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CONTROL MECHANISM

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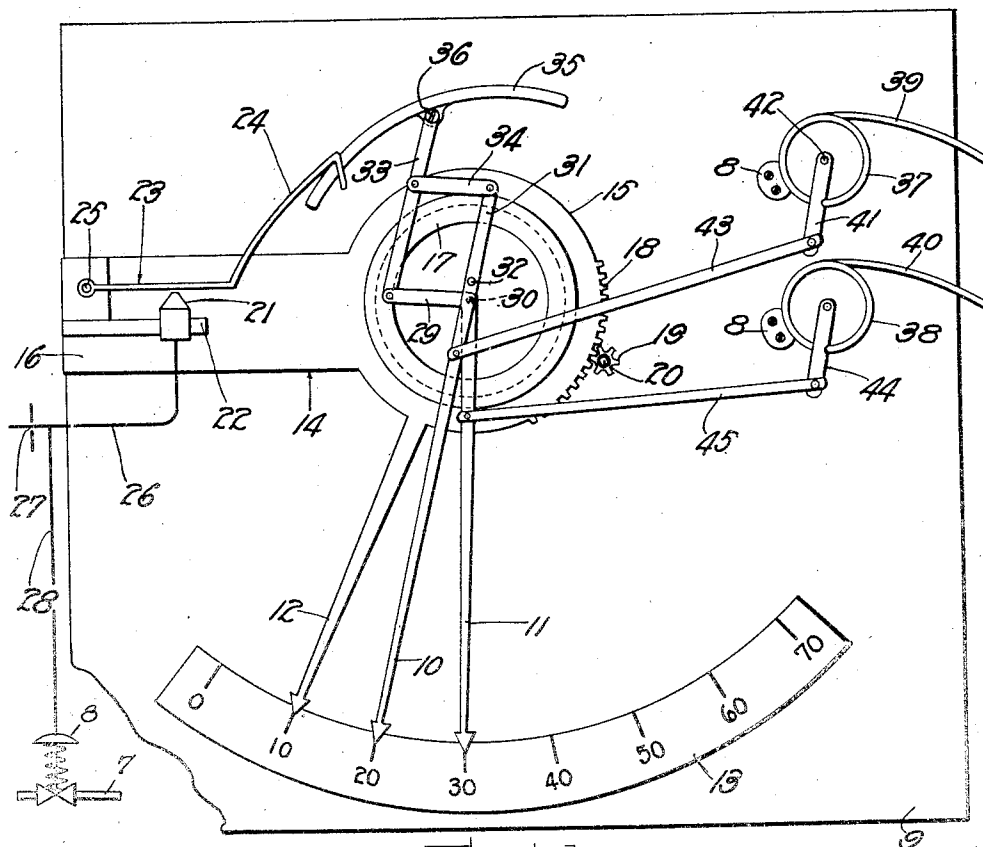


Fig. 1

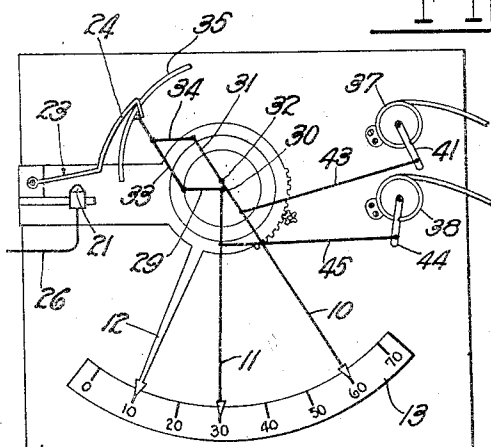


Fig. 2

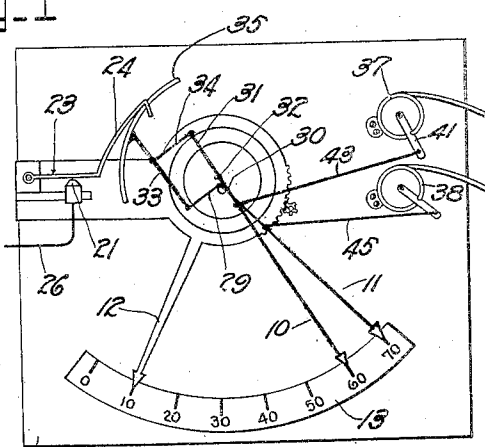


Fig. 3

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CONTROL MECHANISM

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12 Claims. (Cl. 74-469)

This invention relates to an improvement in control instruments of the kind used in connection with power operated valves or like devices to govern the value of a variable, and particularly concerns an improved means, adaptable to various kinds of standard instruments, for maintaining a predetermined ratio between the value of a controlled or dependent variable and that of another variable, the latter being independent or controlled from an external source.

One object of this invention is to provide means which may be advantageously used either, to control a dependent variable in exact accordance with the changing value of an independent variable, or in accordance with some other function of the change in value, that is, the change in value of the dependent variable may desirably be a linear function of the change in value of the independent variable, or the value may vary in relation thereto as the square root or other definite function thereof.

Another object of this invention is to provide a ratio control mechanism which may be incorporated into various kinds of standard instruments without disturbing the normal operation of the standard mechanism used for the control of a single variable, other than a slight alteration, and thus to enable the same mechanism to be used as a ratio controller. While certain standard instruments have their pen or indicating arms pivoted on a common center, as illustrated, for example, in Letters Patent of the United States to Bristol et al, No. 1,773,702, and while the corresponding arms of other instruments have their pivotal points arranged in straddled relation, as shown in my United States Patent No. 2,002,686, the device herein shown and described is equally well adapted for either kind of operating assembly.

It is a further object of this invention to provide a ratio control mechanism which may be set to maintain the selected value differential by the same means normally used in the instrument for determining the control setting of a single variable, the set difference being indicated or recorded on the usual scale of calibration.

In carrying out the preferred form of this invention, I have substituted for the usual operating connections between the condition responsive elements, such as helical coils, and the power controlling device, such as a nozzle and flapper, a movement comprising four separate members having the general configuration of a parallelogram, namely, a four-sided figure in which the opposite sides are always substantially parallel during all operating positions, and by combining an adjustable cam with one of these members I vary the nozzle-flapper relation relatively to the coil movement to obtain the control differential required. Because of the configuration of these

parts, I am able to produce the results desired by means of a simple and effective mechanism.

The invention will be more fully understood, and further objects and advantages will appear from the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a front elevation of a portion of an air-operated indicating pressure controller showing an operating and indicating mechanism embodying my invention which is set to maintain a linear operating differential between two variables as indicated on the scale of calibration.

Fig. 2 is a diagrammatic view of a part of the mechanism illustrated in Fig. 1 showing the position of the parts when the leading or independent pressure increases by an amount indicated on the calibrated scale.

Fig. 3 is a view similar to Fig. 2 showing the position of the parts when the following or controlled pressure is increased correspondingly.

Having reference to Fig. 1 of the drawing the operating mechanism of an indicating ratio pressure controller is shown mounted on a suitable backing plate 9 by which the assembly may be conveniently attached to an instrument case not illustrated. The mechanism is provided with indicating pointers 10 and 11 and a setting indicator 12, herein shown as adapted to cooperate with a pressure scale 13, it being understood that the pointers and scale may be replaced by pen arms and a chart if desired, and further that the device is equally well adapted for the control of temperature, level, rate of flow or other variable.

At 14 is an assembly support including a circular portion 15 and an extension 16, the circular portion being rotatably mounted on the backing plate 9 by means of a fixed bearing ring 17 and having a gear segment 18 meshing with a pinion 19, which is in turn mounted on a shaft 20. The shaft 20 may be provided with a squared end suitable for a key, not shown, by which the assembly support arm may be rotated in a clockwise or counter direction. The setting indicator 12 is attached to the circular portion 15 and serves to indicate the differential setting in a manner to be described. The extension 16 may carry a nozzle 21 mounted on a member 22 secured to the extension. Cooperating with the nozzle 21 is a flapper 23 secured at one end to a cam follower arm 24 and pivotally supported at 25 to the extension 16. The free end of cam follower 24 is supported on a cam 26 to be described. While I have herein shown one type of nozzle-flapper construction, it will be understood that any usual control mechanism may be employed.

A convenient operating fluid, for example, air may be supplied under pressure to the nozzle 21 through a line 28 having a restricted orifice 27. A pipe 28 may connect the nozzle line with a motor valve 3, herein shown in conventional

manner as governing fluid flow through a line 7 to vary the value of a dependent variable, or the pipe 28 may connect with any other power operated device suitable for governing any dependent variable, the value of which may be desirably controlled in some predetermined relation to the value of an independent variable. The nozzle 21, line 26 and pipe 28 constitute a simple form of pressure system for actuating power operated devices, as referred to above, either directly or indirectly through a pilot of any standard construction, the particular form of pressure system employed being immaterial to the present invention.

The ratio movement by which a selected ratio between the value of the controlled pressure and the value of the independent pressure may be established and maintained is comprised essentially of four members which are so arranged in respect to their relative positions and movements as substantially to constitute a parallelogram under all conditions of setting and control. These members comprise an arm 29 rigidly secured to a pivot shaft 30 to which the pointer 11 is also rigidly secured; an arm 31 rigidly connected to the pointer 10 which is in turn mounted on a pivotal shaft 32, the shafts 30 and 32 being herein shown as arranged in straddled relation instead of having a common center of rotation as is also usual; and a lever 33 and link 34, the lever being pivoted at one end to the free end of the arm 29 and at its other end being arranged to carry the cam 35, and the link being pivotally connected to the lever 33 and arm 31 as shown. The cam 35 may be adjustably secured to the lever 33 by means of a frictional mounting such as a screw 36 or the like.

The pointers 10 and 11 may be actuated by helical coils 37 and 38 respectively secured to the plate 9 by supports 8, the former coil being responsive to an independent variable, by means of a pipe 39, and the latter coil being sensitive to a controlled variable which it is desired to maintain at a definite ratio value relatively to the independent variable by means of a pipe 40. The free end of the coil 37 is adapted to rotate an arm 41, pivoted on a shaft 42, at the center of the coil and is arranged to move the arm in a counterclockwise direction on an increase of magnitude of the independent variable. The pointer 10 may be operatively connected to the arm 41 by a link 43, by which means the pointer is positioned on the calibrated scale 13 in accordance with the value of the independent variable. The pointer 11 may be in operative connection with the helical coil 38 by means of arm 44 and link 45 arranged in a similar manner to the connecting parts described. The coil 38, which is responsive to the magnitude of the dependent variable, positions the pointer 11 over the calibrated scale 13.

The cam 35 and ratio movement, including pointer arms 29 and 31, link 34 and lever 33, described above cooperate to position the flapper 23 in relation to the nozzle 21 in accordance with the relative positions of the pointers 10 and 11. As shown in the drawing the cam surface is laid out substantially on the arc of a circle and the cam is positioned in such a way relatively to the lever 33 and follower 24 that a change in value of the independent variable is followed by the same change in value of the dependent variable in order to maintain a constant differential between the two variables. The action may be varied so that the change in value of the de-

pendent variable is some multiple or sub-multiple of the value change of the independent variable by swinging the cam about its mounting on arm 33. When the cam 35 is tilted in a counterclockwise direction about its pivot 36 the value of the dependent variable changes as a sub-multiple of the value change of the independent variable, and when the cam is tilted clockwise the opposite occurs. By changing the shape of the cam the value changes may be made to conform to a square root function or the like.

The operation of the device is as follows:

Having reference to Fig. 1, assuming that the value of the independent variable is twenty, as shown by pointer 10, and the dependent variable is to be maintained at a constant differential value of ten units higher, the assembly support 14 is rotated by the pinion 19 until the setting indicator 12 shows a unit differential of ten on the calibrated scale 13. The rotation of assembly plate 14, for example, in a counter-clockwise direction to move the setting indicator 12 from zero to ten on the calibrated scale 13, moves the nozzle 21 away from the flapper 23 reducing the nozzle pressure and by means of suitable control mechanism, governed by the pressure in pipe 28, causes the value of the dependent variable to increase to thirty on the scale as indicated by pointer 11. The movement of pointer 11 towards thirty on the scale swings arm 29 about its fixed pivot 30 lowering lever 33 and cam 35 and moves the flapper toward the nozzle 21 to reduce gradually the rate of increase of the dependent variable and finally to check its increase entirely. When the pointer 11 arrives at thirty on the scale the flapper-nozzle relation has been established to maintain the dependent variable at that value. Thus a standard instrument setting mechanism, which is used for setting the control point of a single variable, may be used without any mechanical change for setting the differential between two variables.

Having reference to Figs. 1, 2 and 3, if it is assumed that the independent variable increases forty units in the course of operation, arm 41 will be rotated counter-clockwise by coil 37 and by means of link 43 will move pointer 10 from twenty to sixty. Arm 31 is thus rotated in a counter-clockwise direction around its fixed pivot 32 and by means of link 34 turns lever 33 and cam 35 in the same direction about the pivotal connection of said lever with arm 29. Movement of cam 35 as described serves to raise follower 24 and consequently flapper 23 from the position shown in Fig. 1 to that shown in Fig. 2 thereby effecting an increase in the value of the dependent variable. Increase of value of the dependent variable will cause helical coil 38 to unwind and rotate arm 44 in a counter-clockwise direction. Link 45 will thus move pointer 11 from its position at thirty on scale 13, as shown in Fig. 1, to position seventy on the scale as shown in Fig. 3. As pointer 11 approaches seventy the arm 29 is turned counterclockwise around fixed pivot 30, and lever 33 and cam 35 are lowered to cause the flapper 23 to approach the nozzle 21 to reduce gradually the rate of increase of the dependent variable and finally to check its increase entirely. When the pointer 11 arrives at seventy the required nozzle-flapper relation is established to maintain the unit differential between the variables. If the independent variable decreases in value, the opposite occurs.

In general the operation of the ratio movement is such that the selected differential is deter-

mined by the hand setting, and thereafter the independent variable establishes the control setting for the dependent variable around which the dependent variable operates. While one particular form of the invention has been described in detail in order that the constructional features may be clearly understood, it will be obvious that the detailed character of the description is not intended as definitive of the scope of the invention, the underlying principles of which may be embodied in various forms.

In the claims:

1. A ratio control movement for connecting driving members and a driven member and including in combination, a lever having a fixed pivot which is rotatable about its pivot in accordance with movement of one of said driving members, a floating lever pivotally mounted on said lever at a point apart from its fixed pivot, a second lever having a fixed pivot approximately at the pivotal mounting of said first lever which is rotatable about its pivot in accordance with movement of another of said driving members, a link pivotally connected to said second lever and to said floating lever at points substantially equidistant from the pivotal mountings of each of said levers having an effective length substantially equal to the effective length of said first lever, and means operatively connecting said floating lever with said driven member, said means and said link and levers combining, when the levers having fixed pivotal mountings are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in the opposite direction by another of said driving members.
2. A ratio control movement for connecting driving members and a driven member and including in combination, a lever having a fixed pivot which is rotatable about its pivot in accordance with movement of one of said driving members, a floating lever pivotally mounted on said lever at a point apart from its fixed pivot, a second lever having a fixed pivot approximately at the pivotal mounting of said first lever which is rotatable about its pivot in accordance with movement of another of said driving members, a link pivotally connected to said second lever and to said floating lever at points substantially equidistant from the pivotal mountings of each of said levers having an effective length substantially equal to the effective length of said first lever, a cam mounted on said floating lever in operative connection with said driven member, said cam and said link and levers combining, when the levers mounted on fixed pivots are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in another direction by another of said driving members.
3. A ratio control movement for connecting driving members and a driven member and including in combination, a lever having a fixed pivot which is rotatable about its pivot in accordance with movement of one of said driving members, a floating lever pivotally mounted on said lever at a point apart from its fixed pivot, a second lever having a fixed pivot approximately at the pivotal mounting of said first lever which is rotatable about its pivot in accordance with movement of another of said driving members, a link pivotally connected to said second lever and to said floating lever at points substantially
- equidistant from the pivotal mountings of each of said levers having an effective length substantially equal to the effective length of said first lever, said floating lever having a free end extending beyond its pivotal connections, a cam mounted on the free end of said floating lever, said cam and said levers combining, when the levers mounted on fixed pivots are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in another direction by another of said driving members.
4. A ratio control movement for connecting driving members and a driven member and including in combination, a lever having a fixed pivot which is rotatable about its pivot in accordance with movement of one of said driving members, a floating lever pivotally mounted on said lever at a point apart from its fixed pivot, a second lever having a fixed pivot approximately at the pivotal mounting of said first lever which is rotatable about its pivot in accordance with movement of another of said driving members, a link pivotally connected to said second lever and to said floating lever at points substantially equidistant from the pivotal mountings of each of said levers having an effective length substantially equal to the effective length of said first lever, a cam mounted on said floating lever, said cam and said link and levers combining, when the levers mounted in fixed pivots are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in another direction by another of said driving members, and means for tilting said cam in respect to said driven member to vary the ratio of movement imparted to said driven member by one driving member in respect to the movement imparted by another driving member.
5. A ratio control movement connecting driving members and a driven member and including in combination, a pair of angularly disposed members having fixed pivots each of which members is rotatable by a driving member, a second pair of angularly disposed members pivotally mounted on said first pair of members and pivotally connected to each other substantially to form in conjunction with said first pair of members a parallelogram, and means for operatively connecting one member of said second pair of members to said driven member, said means and said pairs of members combining, when the members of said first pair of members are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in the opposite direction by another of said driving members.
6. A ratio control movement connecting driving members and a driven member and including in combination, a pair of angularly disposed members having fixed pivots each of which is rotatable by a driving member, a second pair of angularly disposed members pivotally mounted on said first pair of members and pivotally connected to each other substantially to form in combination with said first pair of members a parallelogram, and a cam for operatively connecting one member of said second pair of members to said driven member, said cam and said pairs of members combining, when the members of said first pair of members are rotated in the same direction by said driving members, to effect movement of said driven member in one direction by one of said driving members and in an-

