May 28, 1957 J. L. CRONK 2,793,540

FEED-BACK MECHANISM LEAF SPRING CLAMP

Filed July 27, 1953 2 Sheets-Sheet 1

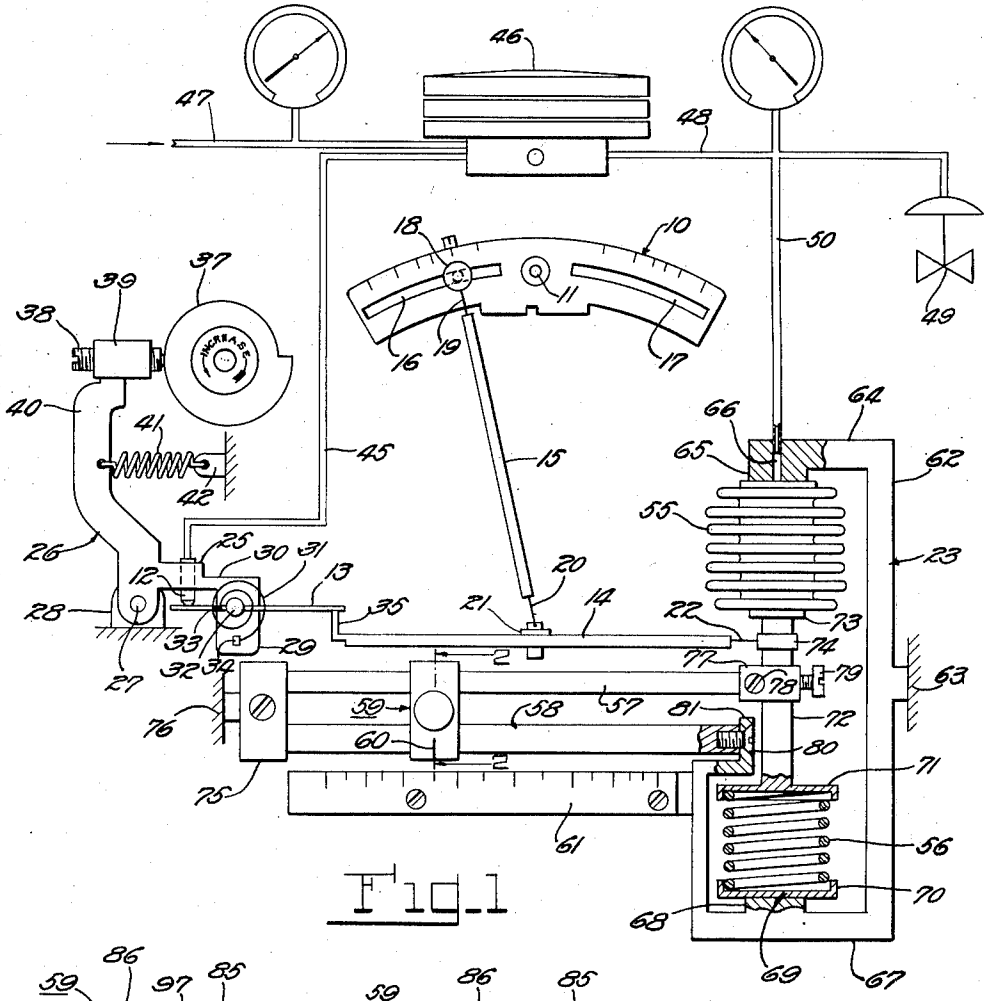

Fig. 1

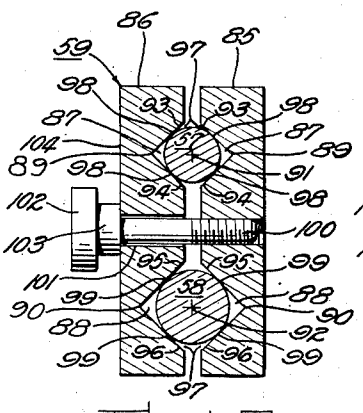

Fig. 2

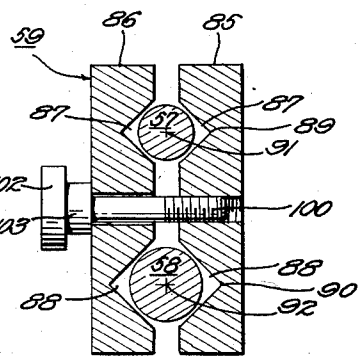

Fig. 3

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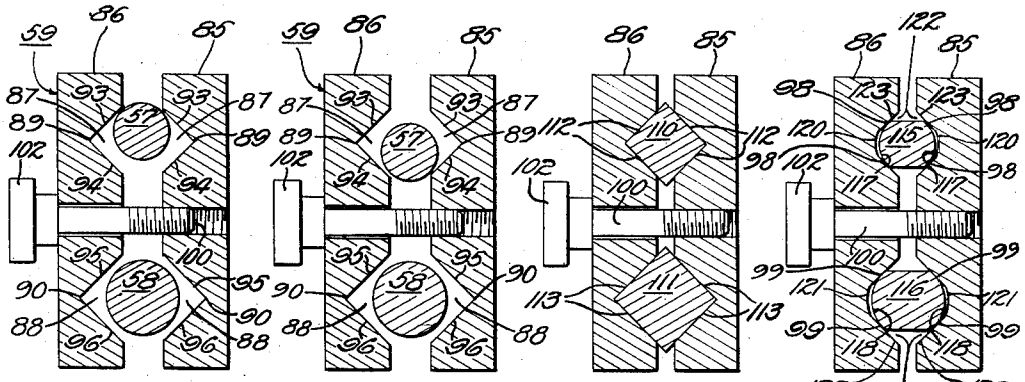

Fig. 4 Fig. 5 Fig. 6 Fig. 7

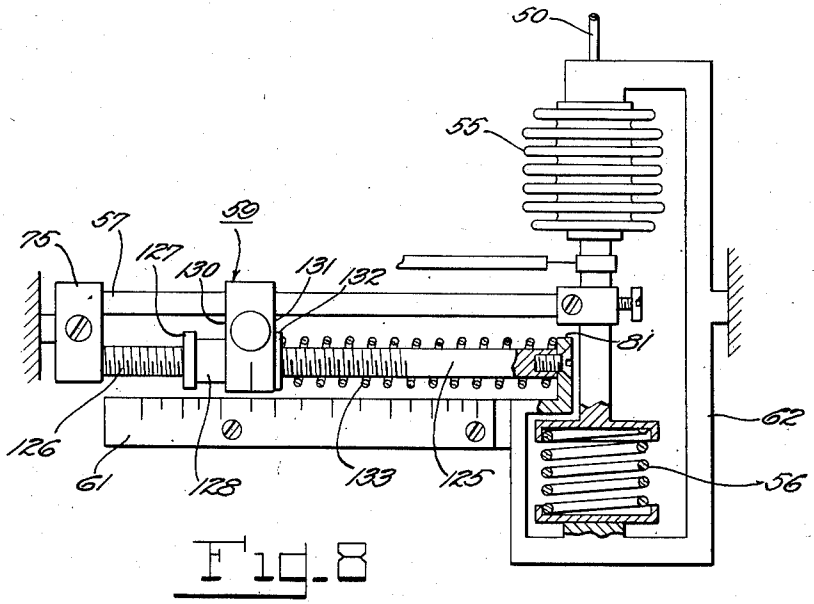

Fig. 8

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FEED-BACK MECHANISM LEAF SPRING CLAMP

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Application July 27, 1953, Serial No. 370,589

9 Claims. (Cl. 74—522)

This invention relates to an improvement in controllers, transmitters and the like and particularly concerns a feed-back mechanism which is commonly employed in connection with a primary response element to vary a controlling pressure for the purpose of providing a proportioning band width which is suited to the process conditions. When so employed, the feed-back mechanism functions in a negative sense, since it modifies the pressure change initiated by the primary element. A controller of this type is disclosed in the United States patent to C. E. Mason No. 2,616,440, dated November 4, 1952, and includes a primary response element in combination with a pressure actuated leaf spring and clamping device therefor which is utilized for this purpose. In this connection, it will be understood by those skilled in the art that by reversing the action of the leaf spring or of a valve by which the controller pressure is varied by the primary element and feed-back mechanism, a so-called gap action may be obtained, whereby a servomotor or other device functioning to permit the value of a variable to change between selected limits is actuated to reverse the direction of value change when either one of said limits is reached. When thus employed, the feed-back mechanism functions in a positive sense, since it amplifies the pressure change initiated by the primary element.

As heretofore constructed, so far as known to me, the feed-back mechanism includes a flat leaf spring rigidly mounted at one end with its free end subjected to the force of a bellows or the like responsive to an operating pressure. In its normal flat position the leaf spring is mounted in parallel with a track in the form of a pair of bars rigidly supported at each end and adapted to carry a clamping device by which the leaf spring can be rigidly held at any selected position within its length for the purpose of varying the spring characteristic and therefore the movement of the free end of the leaf spring per increment of force applied thereto. One objection to this arrangement is that a relatively intricate and expensive clamping device consisting of several special parts is required. Another objection relates to the adjustment of the clamping device, namely, to tighten or loosen the clamp by practicable means, two separate operations are necessary, one to tighten or loosen that portion of the clamp that embraces the leaf spring, and the other to tighten or loosen that portion of the clamp which engages the track. And I have found that by reason of the clamp and leaf spring construction referred to, unless a definite clamping sequence is adhered to, improper clamping results and the desired width of proportioning band or gap action is not obtained.

The mechanism embodying this invention overcomes the objections referred to and provides a cantilever spring member and clamping arrangement therefor which is inexpensive to produce, is self-aligning, and may be quickly and accurately adjusted to meet the operating conditions. And it will be understood that while the device embodying this invention is particularly suited for use as a feed-back device in pneumatic controllers, transmitters and the like, it may have other uses wherein it is desirable to actuate a driven member by the movement of the free end of a cantilever spring on a basis which has some required proportional relation to a change in force to which the spring is subjected.

It is an object of this invention to provide a cantilever spring member combined with an inexpensive yet positive, self-aligning clamp which may be tightened or loosened by a single knob or equivalent member for the purpose of obtaining a selected spring characteristic.

It is an object of this invention to provide a simple form of cantilever spring and clamp therefor for operation in conjunction with a pressure operated element and a driven member to be actuated thereby to provide any desired proportional increment of movement to the driven member in relation to the increment of movement of the pressure operated element.

And it is an object of this invention to provide a simple form of feed-back device which may be utilized with a primary element in a controller, transmitter, or the like, for operating a valve governing the instrument pressure for the purpose of modifying a change in pressure initiated by the primary element on any desired proportional basis, or for the purpose of amplifying the pressure change and reversing the direction of said change when the pressure value has reached selected limits.

These and other objects of this invention will be more fully understood from the following description when taken in connection with the accompanying drawings, in which,

Fig. 1 is a front elevation, partly in diagram, of a controller or transmitter including a feed-back mechanism embodying this invention;

Fig. 2 is a detail in section of the clamp and associated spring member and guide member taken on line 2—2 of Fig. 1 showing the parts enlarged and in clamped position;

Figs. 3–5 are views similar to Fig. 2 showing the relation of the parts under different operating positions when the clamp is loosened;

Figs. 6 and 7 are detail sections similar to Fig. 2 but showing modified constructions; and

Fig. 8 is a front elevation of a modified form of feed-back mechanism.

Having reference to the drawings and particularly to Fig. 1, there is shown a pneumatic controller, which may also be used as a transmitter, for the measurement of liquid level. For this purpose an arc-shaped member **10** mounted on a shaft **11** rotated by means responsive to changes in liquid level, as by a displacer, float or the like, not shown, may be employed. The member **10** is in operative connection with a valve in the form of a nozzle **12** and flapper **13** by means of a flapper operating lever **14** and link **15**, whereby rotary movements of the shaft **11** are communicated to the flapper. The member **10** is provided with arc-shaped slots **16** and **17** suitable to receive an adjustable fastening member **18** with which one end of the link is connected, as by a spring wire pivot **19**. The other end of the link has a spring wire pivotal connection **20** with a bracket **21** attached to the lever **14**, and the lever has a leaf spring pivotal connection **22** with the feed-back mechanism, to be described, and generally indicated at **23**.

The nozzle **12** is mounted on the horizontal arm **25** of a control point setting angle lever **26** which is in turn pivotally mounted at **27** on a bracket **28**. The flapper **13** is pivotally mounted preferably on a depending portion **29** of the horizontal arm **30**, the parts being arranged so that the longitudinal axis of the flapper is normal to the axis of the nozzle when the parts are held in engagement, as by a suitable spiral spring **31** surrounding the flapper pivot **32** and connected with the flapper at one end **33** and with the arm portion **29** at the other end **34**. An

extension 35 at the free end of the flapper lever 14 serves to position the flapper in respect to the nozzle.

It will be understood that by means of the slots 16 and 17 in the arc-shaped member 10 the movement of the lever 14 per increment of rotation of the shaft 11 may be varied to suit the operating conditions. And it will also be understood that the valve action may be reversed by removing the fastening member 18 from the slot 16 and connecting the member 18 with the slot 17 at the other side of the shaft 11. When the link 15 is disposed in the position shown in Fig. 1, a clockwise rotation of the shaft 11 reduces the nozzle pressure, and when the fastening member 18 is in the slot 17 at the opposite side of the shaft, the clockwise rotation of the shaft increases the nozzle pressure.

Means for adjusting the control setting of the instrument may be in the form of a cam 37 which is rotatable on a fixed mounting, not shown, and cooperates with a screw 38 threaded through a cylindrical portion 39 of a vertical leg 40 of the angle lever, the members being held in engagement by an extension spring 41 secured at one end to the arm 40 and at the other end to a fixed bracket 42. With the link positioned as shown in Fig. 1, if it be assumed that the shaft 11 is rotated counterclockwise on a rise in liquid level, adjustment of the angle lever 26 clockwise lowers the level setting and vice versa.

The nozzle 12 is connected with a supply of regulated fluid pressure from a source not shown by means of a pipe 45, a pilot 46 and a supply pipe 47. The pilot 46, herein diagrammatically illustrated, may be of any well-known construction such, for example, as shown in the United States patent to Hubley No. 2,327,898, dated August 24, 1943. The pilot is provided with the usual restriction, not shown, having a capacity less than that of the nozzle 12, so that the nozzle pressure depends on the relative position of the flapper 13 in respect to the nozzle. The pilot is so arranged that an increase in nozzle pressure provides a proportional increase in pilot output pressure and vice versa. The output pressure is connected by means of a pipe 48 with a device to be actuated, such as a valve 49, and is also connected by means of a pipe 50 with the feed-back mechanism 23, to be described. The mechanism hereinabove described constitutes a primary response device which is particularly adapted to measure changes in liquid level, it being understood that any well-known type of primary response suited to the process conditions may be employed.

The feed-back mechanism 23 comprises a bellows 55 which is opposed by a compression spring 56, a cantilever spring member 57 which has associated therewith a guide member 58, and a clamping device, generally indicated at 59, having an index marking 60 which cooperates with a suitable scale 61. The bellows 55 and spring 56 are mounted at opposite ends of a frame 62 which may be secured to a fixed support 63 within the instrument case. A laterally extending part 64 of the frame has a depending portion 65 to which the bellows is secured, a suitable passage 66 being provided for communicating the interior of the bellows with the output pressure pipe 50. The other end of the frame has a laterally extending base part 67 having an upwardly extending portion 68 to which a spring plate 69 is secured. The plate 69 is in the form of a disk having an annular flange 70 and is adapted to receive the lower end of the spring 56. The other end of the spring 56 is received within a plate 71, similar in construction to the plate 69, which is secured to the lower end of a post 72, the upper end of the post being connected to a disk 73 secured to the center of the free end of the bellows 55. The post 72 carries a collar 74 to which one end of the leaf spring pivot 22 of the flapper lever is rigidly secured.

Referring to Figs. 1 to 5 inclusive, the cantilever spring member 57 is in the form of a resilient solid rod as herein shown which is circular in cross section, but which may be in the form of a tubular member if desired. One end of the rod 57 is secured to a fixed member 75 which, as herein shown, is in the form of a clamp rigidly secured to a fixed support 76. The other end of the rod 57 is rigidly connected with a block 77, as by a set screw 78, which in turn may be secured to the post 72 by a set screw 79. The guide member 58 is of relatively rigid construction and is also preferably in the form of a reasonably heavy circular rod which may also be of tubular shape. One end of the guide rod 58 is rigidly held by means of the clamp 75 and the other end of the guide rod is connected, as by a screw 80, with an upwardly extending arm 81 which is preferably integral with the base member 67 of the frame. The parts are so arranged that when the output pressure is at the mid point of its range, for example, at 9 p. s. i. in a pressure range of 3 p. s. i. to 15 p. s. i., the force afforded by the compression spring 56 is just sufficient to counterbalance the force provided by the bellows 55. Under these conditions the spring rod 57 is in its normal unsprung position as shown in Fig. 1 with the guide rod 58 disposed in parallel therewith.

It will be understood that the bellows 55 deflects the free end of the spring rod 57 downwardly from its horizontal position when the output pressure increases above 9 p. s. i., and that the compression spring 56 deflects the spring rod upwardly from its horizontal position when the output pressure drops below 9 p. s. i. Thus when the arc-shaped member 10 rotates clockwise as viewed in Fig. 1, the flapper lever 14 is rotated clockwise about its pivot 22, thereby moving the flapper 13 away from the nozzle 12 and reducing the output pressure in the bellows 55. The decrease in output pressure in the bellows 55 permits the compression spring 56 to deflect the spring rod 57 upwardly and contract the bellows 55 until the force exerted by the spring rod plus the force exerted by the bellows is equal to the force generated by the compression spring. The flapper lever 14 is thus rotated counterclockwise about the link pivot 20, thereby returning the flapper 13 to a throttling relation with the nozzle and providing a reduction in output pressure, which reduction is proportional to the clockwise rotation of the arc-shaped member 10. Upon the counterclockwise rotation of the arc-shaped member 10, the output pressure is increased and the spring rod 57 is deflected downwardly by the bellows 55 from its normal mid position until the force generated by the compression spring 56 plus the force exerted by the spring rod is equal to the force generated by the bellows 55. Thus the flapper 13 is returned to a throttling relation with the nozzle 12 at an increased output pressure, which increase is proportional to the counterclockwise movement of the arc-shaped member 10.

It will be seen from the above that unless the output pressure is at its mid value the spring rod 57 assumes a nonparallel relation with the guide rod 58, and it will be understood that the amount of movement afforded to the flapper lever pivot 22 per increment of output pressure change depends on the spring characteristic of the rod 57 which in turn depends on the free length of the spring rod, or in other words, on the position of the clamp 59.

The clamp herein disclosed in Figs. 1 to 5, inclusive, coacts with the spring rod and guide rod in a manner to enable the clamp to be readily positioned at any location on the spring rod and guide rod required for the purpose. Furthermore, the parts are so arranged that if adjustment is made when the output pressure has departed from the mid value and the free length of the spring rod is not in parallel with the guide rod, when the clamp is tightened the spring rod will be automatically drawn into parallel relation with the guide rod between the clamp 59 and the fixed member 75.

Referring to Figs. 2 to 5, the clamp comprises two jaws 85 and 86, each jaw being provided with two V-shaped recesses or notches 87 and 88, the apex 89 of

one notch being spaced from the apex **90** of the other notch by an amount which is equal to the distance between the longitudinal axes **91** and **92** of the spring rod and guide rod, respectively, when they are disposed in parallel. The notches **87** and **88** in the jaw **85** are oppositely disposed to the corresponding notches **87** and **88** in the jaw **86**, each notch extending across the width of the jaw, the notches **87** being provided with side faces **93** and **94** and the notches **88** having side faces **95** and **96**. The side faces are preferably disposed at an angle of 90 degrees to each other to form an entrance portion **97** and are adapted to engage the circular surface of the rods at points **98** and **99** as indicated in sectional Fig. 2. It will be noted that the distance between the points **98** on the rod **57** and between the points **99** on the rod **58** is less than the width of the entrance portion **97** of each pair of notches. It will be understood that angles other than the 90 degree angles shown may also be employed without departing from the scope of my invention.

Means for drawing the jaws together is in the form of a screw **100** which passes freely through an opening **101** in the jaw **86** and threads into the opposite jaw **85** at a point midway between the V notches **87** and **88**. The screw **100** has a knob **102** provided with a collar **103** which is adapted to engage the outer surface **104** of the jaw **86**. Thus when the jaws are clamped to the rods **57** and **58** as shown in Fig. 2, the notch surfaces **93** and **94** engage the circular surfaces of the rod **57** at points **98** and the notch surfaces **95** and **96** engage the circular surface of the rod **58** at the points **99** all as indicated in cross section. By this means the rod **57** is rigidly secured to the rod **58** at the spacing desired.

Referring to Fig. 3, wherein the clamp has been loosened and the spring rod and guide rod are disposed in parallel, the output pressure being at its mid value, since the guide rod and spring rod are centered in the V notches **87** and **88**, the clamp need only to be loosened slightly to permit it to be moved along the rods to some selected position and thereafter tightened by one single operation.

Referring to Fig. 4, there is shown a clamp **59** which has been loosened and the spring rod **57** and guide rod **58** are not in parallel since the instrument output pressure is less than its mid value. Under these conditions the clamp should be loosened slightly more than required when the rods are in parallel in order to readily slide it along the rods. However when the clamp is drawn together by the screw **100**, the notch faces **93** and **96** engage the surface of the rods **57** and **58**, respectively, and afford a wedging action by which the spring rod **57** is drawn towards the guide rod **58** until the opposite faces **94** and **95** of the notches engage the surface of the rods. When this occurs, the rods are in parallel between the clamp **59** and the fixed member **75**. Furthermore as the screw is tightened, the faces of the V notches align the clamping jaws with the rods so that the planes defined by the apexes **89** and **90** of each pair of oppositely disposed notches are bisected by a plane defined by the axes **91** and **92** of the spring rod and guide rod.

Referring to Fig. 5, there is shown a clamp which has been loosened, the spring rod **57** and guide rod **58** being also in nonparallel relation since the instrument output pressure is higher than its mid value. When the clamp is suitably loosened for adjustment, it will be noted that the rods are closer together than when the spring rod is in its normal undeflected position. Thus under these conditions, when the clamp is tightened, the faces **94** and **95** of the notches afford a wedging action by which the spring rod **57** is separated from the guide rod **58** until the opposite notch faces **93** and **96** engage the surface of the rods and the spring rod **57** is forced to its normal parallel relation with the guide rod **58** between the clamp **59** and the fixed member **75**.

In Figs. 6 and 7, modified constructions are illustrated. In Fig. 6 a spring rod **110** and a guide rod **111** are shown

as square in cross section. In this arrangement the opposite sides **112** of the spring rod **110** and the opposite sides **113** of the guide rod **111** define a 90 degree angular construction which is adapted to make a snug fit within its associated V notch. It will be understood that when the clamp is suitably loosened for adjustment, the adjustment may be readily made and thereafter the spring rod **110** may be drawn into parallel relation with the guide rod **111** between the clamp **59** and the fixed support **75**. And while I have shown the rods as square in cross section, they may have other cross sectional configurations as long as two opposite sides define angles which are adapted to fit into the V notches of the jaws **85** and **86**.

In Fig. 7, I have shown a flattened spring rod **115** and guide rod **116** having arc-shaped side portions **117** and **118**, respectively. The notches instead of being in the form of a V have bed portions **120** and **121** each defining an arc which is preferably adapted to conform to the arc-shaped side portions of the rods. Since the entrance portion **122** of the notches is wider than the spacing between the clamp engaging points **98** on the rod **57** and **99** on the rod **58** and the sides **123** of each notch flare outwardly as shown, it follows that the clamp may be loosened, adjusted, and tightened to provide for adjustment and for the clamping action desired in the manner described above.

Referring to Fig. 8, there is shown a feed-back mechanism which is particularly suited for transmitters wherein an extremely accurate but relatively limited proportioning band adjustment is required. The feed-back mechanism includes the clamp **59** and is generally similar to that shown in Fig. 1, with the exception that the device is provided with a guide rod **125** which is associated with a vernier means for accurately adjusting the clamp to provide the exact spring characteristic desired. For this purpose the guide rod **125** is threaded as indicated at **126** preferably over a major portion of its length. A suitably threaded knob **127** is mounted on the guide rod **125** and is provided with a collar portion **128** which is adapted to span the opening between the jaws of the clamp when the jaws are in their maximum open position, and engage the face **130** of each jaw. The opposite face **131** of each jaw is suitably engaged by a washer **132** which has a sliding fit with the guide rod **125**, and a compression spring **133** surrounds the rod and is confined between the washer and the arm **81** of the frame **62** in which the bellows **55** and the spring **56** are mounted. Thus the clamp is maintained in contact with the collar portion **128** of the knob **127** by the spring **133** and may be accurately positioned by the knob at any selected point along the rods **57** and **125**, thereby permitting the exact spring characteristic required to be obtained.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring member having a rigidly supported portion and a free length deflectable from a normal position, a single rigidly supported guide member spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part, a clamp spanning said spring member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed operating and clamping recesses in spaced parallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said members when the spring member is in its normal undeflected position, said recesses each having an entrance portion defined by outwardly flaring straight side portions and said spring member and

guide member each having at opposite sides thereof coacting portions for engagement with said side portions within said entrance portion when said members are both in parallel and in nonparallel relation, and means for varying the spacing between said clamping jaws to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

2. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring member having a rigidly supported portion and a free length deflectible from a normal position, a single rigidly supported guide member spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part, a clamp spanning said spring member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said members when the spring member is in its normal undeflected position, said recesses each having an entrance portion and a bed portion, said entrance portion being defined by outwardly flaring side portions and said spring member and guide member each having at opposite sides thereof coacting portions spaced apart at a width which is substantially less than the width of said entrance portion for engagement with said side portions between said entrance portion and said bed portion when said members are both in parallel and in substantial nonparallel relation, and means for varying the spacing between said clamping jaws to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

3. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring member having a rigidly supported portion and a free length deflectible from a normal position, a single rigidly supported guide member spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part, a clamp spanning said spring member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said members when the spring member is in its normal undeflected position, said recesses being V-shaped in cross section forming an entrance portion and a bed portion, and said spring member and guide member each having at opposite sides thereof a coacting portion of substantially less width than said entrance portion for engagement with said side portions between said entrance portion and said bed portion when said members are both in parallel and in substantial nonparallel relation, and means for varying the spacing between said clamping jaws to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

4. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring comprising a resilient member of curvilinear cross section having a rigidly supported portion and a free length deflectible from a normal position, a single rigidly supported guide member spaced apart from said resilient member and having its longitudinal axis substantially in parallel with the longitudinal axis of the resilient member when the latter is in its normal undeflected position, means connecting the free length of said resilient member with said pressure responsive element and said part, a clamp spanning said resilient member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said resilient member and guide member when the resilient member is in its normal undeflected position, said recesses having an entrance portion and a bed portion, said entrance portion being defined by outwardly flaring side portions and said resilient member and guide member each having at opposite sides thereof coacting portions which are spaced at a width that is substantially less than the width of said entrance portion for engagement with said side portions between said entrance portion and said bed portion when said members are both in parallel and in substantial nonparallel relation, and means for varying the spacing between said clamping jaws to permit the free length of said resilient member to be varied and to draw the remaining portion of said resilient member into parallel relation with said guide member.

5. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring member having a rigidly supported portion and a free length deflectible from a normal position, a single rigidly supported guide member spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part, a clamp spanning said spring member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said spring member and guide member when the spring member is in its normal undeflected position, said recesses having outwardly flaring side portions and at least two oppositely disposed recesses being V-shaped in cross section, one of said members having angular shaped portions at two opposite sides thereof which portions are adapted to make a snug fit within said V-shaped recesses, and the other of said members having recess engaging portions at two opposite sides thereof suitable for engagement with the outwardly flaring side portions of the other two oppositely disposed recesses, and means for varying the spacing between said clamping jaws to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

6. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring member having a rigidly supported portion and a free length deflectible from a normal position, a guide rod member of circular cross section supported against lateral and lengthwise movement spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part to be actuated thereby, a clamp span-

ning said spring member and guide member comprising clamping members disposed at opposite sides of said members and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation each having an entrance portion defined by outwardly flaring side portions which are adapted to engage said members at opposite sides thereof, the width of said entrance portion being substantially greater than the width of the loci of engagement of said members with said side portions to permit said side portions to engage said members within said entrance portion when the members are both in parallel and nonparallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said members when the spring member is in its normal undeflected position, said guide rod member having a threaded portion, an adjustment member threaded on said portion and in operative connection with said clamp, at least one of said last mentioned members being rotatable in respect to the other, and means for varying the spacing between said clamping members to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

7. In a feed-back mechanism for a pneumatic instrument which includes a pressure responsive element and a part to be actuated thereby, in combination, a cantilever spring having a rigidly supported portion and a free length deflectible from a normal position, a rigidly supported guide rod member of circular cross section spaced apart from said spring member and having its longitudinal axis substantially in parallel with the longitudinal axis of the spring member when the latter is in its normal undeflected position, means connecting the free length of said spring member with said pressure responsive element and said part to be actuated thereby, a clamp spanning said spring member and guide member comprising clamping jaws disposed at opposite sides of said members and including a pair of oppositely disposed guide and clamping recesses in spaced parallel relation, said recesses each having an entrance portion and a bed portion, the entrance portion being defined by outwardly flaring straight side portions, and said cantilever member and guide member each having at opposite sides thereof coacting portions spaced apart at a width which is substantially less than the width of the said entrance portion for engagement with said side portions between said entrance portion and said bed portion when said members are both in parallel and in substantial nonparallel relation, the spacing between the longitudinal axes of said recesses being equal to the spacing between the longitudinal axes of said members when the spring member is in its normal undeflected position, said guide member having a threaded portion, a rotatably mounted adjustment member threaded on said portion and adapted to engage one side of said clamp for moving said clamp along said guide member in one direction, resilient means in operative connection with said clamp tending to move it in the opposite direction, and means for varying the spacing between said clamping jaws to permit the free length of said spring member to be varied and to draw the remaining portion of said spring member into parallel relation with said guide member.

8. In mechanism of the character described wherein a driven member is actuated by the movement of the free portion of a cantilever spring on a basis which has some required proportional relation to a change in force to which the spring is subjected, in combination, a cantilever spring rod of circular cross section rigidly mounted at one end having its free portion in operative connection with a driven member and subjected to a force-applying element, resilient means opposing the force of said element, a rigidly supported guide rod of circular cross section spaced apart from said spring rod and having its longitudinal axis substantially in parallel with the longitudinal axis of the guide rod when the latter is in its undeflected position, a clamp spanning said spring rod and guide member comprising clamping jaws disposed at opposite sides of said rods and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, each of said recesses having outwardly flaring straight side faces forming an entrance portion, one pair of said recesses being adapted to engage said spring rod within said entrance portion and the other pair of said recesses being adapted to engage said guide rod within said entrance portion when said members are both in parallel and in substantial nonparallel relation, and means for varying the spacing between said jaws to tighten or loosen said clamp.

9. In apparatus of the character described wherein a driven member is actuated by the movement of the free portion of a cantilever spring on a basis which has some required proportional relation to a change in force to which the spring is subjected, in combination, a cantilever spring rod of circular cross section rigidly mounted at one end having its free end in operative connection with a driven member and subjected to a force-applying element, resilient means opposing the force of said element, a rigidly supported guide rod of circular cross section spaced apart from said spring rod and disposed in parallel relation therewith when the spring rod is in an undeflected position, a clamp spanning said spring rod and guide rod comprising clamping jaws disposed at opposite sides of said rod and including a pair of oppositely disposed guiding and clamping recesses in spaced parallel relation, each of said recesses being generally V-shaped to form an entrance portion, one pair of said recesses being adapted to engage said spring rod within the entrance portion, and the other pair of said recesses being adapted to engage said guide rod within the entrance portion when said members are both in parallel and in substantial nonparallel relation, and means for varying the spacing between said jaws to tighten or loosen said clamp.

References Cited in the file of this patent

UNITED STATES PATENTS

1,149,599	Small	Aug. 10, 1915
1,729,911	Smith	Oct. 1, 1929
2,616,440	Mason	Nov. 4, 1952