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F. W. BLANCHETTE

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GAGING APPARATUS FOR GRINDING MACHINES AND THE LIKE

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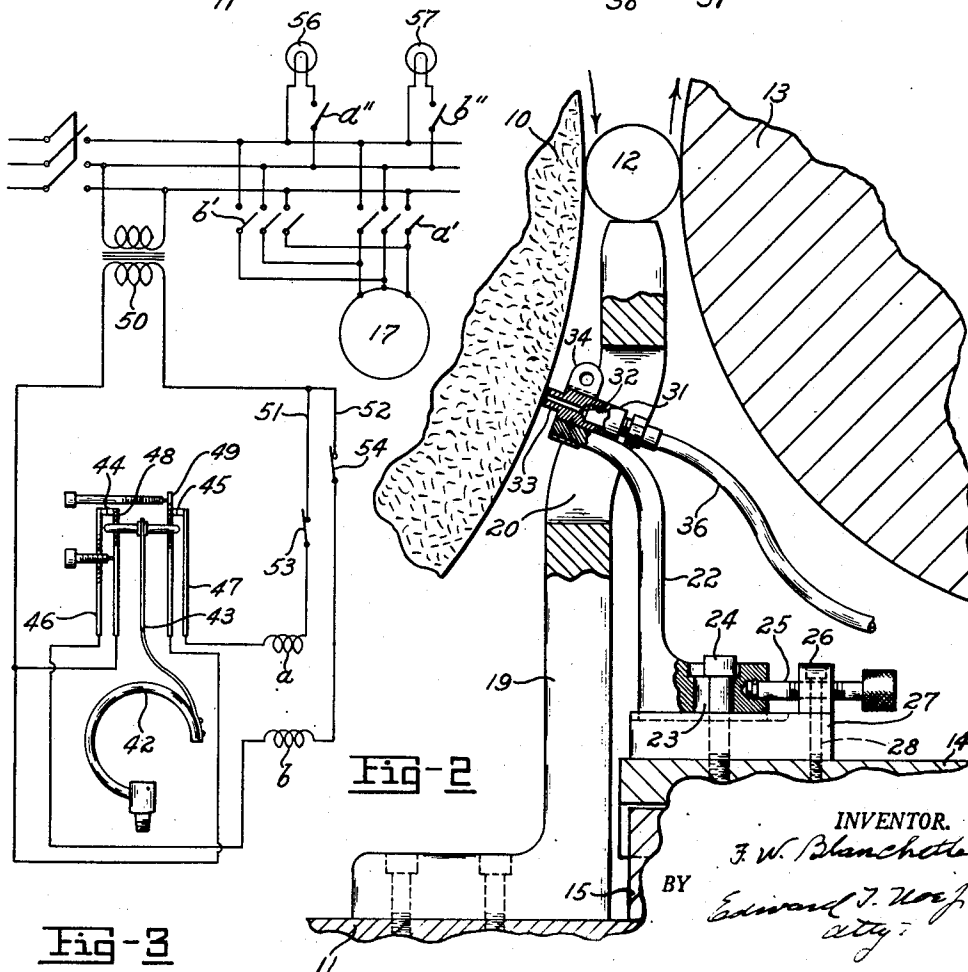
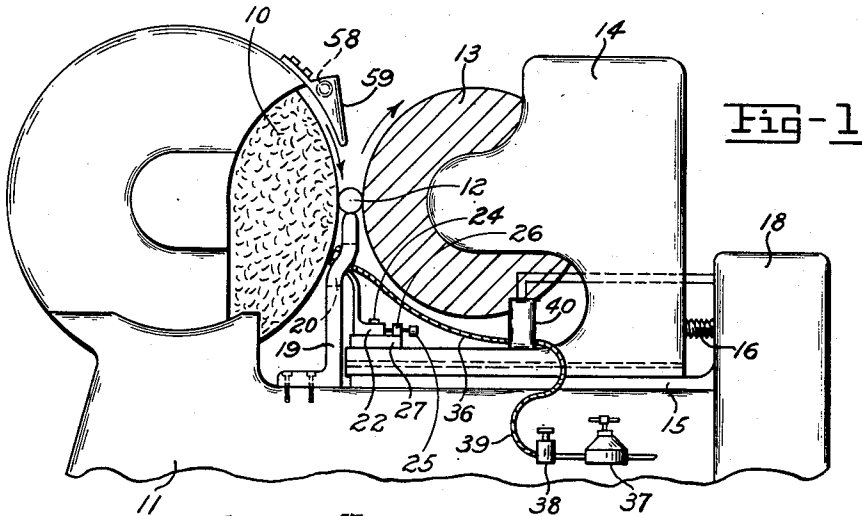


Fig-3

INVENTOR.
F. W. Blanchette
BY
Edward J. Neuf
att'y.

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GAUGING APPARATUS FOR GRINDING
MACHINES AND THE LIKE

Frank W. Blanchette, Montclair, N. J.

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This invention relates to grinding machines and the like and more particularly to the gauging of the size of the part which is machined.

One object of the invention is the provision of a grinding machine having an air gauging device which cooperates with the grinding surface of the grinding wheel and which is so arranged as to permit compensation for grinding wheel wear in controlling the size of the part operated upon.

Another object is the provision of a grinding machine of the character mentioned having an adjustable slide forming the support of a cooperating wheel, the nozzle of the air gauge being carried on the slide for movement therewith.

Another object is the provision of a centerless grinding machine having a grinding wheel and a slide supported regulating wheel, the slide also supporting the holder on which the gauging nozzle is located so that the end of the nozzle cooperates with the grinding wheel, with means automatically controlled by the air gauging system to maintain a definite predetermined size of the part ground.

Another object resides in the method of controlling a grinding machine in which the work is ground between the grinding wheel and a regulating wheel and in which an air gauging nozzle cooperating with the surface of the grinding wheel is employed in gauging the size of the part.

Other objects and advantages of the invention will be apparent from the following description, the appended claims and the accompanying drawing, in which,

Fig. 1 is a side elevation of the upper portion of a grinding machine embodying the present invention;

Fig. 2 is an enlarged side elevation of a portion of the grinding machine; and

Fig. 3 is a diagrammatic illustration of the electrical circuits.

Referring more particularly to the drawing in which the same reference numerals are applied to like parts in the different views, the invention as herein illustrated is incorporated in a grinding machine or the like in which the work is ground or finished by a grinding or surfacing wheel 10 arranged for rotation on the machine frame 11 and operated by a suitable motor of any conventional character. In the particular form of machine shown for purposes of illustration, the work 12 is ground or finished in a centerless grinder between the grinding wheel and a regulating wheel 13 which is rotatably

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mounted on a slide or carriage 14 slidable on guideways 15 towards and from the grinding wheel. The wheels may be of cylindrical form or, if the work is to be finished with a curved or angular surface or surfaces as in the case of thread grinding, the wheels are surfaced or formed to produce the desired shape on the part ground. The regulating wheel may be driven in any conventional manner employed in centerless grinders.

The slide 14 is adjustable by means of an adjusting screw 16 operated by an electric motor 17 contained in the motor housing 18 so that the position of the regulating wheel 13 with respect to the grinding wheel may be such as to give the desired diameter to the part being ground. It will be understood that reference herein to the term "grinding" also includes lapping or other abrasive finishing.

As is usual in centerless grinders, the work is supported so it is substantially in the plane containing the axis of the grinding and regulating wheels. This support 19, as shown, is carried directly on the frame 11. The support has an opening 20 the purpose of which will be later referred to.

A holder 22 is adjustably mounted on the slide 14 for movement towards and from the grinding wheel. This holder, as shown, has an elongated passage 23 and is held firmly in place by a screw 24 extending down through this passage and threaded in the slide 14. When the screw 24 is loosened, the holder 22 can be shifted in guides provided in the holder base 27 by rotating the adjusting screw 25 which is threaded in a post 26 projecting upwardly from the base 27. The base is secured firmly to the slide 14 by one or more hold down screws 28.

The holder 22 extends upwardly and through the opening 20 of the work support and at its upper end it carries a body member 31 below the mid point of the work being ground. This body member has an axially extending passage 32 terminating in an outlet nozzle 33 facing the grinding wheel but spaced therefrom. The body member 31 may be of substantially cylindrical form, clamped adjustably on the holder 22 by means of the split clamp ring 34 so that the position of the body member on the holder can be adjusted towards and from the axis of the grinding wheel. The passage 32 is supplied with air under pressure from a conduit 36. Air is supplied under pressure from the factory air line, for example, to a pressure regulator 37 through an adjustable flow restrict-

ing valve 38 to a conduit 39 leading to a connection block 40 from which the conduit 36 extends. The connection block 40 supports and is connected to a pressure responsive device which preferably, as herein shown, includes a pressure responsive element 42 operating an arm 43, controlling electric switches 44 and 45. The pressure responsive switches comprised of the elements just mentioned may be of the character disclosed in Aller Patent 2,448,653, granted September 7, 1948. The switch blade 46 of the pressure controlled switch is connected to a relay b. The switch blade 47 is connected to a relay a. Switch blades 48, 49 are connected together and to one side of the secondary 50 of a transformer, the other side of the secondary being connected through wires 51 and 52 respectively to the relays a and b through manually operable normally closed switches 53 and 54. Ordinarily under operating conditions and when the nozzle is properly positioned from the grinding wheel, the limited space between the rotating grinding wheel and the end of the nozzle 33 restricts the flow of air under pressure to such an extent as to produce a pressure on the pressure responsive element 42 so that the arm 43 is centrally positioned as shown in Fig. 3 and the circuits are closed through relays a and b. When these circuits are closed the switches a' and b' respectively are opened. These switches a' and b' control operation of the motor 17 in one direction or the other according to which one is closed.

The relays a and b also control switches a'' and b'' respectively so as to close these switches when the relays are deenergized. Each of the switches a'' and b'' is connected in series with a signal lamp or indicator such as the lamps 56 and 57 respectively.

Cooling liquid is supplied through a pipe 58 to a supply tank 59 from which the liquid flows down onto the work 12 during operation. Thus there is a continuous film of liquid on the grinding wheel below the work location but there is no large collection of the liquid below the workpiece. The nozzle itself is preferably a round opening having a diameter of the order of several hundredths of an inch. The face of the nozzle facing towards the grinding wheel is preferably surfaced by the grinding wheel itself before set up. After being set up properly on the machine, by adjusting the screw 25 or by moving the nozzle body 31 in its clamp 34, there is a small spacing between the grinding wheel and the end face of the nozzle of the order of a thousandths of an inch. It has been found that with a 60 grit wheel, with a space of one-thousandth of an inch between the nozzle and the wheel and using twenty-five pounds pressure at the outlet of the pressure regulator, and with a .072" round jet hole, with the grinding wheel rotating about 3000 R. P. M., there is a very accurate control of the size of the workpieces produced. When the grinding wheel wears slightly in operation, the space between the grinding wheel and the end of the nozzle increases so as to permit the air leakage of air from the nozzle to increase and thus slightly lower the pressure to which the element 42 is subjected. This opens the contact between the switch blades 49 and 47, opening relay a to close motor control switch a' while simultaneously closing signal light control switch a''. Thus the operator is aware that the tolerance limits of the grinding operation are being exceeded,

and where there is no automatic control of the motor 17, he can manually control the motor, although it is preferred to have this control automatic, as by having the relay a control the switch a' directly as shown. The motor thus turns the screw 16 and moves the regulating wheel closer to the grinding wheel until the switch blades 47 and 49 contact again, whereupon this movement stops. The normal operation conditions are thus automatically restored and grinding wheel wear automatically compensated. As the regulating wheel is moved towards the grinding wheel, the nozzle itself is of course moved to an equal degree thus effectively maintaining an accurate control of the size of the parts produced.

In set up, the nozzle is positioned by trial or experience at what is thought to be the proper position from the grinding wheel and with the coolant liquid flowing on the work or part being ground. A part is ground and then examined for size after being removed from the machine to see that the set up is proper. If the size of the part produced is not precisely correct, the position of the nozzle is properly adjusted so the next piece produced will be ground to the precise size required, within the specified tolerance limits. Since the end of the nozzle is always spaced from the grinding wheel at least after initial setup, there will be no substantial wear on the end of the nozzle and since the speed of the grinding wheel is relatively constant in operation and the workpiece itself keeps the thickness of the film of coolant liquid on the grinding wheel just below the work location substantially constant, the gauging produced by the nozzle is extremely accurate and adequate to maintain a part size to within one ten-thousandth of an inch or even much less.

The same gauging indication will not obtain if the grinding wheel is stationary or if there is no coolant liquid flowing as obtains during normal operation because the speed of the grinding wheel has some effect on the reading. The presence of the film of coolant liquid on the grinding wheel also has some effect on the rate at which air will discharge from the end of the nozzle, so the setup is made under normal operating or running conditions. The exact positioning of the nozzle is determined, as previously mentioned, by accurately gauging the finished part after a trial run following preliminary setup, to determine any size deviation in the setup arrangement so that it can be corrected by adjustment of the nozzle position.

While the form of apparatus and the method of operation herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited thereto, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A grinding machine comprising a grinding wheel, a support for said grinding wheel, an adjustable slide on said support, work positioning means carried by said slide for arranging the work to contact the grinding wheel at a grinding zone, a body carried by said slide, said body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice,

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means for supplying air under regulated pressure to said body passage, said means for supplying air including a connection means to said body passage, and means operatively connected to said connection means and responsive to air flow through said orifice for indicating an increase in the space between the orifice and the grinding wheel beyond a predetermined limit.

2. A grinding machine comprising a grinding wheel, a regulating wheel, a support for said grinding wheel, a slide mounted on said support and mounting said regulating wheel for movement towards the grinding wheel, a body carried by said slide, said body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice, means for supplying fluid under regulated pressure, a connection including a flow restricting means between the body passage and the fluid supplying means, a pressure responsive switch connected between the orifice and the flow restricting means, and indicating means controlled by said switch.

3. A grinding machine comprising a grinding wheel, a regulating wheel, a support for said grinding wheel, a slide mounted on said support and mounting said regulating wheel for movement towards the grinding wheel, a body carried by said slide, said body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice and at a point below the normal zone of engagement of the grinding wheel with the work, means for supplying fluid under regulated pressure, a connection including a flow restricting means between the body passage and the fluid supplying means, a pressure responsive switch connected between the orifice and the flow restricting means, and means controlled by said switch for automatically shifting said slide to maintain a predetermined spacing between the orifice and the grinding wheel.

4. In a grinding machine having a grinding wheel, a second wheel spaced from the grinding wheel and adapted for cooperation therewith to engage opposite sides of the work to be ground, a slide supporting said second wheel, gauging means comprising a body having a passage terminating in an orifice, means for supporting said body on said slide so that the orifice faces the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice at a point below the level of the grinding wheel axis, means for supplying fluid under regulated pressure, a connection between said fluid supplying means and the body passage, pressure responsive means connected to the body passage and means controlled by said pressure responsive means for indicating a change in the space between the orifice and the grinding wheel.

5. In a grinding machine having a grinding wheel, a second wheel spaced from the grinding wheel and adapted for cooperation therewith to engage opposite sides of the work to be ground, a slide supporting said second wheel, gauging means comprising a body having a passage terminating in an orifice, means for supporting said body on said slide so that the orifice faces the operating surface of the grinding wheel in such

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closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice at a point below the level of the grinding wheel axis, means for supplying fluid under regulated pressure, a connection between said fluid supplying means and the body passage, pressure responsive means connected to the body passage, means for supplying cooling liquid to the grinding wheel above the work location, and means controlled by said pressure responsive means for automatically controlling the position of said second wheel with respect to the grinding wheel.

6. A grinding machine comprising a grinding wheel, a support for said grinding wheel, an adjustable slide on said support, work positioning means on said slide for supporting a workpiece for contact with the grinding wheel at a grinding zone, an air gauging means on said slide, said air gauging means including a body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the flow of air through the orifice is directly controlled by the grinding surface of the grinding wheel.

7. The method of controlling a grinding machine having a grinding wheel and an adjustable cooperating wheel which controls the parts position, which method comprises gauging the wear of the grinding wheel by controlling air flow directly by the surface of the grinding wheel when the grinding wheel is operating at a normal grinding speed, and adjusting the position of the cooperating wheel in accordance with the results of the gauging operation to maintain a required size of the parts ground.

8. The method of controlling a grinding machine having a grinding wheel and a cooperating regulating wheel which comprises supplying coolant liquid onto the work, and at a point below the work gauging the wear of the grinding wheel by controlling air flow directly by the wet surface of the grinding wheel when the grinding wheel is operating at a normal grinding speed and controlling the position of the regulating wheel in accordance with the results of the gauging operation.

9. The method of controlling a grinding machine having a grinding wheel and a work positioning means which comprises supplying coolant liquid onto the work from above, and at a point below the work gauging the wear of the grinding wheel by controlling the flow of air from an air orifice directly by the wet surface of the grinding wheel when the grinding wheel is operating at a normal grinding speed and concurrently and equally positioning the work positioning means and the air orifice in accordance with the results of the gauging operation.

10. A grinding machine comprising a grinding wheel, a support for said grinding wheel, a slide on said support, work positioning means on said slide for supporting a workpiece for contact with the grinding wheel at a grinding zone, means for supplying coolant liquid onto the workpiece from above, and an air gauging means on said slide, said air gauging means including a body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel below the grinding zone in such closely spaced relation therewith that the flow of air to the orifice is directly controlled by the wet surface of the grinding wheel.

11. A grinding machine comprising a grinding

wheel having a peripheral grinding surface, a first support for said grinding wheel, a second support, work positioning means on said second support for supporting a workpiece for contact with the grinding wheel at a grinding zone, means for supplying a coolant liquid onto said workpiece from above, an air gauging means on said second support, said air gauging means including a body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relationship therewith that the flow of the air through the orifice is directly controlled by the grinding surface of the grinding wheel, the fluid leakage orifice facing the grinding wheel below the grinding zone, and means for relatively adjusting the first and second supports in accordance with the results of the gauging operation.

12. A grinding machine comprising a grinding wheel, a support for said grinding wheel, an adjustable slide on said support, work positioning means on said slide for supporting a workpiece for contact with the grinding wheel at a grinding zone, an air gauging means on said slide, means supporting said air gauging means in adjustably fixed positions on said slide, said air gauging means including a body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the flow of air through the orifice is directly controlled by the grinding surface of the grinding wheel.

13. A grinding machine comprising a grinding wheel, a support for said grinding wheel, a slide on said support, work positioning means carried by said slide for arranging the work to contact the grinding wheel at a grinding zone, said slide being adjustable for movement towards the grinding wheel, a body carried by said slide, said body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice, means for supplying fluid under regulated pressure, a

connection including a flow restricting means between the body passage and the fluid supplying means, a pressure responsive switch connected between the orifice and the flow restricting means, and an indicating means controlled by said switch.

14. A grinding machine comprising a grinding wheel, a support for said grinding wheel, a slide on said support, work positioning means carried by said slide for arranging the work to contact the grinding wheel at a grinding zone, said slide being adjustable for movement toward the grinding wheel, a body carried by said slide, said body having a passage terminating in a fluid leakage orifice facing the operating surface of the grinding wheel in such closely spaced relation therewith that the grinding wheel directly controls the flow of air through the orifice, and at a point below the normal zone of engagement of the grinding wheel with the work, means for supplying fluid under regulated pressure, the connection including a flow restricting means between the body passage and the fluid supplying means, a pressure responsive switch connected between the orifice and the flow restricting means, and means controlled by said switch for automatically shifting said slide to maintain a predetermined spacing between the orifice and the grinding wheel.

FRANK W. BLANCHETTE.

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