Sept. 27, 1960 M. F. KAUTZ 2,953,929

DIFFERENTIAL ADJUSTMENT

Filed Sept. 26, 1958

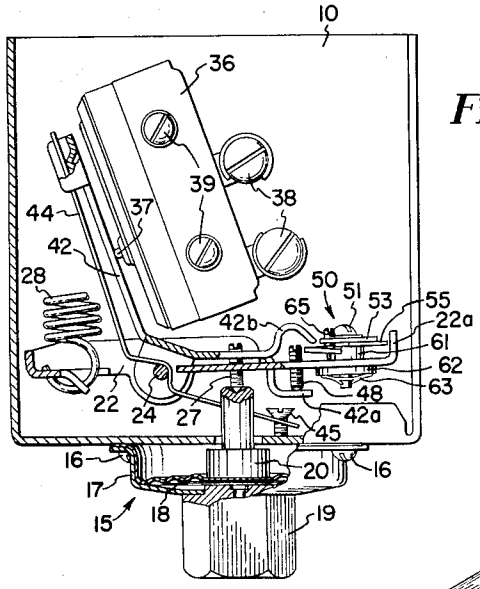


Fig. 1

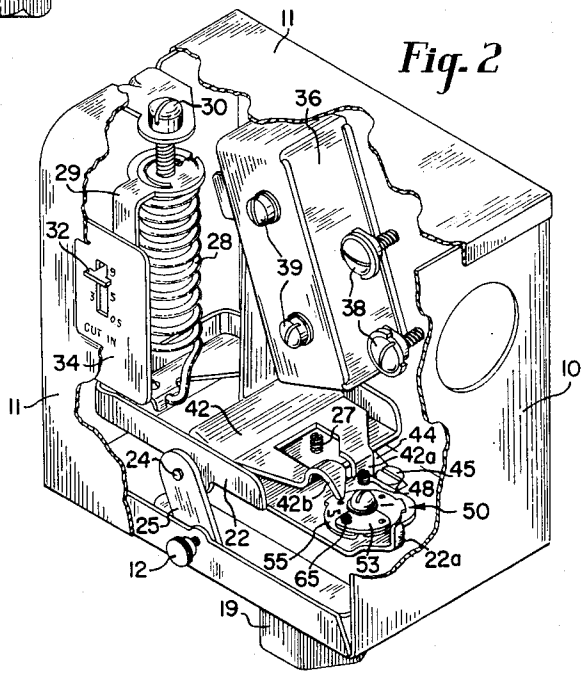


Fig. 2

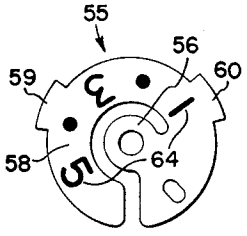


Fig. 3

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United States Patent Office 2,953,929 Patented Sept. 27, 1960

2,953,929

DIFFERENTIAL ADJUSTMENT

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Filed Sept. 26, 1958, Ser. No. 763,565

10 Claims. (Cl. 74—100)

This invention is directed to differential adjusting means suitable for use with condition responsive control devices. A common use of differential adjusting mechanisms is in pressure responsive switches.

The objects of the invention is to provide a control device having a differential adjustment that can be calibrated so that an indicating scale will show actual differential in terms of condition value.

The disclosed control device is of the type having a lost motion differential adjustment driving a snap switch that has two stable operating positions. The arrangement is such that the switch will stay in either of these positions until driven to the other. Differential is adjusted by changing the extent of lost motion. Such differential adjusting arrangements are old, but were lacking in means for setting the differential indicating scale to read correctly at more than one point. Under some circumstances it is impossible to provide a precalibrated scale that will reasonably match a screw of given pitch or cam of fixed shape in all units of a device to be manufactured in quantity. In the pressure control illustrated, the principal cause of variations for which correction must be made is in the effective spring rates of the pressure sensing diaphragms applied to different devices. According to the invention one of the abutments in the lost motion connection is in the form of a variable pitch cam that can be adjusted so that a predetermined angular movement will produce a predetermined change in differential of the control device.

In the drawing:

Figure 1 is an elevation, partly in section, of a pressure control incorporating the invention.

Figure 2 is a perspective view of the instrument shown in Figure 1.

Figure 3 is a plan view of the differential dial.

The pressure actuated switch shown in the drawing has a case **10** open at the front and top and a cover **11** that hooks over the upper rear and the upper and the front edges of case and is held by a screw **12** in an upturned edge at the bottom of the case.

A diaphragm assembly **15** is secured to the bottom of the case **10** by screws **16** and includes a housing **17** within which a cup shaped diaphragm **18** is fitted. A pressure connection **19** is secured to the bottom of the housing **17**. An actuator **20** has an enlarged lower end engaging the diaphragm and a portion of small diameter extending through an opening in the bottom of case **10**.

A main lever **22** is pivoted in the case **10** on a rod **24** which is supported at its rear end in the back of the case and at its front end in a bracket **25** attached to the bottom of the case. A main calibration screw **27** is threaded in the main lever **22** with its lower end engaging a crater in the top of actuator **20**. A control point adjusting spring **28** engages the left end of the main lever **22** and biases it in a clockwise direction to oppose expansion of the diaphragm. The top of spring **28** is in threaded engagement with an indicator member **29** which in turn is threaded to receive an adjusting screw **30**. The

head of the screw **30** bears on a tab formed in case **10** and an opening (not shown) is provided in cover **11** so that the screw can be adjusted without removing the cover. The indicator **29** has an offset portion **32** that extends through a slot in a scale plate **34** formed as part of case **10**. The offset portion **32** prevents rotation of indicator **29** when the screw **30** is adjusted and also cooperates with suitable indicia on scale plate **34** to indicate the pressure at which the control device will be moved to one of its operative positions.

A snap switch **36** having an operating plunger **37** and terminals **38** is secured to the back of case **10** by screws **39**. The switch may be of the type shown in McGall 1,960,020. A differential lever **42** is pivoted on the rod **24** which also pivotally mounts the main lever **22**. The portion of lever **42** to the left of its pivotal axis extends upwardly parallel to the case of the snap switch **36** and operatively engages the switch plunger. A leaf spring **44** engages the differential lever **42** at its upper extremity and biases this lever in a clockwise direction. Intermediate its ends the spring **44** bears on the rod **24** and its right hand end is slotted to lie under the head of a screw **45**. Screw **45** which is threaded in case **10** is adjusted so that the bias on lever **42** results in an inward force on the snap switch plunger intermediate the operating and release forces of the switch. Hence, unless another force is applied to the differential lever **42**, the switch will remain in either of its operative positions.

The right hand end of differential lever **42** has a portion **42***a* offset downwardly to lie beneath main lever **22**. A screw **48** threaded in the main lever is adapted to engage portion **42***a* of lever **42** to drive the lever **42** in a clockwise direction.

The differential lever **42** is driven in a counterclockwise direction by an abutment surface in the form of a cam **50** of variable pitch rotatably mounted on the main lever **22**. The cam assembly includes a stud **51** extending through the main lever. A laterally extending bracket **53**, a normally flat flexible dial **55** which provides the actual cam surface, and a spacing washer **61** are secured to the upper part of the stud **51**. Beneath the main lever **22** the stud carries a friction washer **62** and a spring washer **63** which biases the friction washer toward the main lever. The arrangement is such that the cam assembly will remain in any angular position to which it is adjusted.

As seen in Figure 3, the flexible dial **55** has a central portion **56** that engages the stud, a portion extending radially from the central portion and an arcuate peripheral portion **58** supported at one end by the radial portion. In addition, radially extending ears **59** and **60** are provided to cooperate with an upwardly extending portion **22***a* of main lever **22** to limit the range of angular adjustment of the cam. The right hand end of the differential lever **42** is provided with an abutment portion **42***b* offset upwardly and adapted to engage the upper surface of the dial **55**. The extremity of portion **42***b* also acts as a pointer cooperating with numerals **64**, indicative of pressure, on the surface of dial **55**.

The bracket **53** is screw threaded at a point overlying the free end of the arcuate portion **58** of the dial **55** to receive a cam adjusting screw **65**. The screw **65** is adjusted to deflect the free end of the dial downwardly out of its normal plane so that the cam will have the required slope to produce an actual operating differential in agreement with the differential indicated by the numerals on the dial surface. In manufacture, all dials for a particular type of instrument have the numerals disposed in the same angular relation on the dial surface. As stated above, it has been found that variations in spring rate of the mechanism, particularly of the diaphragm itself, produce rather wide differences from one

device to another in the change in pressure required to move the main lever through a given distance. Also there is some variation between different devices in the movement required to drive the snap switch through its differential. All possible variables are resolved by providing a cam of variable slope.

To calibrate the differential adjustment, the numeral **1** is set beneath the pointer provided by extension **42***b* of differential lever **42** and the screw **48** adjusted to produce an actual operating differential of one pound per square inch. Since the numeral **1** is located at a portion of the dial that has substantially no deflection when the screw **65** is turned to deflect the dial, subsequent adjustment of screw **65** will not appreciably affect this adjustment. The dial is then turned until the numeral **5** lies beneath the lever extension **42***b* and the screw **65** adjusted to produce an actual operating differential of five pounds per square inch.

In the illustrative device the snap switch is of the normally open type so that at pressures beneath the control range, the spring **28** holds the switch in closed position. Hence, the switch will open at the pressure indicated on the scale plate **34** plus the pressure indicated on dial **55**, and will close at the pressure indicated on scale plate **34**. With this arrangement there is no possibility of the differential being adjusted so wide at any main scale setting that the switch will not cut in, because differential is added to the main adjustment. It will be noted that differential will be substantially unaffected by adjustment of spring **28** because the switch always cuts in at the same position of the diaphragm regardless of the force required to move the main lever.

It will be understood that the invention is not limited to differential adjustments in which the lost motion adjustment is between two levers. Obviously the lost motion could be between any two relative movable members or between a movable member and a stationary portion of the device.

I claim as my invention:

1. A control device comprising, a condition responsive element, a control element having two stable operating conditions, a lost motion driving connection between said condition responsive element and said control element, said lost motion connection including an adjustable abutment consisting of a member rotatable on an axis substantially parallel to the direction of relative movement of the abutting portions of the connection, a normally flat spring strip having a portion extending radially from said member and an arcuate portion encircling said member and radially spaced therefrom, a plate extending radially from said member and overlying the free end of the arcuate portion of said strip, a screw in threaded engagement with said plate and engaging the free end of the arcuate portion of said strip and adjustable to deform the arcuate portion of said strip into helical form providing an abutment surface of adjustable pitch, and an indicator of condition value positioned in accordance with the angularly adjusted position of said member.

2. A control device comprising, a condition responsive element, a control element having two stable operating conditions, a lost motion driving connection between said condition responsive element and said control element, said lost motion connection comprising abutment means rotatable on an axis substantially parallel to the direction of relative movement, said abutment means having a helical abutment surface of variable pitch, means for changing the pitch angle, and an indicator of condition value positioned in accordance with the angularly adjusted position of said abutment means.

3. A control device comprising, a condition responsive element, a control element having two stable operating conditions, a lost motion driving connection between said condition responsive element and said control element, said lost motion drive including an adjustable abutment comprising a normally flat arcuate spring strip angularly adjustable on the axis of the arc, means for adjusting the relative axial spacing of the two ends of said strip, and an indicator of condition value positioned in accordance with the angularly adjusted position of said strip.

4. A control device comprising, a condition responsive element, a control element having two stable operating conditions, a driving connection between said elements, means for adjusting and indicating the condition values at which said control element is moved to both of its operating conditions, said driving connection including lost motion means for varying the relation of the two operating conditions, said lost motion means including an adjustable abutment comprising a normally flat arcuate spring strip angularly adjustable on the axis of the arc, means for adjusting the relative axial spacing of the two ends of the strip, and an indicator of condition value positioned in accordance with the angularly adjusted position of said strip.

5. A control device comprising, first and second coaxially pivoted levers, condition sensing means acting on said first lever to position said lever in accordance with condition value, a control element actuated between two operative positions by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments comprising an arcuate strip carried at one end by a member rotatable on an axis spaced from and normal to the pivotal axis of said levers, means for varying the axial deflection of the other end of said strip, and indicia of condition value rotatable with said strip.

6. A control device comprising, first and second coaxially pivoted levers, condition sensing means acting on said first lever to position said lever in accordance with condition value, a snap switch actuated by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments comprising an arcuate strip carried at one end by a member rotatable on one of said levers on an axis normal to and spaced from the axis of said levers, means for determining the axial deflection of the other end of said strip, and indicia of condition value on said strip cooperating with an index on said one lever to indicate operatng differential.

7. A control device comprising, a frame, first and second levers coaxially pivoted on said frame, an expansible chamber acting on said first lever, a spring acting between said frame and said first lever to oppose expansion of said chamber, indicia associated with said spring to indicate the control point of the device in terms of condition value, a snap switch actuated by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments comprising an arcuate spring strip carried at one end by a member rotatable on one of said levers on an axis normal to and spaced from the axis of said levers, means for adjusting the axial deflection of the other end of said strip, and cooperating indicia of condition value on said one lever and said strip to indicate operating differentials in accordance with the angular adjustment of said member and said strip.

8. A control device comprising, first and second coaxially pivoted levers, condition sensing means acting on said first lever to position said lever in accordance with condition value, a control element actuated between two operative positions by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments including a member rotatable on one lever on an axis normal to and spaced from the lever axis and an arcuate strip carried at one end on said member, a screw adjustable in said member and engaging the other end of said strip to determine the relative axial deflection of the two ends of said strip, and cooperating indicia of condition value on said member and on said lever.

9. A control device comprising, first and second coaxially pivoted levers, condition sensing means acting on said first lever to position said lever in accordance with condition value, a control element actuated between two operative positions by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments being an arcuate spring strip rotatably mounted on one of said levers, means for adjusting the relative axial spacing of the two ends of said strip, and cooperating indicia of condition value on said lever and on said strip.

10. A control device comprising, a frame, first and second levers coaxially pivoted on said frame, an expansible chamber acting on said first lever, a spring acting between said frame and said first lever to oppose expansion

of said chamber, indicia associated with said spring to indicate the control point of the device in terms of condition value, a snap switch actuated by said second lever, cooperating abutments on said levers to cause said second lever to move with said first lever, one of said abutments being an arcuate spring strip rotatably mounted on one of said levers, means for adjusting the relative axial spacing of the two ends of said strip and cooperating indicia of condition value on said lever and on said srtip.

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