

Feb. 10, 1970

KATSUMI MIYAMOTO

3,494,078

AUTOMATIC SIZING DEVICE OF INTERNAL GRINDER

Filed May 29, 1967

3 Sheets-Sheet 1

Fig. 1

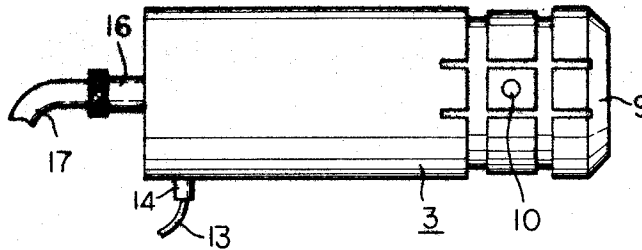


Fig. 2

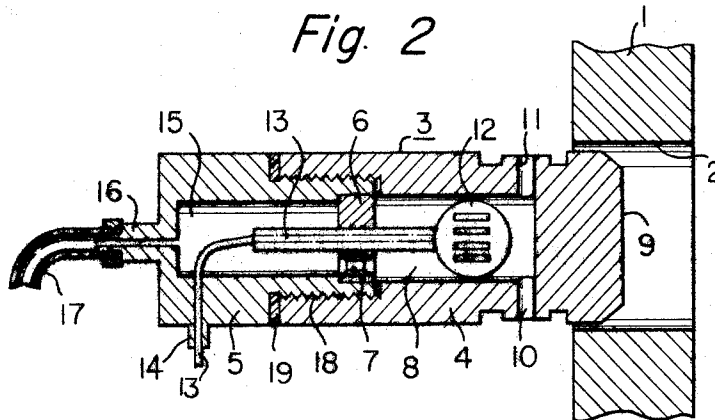
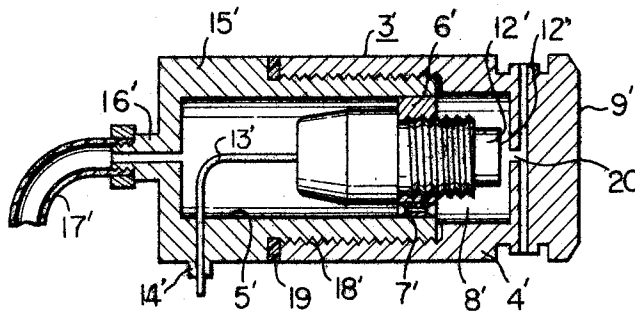


Fig. 3



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Fig. 4A

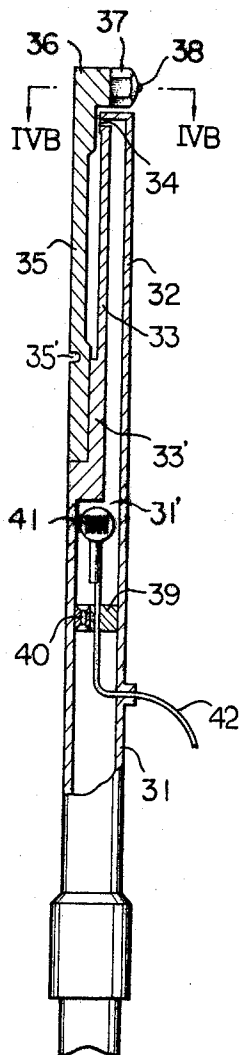
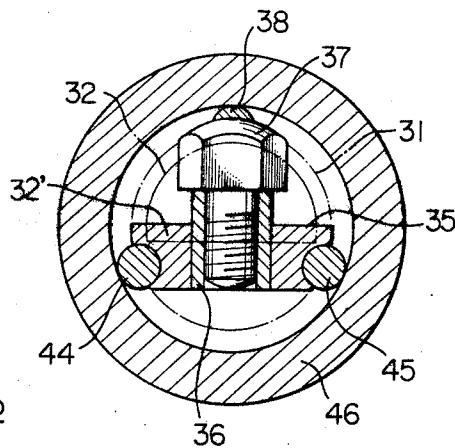


Fig. 4B



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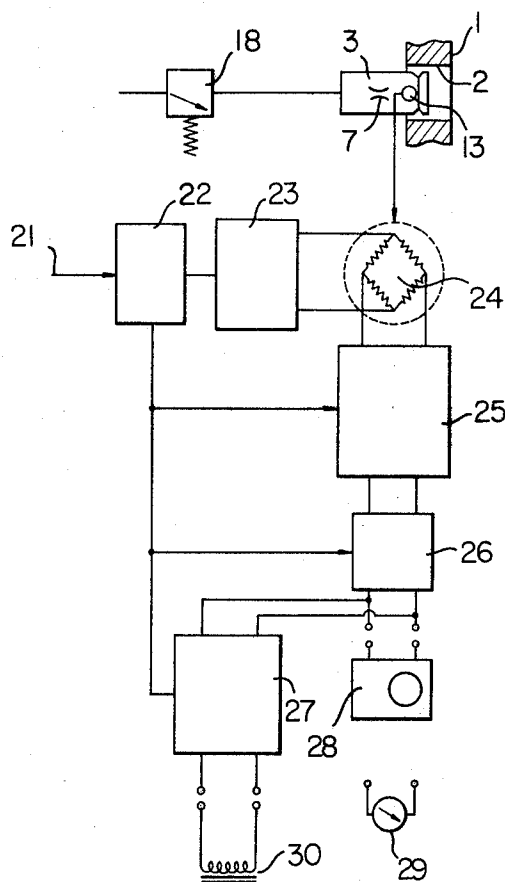
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Fig. 5



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AUTOMATIC SIZING DEVICE OF INTERNAL GRINDER

Katsumi Miyamoto, % Tokyo Seimitsu Co. Ltd.,
337 Shimorenjaku, Mitaka-shi, Tokyo, Japan

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6 Claims

ABSTRACT OF THE DISCLOSURE

The present invention relates to an automatic device for sizing the predetermined internal diameter of the work during the internal grinding operation. The principle of the back-pressure type air gauge system accompanied by an air pressure-quantity electricity converting element, such as a semi-conductor strain gauge, is applied to the device of the present invention.

The present invention relates to an automatic sizing device of an internal grinder, and more particularly, relates to an automatic device for inspecting the predetermined internal diameter of work in an internal grinding operation by applying the principle of a back-pressure type air gauge.

Generally, various methods for inspecting the predetermined internal dimension of work in internal grinding operations have been attempted so that the grinding operation may be stopped when the internal dimension of work reaches a predetermined value. For example, periodic attempts are made to insert a measuring head such as a plug gauge into the work as the grinding wheel used for said internal grinding operations periodically is moved out of the work, while the grinding operation is being carried out, and the operation is stopped when the plug gauge can be inserted into the work, or measuring methods by the so-called one-point contact measuring method, two-point contact measuring method, or three point contact measuring method are applied to inspect the predetermined dimension of the work. However, in none of the above-mentioned methods is the internal dimension of the work always accurately measured.

Another object of the present invention is to solve the above-mentioned problems.

Another object of the present invention is to provide an automatic device for inspecting the predetermined internal diameter of the work in a grinding operation.

A further object of the present invention is to provide an improved method for inspecting the predetermined internal diameter of the work automatically during the operation.

While the invention has been described in conjunction with certain embodiments thereof, it is to be understood that various modifications and changes may be made without departing from the spirit and scope of the invention.

FIG. 1 is a side view of the measuring head of the sizing device embodying the present invention.

FIG. 2 is an explanatory sectional view taken along the longitudinal axis of the measuring head of the sizing device shown in FIG. 1 with the top end portion of the head inserted into the work.

FIG. 3 is a modified embodiment of the measuring head shown in FIG. 1, which is shown as a sectional view taken along the longitudinal axis of the measuring head.

FIG. 4A is a side view, partly in section, of the other embodiment of the measuring head of the sizing device according to the present invention.

FIG. 4B is a sectional view of the measuring head of

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the sizing device, taken along line IVB-IVB in FIG. 4A and showing the relative position of the measuring head when the top end of the head of the sizing device is inserted into the work.

FIG. 5 is a diagrammatic view showing the relation between the elements of the sizing device of the present invention.

Referring to FIGS. 1, 2 and 5, an embodiment of the measuring head 3 of the sizing device comprises a cylindrical outer shell 4 and another cylindrical outer shell 5 connected with the cylindrical outer shell 4 by means of thread engagement 18, so as to form one body. An intervening wall 6 is disposed within the measuring head 3 in such a way that the intervening wall 6 is located at the connected position of the cylindrical outer shells 4 and 5, thereby, the inside cylindrical room of the measuring head 3 is divided into two related small cylindrical rooms 8 and 15, as shown in FIG. 2. The intervening wall 6 is provided with an orifice 7. Air jet nozzles 10 and 11, by which the room 8 is connected with the atmosphere, are disposed at the end portion 9 of the measuring head 3. Further, an air pressure-quantity of an electricity converting element 12, such as a semi-conductor strain gauge is disposed in the small cylindrical room 8. The other small cylindrical room 15 is connected with an air supply conduit 17 through a tap 16 projected outward from the rear end of the cylindrical outer shell 5. To prevent air leakage through the connected portion of both cylindrical shells 4 and 5, a packing 19 is inserted between the outer shells 4 and 5. A lead wire 13 is connected to an intermediate electrical element of the device so as to transmit the electrical signal detected by the air pressure-quantity of electricity converting element 12 through the projecting portion 14 of the shell 5.

When the above-mentioned head 3 is inserted periodically into the work 1 in such a way that the head 3 is traversed along the coaxial direction of the work 1 synchronously with the traverse motion of the grinding wheel (not shown), and compressed air having constant pressure for example, compressed air of 0.7-3 kg./cm.²) is fed into the small room 15 of the head portion 3 through an air supply conduit 17, the air pressure of the small room 8 of the outer shell 4 varies in accordance with the variation of the quantity of flow discharging from the air jet nozzles 10 and 11, which variation of discharging from the air jet nozzle varies in accordance with the variation of the internal diameter of the work. As the electric resistance of the strain gauge 12 also varies in accordance with the variation of the air-pressure in the small room 8, when a constant voltage is impressed on the strain gauge 12, the electrical output of the strain gauge 12 proportional to the variation of the pressure in the room 8 can be detected.

Referring to FIG. 5, a constant voltage (for example, 5 kc., 5 v.) is impressed, on a bridge circuit 24 comprising a semi-conductive resistance by means of an A-C power source 21 through a constant voltage circuit 22 and a constant voltage oscillation circuit 23, the electric voltage of the bridge circuit 24, which varies proportionally with the variation of the air pressure in the small room 8, is amplified by an A-C amplifier 25, and further rectified by a rectifier 26, thereby the variation of the rectified voltage of the rectifier 26 can be inspected by an oscillograph 28, that is, the internal diameter 2 of the work 1 can be always inspected by the oscillograph 28 while inserting the head 3 to the work 1.

As described above, the head 3 is periodically moving in and out of the work, consequently, the detecting period is very short. However, the capacity of the small room 8 is so small that a rapid response with high accuracy of the air pressure change in the room 8 can be obtained.

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Further, the character of the frequency response of the strain gauge 12 is excellent, consequently, high accuracy inspection can be obtained.

The shape of the measuring head 3 may be changed and a foil strain gauge may be used instead of the above-mentioned strain gauge, by which practically the same result can be obtained.

In FIG. 3, a modified embodiment of the measuring head of the sizing device of the present invention is shown. A semi-conductor strain gauge 12' having a sensing portion 12'' is disposed in the small room 8 instead of the strain gauge 12 in FIG. 2, in such a way that the sensing portion 12'' faces a central air jet nozzle 20 for air flow. Other elements of the measuring head are the same as those of the first embodiment shown in FIG. 2. For easy understanding, the elements in FIG. 3 corresponding to those of the first embodiment shown in FIG. 2 are designated by corresponding numerals associated with a prime (') symbol.

The other embodiment of the measuring head shown in FIG. 4A is an example in which the three point contact measuring method is used. As shown in FIG. 4, to decrease the space of the small room 31' corresponding to the small room 8 in FIG. 2, the orifice 40 is disposed at the closed position of an air jet nozzle forming an air jet. A semi-conductor strain gauge 41 is disposed in the small room 31'. A cylindrical shell 31 comprises a main cylindrical portion and a partly cylindrical portion 32 extending from the main cylindrical portion. The partly cylindrical portion 32 is provided with the same curvature and dimension as the main cylindrical portion and a flattened portion 33. The cylindrical shell 31 is connected with the air supply conduit. The leaf 35 in close contact with the outside surface of the flattened portion 33 is secured at its end to the rear base portion 33' of the flattened portion 33 so as to move its front end portion to the front end portion of said flattened portion 33, but it always tends to bend toward said flattened portion 33. The plate 35 is provided with a neck 35' by which the leaf 35 can bend easily. The air jet nozzle 34 is disposed at an end portion of the flattened portion 33, and the front end portion of the leaf 35 is located at the closed position of the air jet nozzle 34, a contact point 38 which is one of the three contact points for the three-point contact measuring method is disposed at the front end portion 36 of the leaf 35, while the other two contact points 44 and 45 of the three-point contact measuring method are disposed on both sides of the portion 32' extending from the partly cylindrical portion 32 to form an isosceles triangle along with the point 38, as shown in FIG. 4B, in which drawing the three points contact measuring method utilizing points 38, 44, and 45 with a section of a cylindrical work 46 is shown.

As the front end portion of the leaf 35 can bend to the flattened portion 33, when the top end portion of the measuring head is inserted into the work 46, the contact point 38 is displaced inwardly or outwardly relatively to the other two contact points 44 and 45 in accordance with the internal diameter of the work 46, whereby, the relative position of the leaf 35 to the air jet nozzle 34 is changed. Consequently the back pressure in the small room 31' is changed in accordance with the internal diameter of the work 46, the voltage variation proportional to the variation of the back pressure is generated by the semi-conductor strain gauge 41 and is transmitted to the amplifier described in the first embodiment through lead wire 42.

The measuring method and effect of the measuring head shown in FIG. 4A are almost the same as in the first embodiment shown in FIG. 1 and 2.

The measuring head described in the above-mentioned three embodiments can be used as follows. That is, the measuring head is inserted in the work after it is stopped, and the internal diameter of the work can be inspected by using a galvanometer 29. Further, automatic control of

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the internal grinding operation can be effected by applying the sizing device of the present invention, that is, a gate circuit 27 which is added to the electric circuit described in the first embodiment, as shown in FIG. 5. The rectified output of the rectifier 26 is always compared with a predetermined value of voltage by the gate circuit, and when the rectified output differs from the predetermined value, that is, becomes more than or less than the predetermined value, the grinding speed or traverse speed of the grinding wheel or spark-out period is adjusted automatically, or the internal grinding machine is automatically stopped by a signal from an actuating electrical circuit 30 connected to the gate circuit 27.

Further, the above-mentioned sizing device may be used for inspecting the internal diameter of work produced by the internal grinding machine or other machine.

While the invention has been described in conjunction with certain embodiments thereof, it is to be understood that various modifications and changes may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. An improvement for a device for sizing the predetermined internal diameter of work in an internal grinding operation by an internal grinding machine provided with a grinding wheel and traverse motion mechanism for traversing said grinding wheel, said improvement comprising a measuring head periodically inserted in the work during the grinding operation, said measuring head provided with at least one air jet nozzle disposed to its front end portion and an orifice closely disposed to said air jet nozzle and a small room formed between said air jet nozzle and said orifice and an air pressure-quantity electricity converting element disposed in said small room, said small room connected with the atmosphere through said air jet nozzle; means for supplying compressed air having constant pressure to said small room through said orifice; a visible electrical device for showing the internal diameter of the work in accordance with an output signal of said air pressure-quantity electricity converting element; and an electrical means for transmitting said output signal of said air pressure-quantity electricity converting element to said visible electrical device.

2. An improvement according to claim 1, further characterized by, an electrical actuating circuit for changing the working condition of said internal grinding operation.

3. An improvement according to claim 1, further characterized by, an electrical actuating circuit for stopping said internal grinding operation.

4. An improvement according to claim 1, wherein said measuring head comprises a front outer shell having a front end closed portion, a rear outer shell having a rear end closed portion and connected at its front end portion with the rear end portion of said front outer shell by thread engagement, an intervened wall disposed in said measuring head in such a way that said intervened wall is disposed to the connected portion of said front and rear outer shell so as to form a small room in said front outer shell, said front outer shell provided with at least one air jet nozzle connecting said small room with the atmosphere, said rear outer shell connected with an air supply source by a conduit, said intervened wall provided with an orifice connecting said small room with said air source through said rear shell, and said air pressure-quantity electricity converting element disposed in said small room.

5. An improvement according to claim 1, wherein, said air pressure-quantity electricity converting element is a semi-conductor strain gauge.

6. An improvement according to claim 1, wherein said measuring head comprises a cylindrical shell having a partly flattened portion extending along its axial direction, a leaf secured at its rear base portion to the middle portion of said cylindrical shell in such a way that said leaf

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faces said extended flattened portion and combined outside lateral profile of said cylindrical shell and said leaf is almost a circular profile and the front free end portion of said leaf slightly tends to bend toward said cylindrical shell, a contact point of a three-point measuring system secured to said front free end portion of said leaf, two other contact points of said three-point contact measuring system disposed to both sides of an elongated front end portion from the front end of said cylindrical shell in such a way that said three contact points form the respective points of said three-point contact measuring method, a neck disposed outside of said leaf for providing sensitive detecting ability when said contact point contacts the internal wall of said work, the rear end of said cylindrical shell connected with an air source, said cylindrical shell provided with an air jet nozzle at its front

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end portion and an orifice closely disposed to said air jet nozzle in it and an air pressure-quantity of electricity converting element disposed in a small room between said air jet nozzle and said orifice, and the front end portion of said leaf is made to face said air jet nozzle.

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