Jan. 15, 1957 A. M. JOHNSON 2,777,257

HONE WITH PRESSURE ACTUATED GAGE

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Fig. 1

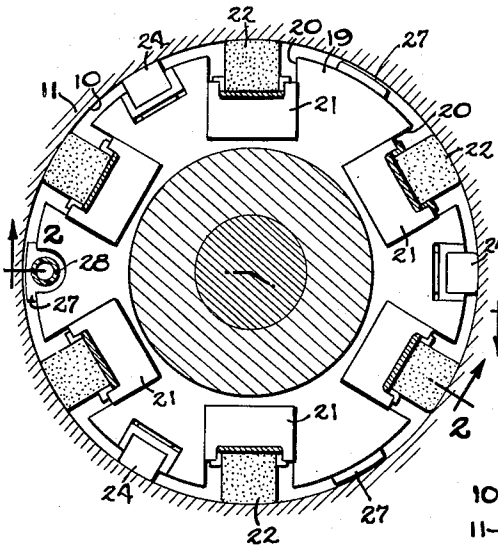


Fig. 2

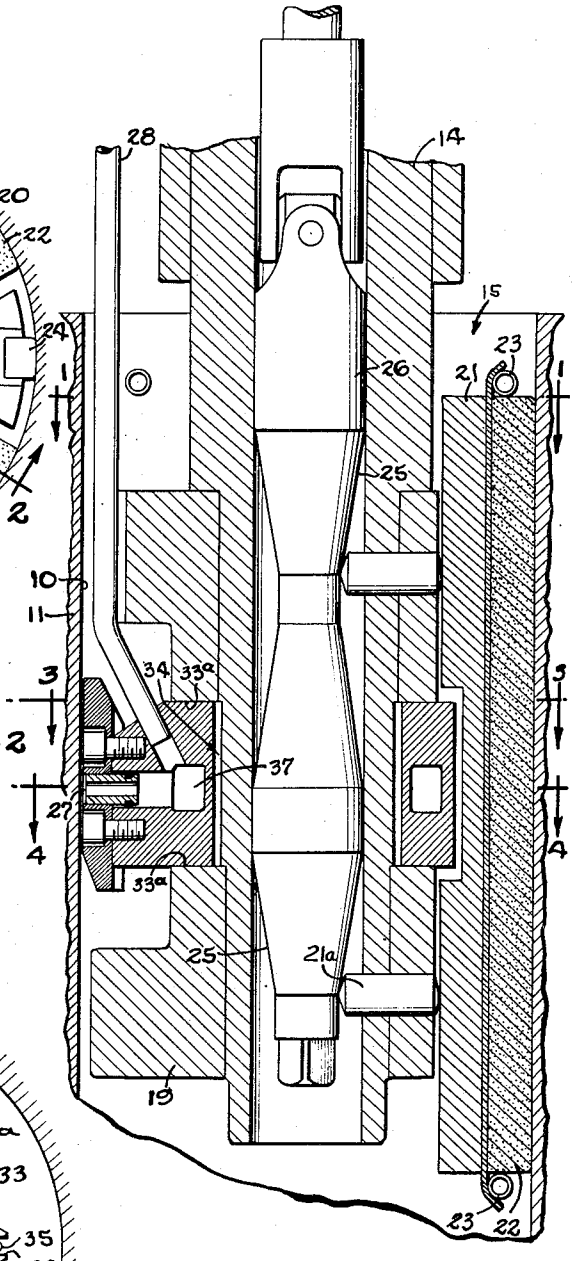
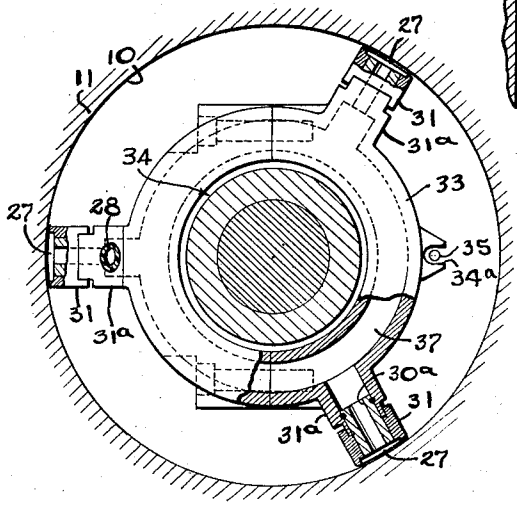


Fig. 3



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HONE WITH PRESSURE ACTUATED GAGE

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Fig. 4

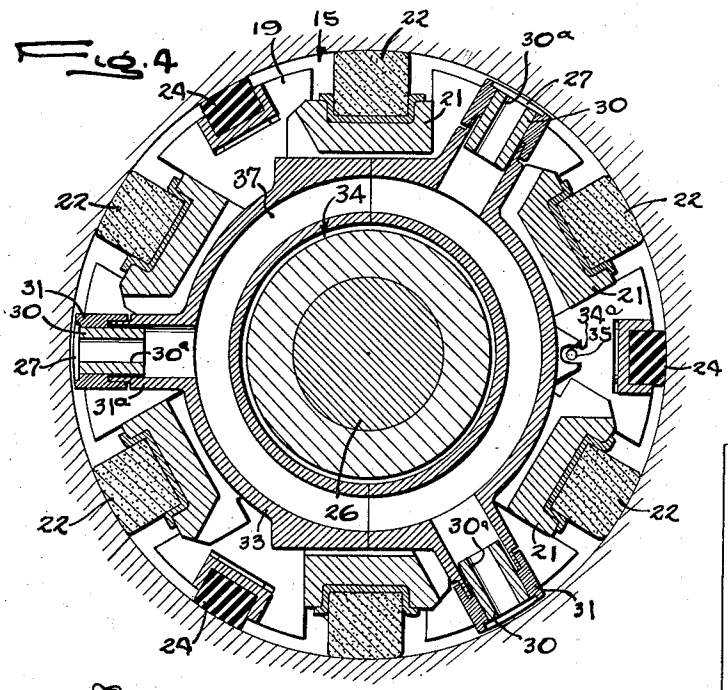


Fig. 5

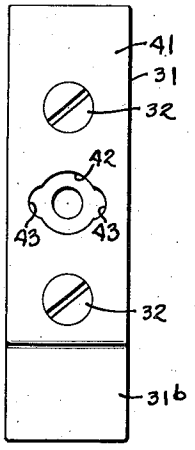


Fig. 6

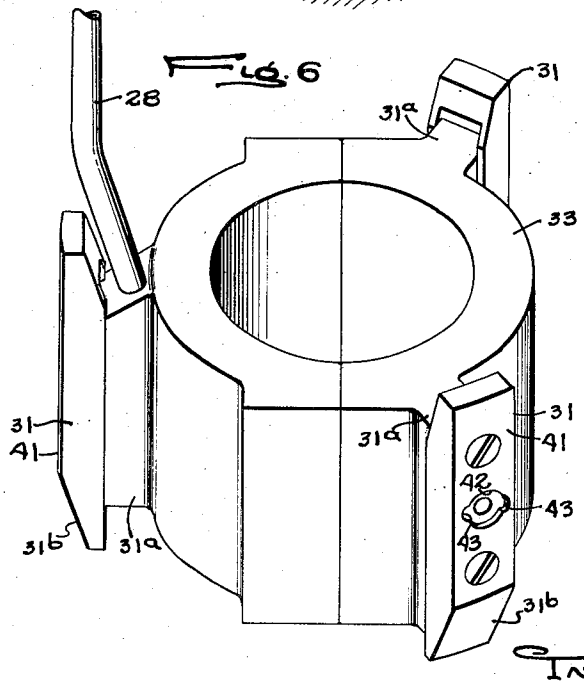
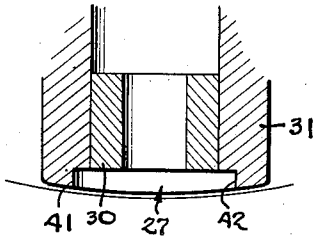


Fig. 7



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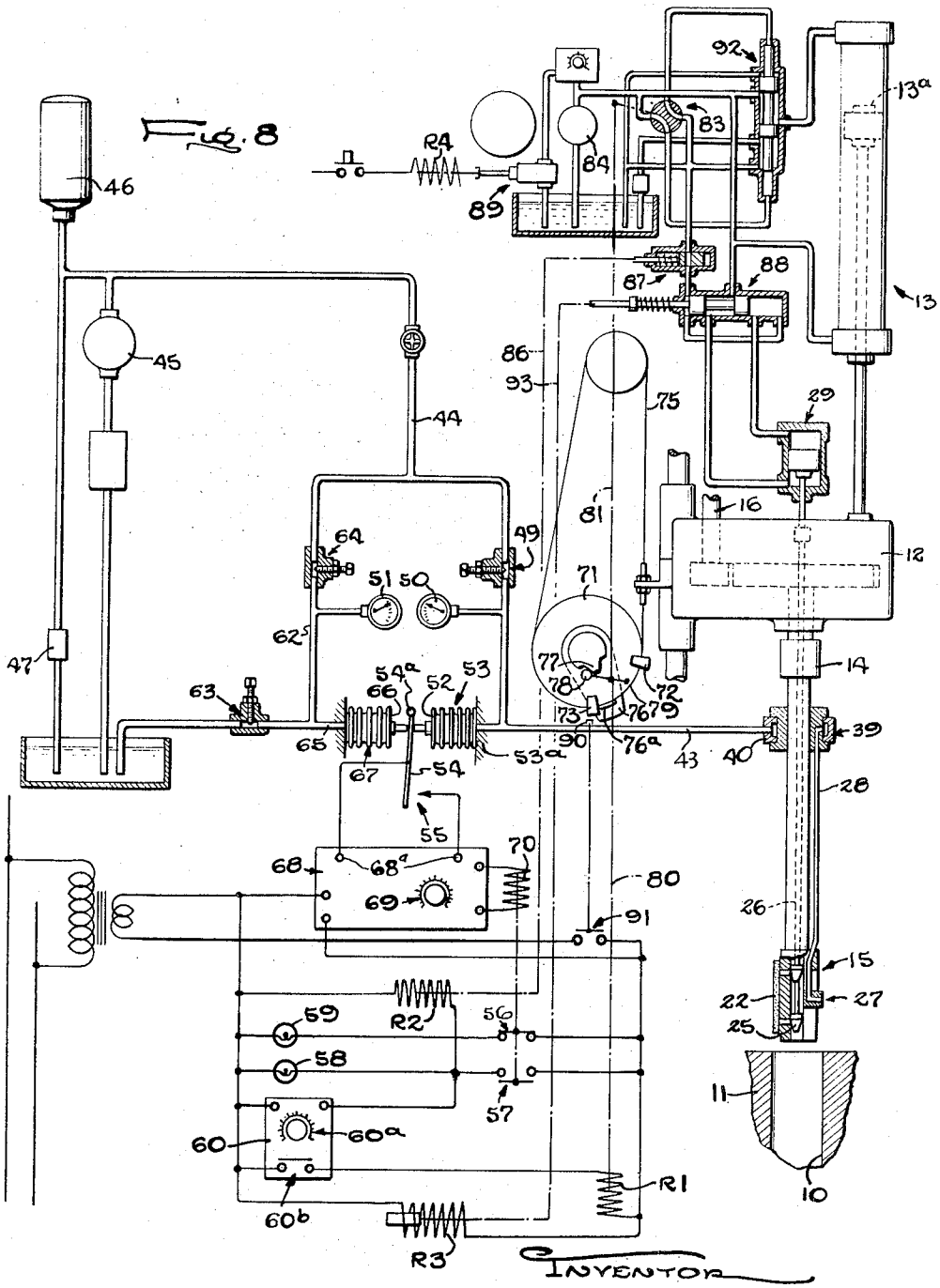
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HONE WITH PRESSURE ACTUATED GAGE

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Fig. 8



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2,777,257

HONE WITH PRESSURE ACTUATED GAGE

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Application August 19, 1953, Serial No. 375,267

8 Claims. (Cl. 51—34)

This invention relates to a honing tool combined with a fluid actuated gage for measuring or indicating the size of a cylindrical bore through the use of a pressure impelled jet of fluid directed against the surface of the bore, or a surface of the same size.

The general object is to provide, in a honing tool of the above character, a jet type gaging device capable of sensing changes in the work bore size with extreme precision and without any mechanical contact with the bore wall.

Another object is to provide a jet type size sensing device for a honing tool having a plurality of fluid jets shaped and mounted in a novel manner such as to maintain a close proportional relation between the pressure of the fluid supplied to the jets and the size of the bore being honed.

A further object is to utilize the improved size sensing device to terminate a honing cycle automatically while insuring that the full length of the work bore is of a precise size.

The invention also resides in the novel arrangement and mounting of the jet nozzles in relation to the work bore and the hone body.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a transverse sectional view taken on the line 1—1 of Fig. 2 and showing a honing tool embodying the novel features of the present invention.

Fig. 2 is a fragmentary sectional view taken along the broken line 2—2 of Fig. 1.

Figs. 3 and 4 are sections taken respectively along the lines 3—3 and 4—4 of Fig. 2.

Fig. 5 is a face view of one of the fluid nozzles and its mounting.

Fig. 6 is a fragmentary perspective view of the nozzle carrier.

Fig. 7 is a fragmentary and enlarged dimensioned cross section of one of the nozzles.

Fig. 8 is a schematic view and hydraulic circuit diagram.

The purposes of illustration, the improved gage is shown in the drawings in a typical machine for honing a cylindrical bore 10 in a workpiece 11 which comprises a head 12 adapted to be reciprocated by a fluid pressure operated actuator 13 of the piston and cylinder type. Journaled in the head 12 and projecting from one face thereof is a spindle 14 carrying a honing tool 15 and driven from a power shaft 16.

Such honing tools usually comprise a body 19 angularly notched to provide radial guides 20 (Fig. 1) for the carriers 21 of an annular series of abrasive stones 22, the latter being normally contracted by springs 23 encircling the ends of the stone carriers. Through pins 21a, the backs of the carriers bear against conical cams 25 on a rod 26 which extends up through the spindle 14 and is movable axially up and down to contract or expand the hone. The rod 26 turns with the hone and through a suitable thrust coupling is connected to the piston of an actuator 29 by which the cams 25 may be shifted axially to expand or contract the hone.

Six honing stones are employed in the hone, these being, in this instance, spaced equidistantly around the body 19 which, in accordance with standard practice, carries the usual fiber guides 24 by which the hone is held while being withdrawn from the work bore. In this instance, three guides are equally spaced around the body as shown in Fig. 1, each being disposed between two of the adjacent stones.

The improved gaging device may be utilized to indicate continuously the size of a cylindrical bore being honed or to give a signal when a predetermined bore size has been attained. It includes generally a plurality of orifices 27 supplied with pressure fluid through a common flexible conduit 28 and floatingly mounted on the hone body 19 in positions to direct jets of fluid against the wall of the bore 10 thereby causing the pressure in the conduit to change as the position of the work surface and therefore the gap between the nozzle end and the work is increased by the action of the honing stones 22.

Each of the orifices 27 is at the end of a nozzle comprising a tubular plug 30 pressed into a shoe 31 which is attached by screws 32 to radial lugs 31a on the periphery of a carrier ring 33 mounted for free transaxial floating relative to the hone body and the work bore as permitted by flexing of the fluid supply tube 28. In the present instance, the carrier is disposed between and slidably guided by the walls 33a of a groove 34 which encircles the hone body midway between the stone ends.

Although a larger number of nozzles may be used, three are employed in the present instance, these alternating with the wiper guides 24 and being disposed between the adjacent stones of the other three pairs. In its floating movement, the carrier is held against turning relative to the hone body by a pin 35 projecting into the radial slot 34a in the carrier. At their inner ends, the nozzles 30 communicate through radial holes 30a with an annular passage 37 connected to the lower end of the flexible conduit 28 which lies in a notch in the hone body and extends upwardly along the spindle to a transfer ring 39 (Fig. 8) of well known construction surrounding the spindle and formed in part by a non-rotatable collar 40 movable up and down with the tool head 12.

Where ordinary machine coolant is used as the pressure fluid to form the jets, usually at a pressure of about 40 p. s. i., the orifice holes through the plugs 30 are about ⅛ of an inch in diameter and extend to within .010 of an inch of the outer face 41. In the present instance, the outer ends of the holes are enlarged as indicated at 42 (Fig. 8) as by counterboring the nozzle supports 31 to a diameter of ¼ of an inch and a depth of about .030 of an inch. In some instances, it is desirable to further enlarge the counterbore by short wings 43 projecting horizontally from opposite sides of the bore. Due to such enlargement of the orifices at their outer ends, the pressure fluid delivered through the nozzles impinges against and is distributed over larger areas of the bore wall which has been found somewhat more effective in producing the centering action later described.

The three or more orifices 27 formed as above described are made of the same size and shape, are disposed in a common plane, are herein angularly spaced apart equal distances around the carrier 33, and are also disposed at equal radii from the axis of the carrier as determined by the spacing of the faces 41 of the shoes 31 from the center of the carrier. With the orifices 27 thus constructed and arranged, it will be apparent that upon the delivery of fluid under pressure to the common supply

passage 37, jets of substantially identical form and intensity will be directed outwardly from the orifice ends.

I have discovered that if the free floating carrier described above is disposed within a cylindrical bore of a radius only slightly larger, preferably less than .010 of an inch, than the spacing of each orifice end from the carrier center, the pressure drop in the supply line 28 due to the combined flow from all of the orifices will be precisely proportional and bear a fixed relation with respect to the diameter of the bore. While the reason for such high precision is not readily apparent, it is believed to be attributable in some degree to a centering action sufficient to overcome the friction on the nozzle carrier 33 and resulting from the reaction on the nozzle carrier of the three equally sized and spaced jets of fluid as they impinge on the wall of the bore after their discharge from the nozzle tips so closely spaced to the bore wall. That is to say, under the three forces thus exerted on the carrier, the latter is shifted edgewise until the forces become substantially equalized and the carrier centered in the bore.

The precise proportioning of the control pressure and the size of the bore may also be due to the fact that, with the nozzle tips so close to the bore wall there is an averaging of the flows from the several nozzles to that the combined flow remains constant for a given size of bore even though the nozzle carrier may to some extent be disposed eccentrically in the bore and such eccentricity may vary somewhat in the course of a honing operation. For this same reason including the employment of at least three floating jets, the sizing device operates to sense the average diameter of an eccentric bore rather than to respond to a low point of the latter and give a false indication. In effect, by responding to the combined flow from three or more floating jets, the sizing device is less sensitive to noncircular bores at the start of a honing cycle thus avoiding premature and improper termination of the cycle before the eccentricity has been removed.

It will be observed that the floating or centering action above described occurs independently of the position of the hone body 19. As a result, the carrier position at any instant relative to the bore wall 10 is established independently of the hone position and is not influenced by lateral shifting of the hone body due to uneven wearing of the stones, the following of an eccentric bore, etc. Therefore, even though the carrier rotates with the hone body and is supported on the latter, its position is controlled by the bore wall through the action of the fluid jets. There is no mechanical contact at any time between the sizing device and the bore wall and therefore no possibility of marking the finished wall during withdrawal of the collapsed hone after the bore has been honed to the desired size. As the honing tool is advanced into the work at the start of a new cycle, inclined surfaces 31b at the outer ends of the shoes 31 engage the bore wall and thus guide the carrier 33 into the bore.

The transfer ring 39 above described communicates through a conduit 43 (Fig. 8) with a pipe 44 supplied with liquid under pressure by a motor driven coolant pump 45 and connected to a suitable accumulator 46. Through the latter and an automatic valve 47 in a bypass line, the supply pressure is maintained approximately constant. The pressure of the fluid as delivered to the conduit 43 and the orifices 27 may be adjusted as desired by manual setting of a restriction or needle valve 49 interposed in the conduit, the pressure in which is indicated continuously on a gage 50. The supply pressure is read on a gage 51.

Pressure changes in the conduit 43 due to changes in the size of the work bore during a honing cycle are evidenced by movement of a wall 52 of a bellows 53, communicating at its other end with the conduit, this end being anchored on a suitable support 53a. The movable wall is coupled to an indicator such as an arm 54 fulcrumed at 54a and carrying at its free end the movable contact of a switch 55 whose closure signals the attainment of proper diameter of that part of the work bore then being scanned by the fluid jets.

To eliminate the detrimental influence of changes in the supply pressure so as to achieve optimum accuracy in the dimensional measurement of the work bore size, a by-passage 62 communicates with the supply line 44 and leads to an orifice 63 through which the pressure fluid may escape continuously. The secondary control pressure thus developed and similarly influenced by changes in the supply pressure is capable of being combined with the main control pressure in the conduit 43 whereby to produce a pressure differential which is precisely a function of the spacing of the main orifices 27 from the work surface.

The by-passage 62 comprises a conduit branching off from the supply line 44 between the pump and the adjusting valve 49 and includes a similar manually adjustable valve 64. Herein the by-pass orifice 63 is a needle valve variable in size according to the adjustment of its stem. Coolant escaping through the restriction 63 is returned to the sump to which the pump inlet is connected. The pressure within the by-passage between the restrictions 63 and 64 is indicated on a master gage 51 and is exerted through a connection 65 on the wall 66 at the free end of a bellows 67 suitably supported from its other end. Preferably, the effective pressure area of the wall 66 is the same as that of the wall 52.

The two control pressures are combined by arranging the movable walls 52 and 66 in opposed relation on opposite sides of the indicating lever 54 to which the two walls are suitably connected. Thus, the position of the arm 54 at any time and within its permissible range of movement will be determined by the difference in the pressures between the conduits 43 and 62. Assuming for example that the pressure in the bellows 67 remains constant, the arm will swing progressively to the right as viewed in Fig. 8 as the gaps between the bore wall and orifices 27 are increased in width and the pressure in the bellows 53 is thereby lowered. Thus, the arm is arranged to close the switch 55 at a predetermined pressure difference corresponding to a desired work bore size.

Through the use of the improved fluid actuated sizing device described above, it has been possible in actual service to sense extremely small variations in the diameter of the work bore, these being consistently within .0002 of an inch while leaving the finished surface free of marking of any kind. Such remarkable accuracy is attributable to the use of three or more fluid jets arranged and mounted as above described for free floating transaxially of the bore so that the effective control pressure is determined by the combined flow of fluid from the several orifices.

With the fluid jets mounted as above described to move back and forth through the bore along with the honing tool, all of the different sections of the bore are scanned by the fluid jets and thus measured during each stroke of the hone. As a result of this progressive feeling action, the signal above described indicating proper size of the bore may be given when the fluid jets are impinging against one section of the bore wall while other sections may still be undersize. Thus, the switch 55 must remain closed for an interval equal to the length of one stroke of the hone in order to constitute a signal that the entire bore is up to size.

In another of its aspects, the present invention utilizes the precise size sensing and the progressive work feeling actions above described to terminate the cycle of a standard honing machine while insuring that the work bore will be finished to the desired precise size throughout its entire length. For this purpose, the power actuators 13 and 29 are controlled in a novel manner to continue the reciprocation of the hone beyond the time of initial closure of the switch 55 and until this switch has remained closed continuously for a full stroke of the

honing tool. In general, such control is achieved through the use of a timing device 68 (Fig. 8) which is activated in response to the initial sensing of the proper size of any one area of the bore, which is disabled or reset automatically in response to the subsequent sensing of an undersize area, and which, when active, for a period at least equal to the full stroke of the honing tool, gives a signal indicating that all areas of the work bore are up to size.

While the timing device may take various forms and operate mechanically or hydraulically, it is preferred to employ a timer of an electrical character, one example of which is manufactured by Cutler-Hammer of Milwaukee under the trade designation of 13522–ED4. As is well understood in the art, this control is activated by closure of a circuit across its input terminals 68ª, this being effected herein by closure of the switch 55. Upon subsequent opening of the switch, the timer is reset automatically, and, when it is energized for a predetermined interval, determined by the adjustment of a knob 69, a solenoid 70 in the output circuit of the unit is energized to close a normally open switch 57, this solenoid and its switches forming a part of the timer unit 68. Closure of the switch 57 energizes a signal lamp 58 to indicate that the entire length of the bore is up to size while closure of the switch 56 energizes a lamp 59 thus indicating that all or part of the bore is undersize.

To provide for the usual "sparking out" of the bore after the bore is up to size, the honing tool is reciprocated back and forth within the bore without further expansion. This is achieved in the present instance through a second timing device 60 of well known construction energized as shown when the switch 57 is closed and then operating, after the lapse of a predetermined interval determined by the adjustment of a knob 60ª, to close as witch 60ᵇ. This completes a circuit for energizing a relay R1 for causing the honing tool to be fully withdrawn from the work bore. Closure of the switch 57 also completes a circuit for energizing a solenoid R2 whose armature is joined through a connection 86 to the movable member of a spring opened valve 87.

The timer actuated switch 57 above described may be utilized to terminate the cycle of a standard honing machine through the control shown schematically in Fig. 8 and more fully described in Patent No. 2,381,572. In this control, a disk 71 carrying spaced dogs 72 and 73 is oscillated back and forth through a chain connection 75 with the honing head 12 and has loose thereon an arm 76 engageable by the dogs and carrying a cam 77 which acts on a follower lever 78 fulcrumed at 79. Through connections 80 and 81 the lever is joined to the armature of the solenoid R1 and to the operating arm of a pilot valve 83. The latter directs the flow of pressure fluid delivered by a motor driven pump 84 to the fluid actuators of a relay valve 92 or to a valve 88 controlling the hone expanding actuator 29.

With the parts positioned as shown in Fig. 8 to hone a new workpiece, and with the pump 84 operating, a cycle is initiated by operating a suitable control device to close a valve 89 in a by-pass outlet of the pump thus directing fluid through the valve 83 to the actuator for shifting the plunger of the valve 92 upwardly. Pressure fluid is thus applied to both ends of the differential piston 13ª to initiate downward movement of the honing head 12. After the collapsed tool 15 enters the work bore 10 and approaches the lower end thereof, the dog 72 engages a part 76ª on the arm 76 to shift the latter into engagement with a follower 90 thereby closing a switch 91 which remains closed during the remainder of the cycle. In the final downward movement of the tool, the cam 77 on the arm 76 actuates the lever 78 to operate the valve 83 and reverse the valve 92 thus initiating an upward stroke of the honing tool. At the same time and in response to closure of the switch 91 a solenoid R3 is energized and operates through a connection 93 to reverse the valve 88 and admit pressure fluid to the actuator 29 to expand the honing tool at a rate determined by a metering device (not shown).

After the honing tool has been drawn upwardly but is still engaging the work bore, the dog 73 shifts the arm 76 counterclockwise far enough for the cam 77 to reverse the position of the valve 83 and through the valve 92 thus initiate a downward stroke of the honing tool. The latter thus reciprocates back and forth within the bore and since the latter is undersize, the switch 55 of the jet sizing device remains open.

As soon as enough stock has been removed from the bore wall to bring any part of the latter up to the desired size, the switch 55 will be closed as the fluid jets scan such part of the wall. This activates the timer 68 to start the measurement of a time interval. If another part of the work bore being scanned by the fluid jets is undersize, the switch 55 will open and the timer will be reset automatically. Finally, when the bore 10 is up to size throughout its full length, the switch will remain closed long enough for the timer to complete its cycle and energize the relay 70 thus closing the switch 57. The latter energizes the solenoid R2 which through the connection 86 closes the valve 87 to block the further flow of fluid to the expanding actuator 28 thus holding the stones of the honing tool at a fixed diameter as the reciprocation of the tool continues for the purpose of sparking out the bore.

Closure of the switch 57 also activates the timer 60 which, after the lapse of the sparking out interval, closes the switch 60ᵇ to energize the solenoid R1 and through the connection 80 shift the valve 83 independently of the cam 77 to initiate an upstroke of the tool which continues beyond the upper end of the bore until the dog 73 moves far enough to shift the arm 76 and open the switch 91 at which time the hone is completely out of the work. The opening of the switch 91 interrupts the circuits for all of the solenoids R1, R2, R3, and R4 and also the energizing circuit for the timer 68. All of the parts are thus brought to rest in the position shown in Fig. 8.

With the jet sizing control controlling the operation of a honing machine in the manner described above, it is possible to hone successive workpieces consistently with an accuracy within .0002 of an inch. At the same time, each bore is finished to the desired diameter throughout its full length.

I claim as my invention:

1. In a machine for honing a work bore, the combination of, a rotary spindle, a hone mounted on said spindle for rotation therewith including a body and honing elements angularly spaced around said body and mounted thereon for bodily radial adjustment to expand or contract the cylindrical abrading face defined by the outer edge surfaces of said elements, a carrier of smaller diameter than said abrading face mounted on said body for free floating movement transaxially of the hone with all parts on the carrier disposed out of mechanical contact with the wall of the bore engaged by said abrading face, at least three nozzles mounted on and spaced around said carrier and terminating in outwardly and radially opening orifices of equal size equidistantly spaced from a common center on said carrier and terminating close to but short of said abrading face by less than ten thousandths of an inch, each of said orifices being disposed between two of the adjacent honing elements and adapted when supplied with fluid under pressure to form a fluid jet directed outwardly against the wall of said work bore, means defining a fluid passage rotatable with said spindle and communicating with each of said nozzles, means for supplying fluid to said passage under a pressure of sufficient magnitude to cause said carrier to be located in said bore solely by the combined action of said jets on the bore wall, and means for sensing in said passage variations in the

pressure resulting from the combined flow of fluid from the several orifices.

2. In a machine for honing a work bore, the combination of, a rotary spindle, a hone mounted on said spindle for rotation therewith including a body and honing elements spaced around said body and mounted thereon for bodily radial adjustment to expand or contract the cylindrical abrading face defined by the outer edge surfaces of said elements, a carrier of smaller diameter than said abrading face mounted on said body for free floating movement transaxially of the hone with all parts on the carrier disposed out of mechanical contact with the wall of the bore engaged by said abrading face, at least three nozzles mounted on and angularly spaced around said carrier and terminating in outwardly and radially opening orifices terminating close to but short of the cylinder defined by said abrading face by less than ten thousandths of an inch when the face is expanded against the bore wall, each of said orifices when supplied with fluid under pressure forming a fluid jet directed outwardly against the wall of said work bore, means defining a fluid passage rotatable with said spindle and communicating with each of said nozzles, means for supplying fluid to said passage under a pressure of sufficient magnitude to cause said carrier to be located in said bore and out of mechanical contact with the wall thereof solely by the combined action of said jets on the bore wall, and means for sensing in said passage variations in the pressure resulting from the combined flow of fluid from the several orifices.

3. In a machine for honing a work bore, the combination of, a rotary spindle, a hone mounted on said spindle for rotation therewith including a body and honing elements equidistantly spaced around said body and mounted thereon for bodily radial adjustment to expand or contract the cylindrical abrading face defined by the outer edge surfaces of said elements, a carrier mounted on said body for free floating movement transaxially of the hone with all parts on the carrier disposed out of mechanical contact with the wall of the bore engaged by said abrading face, at least three nozzles mounted on and spaced around said carrier and terminating in outwardly and radially opening orifices terminating close to but short of the cylinder defined by said abrading face, each of said orifices, when supplied with fluid under pressure forming a fluid jet directed outwardly against the wall of said work bore, means for supplying fluid to said nozzles under a pressure of sufficient magnitude to cause said carrier to be positioned in said bore out of mechanical contact with the bore wall, and means for sensing variations in the supply pressure resulting from the combined flow of fluid from the several orifices.

4. In a machine for honing a work bore, the combination of, a rotary spindle, a hone mounted on said spindle for rotation therewith including a body and honing elements spaced around said body and mounted thereon for bodily radial adjustment to expand or contract the cylindrical abrading face defined by the outer edge surfaces of said elements, a carrier of smaller diameter than said abrading face mounted on said body for free floating movement transaxially of the hone, at least three nozzles mounted on and spaced around said carrier and terminating in outwardly and radially opening orifices terminating close to but short of the cylinder defined by said abrading face and adapted when supplied with fluid under pressure to form a fluid jet directed outwardly against the wall of said work bore, means for supplying fluid to said orifices under a pressure of sufficient magnitude to cause said carrier to be located in said bore solely by the combined action of said jets on the bore wall, and inclined surfaces on said carrier converging radially toward said spindle and the end of said hone remote from the spindle operable during entry of said hone in said bore to engage the end of the bore wall and guide the entry of said carrier into the bore.

5. In a machine for honing a work bore, the combination of, a rotary spindle, a hone mounted on said spindle for rotation therewith including a body and honing elements mounted thereon for bodily radial adjustment to expand or contract the cylindrical abrading face defined by the outer edge surfaces of said elements, a carrier of smaller diameter than said abrading face mounted on said body for free floating movement transaxially of the hone, at least three nozzles mounted on and spaced around said carrier and terminating in outwardly and radially opening orifices terminating close to but short of said abrading face adapted when supplied with fluid under pressure to form a fluid jet directed outwardly against the wall of said work bore, and means for supplying fluid to said nozzles under a pressure of sufficient magnitude to cause said carrier to be located in said bore solely by the combined action of said jets on the bore wall, said orifices being disposed, when said honing elements are engaging said bore wall, sufficiently close to the wall to produce a combined resultant flow such as to maintain a fixed relationship between the diameter of the bore and the pressure of the fluid supplied to said nozzle.

6. In a machine for honing a work bore to a precise predetermined diameter, the combination of, a honing tool, power actuated mechanism for rotating the tool, advancing the same into said bore, expanding the tool against the bore wall and reciprocating the expanded tool, means movable back and forth in said bore with said tool and operable for sensing changes in the diameter of different cross sections of said bore as the latter is enlarged including nozzles for projecting jets of fluid under pressure against said bore wall and means responsive to the back pressure in said nozzles and operable to give a signal when any area of said work bore engaged by said jets attains said predetermined diameter at the area of said bore wall engaged by said jets, a normally inactive timing device adapted to start a time measurement when activated, means operable to activate said device in response to said signal and to inactivate the device when the signal is interrupted, and means actuated by said device and controlling said mechanism to collapse said hone and withdraw the same from said bore when said signal has continued uninterruptedly for at least a full stroke of said honing tool.

7. In a machine for honing a work bore to a precise predetermined diameter, the combination of, a honing tool, power actuated mechanism for rotating the tool, advancing the same into said bore, expanding the tool against the bore wall and reciprocating the expanded tool, means movable back and forth in said bore with said tool and operable for sensing changes in the diameter of different cross sections of said bore as the latter is enlarged including nozzles projecting jets of fluid under pressure against said bore wall and means responsive to the back pressure in said nozzles and operable to give a signal when any area of said work bore engaged by said jets attains said predetermined diameter at the area of said bore wall engaged by said jets, a device adapted when activated uninterruptedly for an interval corresponding to the length of one stroke of said honing tool to discontinue effective honing action by said tool, and means for activating said device in response to said signal and discontinuing the activation when the signal is interrupted.

8. In a machine for honing a work bore to a precise predetermined diameter, the combination of, a honing tool, power actuated mechanism for rotating the tool, advancing the same into said bore, expanding the tool against the bore wall and reciprocating the expanded tool, means movable back and forth in said bore with said tool and operable for sensing changes in the diameter of different cross sections of said bore as the latter is enlarged including nozzles projecting jets of fluid under pressure against said bore wall and means responsive to the back

pressure in said nozzles and operable to give a signal when any area of said work bore engaged by said jets attains said predetermined diameter at the area of said bore wall engaged by said jets, a normally inactive timing device adapted, after continuous activation for an interval corresponding to approximately one stroke of said honing tool, to interrupt the honing action by the tool, and means for activating said device throughout the continuance of said signal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,284,325	Kline	May 26, 1942
2,403,546	Olsen	July 9, 1946
2,688,219	Taylor	Sept. 7, 1954

OTHER REFERENCES

Publication "American Machinist Magazine," May 22, 1947, page 162.