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SIZE GAUGING DEVICE ON HONING TOOL

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3 Sheets-Sheet 1

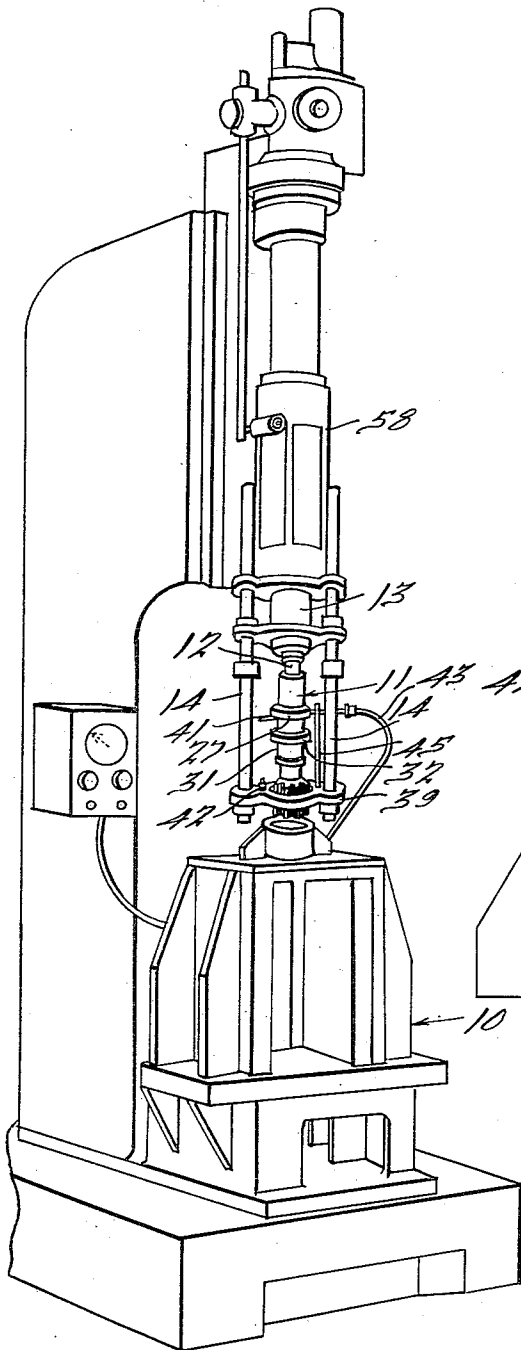


Fig. 1.

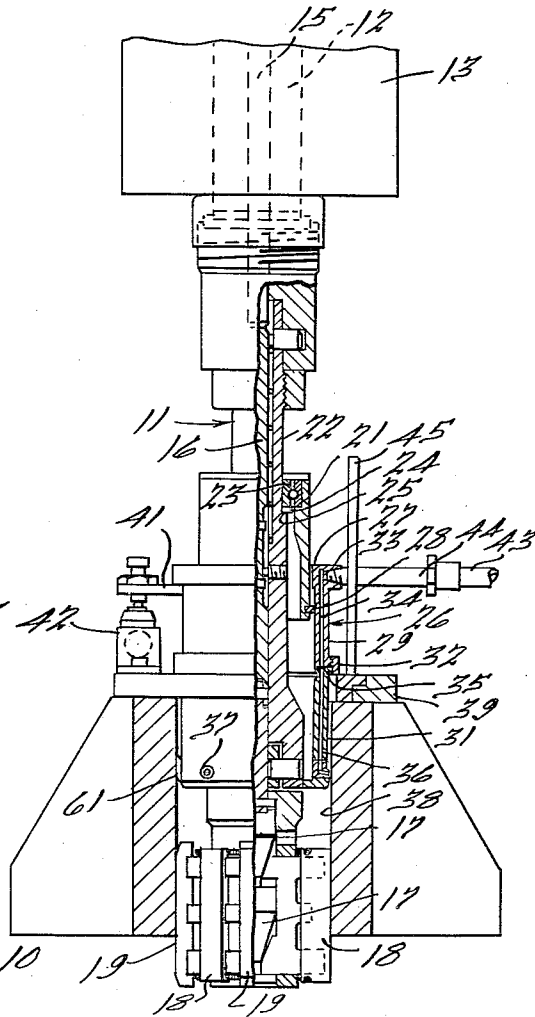


Fig. 2.

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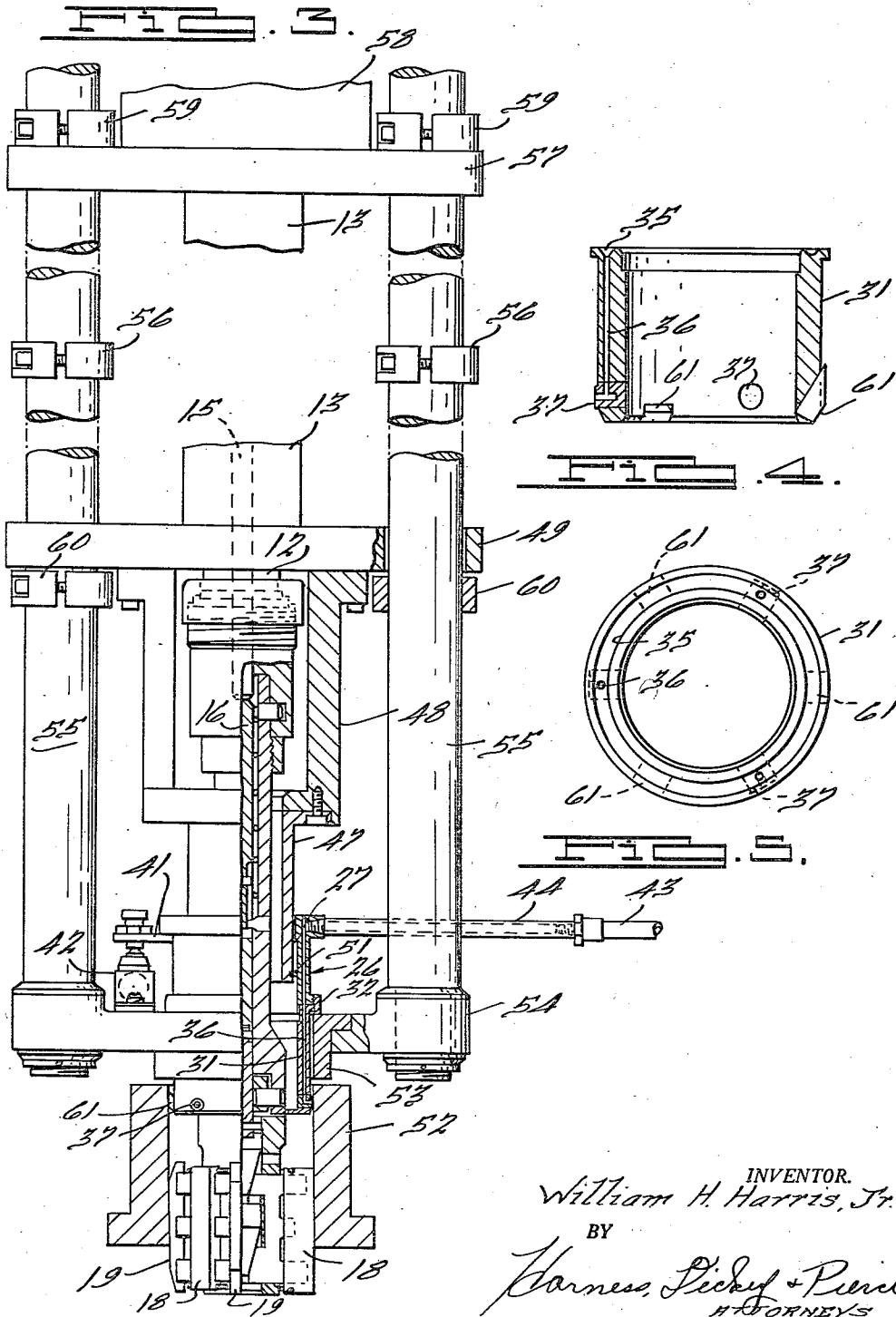
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3 Sheets-Sheet 2



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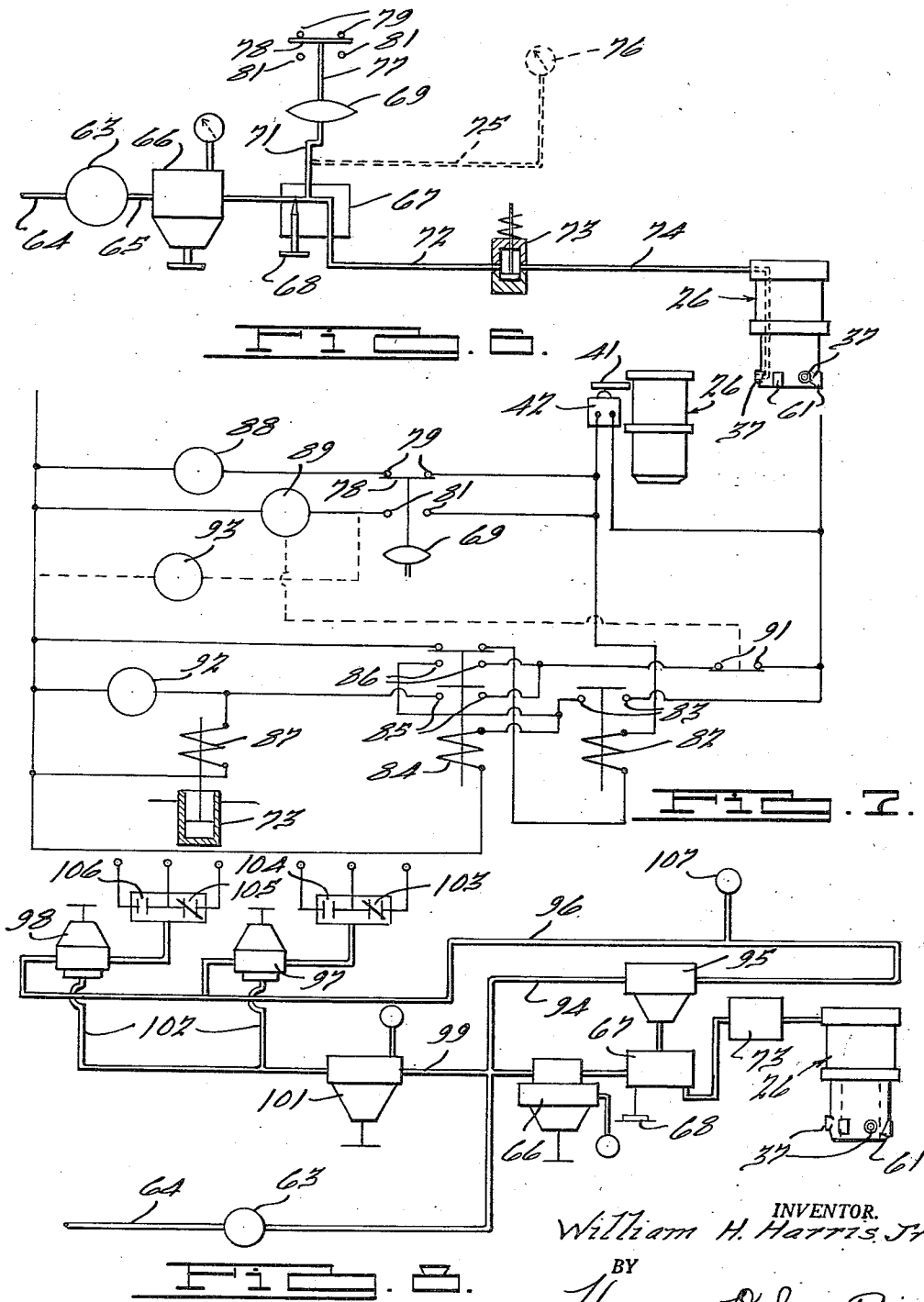
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3 Sheets-Sheet 3



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SIZE GAUGING DEVICE ON HONING TOOL

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7 Claims. (Cl. 51—34)

This invention relates to air gauging devices for controlling the termination of honing operations, and particularly to an air gauging device for cylindrical bores of workpieces which becomes operative near the end of the honing operation.

Air gauging has been employed heretofore for many purposes and has been used for honing cylindrical workpieces, as disclosed in the patent to J. E. Kline, No. 2,284,325, issued May 26, 1942, and assigned to the assignee of the present invention. In this type of honing, the air for gauging is supplied throughout the honing operation, during the rough honing operation, as well as the finish honing.

In accordance with the present invention, where rough and finish honing are to be accomplished in a single operation, the air gauge mechanism is inoperative throughout most of the honing operation and becomes effective only during the final honing stage. This delayed action of the gauging device is accomplished by a sleeve which can enter the bore only when the approximate diameter is reached. Thereafter, the sleeve carries the gauging device into the bore upon each downward stroke of the honing tool. When the gauging device enters the bore during each downward stroke of the tool, air is directed through the gauging nozzles against the surface of the bore and the drop in pressure of the supplied air accurately gauges the final size to which the bore diameter is finish honed.

Accordingly, the main objects of the invention are: to provide a gauging device for honing a bore which comes into operation near the end of the honing cycle when size is substantially reached; to provide a gauging device for a honing tool which may be mounted on the tool or on the support for the tool, having a body of a size which prevents the air gauging nozzles carried thereby from entering the bore until size is substantially reached; to provide an air gauging device having a diameter slightly smaller than the desired diameter which will not enter the bore when given an opportunity to do so each downward stroke of the tool until the honing operation has increased the bore size to slightly less than the desired size, and, in general, to provide a device for gauging the size of a bore which is simple in construction, positive in operation and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a perspective view of a honing machine having a gauging device thereon, embodying features of the present invention, with the gauging device mounted on the tool;

Fig. 2 is an enlarged, broken sectional view of the structure illustrated in Fig. 1;

Fig. 3 is a view of structure, similar to that illustrated in Figs. 1 and 2, showing the gauging device mounted on the reciprocating support for the tool;

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Fig. 4 is an enlarged sectional view of the gauge body which enters the bore, having gauging nozzles thereon;

Fig. 5 is a plan view of the body illustrated in Fig. 4; Fig. 6 is a diagrammatic view of a fluid circuit employed with the air gauging device of the present invention;

Fig. 7 is a view of a wiring diagram of the circuit for controlling the operation of the units in the fluid circuit illustrated in Fig. 6, and

Fig. 8 is a diagrammatic view of another fluid circuit which may be employed with the gauging device of the present invention.

Referring to Figs. 1 and 2, a honing machine 10 is illustrated having thereon a honing tool 11 provided with an air gauging device of the present invention. A rotatable spindle 12, reciprocated by a ram 13, supports the tool 11 and drives it in rotation and reciprocation. A pair of guide bars 14 is mounted on the end of the ram 13 having an apertured plate 39 at the lower ends which is lowered toward the workpiece during each downward movement of the tool and raised therefrom while the tool is withdrawn from the workpiece to have the wall of the aperture encompass the hone body. The spindle 12 has a feed rod 15 disposed centrally therein for lengthwise movement to advance a rod 16 of the tool and cones 17 on the forward end thereof for moving the honing stones 18 radially. Guide elements 19 are provided on the tool between the stones 18 for guiding the tool on the surface of the cylinder bore, such elements being fixed or adjustable radially relative to the tool body. The tool is reciprocated and rotated to perform the honing operation on the cylinder bore as the stones are urged outwardly by the cones 17 and the rod 15 is fed downwardly at a predetermined rate.

A sleeve 21 is supported about the honing tool spindle 22 on a bearing 23 which rests upon a ring 24 supported on a shoulder 25 of the tool body. A gauging device 26 surrounds the sleeve 21 having an inwardly directed shoulder 27 at the top engageable by a ring 28 of the split type which is retained in an annular recess in the outer face of the sleeve 21. When the sleeve is raised, the ring 28 strikes the shoulder 27 and raises the gauging element 26 therewith. Clearance is provided between the sleeve 21 and the shoulder 27 so that the gauging device 26 may shift relative thereto. The vertical distance between the ring 28 and shoulder 27 is less than the vertical distance between the top end of the guiding elements 19 and stones 18 and the bottom of the gauging element 26 so that when the tool and sleeve 21 are raised, the top ends of the guide elements and stones will never strike the bottom of the gauging element.

The gauging element 26 has a sleeve 29 joined to a sleeve 31 in extension thereof by an internally threaded ring 32. The sleeve 29 has a port 33 at the top joined by vertical passageways 34 which communicate with an annular recess 35 in the top face of the sleeve 31, as more clearly shown in Fig. 4. When the two sleeves are secured together by the ring 32, air entering the port 33 passes into the annular passageway 35 and then through passageways 36 to nozzles 37, from which the delivered air impinges against the surface of the cylindrical wall being honed. When a honing operation is initiated, the bottom of the sleeve 31 will strike the top of the workpiece 38 and will not enter the bore if the diameter is less than the finished diameter. This will occur upon each reciprocation of the honing tool until the bore diameter has been enlarged sufficiently to permit the sleeve 31 of the gauging device 26 to enter the bore which will thereafter occur each time the tool passes downwardly in the bore, as illustrated in Fig. 2.

Upon the reciprocation of the tool upwardly, the ring 28 will strike the shoulder 27 and cause the withdrawal of the gauging element 26 from the bore as the tool moves

outwardly thereof an amount less than half of the length of the stone 18. Upon the downward reciprocation, the sleeve 31 of the gauging element 26 will again enter the bore so that air gauging may occur. The ring 32 which joins the sleeves 29 and 31 will rest upon the plate 39 when the sleeve 31 enters the bore, and before this occurs a finger 41 on the sleeve 29 will strike the plunger of a switch 42 secured on the plate 39. The operation of the switch 42 produces the energization of a valve (not shown) for introducing air into a flexible conductor 43 and a connector 44 which is threaded or otherwise secured to the sleeve 29. From the connector 44 the air passes into the port 33, passageways 34, 35 and 36, to the nozzles 37. The plate 39 supports a rod 45 against which the connector 44 abuts to prevent the rotation of the gauging device 26 as the honing tool rotates. As the sleeve 31 of the gauging device 26 enters the bore, the air will be turned on to have it pass from the nozzles 37 against the surface of the bore being honed, and when the bore has enlarged sufficiently to cause a drop in the pressure of the air being delivered, indication is provided that the desired bore size has been reached. A servo mechanism is actuated by the drop in pressure which contracts the stones of the honing tool and withdraws the tool from the bore directly or after a desired run-in period occurs, with the stones of the tool retained on a fixed diameter to produce a finishing operation.

In Fig. 3 a similar construction is illustrated, one wherein a gauge supporting sleeve 47 is mounted on a yoke 48 attached to a plate 49 secured to the end of the sleeve 13. As the sleeve is raised, the yoke 48 and sleeve 47 are raised therewith. A ring 51 on the outer surface of the sleeve 47 strikes the shoulder 27 of the gauging device 26 and raises the gauging device from the workpiece 52 before the guiding elements and stones of the tool strike the bottom of the sleeve 31 of the gauging device. When the tool is lowered into the bore, the bottom of the sleeve 31 engages the top of the workpiece 52 when the bore is undersize and will continue to do so each downward reciprocation of the tool until sufficient material has been removed from the bore to permit the gauging device 26 to enter therein, as illustrated in the figure. When this occurs, the ring 32 of the gauging device strikes the guide cylinder 53 to limit the downward movement of the gauging device while the tool and sleeve 47 are permitted to continue the downward movement. Prior to the time the ring 32 strikes the guide cylinder 53, the finger 41 of the gauging device 26 engages the plunger of the switch 42 to operate a solenoid valve and cause a flow of air through the conductor 43 and connector 44 to the gauging device 26 and to set up an electric responsive circuit.

The guide ring 53 is carried on a plate 54 on a pair of rods 55. These rods are raised after the honing tool has been raised an amount to permit the stones 18 and guide elements 19 to move within the guide ring 53, whereupon the plate 49 strikes the stop rings 56 to cause the rods 55 and the plate 54 to move upwardly as a unit with the sleeve 13. An additional plate 57 is mounted on the cylinder 58 of the machine through which the rods are guided during the reciprocating movement. Stop rings 59 on the rods engage the plate 57 when the sleeve 13 is moved downwardly to limit the downward movement of the rods and plate 54. Upon the downward movement of the spindle 12 and sleeve 13, the honing tool 11 and rods 55 move downwardly therewith until the rings 59 engage the plate 57, at which time the tool 11 will move out of the ring 53 and pass into the bore of the workpiece 52. The ring 51 is spaced a sufficient distance from the shoulder 27 to permit the stones 18 and guide elements 19 to be moved from the upper end of the bore of the workpiece without contacting the gauging ring upon the final withdrawal of the honing tool from the bore. When the plate 49 engages the rings 56, 75

the plate 54 positions the ring 53 about the tool to maintain the guide elements and stones therewithin upon the further upward movement of the sleeve 13.

As illustrated in Figs. 4 and 5, the sleeve 31 of the gauging device 26 has at least three jet nozzles 37 equally spaced on the lower peripheral surface thereof. Interjacent the nozzles 37, hardened blocks 61 are provided which are tapered to guide the sleeve 31 into the bore. These hardened blocks may be changed to conform the sleeve 31 to a change in the desired bore diameters. The nozzles will be adjusted outwardly or inwardly to conform to the new diameter. Also, the blocks may be renewed from time to time in case of wear without damage to the gauging device. The shoulder 27 of the gauging device 26 is spaced from the sleeves 21 and 47 so that it may shift laterally if urged to do so by the blocks 61 to accurately center the nozzles relative to the bore axis. Since the wear of the stones of the tool may occur in disproportionate amounts, there is no assurance that the axis of the tool will coincide with the axis of the bore, and it is for this reason that the gauge is permitted to shift laterally so that it may automatically center its axis on that of the bore each time it enters therein. For controlling the delivery of air to the nozzles 37 when the sleeve 31 enters the bore and for gauging from the rate of flow of air, reference will now be had to the wiring diagram and air circuit employed in combination with the gauging devices 26 as illustrated on the tool and on the sleeve 13 of Figs. 2 and 3, respectively.

A simple fluid circuit for controlling the gauging of diameter size for a long bore when the gauge will remain within the bore for a substantial time each reciprocation is illustrated in Fig. 6. In this arrangement, a filter 63 is connected in a supply line 64 which is joined by a line 65 to a pressure regulating device 66 of conventional form. Air under regulated pressure is conducted through a control valve 67 wherein the rate of flow is controlled by a needle 68. The air flowing from the valve 67 is directed by a conduit 71 to a pressure diaphragm 69. A conduit 72 communicating with the conduit 71 is connected to a solenoid actuated valve 73 from which a conduit 74 extends to the gauging device 26. A conduit 75 may also be connected to the conduit 71 and to a gauge 76 to provide visual indication of the pressure in the circuit which may be desirable for repeating similar operations by setting the needle 68 of the valve 67.

The diaphragm of the device 69 is connected by a rod 77 to a conducting bar 78 for the purpose of bridging sets of contacts 79 and 81. Before the operation, when air is freely flowing from the nozzles of the gauging device 26, the needle valve 68 is carefully adjusted to permit the pressure diaphragm 69 to retract the bar 78 and bridge the contacts 81. When restriction is provided to the flow of air from the nozzles, the back pressure in the conduits 72 and 74 causes the pressure diaphragm 69 to move the conducting bar 78 outwardly to bridge the contacts 79. This will occur during the honing operation when the sleeve 31 of the gauging device 26 first enters the bore. As the diameter of the bore increases while the honing operation progresses, the back pressure in the conduits 72 and 74 will reduce and when this reduction is sufficient, the pressure diaphragm 69 will drop the conducting bar 78 to bridge the contacts 81 and indicate that size has been reached. The honing operation may be discontinued by the circuit completed by the bridging of the contacts 81 either directly or after a "run-in" time.

In Fig. 6 a wiring diagram is illustrated, employed in connection with the fluid system illustrated in Fig. 5. The finger 41 of the gauging device will operate the switch 42 to close its set of contacts each time the gauging device 26 enters the bore. Prior to this time, the fluid circuit is inoperative and the valve 73 is closed, preventing the admission of air to the gauging device. When the switch 42 is closed, a solenoid 82 is energized, closing contacts

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83 to complete a circuit to a solenoid 84 which completes a circuit to contacts 85 and contacts 86. The contacts 86 complete a holding circuit through the solenoid 84 which will become de-energized when the solenoid 82 is de-energized upon the upward movement of the finger 41 from the switch 42 each reciprocation of the honing tool thereafter. The contacts 85 energize a solenoid 87 for opening the valve 73, providing a flow of air through the nozzles of the gauging device 26. Contacts 79 are closed since the back pressure from the nozzles will maintain pressure on the diaphragm 69 and cause the contacts to be bridged by the conducting bar 78. The closing of the contacts 79 energizes a relay 88 which controls the speed of honing and the rate of feed of the honing stones. When the flow of air from the nozzles has increased a predetermined amount as the honing operation continues, the reduction in back pressure on the diaphragm 69 will cause the conductor bar 78 to move downwardly, breaking the contacts 79 and bridging the conductors 81. When this occurs, indication is had that the bore has reached the desired diameter.

The completion of the circuit through the contacts 81 energizes a relay 89 which opens contacts 91 to de-energize the solenoids 84 and 87 and thereby interrupt the flow of air to the gauging device 26. The relay 89 may immediately cause the stones of the tool to retract and the tool to be withdrawn from the work or may set up a "run-out" time adding a number of strokes to the honing tool without feeding the stones outwardly for the purpose of finishing the surface of the bore. During the gauging operation, the air is constantly flowing from the nozzles of the gauging device, and while the conducting bar 78 may shift from the contacts 79 to 81 due to the lack of back pressure in the conduits 72 and 74 when the gauging device is out of the bore, no indication will result therefrom since the contacts and switch 42 are opened. These contacts are only closed after back pressure is produced on the air in the conduits 72 and 74 after the gauging device enters the bore, at which time the conducting bar 78 bridges the contacts 79. When size is reached, the back pressure has reduced sufficiently to permit the diaphragm 69 to function to move the conducting bar 78 to bridge the contacts 81 and open the circuit through contacts 79. A lamp 92 may be placed in circuit with the contacts 85, to be lighted during the time the gauging operation is in effect, that is to say, between the time the gauging device 26 enters the bore until size is reached. An additional light 93 may be placed in circuit with the contacts 81 which will become energized at the time size is reached to give visual indication of the "run-out" period thereafter and the termination of the operation. This light will flash each time the gauge enters the bore after final size has been reached and the lamp will be de-energized when the gauging device 26 is withdrawn from the workpiece.

In Fig. 8 another type of fluid circuit is illustrated, that which may be employed on a workpiece having short bores, one in which the gauging device is in the bore a very short time. This fluid circuit provides a more rapid response so that accurate gauging will occur in the short time in which the sleeve 31 is within the bore. The supply of fluid from the conduit 64 passes through the filter 63 to the regulator 66, valve 67, solenoid valve 73 to the gauging device 26 in the same manner as illustrated in Fig. 6. However, the fluid from the filter also enters through a conduit 94 to a booster 95 from which the back pressure of air from the gauging device 26 is conducted through a conduit 96 to one side of the diaphragms in pressure responsive devices 97 and 98. Air from the filter 63 also passes through a conduit 99 through a regulator 101 through conduits 102 to the opposite side of the diaphragm of the devices 97 and 98. Adjustment is so made as to have the device 97 operate upon a differential of pressure higher than that which operates the responsive device 98. Therefore, after the gauging opera-

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tion is initiated, upon the passage of the sleeve 31 into the bore, the operation will continue until the pressure differential is such that the device 97 will operate to open a switch 103 and close a switch 104. The operation of switches can be utilized for changing the speed of reciprocation of the tool and the feed-out of the stones 18 thereof. When further differential in pressure occurs, the device 98 will operate for opening the contacts 105 and closing the contacts 106 which may be utilized for controlling the size either by terminating the operation or setting up a "run-out" period. Such an arrangement is desirable if additional honing is required due to the shrinkage which may occur to the bore after the operation, or for some other reason. In view of the fact that higher pressures may be used in the system, a more rapid response will occur to the devices 97 and 98 so that such responses will occur even though the gauging device 26 is within the bore only a short time due to the fact that the bore is short in length. A gauge 107 in the conduit 96 indicates the pressures within the conduit and the pressures present at the time the devices 97 and 98 operate.

In any of the arrangements herein illustrated and described, the gauging of the bore will not occur until such size is reached that the gauging device will enter the bore. This gives a rough idea of size but the actual precise sizing occurs thereafter through the functioning of the air gauge mechanism which is capable of gauging the last tenths of thousandths of stock which is to be removed. The control is such that a "run-out" time may be included to finish the surface of the bore with a fine finish while removing a slight amount of stock, the removal of which was anticipated by the diameter at which termination was indicated.

What is claimed is:

1. In a gauging device for a honing machine, a honing tool, a sleeve type of gauging device through which the honing tool extends, means supporting said gauging device for lateral shifting movement and for insertion into the bore after the tool has passed thereto, a fluid responsive circuit which conducts fluid to the gauging device from which it is directed against the surface of the bore, an electric circuit having switches therein, means responsive to each entrance of the gauging device within the bore to operate a switch in said electric circuit, and means within the fluid circuit responsive to a drop in pressure of the fluid delivered to the gauging device for operating a second switch in said electric circuit.

2. In a gauging device for a honing machine, a honing tool, a sleeve type of gauging device through which the honing tool extends, means supporting said gauging device for lateral shifting movement and for insertion into the bore after the tool has passed thereto, a fluid responsive circuit which conducts fluid to the gauging device from which it is directed against the surface of the bore, an electric circuit having switches therein, means responsive to each entrance of the gauging device within the bore to operate a switch in said electric circuit, means within the fluid circuit responsive to a drop in pressure of the fluid delivered to the gauging device for operating a second switch in said electric circuit, and means responsive to the actuation of said second switch for terminating the honing operation.

3. In a gauging device for a honing machine, a honing tool, a sleeve type of gauging device through which the honing tool extends, means supporting said gauging device for lateral shifting movement and for insertion into the bore after the tool has passed thereto, a fluid responsive circuit which conducts fluid to the gauging device from which it is directed against the surface of the bore, an electric circuit having switches therein, means responsive to each entrance of the gauging device within the bore to operate a switch in said electric circuit, means within the fluid circuit responsive to a drop in pressure of the fluid delivered to the gauging device for operating a

second switch in said electric circuit, and means actuated by said second switch for controlling the termination of the honing operation.

4. In a device for gauging a honing operation performed by a honing tool mounted on a machine provided with means for driving the honing tool in reciprocation and rotation, a sleeve about said honing tool in spaced relation thereto permitting lateral displacement of the sleeve, a shoulder on the inner surface of said sleeve adjacent to the top thereof, a ring on a reciprocating part of the tool and machine within said sleeve engageable with the shoulder thereof for raising the sleeve therewith, said sleeve having passageways for a fluid, and nozzles on said sleeve connected with the passageways for directing a fluid onto the surface of the bore being honed when the diameter has reached a size to permit the entrance of the sleeve therinto.

5. In a device for gauging a honing operation performed by a honing tool mounted on a machine provided with means for driving the honing tool in reciprocation and rotation, a sleeve about said honing tool in spaced relation thereto permitting lateral displacement of the sleeve, a shoulder on the inner surface of said sleeve adjacent to the top thereof, a ring on a reciprocating part of the tool and machine within said sleeve engageable with the shoulder thereof for raising the sleeve therewith, said sleeve having passageways for a fluid, nozzles on said sleeve connected with the passageways for directing a fluid onto the surface of the bore being honed when the diameter has reached a size to permit the entrance of the sleeve therinto; an air circuit for delivering a fluid to the passageways and the nozzles at a predetermined rate and pressure, and means actuated upon the movement of the sleeve into the bore being honed for initiating the flow of said fluid.

6. In a device for gauging a honing operation performed by a honing tool mounted on a machine provided with means for driving the honing tool in reciprocation and rotation, a sleeve about said honing tool in spaced relation thereto permitting lateral displacement of the sleeve, a shoulder on the inner surface of said sleeve adjacent to the top thereof, a ring on a reciprocating part of the tool and machine within said sleeve engageable

with the shoulder thereof for raising the sleeve therewith, said sleeve having passageways for a fluid, nozzles on said sleeve connected with the passageways for directing a fluid onto the surface of the bore being honed when the diameter has reached a size to permit the entrance of the sleeve therinto, an air circuit for delivering a fluid to the passageways and the nozzles at a predetermined rate and pressure, means actuated upon the movement of the sleeve into the bore being honed for initiating the flow of said fluid, and an electric circuit for indicating the drop in pressure in the fluid of the system which is completed only during the time the sleeve is within the bore.

7. In a device for gauging a honing operation performed by a honing tool mounted on a machine provided with means for driving the honing tool in reciprocation and rotation, a sleeve about said honing tool in spaced relation thereto permitting lateral displacement of the sleeve, a shoulder on the inner surface of said sleeve adjacent to the top thereof, a ring on a reciprocating part of the tool and machine within said sleeve engageable with the shoulder thereof for raising the sleeve therewith, said sleeve having passageways for a fluid, nozzles on said sleeve connected with the passageways for directing a fluid onto the surface of the bore being honed when the diameter has reached a size to permit the entrance of the sleeve therinto, an air circuit for delivering a fluid to the passageways and the nozzles at a predetermined rate and pressure, means actuated upon the movement of the sleeve into the bore being honed for initiating the flow of said fluid, an electric circuit for indicating the drop in pressure in the fluid of the system which is completed only during the time the sleeve is within the bore, and means actuated upon the drop of pressure for controlling the termination of the honing operation.

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