Sept. 7, 1948. W. F. ALLER 2,448,653

SIZE GAUGING DEVICE

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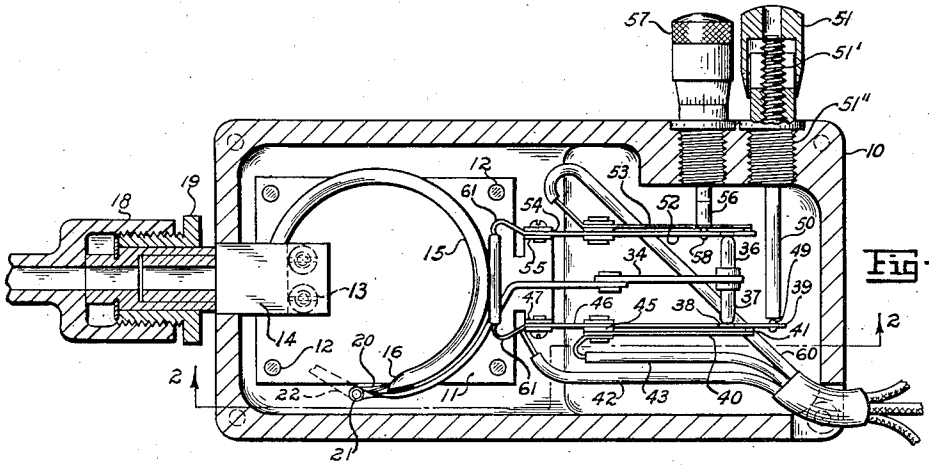


Fig-1

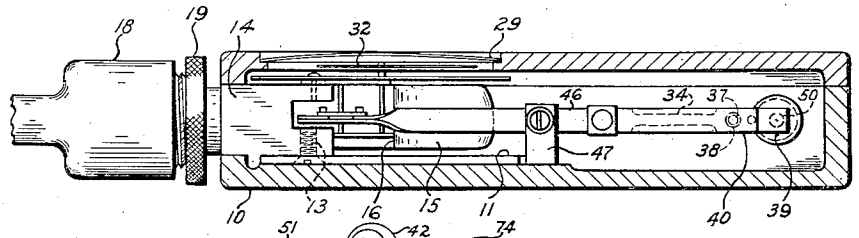


Fig-2

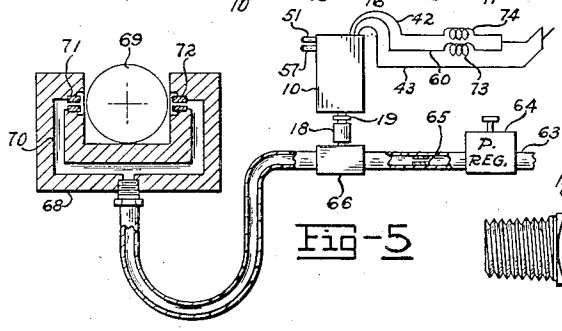


Fig-5

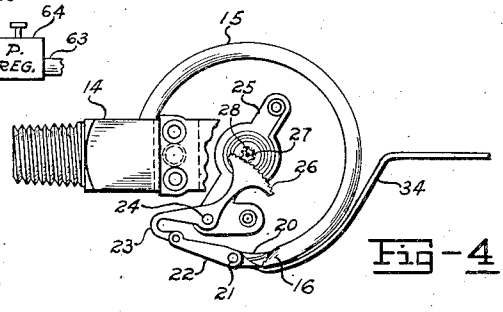


Fig-4

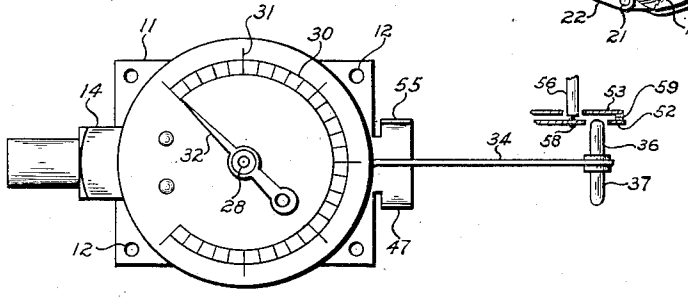


Fig-3

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SIZE GAUGING DEVICE

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4 Claims. (Cl. 73—37.5)

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This invention relates to precision gauging of the size of objects.

One object of the invention is the provision of a precision gauging apparatus embodying an air leakage gauging nozzle or nozzles cooperating with the workpiece or object to be gauged as to size, and an air pressure controlled electric switch having individually adjustable contact blades normally biased into exact positions and cooperating with spring blades controlled by a rigid arm secured to the free end of a curved hollow tube that is responsive to changes in air pressure as such changes are induced in a size gauging operation, the construction being such as to operate with no looseness of construction and with extreme preciseness and freedom from error.

Another object of the invention is the provision of a gauging apparatus of the character mentioned, in which the pressure tube has an arcuate extent less than 360 degrees and the switch operating arm to which it is fixed is arranged in the plane of expansive movement of the pressure responsive tube and amplifies the movement of the tube.

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 view, with the housing or support in central section, of an air pressure controlled electric switch employed in the present invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail view showing the pressure responsive tube support and the indicating mechanism that may be associated with it;

Fig. 4 is a detail showing the connection between the indicating pointer shaft and the end of the pressure responsive tube and also showing a portion of the rigid switch operating arm; and

Fig. 5 is a view showing the application of the pressure switch in the size gauging apparatus of the present invention.

In accordance with the present invention a precision gauging apparatus is provided that checks, compares or selects the sizes of objects or parts by measurement of the leakage flow of air supplied under pressure through a gauging nozzle or nozzles cooperating with the object. The air pressure variations caused by size differences in the object gauged as compared to conditions when an object or standard of the exact or known

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size is used, are effective on a pressure responsive curved tube which in turn controls adjustable switches that operate electrical gauging, measuring or selecting devices.

As shown in the drawing, in which the same reference numerals have been used in the several views to designate like parts, and more particularly with reference to Fig. 5, the numeral 63 designates a pipe adapted to be connected to the factory air line, 64 is an adjustable pressure regulator that automatically maintains a selected air pressure supplied to a restriction 65 in a pipe 66 communicating with a passage 70 in a gauging body 68 shown as adapted to receive the part or article 69 to be gauged as to size. The passage 70 extends to a gauging nozzle 71 the outer surface of which is spaced slightly from the surface of the object 69, and the space between the nozzle 71 and the object 69 determines the amount of leakage that takes place along the outer surface of the nozzle. This space is determined by the size of the object. There are preferably two of these nozzles, the second nozzle 72 being arranged diametrically opposite the axis of the object 69. The amount of leakage taking place past the ends of the gauging nozzles is thus an accurate indication of the size or diameter of the object, and the amount of this leakage is measured by the pressure existing on the low pressure side of the restriction 65.

When an object or master of known size, representing the maximum permissible size in a tolerance range, is applied to the gauging body 68 a certain pressure will exist in the pipe 66. There will be another pressure existing when a master of the minimum permissible size is applied. When the object to be gauged is applied, if it is within tolerance requirements, the pressure existing in pipe 66 will be between the maximum and minimum pressures determined by the masters.

The pipe 66 is in communication with the end of a curved pressure responsive tube which, in turn, controls a pair of adjustable precision switches that are connected to electrical gauging or sizing devices. The tubes and the switches are arranged in a support 10, connected to pipe 66 by connection 18. The electrical connections extending from the switches are shown at 42 and 69, each connected to an electrical relay 74, 73 which may be of the electromagnetic or electron type. Connection 43 is a common return wire.

The support 10 is shown as a housing in which various operating parts are contained. A sheet

metal plate 11 is secured to the housing by suitable attaching screws 12, the plate being fastened by means of screws 13 to a supply connection 14 which forms the support for the fixed end of a curved hollow pressure responsive tube 15 having a free end 16 which is annularly movable in response to changes in air pressure to which the interior of the tube is subjected through the supply pipe 18. The supply pipe is secured to the projecting end of the supply connection 14 by a suitable attachment nut 19.

A short link 20 is fixed to the free end 16 of the pressure responsive tube and carries a pivot pin 21 which may be connected, as illustrated in Fig. 4, to a pointer operating mechanism to give a visible indication of the pressure, although it should be understood it is quite unnecessary that such linkage and indicating pointer be used. However, where it is desired to provide a direct reading indicating pointer, the pivot pin 21 is connected through a link 22 to a lever 23 having a pivot support at 24 on a mounting plate 25 that is fixed to the supply connection 14. The other end of the lever 23 is a gear segment having teeth 26 meshing with a pinion 27 on the pointer shaft 28. The pointer 32 is visible through a glass 29 and operates over a scale plate 30 having suitable graduations or markings 31.

The pressure responsive tube 15, at its free end 16, is securely fixed to a rigid switch operating arm 34, which is preferably brazed or soldered directly to the outer side of the end portion of the tube, as will be apparent from Fig. 4, so that the arm 34 lies in and moves in the plane in which the tube expands and contracts. The tube has a length in an annular direction less than 360 degrees so that the integral assemblage constituted by the arm 34 and the tube itself will be quite firm and have adequate strength to prevent oscillation or looseness of the free end of the switch operating arm. This firmness of construction permits the gauge to be mounted on a support subjected to vibration without causing oscillatory movements of the contacts. It also is such that there can be no looseness of the pointer in a direction transverse that in which the pointer has normal movement. The construction, however, is such that the free end of the arm 34 has a movement corresponding to the movement of the free end of the tube, but to a considerably amplified degree. This results from the manner in which the arm is extended outwardly to a point remote from the tube, the arm curving around a portion of the tube and then extending straight outwardly but being so arranged that the only place where the arm and the tube are in contact is at the free end of the tube, where the two parts are securely fixed together against any relative movement. The assemblage constituted by the tube and the arm is mechanically frictionless and there is absolutely no lost motion in these parts.

The free end of the arm 34 (see Figs. 1 and 3) is provided with a pair of lugs 36 and 37 of electrical insulating material such as hard rubber or the like. The lug 37 operates freely through a hole or slot 38 in a rigid switch blade 39 that extends generally parallel to the direction of the free end of arm 34. If the lug 37 extends far enough through the hole in blade 39 it contacts and moves or flexes a flexible metal spring strip or blade 40. The rigid blade 39 and the spring strip 40 are provided with contact points 41 that are normally in contact with one another and close the circuit through the two switch blades and through wires 42 and 43 that lead to the indicating or controlling device that is governed by the pressure switch. The spring strip 40 has an inherent spring bias that holds it normally in engagement with the blade 39 and, as will be apparent from Fig. 1, one end of the spring strip is fixed by means of an insulating block 45 to a short spring strip 46 that also carries the blade 39. One end of the spring strip 46 is fastened to an outwardly projecting ear 47 that is struck up in the metal plate 11, the short spring strip 46 serving to normally bias both of the switch blades upwardly as viewed in Fig. 1 and holding an insulating lug 49 on the blade 39 yieldingly against the outer end of an adjustment post 50. The position of the post 50 can be readily changed by turning the control knob 51 thus rotating a threaded portion 51' of the post 50 within a fixed nut 51'' held in the support 10.

At the opposite side of the arm 34 is a similar switch constituted by the rigid blade 52 having a hole in it through which the lug 36 is freely movable, and the flexible strip or blade 53 that is normally biased towards the blade 52 to hold their contact points 59 in engagement. The strip 53 can be moved outwardly by the insulating lug 36 when the outer end of the arm 34 is moved upwardly from the position shown in Fig. 1. The ends of the blades 52 and 53 are carried by a short spring strip 54 secured to an ear 55 on plate 11. The short spring strip 54 normally urges both the switch blades upwardly as viewed in Figs. 1 and 3, and hold the rigid blade 52 against an adjustable post 56 controlled by adjustment knob 57. The adjustment post 56 extends freely through a hole in the flexible blade 53 and engages an insulating lug 58 on the rigid blade 52.

The two adjustment knobs 51 and 57 can be so turned as to locate the two pairs of switch blades free of the ends of the insulating lugs 36 and 37 so that both switches will be closed when the arm 34 is in a centered position as illustrated in Fig. 1, which is a position it assumes when there is some air pressure existing in the interior of the tube. With atmospheric pressure in the tube, the tube will be contracted and the outer end of the arm 34 will move downwardly and engage the flexible spring strip 40 so as to move it out of contact with the rigid blade 39. As the pressure in the tube increases to some predetermined value, and the tube expands it will move the arm 34 upwardly and close the circuit of the switch blades 39 and 40. It may then travel further through a distance controlled by the setting of the knob 57 before the lug 36 engages and opens the switch blade 53 from the rigid blade 52. The amount of motion required of the arm 34 before closing one switch and opening the other can be made as great or as small as desired merely by controlling the position of the knobs 51 and 57.

When a part of standard or known size is applied to the body 68, the knobs 51 and 57 are set so that objects that fall within the acceptable range of sizes will not cause either of the two switches to open. Thus when the object to be tested is in place in the body 68, one or the other of the two switches will be opened if the size of the object is either too large or too small. These switches control the relay coils or electron tubes which are suitably connected to electrically en-

ergized devices such as selector gates or indicators.

Although the insulating knobs **36** and **37** are required to pass through holes in one of the switch blades of each pair of switches, these holes need only be made slightly larger than the size of the insulating lugs since no lost motion can be present in the switch blades themselves and no freedom of movement is permitted the arm **34** in a direction transverse to that in which it is normally movable, or in other words in a plane transverse to the movement of the pressure responsive tube itself.

No undue strains are applied either to the tube, the arm **34**, or the switch blades, such as would interfere with the proper setting and operation of the apparatus, when the arm **34** is moved excessively in one direction or the other due to unusually large pressure or due to zero pressure existing in the tube. This movement cannot effect the setting of the rigid spring blades of the switches and imposes no unusual forces on the operating parts of the mechanism, since the flexible spring blades can yield outwardly to a very considerable degree and will promptly return to full contact with the rigid blades when the moving force is removed. The switch contacts operate in a precise manner so as to make or break contact at an exact position of the arm with a precision of a fractional part of a ten thousandth of an inch movement of the flexible contact. The fixed switch blade arrangement is such that the fixed contact does not yield or move when the pressure of the flexible blade is applied to it or removed from it, and regardless of the extent of flexing movement of the flexible blade it will return to bring its contact point into contact with the adjustably fixed blade under the air pressure condition for which the device is set.

The electrical circuit controlled by the switch blades **39** and **40** is through the wires **42** and **43**, while switch blades **53** and **52** are connected respectively to a wire **60** and to an extension **61** of wire **42**, all the switches and wires being insulated from the tube and the arm **34** so that no current flow through the tube can take place and inaccuracies of indications due to heating or inductive effect on the tube are completely avoided.

With an air pressure switch of this character the automatic operation of air pressure controlled sizing devices can be effected with precision since any particular pressure that may be applied to the pressure responsive tube **15** will always result in exactly the same position of the switches for any initial setup, and precision comparison readings obtained in a device using a supply pressure of the order of twenty pounds per square inch that will show size variations smaller than a thousandth of an inch and, if desired, to show size variations even smaller than one ten-thousandths of an inch. In such a precision sizing extremely reliable operation is necessary and the pressure controlled switches must be necessarily such that the arrangement can be used on vibrating parts, be applied in any of several positions, and be capable of operation over long periods of time without attention, otherwise the employment of a pressure switch in a size gauging system that employs air leakage as a basis for size measurement would be impractical. It is of utmost importance that the device should repeat time after time with exactness and precision capable to distinguish size differentials of the order of a part of a thousandth of an inch.

The present invention accomplishes these desirable results.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, 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. In a precision gauging apparatus for gauging the size of an object by measuring the amount of air leakage supplied under pressure through a gauging nozzle or nozzles cooperating with the object, in combination, a gauging nozzle for cooperation with the object to be gauged, a pressure responsive curved tube having a fixed end and having a closed free end which has expansive movement in a plane in accordance with pressure changes, a support for the fixed end of said tube, means placing the fixed end of said tube in communication with said nozzle, a rigid arm fixedly secured at one end thereof to the free end of the tube and projecting from the tube to a remote location so the remote end of the arm moves in accordance with the movement of the free end of the tube, a rigid switch blade at each side of said arm, a flexible spring blade at each side of said arm biased to contact with its respective rigid blade and movable from its respective rigid blade by said arm, means fixed with respect to said support for carrying said blades, and means for independently adjustably setting said rigid blades to precisely located positions.

2. In a precision gauging apparatus for gauging the size of an object by measuring the amount of air leakage supplied under pressure through a gauging nozzle or nozzles cooperating with the object, in combination, a gauging nozzle for cooperation with the object to be gauged, a pressure responsive curved tube having a fixed end and having a closed free end which has expansive movement in a plane in accordance with pressure changes, a support for the fixed end of said tube, means placing the fixed end of said tube in communication with said nozzle, a rigid arm fixedly secured at one end thereof to the free end of the tube and projecting in the plane of expansive movement of the tube to a location remote from the tube so the remote end of the arm moves in accordance with the movement of the free end of the tube but to an amplified degree, a rigid switch blade at one side of said arm, a flexible spring blade biased to contact with the rigid blade and movable from the rigid blade by said arm, means fixed with respect to said support for carrying said blades, means for adjusting the position of said rigid blade to a precisely located position, and an electrical relay connected to said blades and electrically independent of said tube.

3. In a precision gauging apparatus for gauging the size of an object by measuring the amount of air leakage supplied under pressure through a gauging nozzle or nozzles cooperating with the object, in combination, a gauging nozzle for cooperation with the object to be gauged, a pressure responsive curved tube having a fixed end and having a closed free end which has expansive movement in a plane in accordance with pressure changes, a support for the fixed end of said tube, means placing the fixed end of said tube in communication with said nozzle, a rigid arm fixedly secured at one end thereof to the free end of the tube and projecting in the plane of expansive movement of the tube to a location remote from

the tube so the remote end of the arm moves in accordance with the movement of the free end of the tube but to an amplified degree, an insulating lug near the outer end of the arm, a perforated rigid switch blade through which the lug is freely movable, a flexible spring blade biased to contact with the rigid blade and movable from the rigid blade by said lug, means fixed with respect to said support for carrying said blades, and means for adjustably setting the position of said rigid blade to a precisely located position.

4. In a precision gauging apparatus for gauging the size of an object by measuring the amount of air leakage supplied under pressure through a gauging nozzle or nozzles cooperating with the object, in combination, a gauging nozzle for cooperation with the object to be gauged, a pressure responsive curved tube having a fixed end and having a closed free end which has expansive movement in a plane in accordance with pressure changes, a support for the fixed end of said tube, means placing the fixed end of said tube in communication with said nozzle, the tube having an annular extent less than 360°, a rigid arm fixedly secured at one end thereof to the free end of the tube and projecting in the

plane of expansive movement of the tube to a location remote from the tube so the remote end of the arm moves in accordance with the movement of the free end of the tube, a lug at each side of the outer end of the arm, a pair of perforated rigid switch blades one at each side of said arm through which the lugs are freely movable, a flexible spring blade biased to contact with each rigid blade and movable from the rigid blade by said lugs, means fixed with respect to said support for carrying said blades, and means for independently adjusting the position of each of said rigid blades.

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