June 13, 1939. W. TRIBLE 2,162,038

GRINDING MACHINE

Filed May 17, 1937 2 Sheets-Sheet 1

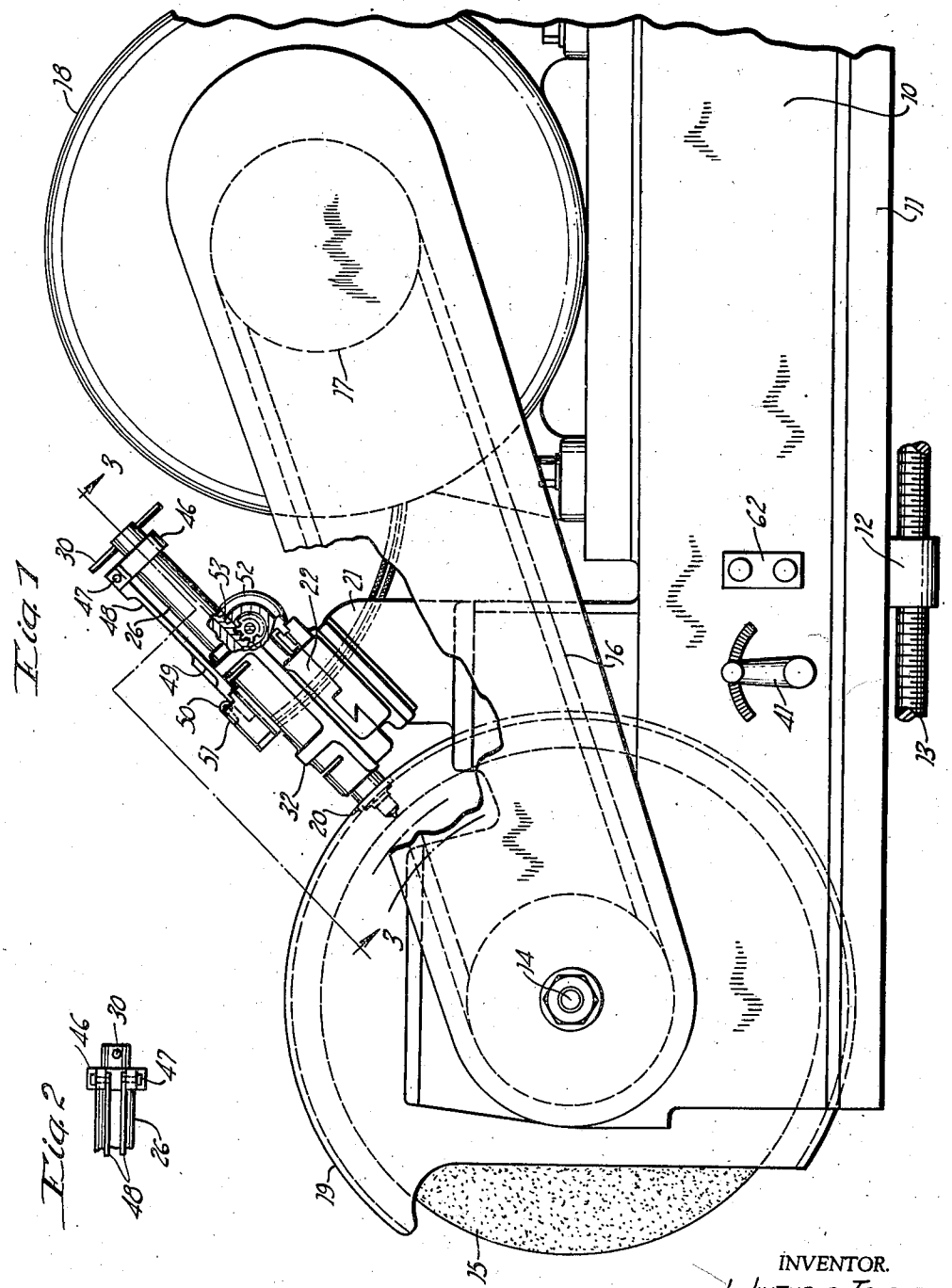


Fig 1

Fig 2

INVENTOR.
WINTHROP TRIBLE

BY
H K Parsons
ATTORNEY.

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Fig. 3

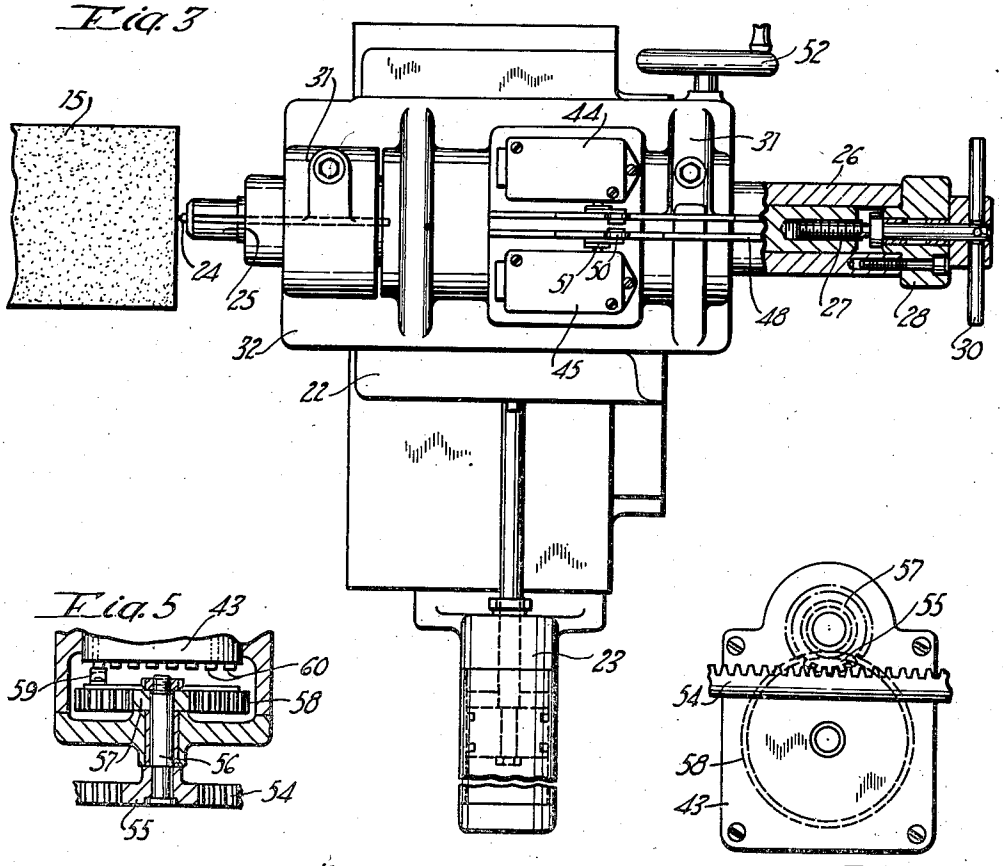


Fig. 5

Fig. 6

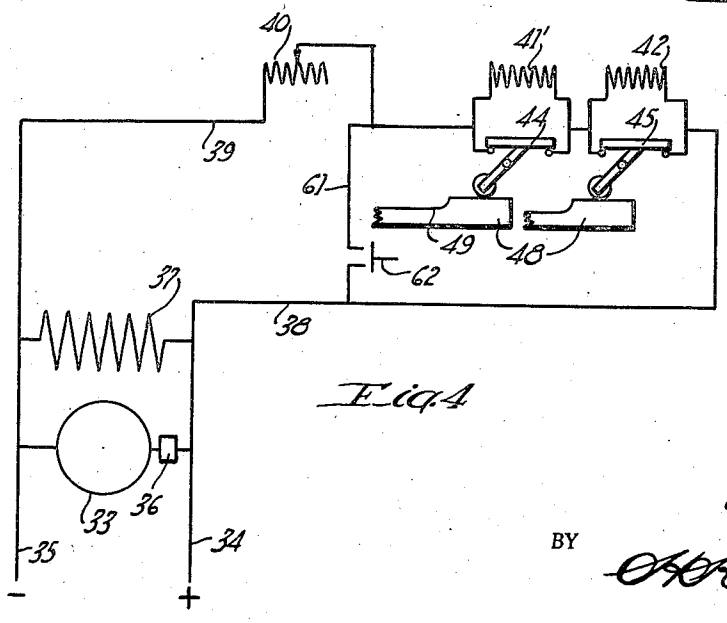


Fig. 4

INVENTOR.
WINTHROP TRIBLE

BY

O. K. Parsons

ATTORNEY.

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GRINDING MACHINE

Winthrop Trible, Cincinnati, Ohio, assignor to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

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12 Claims. (Cl. 51—166)

This invention relates to improvements in grinding machines, and has particular reference to a novel and improved mechanism for determining the surface speed or rate of rotation of a grinding wheel.

According to present commercial practices, in precision grinding and particularly in continuous production work, such as motor vehicle plants or the like, it is desirable to reduce to a minimum the shut-down time necessitated for removal and replacement of the wearing part of the machine, namely, the grinding wheel. Machines are, therefore, designed to utilize a wheel having a large initial diameter which may be greatly reduced in size before replacement is necessary.

It is, however, a recognized fact that such grinding wheels are normally designed and constructed for operation within a certain maximum surface speed as distinguished from the safe R. P. M., the R. P. M. necessary for efficient grinding, therefore, increasing inversely as the diameter of the grinding wheel decreases. For most efficient operation, it is, therefore, desirable that the speed of the wheel increases as its periphery decreases so that the surface speed shall remain as nearly as practicable a constant during the useful life of the wheel.

At the same time, it is essential, both for safety to the operator and for attainment of best grinding results, that means be provided, preventing initial operation in excess of a prescribed preselected speed—ordinarily in the nature of 6500 feet per minute.

It is, therefore, one of the purposes of the present invention to provide a control mechanism for the wheel operation which, as distinguished from prior art mechanisms having reference to independent adjustment of their mechanical elements, is dependent on an adjustment of a member directly related to the wheel itself and whose position is a function of the size of the wheel for automatically controlling the speed at which said wheel is operated.

A further object of the invention is the provision, in connection with a wheel diameter determining mechanism, of a coupled automatic control device for varying the potential rate of operation of the wheel in accordance with the actual diameter thereof.

An additional object of the present invention is the provision of a mechanism which may be readily applied to existing types of grinding machines for effecting improved control of the wheel speed thereof in accordance with the principles of my invention.

An additional object of the present invention is the provision of a mechanism which shall be automatically effective for determination of the maximum potential surface speed of the wheel while permitting selective operation, as desired, at lesser speeds than said automatically determined maximum.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof and it is to be understood that any modifications may be made in the specific structural details there shown and hereinafter described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

In the drawings in which certain specific embodiments of the invention have been illustrated:

Figure 1 is a fragmentary side elevation of a portion of a grinding machine equipped with my improvements.

Figure 2 is a fragmentary plan view of the cam carrying bracket.

Figure 3 is an enlarged plan view partially in section as on the line 3—3 of Figure 1.

Figure 4 is an electrical diagram illustrating the principles of the present invention.

Figure 5 is a fragmentary sectional view illustrating a continuously adjustable form of rheostat device, and Figure 6 is a corresponding fragmentary elevational view thereof.

Figure 6 is an end elevation of the rack and pinion mechanism shown in Figure 5.

The numeral 10 designates the sliding head of a grinding machine movable as on the ways 11, and suitably shiftable as by interengagement of the nut 12 and adjusting screw 13 for effecting back and forth movement of the carriage and parts mounted thereon. Journaled on the carriage is a spindle 14 for the grinding wheel 15, coupled as by belt or belts 16 to the drive pulley 17 of motor 18. Substantially circumscribing the wheel 15 is a wheel guard 19 having a slot 20 for reception of the inner end of a wheel truing mechanism.

This mechanism, as particularly illustrated in Figures 1 and 3, is carried by a bracket 21 secured on the carriage 10 and includes a transversely shiftable slide 22 actuated as by the piston cylinder mechanism 23 for traversing the diamond or like truing device 24 across the periphery of the wheel. This diamond 24 is carried by a rod

or plunger 25 slidably adjusted in sleeve 26 as by screw 27 rotatably or non-translatably mounted in cap 28 on the outer end of sleeve 26 in which the rod 25 is slidably keyed. An actuating handle 30 serves to rotate the screw and thus to effect a limited in and out movement of the truing member 24. The sleeve 26 is, in turn, slidably engaged in clamp bearings 31 of profiling slide 32, translatable with and with respect to cross slide 22.

The foregoing parts are of themselves well known to the art, and it is believed do not require further detailed description.

Referring to Figure 4, it is to be noted that the motor 18 includes the rotating armature 33 having coupled thereto the power lines 34—35 through the control 36 including a conventional armature accelerating contactor and resistor. The field is shunt wound, as indicated at 37, and comprises in the field circuit the leads 38 and 39. Interposed between these leads is the variable resistance speed control rheostat 40 having the operating handle 41 by which the resistance may be increased to reduce the field strength and thus effect desired speeding up of the motor.

Additional resistances may be injected in the 38—39 circuit, either of the fixed resistance type such as the elements 41' and 42, indicated in connection with Figure 4, or of an additional variable type as indicated at 43 in Figure 5.

In the case of the form of the invention illustrated in Figure 4, the circuit, as an entirety, when the machine is supplied with a new full diameter grinding wheel, is normally closed through the switch plates 44 and 45 connected in parallel with resistances 41' and 42 respectively, therefore rendering these resistances ineffective. With the circuit thus conditioned, it will be understood maximum effect exists in the shunt field of the motor which will then operate at its slower speed, the exact rate being dependent upon the adjustment of the manual rate controller 40 for variably determining the motor, and thus the grinding wheel speed.

It is, of course, to be understood that the effective peripheral surface of the grinding wheel 15 is initially formed and subsequently reconditioned by traversing thereof by the truing device 24 and that it is necessary when a new wheel is to be mounted in the machine that the truing device be retracted to a position where it will clear the maximum initial diameter of the wheel. It will further be understood that as the diameter of the grinding wheel decreases, due either to wear from the grinding operation or necessity of reconditioning of the surface to secure best grinding conditions, that the truing device 24 follows up exactly and accurately the wheel radius and at all times serves as an accurate gage device, indicating exteriorly of the guard the size of wheel then existing within the guard. Also, since the reduction of the wheel is effected by the truing device and its setting there exists no variance or lost motion between the parts, and no backing off or like adjustment is necessary. Consequently, this combined gaging and size determining member for the grinding wheel affords an ideal device for utilization in automatic correct determination of proper wheel speed.

For attainment of this result there has been shown, as attached to the cap member 28, the bracket or support plate 46 having removably and adjustably secured thereto, as by the screws 47, the cam bars 48 having recessed cam tracks as at 49 cooperating with rollers 50 on the switch arms 51 for respectively controlling the opening and closing of the switches or contacts 44 and 45. It will be noted, particularly by reference to Figure 1, that when the truing device is in its outwardly retracted position the two cam bars 48 serve to maintain the members 44 and 45 in circuit closing position so that the motor can be operated only at its slower rates of speed. On the other hand, as the truing tool moves inward during reduction of the grinding wheel diameter, first, one, and then the other, of the bars 48 will release the respective rollers 50, causing successive movements of the members 45 and 44 into open position so that, first, resistance 42, and subsequently resistance 41', is thrown into the shunt field of the motor, causing successive potential increases in motor speed which can, of course, be to an extent counteracted by manual adjustment of the variable resistance 40.

It is, of course, to be understood that the inward adjustment of the truing tool may be effected as to minute variations for individual surface reconditionings through handle 30 and screw 27, while general longitudinal adjustment of sleeve 26 may be produced in any desired manner as, for example, by slight loosening of the clamps 31 and employment of a progressive adjusting device, such as the hand wheel 52 operating a pinion engaged with rack 53 on the sleeve. It is further to be understood that while but two cam members 48 have been illustrated, that the number of these may be varied as desired with corresponding individual resistances controlled thereby; also, that the relative positioning of the cam grooves with their stepoffs may be varied by relative longitudinal adjustment of the members 48 with respect to their supporting bracket 46, and in this manner the particular point at which a speed variation is automatically effected may be accurately selected.

Additionally, as has been indicated in connection with Figures 5 and 6, in place of, or in addition to, employment of the cam bars 48, use may be made of a rack bar, such as 54, engageable with the gear 55 on pinion shaft 56 which, in turn, bears pinion 57 meshing with the periphery of gear 58 having contact member 59 for cooperation with the contacts 60 of the rheostat 43. In this form of the invention, the number of resistances 41—42 are thereby greatly multiplied over the single pair indicated in the diagrammatic view, Figure 4, with the result that a finer control of wheel speed may be effected—still depending directly on the wheel radius or diameter as continuously accurately measured and determined by the truing tool adjustment.

In present-day grinding operations, while, as before mentioned, it is ordinarily desired that the R. P. M. of the grinding wheel spindle be increased as the wheel diameter is decreased—this, of course, is effective only to maintain a substantially constant surface speed and therefore constant cutting action as respects the grinding wheel. In some instances, however, it is desirable that the wheel be operated at a slower speed for special finishing operations. In order that this may be readily accomplished, I preferably provide, in parallel with the series of resistances such as 41—42 and their control plates, a second circuit 61 controlled by the speed control selector switch 62. In other words, when this switch is closed, the auxiliary resistances become ineffective and the motor, and thus

the grinding wheel, are again slowed down to a rate ultimately determinable by the adjustable speed determining rheostat or resistance member 40.

From the foregoing description it will be seen that there has been provided an improved extremely compact and efficient wheel speed determining mechanism, embodiable initially as a part of or alternatively as an attachment for various types of grinding machines in which the speed determination is directly controlled by a member engaging and gaging or measuring the diameter of the grinding wheel in place of being effected by remote control devices or adjustment of mechanically related parts which may or may not have the presumed prescribed relation to the actual wheel diameter.

It will further be noted that there has been provided a mechanism which is movable as an entirety with the grinding wheel during any adjustments of the grinding wheel, and adjustable with respect to the grinding wheel mounting or other mechanical elements of the machine only insofar as and to the same extent as the decrease in size of the grinding wheel during operation and therefore operating wheel speed fluctuations are obviated.

It will further be noted that an improved control circuit has been provided by which excess peripheral wheel speed is at all times prevented, but which permits of any desired slowing down of the wheel speed for performance of a particular grinding operation.

It is further to be understood that the present invention relates primarily to the provision of control mechanisms for the rate of rotation or number of revolutions per minute of the grinding machine spindle including an automatic mechanism for varying the potential speed limits dependent on the wheel diameter, and additional mechanism for effecting speed variations within said limits and a third mechanism effective to counteract the first mechanism to the extent of making it possible to slow down the number of revolutions per minute below the limit otherwise established by the automatic mechanism.

It is further to be understood that while the particular type of speed control mechanism illustrated for purposes of understanding of the present invention has been shown as a variable speed motor in which the speed variations are accomplished by varying the electrical effect of the shunt field of the motor, that it is contemplated other forms of speed varying mechanisms may be employed in conjunction with my present improved controls. For example, the manually controllable or even the automatically controllable speed mechanism may be made in the form of shiftable change speed gears or an infinitely variable drive mechanism of either the mechanical or hydraulic type, or that the motor mechanism itself may be a variable hydraulic motor, such as the cam controlled commercially known "Oilgear" or other pump-motor device, and that the reactance of the control device coupled with the truing mechanism may be on the throttle or the positioning of the speed determining cam of such a hydraulic device, within the scope of the succeeding claims without departing from or exceeding the present inventive concept.

What is claimed is:

1. In a grinding machine, the combination with a grinding wheel and a variable speed motor for effecting rotation thereof, of a truing device having a followup movement whereby same may be effectively projected into engagement with the periphery of the grinding wheel during reduction in diameter thereof, electro-mechanical means for varying the speed of said motor, and operative connections between the truing device and said means for increasing the potential rate of motor operation as the truing device is moved in a direction toward the wheel.

2. In a grinding machine, the combination with a grinding wheel and a variable speed motor for effecting rotation thereof, of a truing device having a followup movement whereby same may be effectively projected into engagement with the periphery of the grinding wheel during reduction in diameter thereof, electro-mechanical means for varying the speed of said motor, operative connections between the truing device and said means for increasing the potential rate of motor operation as the truing device is moved in a direction toward the wheel, and additional means for rendering the truing device rate control mechanism ineffective.

3. A mechanism for maintaining a substantially constant peripheral speed of the operative surface of a grinding wheel for a precision grinding machine, including in combination with a support for the grinding wheel spindle and a variable speed mechanism for effecting rotation of the spindle, a first rate adjuster for selectively varying the rate of drive of the spindle within prescribed limits, a second mechanism adjustable in accordance with variations in the diameter of the wheel for varying the limits effective by the first rate adjuster, and additional means for neutralizing the one of said rate adjusters to render same ineffective as respects spindle speed variation.

4. In a precision grinding machine, the combination with the grinding wheel, its supporting spindle, and means for effecting rotation of the spindle, of a truing device radially shiftable in the direction of the operative surface of the wheel, a speed control mechanism, connections between said truing device and said speed control mechanism to vary the potential peripheral speed of the grinding wheel in accordance with the position of the truing mechanism, and additional manually operable means for varying the actual wheel speed within the limits prescribed by the reaction from adjustment of the truing device on said first speed control mechanism.

5. In a precision grinding machine, the combination with the grinding wheel, its supporting spindle, and means for effecting rotation of the spindle, of a truing device radially shiftable in the direction of the operative surface of the wheel, a speed control mechanism, connections between said truing device and said speed control mechanism to vary the potential peripheral speed of the grinding wheel in accordance with the position of the truing mechanism, additional manually operable means for varying the actual wheel speed within the limits prescribed by the reaction from adjustment of the truing device on said first speed control mechanism, and an additional control mechanism for effecting a supplemental slowing down of the wheel speed.

6. A control mechanism for the operating speed of a grinding wheel spindle including a variable speed drive for the spindle, a member positionable in definite relation to the operative peripheral surface of the grinding wheel, a first mechanism operative when said member is in projected position in the presence of a large grinding wheel to

effect a reduced number of revolutions per minute of the spindle, an additional mechanism operable when the member is in retracted position in correspondence with a smaller diameter grinding wheel for effecting a corresponding increase in revolutions per minute of the grinding wheel spindle, and an additional manually controllable mechanism for effecting corresponding variations in the number of revolutions per minute of the grinding wheel irrespective of the position of said first-mentioned member.

7. In a precision grinding machine, including a grinding wheel, a supporting spindle therefor, and a variable speed motor coupled with the spindle for effecting rotation thereof, means for determining the speed of rotation of the spindle and thus the peripheral speed of the wheel, including a truing device incrementally adjustable in a position peripherally to engage and form the face of the wheel, means for effecting incremental adjustments of said truing device, a control circuit for the variable speed motor including serially interposable resistances, and cam means carried by and shiftable with the truing device for determining the successive serial couplings of the resistances in the motor circuit, whereby the potential rate of drive of the grinding wheel and spindle is automatically determined by successive adjustments of the truing device in the direction of the operative face of the wheel.

8. In a precision grinding machine, including a grinding wheel, a supporting spindle therefor, and a variable speed motor coupled with the spindle for effecting rotation thereof, means for determining the speed of rotation of the spindle and thus the peripheral speed of the wheel, including a truing device incrementally adjustable in a position peripherally to engage and form the face of the wheel, means for effecting incremental adjustments of said truing device, a control circuit for the variable speed motor including serially interposable resistances, cam means carried by and shiftable with the truing device for determining the successive serial couplings of the resistances in the motor circuit, whereby the potential rate of drive of the grinding wheel and spindle is automatically determined by successive adjustments of the truing device in the direction of the operative face of the wheel, and additional means in the motor circuit for varying the speed of the motor and thus of the wheel spindle within the limits provided by said cam controlled potential rate determining resistances.

9. Wheel speed control means for a precision grinding machine including a rotatable spindle supporting a grinding wheel, a variable speed motor for actuation of said spindle and a truing device supported adjacent said wheel and shiftable transversely thereof for truing operations and radial with respect thereto to follow up the wheel as the diameter thereof is decreased, said means comprising a plurality of resistance elements coupleable in series in the operating circuit of the variable speed motor, one of said resistances being of the variable type, switch devices determining the effective coupling of certain of the resistances in this circuit, controllers for said switch devices, means including a cam carried by and shiftable with the truing tool in its advance toward and retraction from the grinding wheel for actuating said switch devices operatively to connect and disconnect the respective resistances with respect to the motor circuit whereby different operating speeds of the motor are effected, and means for modifying the electrical effect of the variable resistance and thereby the actual speed of the motor within the range automatically imposed by the truing device cam and adjustment of said resistance controllers.

10. In a machine of the character described, the combination with a grinding wheel spindle and a variable speed drive motor therefor, of a motor actuating circuit including a plurality of serially employable motor rate determinators including a first adjustable rate determinator in the circuit, a plurality of additional rate determinators, automatically operable means for selectively conditiong the circuit to include or exclude said additional rate determinators, and additional means for conditioning the circuit to be effective on the motor exclusive of said additional determinators irrespective of the automatic conditioning thereof.

11. The combination with a precision grinding machine including a bodily shiftable rotatable grinding wheel and a truing device mounted for movement therewith and relative thereto, of means for automatically controlling the rate of rotation of said grinding wheel including a variable speed drive motor mechanically coupled with the grinding wheel for actuation thereof, a power circuit for the motor including a variable resistance speed control element and a plurality of fixed resistance speed control elements, connections between said fixed resistance elements and the truing device for effecting coupling of the circuit by way of or exclusive of said fixed resistance elements dependent on the adjustment of the truing device with respect to the axis of rotation of the grindng wheel, and additional means for coupling the circuit to the motor exclusive of said fixed resistance elements irrespective of the circuit conditioning effected by movement of the truing device.

12. The combination with a precision grinding machine including a bodily shiftable rotatable grinding wheel and a truing device mounted for movement therewith and relative thereto, of means for automatically controlling the rate of rotation of said grinding wheel including a variable speed drive motor mechanically coupled with the grinding wheel for actuation thereof, a power circuit for the motor including a variable resistance speed control element and a plurality of fixed resistance speed control elements, connections between said fixed resistance elements and the truing device for effecting coupling of the circuit by way of or exclusive of said fixed resistance elements dependent on the adjustment of the truing device with respect to the axis of rotation of the grinding wheel, and additional means for coupling the circuit to the motor exclusive of said fixed resistance elements irrespective of the circuit conditioning effected by movement of the truing device, said truing device control including cam elements carried by and movable with the truing device and controllers individual to the respective fixed resistances separately engaging and independently operable by said respective cam elements.

WINTHROP TRIBLE.