously employed in regulating the speed with which the grinding heads are closed together which also determines the pressure with which the grinding wheels are applied to the work.

As shown herein, the pump 14 is provided with an intake duct 20 through which fluid is drawn from a reservoir or sump 21 formed in the base of the machine. A discharge duct 22 connects with the duct system whereby the pressure fluid is delivered to the cylinder 10 as required. Suitable check valves are provided in the ducts 20 and 22 to insure proper flow of the pressure fluid.

The duct system through which pressure fluid is supplied to the cylinder 10 includes a pair of reversing valves for controlling the introduction of pressure fluid into the cylinder, thereby determining the direction in which the grinding heads are to be moved. One valve 23 is of the ordinary 4-way, manually operable type, and enables the attendant to control the movement of the grinding heads as when starting and stopping the machine. Discharge duct 22 of the pump 14 terminates in one port of the valve 23 and the opposite port is provided with a discharge duct 24 leading to the sump 21. Terminating at ports spaced intermediate the first mentioned ports are ducts 25 and 26 leading to a second reversing valve 27. The valve 23 is so constructed that when the duct 22 is connected with duct 25, the duct 24 is connected with the duct 26. A quarter turn of the valve 23 reverses the above connection, connecting the duct 22 with the duct 26 and the duct 24 with the duct 25.

The valve 27 comprises essentially a hollow cylindrical body 28 provided with suitably spaced ports in which the various ducts terminate. A plunger 29 having spaced piston enlargements 30 is reciprocable within the valve body 28 to define variable channels between the ports. With the plunger 29 in normal position as shown in the drawing, the duct 26 leading from the valve 23 is connected by way of a branch duct 26*a* with a duct 31 leading to the inner end of cylinder 10, and the duct 25 is connected with a duct 32 leading to the outer end of the cylinder 10. Pressure fluid delivered through the duct 25 will thus be introduced into the outer end of the cylinder 10 to force the piston inwardly and thus close the grinding disks 6 together on the work 12. Spent pressure fluid from the inner end of the cylinder 10 will be returned via the ducts 31, 26*a*, 26 and 24 to the sump 21. When plunger 29 is shifted to reverse position, the connection of the ducts is reversed, the duct 26 connecting with the duct 32 and the duct 25 connecting with the duct 31. The movement of the grinding heads 2 and 3 will accordingly reverse, thus retracting the grinding wheels 6 from the work.

For actuating the valve 27, automatically controlled electro-magnetic means is provided. This actuating means may conveniently comprise a solenoid 33 adapted to shift the plunger 29 against the force of a compression spring 34 which tends to hold the plunger in normal position.

For rendering the solenoid effective to actuate the valve 27, I provide means automatically controlled in accordance with the load imposed on the driving motors of the machine. In its preferred form, this means comprises a relay having its windings 35 connected in series with one of the motors 7 and having a switch 36 adapted to close the circuit for the solenoid 33. The relay is preferably adjusted so as to become energized and close the switch 36 only when the current drawn by the motor 7 exceeds a predetermined limit. Upon the relay becoming energized, the winding of the solenoid 33 is connected across the conductors of the power circuit 8 by way of conductor 39, winding of the solenoid, conductor 40, switch 36 and conductor 41. The solenoid 33 thereupon becomes energized to actuate the valve 27 and reverse the pressure fluid connections to cylinder 10 and thus reverse the movement of the grinding heads 2 and 3. Since the load on the motors is determined by the pressure with which the grinding wheels are applied to the work, it will be apparent that, with the arrangement shown and described, relay 35 and its associated apparatus will effectively prevent the load from exceeding the capacity of the motors by retracting the grinding wheels from the work when the load limit is approached.

In the particular type of grinding machine herein shown in which the work is equalized between the two grinding wheels, overload control apparatus is required for only one of the motors. It will be apparent, however, that such equipment can readily be provided for each motor when required as, for example, under conditions which render equalization of the work impractical.

In the operation of the grinding machine above described, the motors 7 are started by closing the switches 9 and the work 12 is placed in grinding position on the work support 13. Pump 14 is started and set to deliver pressure fluid in sufficient volume to close the grinding heads together at the desired rate. The optimum rate for closing the heads together will depend upon the particular character of the work to be operated on, but to obtain the maximum efficiency from the driving motors 7, the rate will generally be such that the load imposed upon the motors approaches closely to the limit of their capacity. With the control apparatus as shown, the machine may be set so as to close the grinding heads together at a rate such that the load imposed upon the motors 7 is slightly greater than they are designed to handle, and the control apparatus will insure operation at peak efficiency.

With the pump and grinding wheels operating and the work in grinding position as described, valve 23 is manually set to the position shown in the drawing. Pressure fluid is thereby introduced into the outer end of cylinder 10 by way of ducts 22, 25 and 32, and valve 27 and plunger 11 is shifted outwardly. The mechanically coupled grinding heads are thus closed together to bring the grinding wheels 6 into operative engagement with opposite ends of the work.

As the grinding wheels 6 continue to close together on the work, the pressure exerted thereon increases and likewise the load on the driving motors 7. The motors, accordingly, draw an increasing amount of current, and when the current drawn by the motor associated with grinding head 2 reaches the predetermined cut-off limit, relay 35 becomes energized. Relay 35, by closing its switch 36 completes the circuit for solenoid 33 which also becomes energized and shifts the plunger 29 of valve 27 into reverse position. By reason of this reversal, pressure fluid is introduced into the inner end of cylinder 10 thereby moving the grinding heads apart and relieving the motors of their load. Current drawn by the motors quickly drops below the cut-off limit, deenergizing the relay 35 which opens the solenoid energizing circuit. The valve plunger 29 is thereupon restored to normal posi-

tion by the spring 34 and pressure fluid is again introduced into the outer end of cylinder 10 to close the grinding heads together on the work.

The reversing operation may be repeated several times until the grinding operation is finished. Thus, the grinding wheels may be applied to the work with maximum pressure without danger of overloading the motors thereby enabling them to operate at their most efficient point.

A further advantage in intermittently retracting the grinding wheels from the work during the grinding operation is that it permits the wheels to free themselves of grinding chips and thus enables them to operate with greater efficiency. Likewise, it prolongs the life of the wheels as it tends to prevent them from glazing as often occurs when operation is continued after the wheels become clogged up with material removed from the work.

In view of the foregoing, it will be apparent that I have provided control apparatus of an improved and advantageous character which is particularly adapted for use with grinding machines. The improved control apparatus permits the use of the full capacity of the driving motors throughout the grinding cycle. It also provides means whereby the pressure for closing the grinding wheels together on the work may be set for most efficient operation without danger of overloading the driving motors. Moreover, the control apparatus by effecting a momentary withdrawal of the grinding wheels from the work, permits the wheels to free themselves of grinding chips during the operating cycle and consequently enables them to operate more efficiently.

I claim as my invention:

1. A grinding machine having, in combination, a pair of opposed grinding wheels, an individual electric motor for driving each wheel, means for yieldably supporting work to be operated on between said wheels, hydraulically actuated means for closing the wheels together to engage opposite ends of the work and to retract the wheels from the work, manually operable means for controlling said hydraulically actuated means, electrically actuated means for controlling said hydraulically actuated means independently of said manually operable means, and automatically operated means for controlling said electrically actuated means in accordance with the load imposed on said motors by the closure of the grinding wheels together on the work, said electrically actuated means including a solenoid actuated reversing valve operative in one position to cause the wheels to close together and in another position to cause the wheels to be retracted from the work and said automatic means including a relay associated with one of said motors and adapted to close an operating circuit for said solenoid in response to said one motor drawing a predetermined current.

2. A grinding machine having, in combination, a pair of opposed grinding wheels, an electric motor for driving each wheel, means for supporting work to be operated on by said wheels, hydraulically actuated means for closing the wheels together to operate simultaneously on the work and for retracting the wheels from the work, a source of pressure fluid for actuating said hydraulic means, a manually operable valve interposed between said pressure fluid source and said hydraulic means for controlling the flow of pressure fluid to the hydraulic means, an electrically operated valve interposed between said manually operable valve and said hydraulic means effective when in one position for causing said hydraulic means to close the grinding wheels together and when operated to the other position to cause said hydraulic means to retract the wheels from the work independently of said first valve, and automatic means associated with one of said motors and operative responsive to the load on the motor reaching a predetermined limit for effecting the operation of said electrically operated valve from one position to the other.

3. A grinding machine having, in combination, a grinding wheel, an electric motor for driving the wheel, means for supporting work to be operated on by the wheel, hydraulically actuated means for moving the grinding wheel into operative engagement with the work and for retracting the wheel from the work, a manually operable valve for controlling said hydraulic means to move the wheel toward and from the work, and automatic means including an overload device for said motor and an auxiliary valve operated by said device for controlling said hydraulic means to move the wheel toward the work while said manually operable valve is set to effect movement of the wheel from the work and to move the wheel from the work while said manually operable valve is set to effect movement of the wheel toward the work.

4. A grinding machine having, in combination, a grinding wheel, an electric motor for driving the wheel, means for supporting work to be operated on by the wheel, hydraulically actuated means for moving the grinding wheel into operative engagement with the work and for retracting the wheel from the work, manually operable means for controlling said hydraulic means to move the wheel toward and from the work, and automatic means associated with said motor for controlling said hydraulic means to move the wheel toward and from the work independently of said manually operable means, said automatic means including a relay adapted to be energized when the current drawn by said motor reaches a predetermined limit.

5. A grinding machine having, in combination, a grinding wheel, an electric motor for driving the wheel, means for supporting work to be operated on by the wheel, hydraulically actuated means for moving the grinding wheel into operative engagement with the work and for retracting the wheel from the work, manually operable means for controlling said hydraulic means to move the wheel toward and from the work, and automatic means associated with said motor for controlling said hydraulic means to move the wheel toward and from the work independently of said manually operable means, said automatic means including a relay adapted to be energized when the current drawn by said motor reaches a predetermined limit, and a valve controlled by said relay for controlling the operation of said hydraulic means.

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