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Wray

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[54] **STEP-BY-STEP LINEAR ADJUSTMENT DEVICES**

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[52] **U.S. Cl.** **92/14**, 92/29, 403/31

[51] **Int. Cl.** **F01b 9/00**

[58] **Field of Search** 92/14, 15, 29, 16; 403/31, 403/373, 374

[56] **References Cited**

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[57] **ABSTRACT**

A pneumatic inching device for a rod which is normally free to be coarsely set by hand in its longitudinal direction, comprises a pair of pistons slidingly fitted on the rod in a cylinder bore and respectively coupled to the rod during the forward stroke of each reciprocation of the piston by one of two coupling washers under the eccentric action of the inclined end face of a piston boss against a spring which tends to force the two coupling washers apart and into surface contact with perpendicular partitions. A sleeve of greater radius than the boss serves as end-of-stroke abutment and restores each washer to its unlocked perpendicular position irrespective of any return movement of the piston. Fluidic apparatus is also disclosed which permits repetitive operation of each inching piston and counts the number of piston reciprocations in the case where larger amounts of inching are required.

4 Claims, 2 Drawing Figures

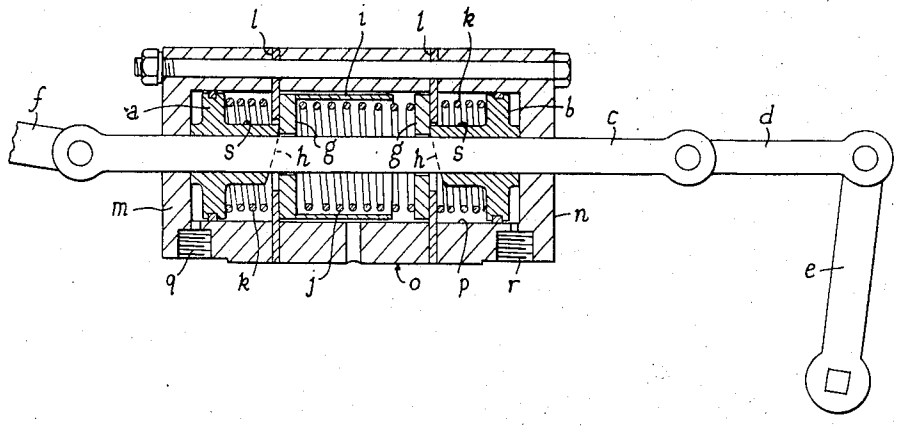


FIG. 1

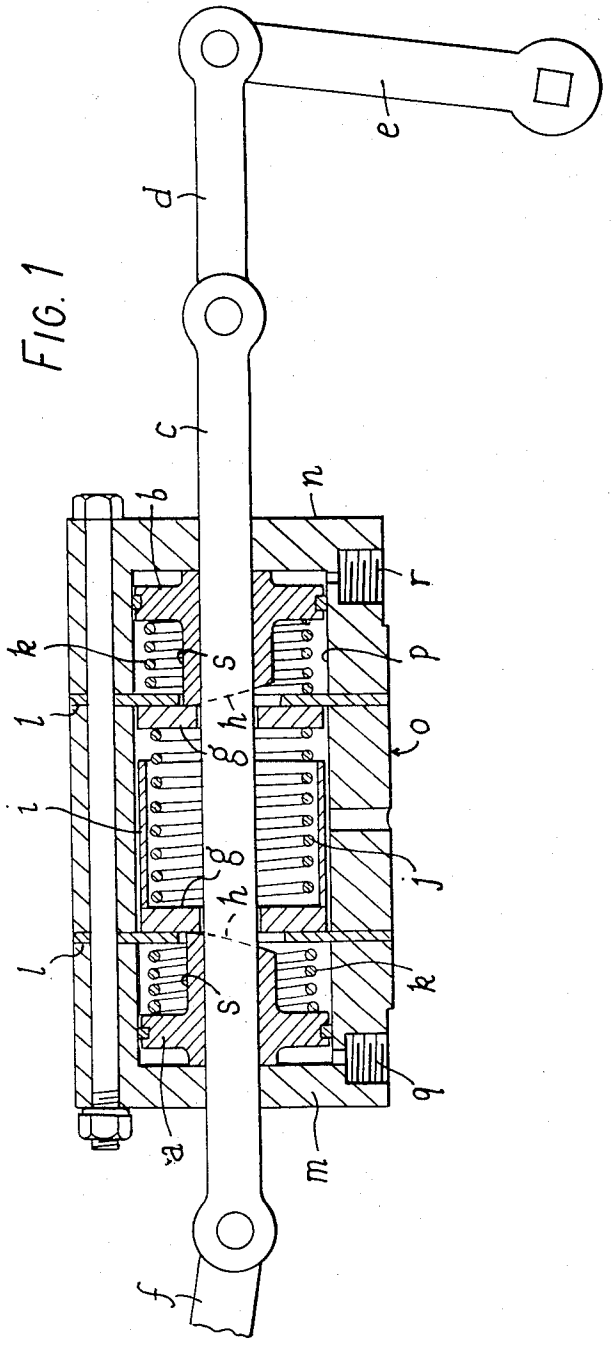
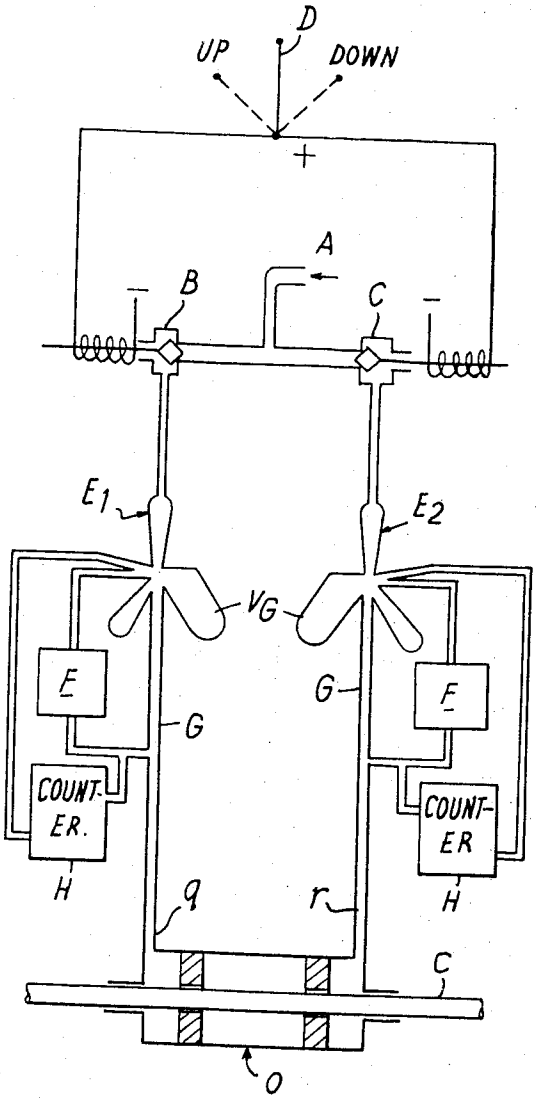


FIG. 2



STEP-BY-STEP LINEAR ADJUSTMENT DEVICES

This invention relates to step-by-step linear actuator devices; it has for an object to provide an improved step-by-step linear actuator device which, while permitting manual adjustment of a longitudinally displaceable member without interference by the actuator device, can be operated after manual coarse adjustment to effect in a step-by-step manner fine adjustment from the position set up by the preceding manual adjustment. Another object is to provide an actuator device of this kind which can be of relatively simple construction.

According to a broad aspect of the invention the actuator device comprises a bar member guided for free logitudinal movement and having at opposite sides two outwardly facing guide surfaces extending longitudinally of the bar member, a coupling member reciprocable longitudinally of the bar member and having two complementary surfaces respectively facing the two guide surfaces of the bar member with a small amount of play, resilient means biasing said coupling member in one direction longitudinally of the bar member, fixed stop means towards which the coupling member is thus biased, and which when fully engaged by the coupling member hold the latter in a position in which said two complementary surfaces are substantially parallel to the longitudinal direction of said two guide surfaces so as to allow free longitudinal movement of the bar member relative to the coupling member, an actuator member operable for reciprocatory movement relative to the frame longitudinally of the bar member independently of the latter and having an engagement portion which, during movement of the actuator member in a direction opposite to said one direction, will engage the coupling member at a point spaced from the bar member beyond one of said complementary surfaces to move the coupling member out of such engagement with said stop means and, in co-operation with said resilient means, tilt said coupling member so as to cause opposite end portions of said complementary surfaces to lockingly engage said guide surfaces and to thereby couple said bar member for movement by said actuator member through said coupling member in said opposite direction, while permitting, during subsequent return movement of the actuator member, the coupling member to follow, independently of the bar member, under the action of said resilient means, such movement of said actuator member in said one direction.

In a convenient construction of an actuating device according to the invention the bar member is a cylindrical rod which is slidable along the common axis of a pair of axially aligned cylinder bores and wherein each cylinder bore contains a piston slidable on the rod for co-operation respectively with the two cylinder bores to constitute an actuator member each piston having an axially projecting boss which extends towards the other piston and whose end face is inclined relative to a plane normal to the longitudinal direction of the rod, the device comprising a pair of coupling members constituted by washers fitting with slight radial play on the rod, and a helical spring interposed between the washers to urge the washers away from each other into contact with the projecting ends of the two piston bosses. Stops are preferably provided which, at the fully retracted positions of the pistons, support each washer at a point diametrically opposite to the projecting portion of the boss of

the piston so that when the washer is held against this stop by the spring, the washer is at right angles to the longitudinal direction of the rod. This ensures free mobility of the rod in the washers when both pistons are in their fully retracted positions, while when either piston is moved towards the other piston by the admission of fluid pressure to its cylinder bore, the projecting edge of its boss will initially tilt the washer at an angle to a plane normal to the rod, thus producing jamming or locking engagement between the washer and the rod, so that further movement of the piston will carry the rod along for the remaining length of the provided piston stroke. In order to ensure release of the rod from the actuating piston as soon as this stroke is completed, a distance bush of an internal radius greater than the radial distance of the projecting portion of each piston boss from the axis of the rod and of a length somewhat less than the distance of the two washers is preferably arranged between the two washers. When one of the pistons has completed a predetermined length of stroke, the distance bush will be in contact with both washers, thus preventing further movement of the leading edge of the washer which has been moved forward by the actuator piston so that continued movement of that piston will restore that washer to a position at right angles to the axis of the rod, thereby releasing the rod from its engagement before eventually terminating the stroke of the actuating piston. It will be readily appreciated that according as one or the other of the two pistons is actuated by fluid pressure towards the other piston, movement will be imparted from the rod in one direction or the other. Preferably fluidic control equipment or other means are provided for automatically imparting to each piston, reciprocatory movement for one single reciprocation or for a desired number of reciprocations.

In order that the invention may be more readily understood, an embodiment will now be described in more detail with reference to the accompanying drawings, in which

FIG. 1 is a sectional elevation of an actuator rod forming part of a linkage equipped with actuating arrangements in accordance with the present invention, while

FIG. 2 diagrammatically illustrates the co-ordination of such a device with suitable fluidic equipment.

Referring now first to FIG. 1, a cylindrical rod *c* forming one element of a linkage *c, d, e, f*, for example an input-control linkage for the prime mover of a pneumatic actuation system, is slidably guided in a fluid-tight manner in the end portions *m* and *n* of a cylinder housing *o*, which has a cylindrical bore *p* sub-divided into three parts by partitions *l*. Each of the two end portions *m* and *n* contains an actuator piston *a* and *b* respectively. Each of these pistons is urged towards its end of the cylinder bore *p*, by a spring *k*, which is supported against the adjacent partition *l*, but can be moved against the action of this spring by the admission of compressed air or other fluid under pressure to the adjacent end of the cylinder through a threaded bore *q* or *r*. Each piston *a* and *b* fits slidingly on the rod *c*, so that normally the latter can be freely moved longitudinally through the cylinder unit *o* without either of the pistons *a* and *b*, and either piston can move freely in the bore *p* without affecting the position of the rod *c*. Two washers *g* are placed on the rod *c*, constituting coupling members, one washer being arranged adjacent to each

partition *l* at the opposite side of the partition to that facing the associated piston *a* or *b*. A spring *j* is interposed between the two washers *g* to keep both washers spaced a maximum distance apart, thus normally holding each of the washers in contact with the adjacent partition *l*, and a distance bush *i* of a length somewhat less than the maximum distance of the two washers *g* is slidable in the cylinder bore *p* between the partitions *l*. The bore of each washer is somewhat larger than the diameter of the rod *c*, the clearance being, for example, 0.005 inch in the case of a rod of ⅜ inch diameter and a washer of a thickness of 3/16 inch, and each piston is provided, at the side facing the adjacent washer, with a projecting boss *s*, whose end face *h* is inclined to a plane at right angles to the axis of the rod *c*, and the adjacent partition *l* has a central bore through which this boss is free to pass. When the piston *a* moves to the right of the drawing with its boss *s* penetrating through this central bore in the adjacent partition *l*, the upper edge of the face *h* of the boss will make initial contact with the adjacent washer *g*, and since the spring *h* opposes movement of the washer towards the right, the washer *g* will tilt over at an angle, assuming more or less the direction of the surface *h*, thereby causing the leading and trailing end portions of the bore of the washer to bite into the surface of the rod *c* and thus lock the left-hand washer *g* against longitudinal movement relative to the rod *c*. As movement of the piston *a* towards the right continues, against the action of the spring *j*, which, through the second washer *g*, is supported against the right-hand partition *l*, the piston *a* will thus, through the left-hand washer *g* which, as mentioned above is locked to the rod *c*, force the latter to participate in the movement of the piston *a*. The length of the distance bush *i* is so chosen as to allow this mutual movement of the washer *g* and a small amount of additional mutual approach of the latter, whereafter, as it is pushed forward by the leading edge of the washer *g*, it will strike the right-hand washer *g* which rests against the right-hand partition. The leading edge of the left-hand washer *g* is thus prevented from further longitudinal movement, and since the force of the piston *a*, acting at the upper edge of the boss *s*, of piston *a*, is opposed by the reaction force of the sleeve *i*, which acts near the upper edge of the left-hand washer *g*, that is to say above the point which the force of the piston *a* is transmitted to this washer by the "upper" edge of the boss face *h*, a couple is produced which will return the left-hand washer *g* to a position perpendicular to the axis of the rod *c*. The locking action of that washer is thus removed so as to terminate a stroke of inching movement of the rod *c*, and the rod *c* is released for free manual adjustment or further inching adjustment by either pistion *a* or piston *b* as required.

As will now be readily appreciated, while each reciprocation of the piston *a* will produce a step of inching movement of the rod *c* towards the right of FIG. **1**, the admission of fluid to the bore *r* will correspondingly produce reciprocation of the right-hand piston *b* and thus similar steps of inching movement of the rod *c* towards the left of FIG. **1**. The rod *c* will be free to be moved manually if required not only when both pistons *a* and *b* are retained in their illustrated positions of rest by their respective springs *k*, but also if, due to inadvertent admission of pressure to one or both of bores *q* and *r*, one or each of the pistons *a* and *b* remains in its advanced position.

To facilitate inching movement of the rod *c* over a distance greater than that produced by a single reciprocation of one of the pistons *a* and *b*, a repeater device, preferably of a fluidic type, may be inserted between each of the bores *q* and *r* and an associated valve which controls the admission of fluid pressure from a source, and this repeater device preferably includes a counter indicating the number of reciprocations executed. If desired the counter may be so constructed that it may be preset to switch-off the reciprocatory movement of the piston with which it is associated after the piston has carried out a preset number of reciprocations.

One form of fluidic system of this kind is illustrated in FIG. **2**, in which the inching device proper is again indicated by the letter *o*. The selective admission of air under pressure from a source A to either of the bores *q* and *r* of the cylinder housing *o* is controlled by valves B and C respectively. These valves are constructed as solenoid valves and are arranged to be respectively operated by throwing a switch lever D from its neutral position shown in full lines to one or the other of the UP and DOWN positions shown in broken lines. Each of the valves B and C when opened leads fluid from the source A to the power jet of an associated fluidic element E_1, or E_2 having a collector line G and causes this element to supply through its collector line fluid to the bore *q* or *r* according to which of the valves B or C has been opened, while at the same time the fluid admitted by the valve B or C charges a pressure reservoir or capacitor chamber F. When sufficient pressure has been built up in the capacitor chamber F, the built-up pressure in that chamber causes the flow of the power jet to be deflected so that instead of reaching the collector line G that leads to the bore *q* or *r*, the power jet will be diverted to a vent outlet V_G. The resultant drop of the pressure in the bore *q* or *r* enables the associated piston *a* or *b* to return from the end of its inching stroke. Finally, when the pressure in the capacitor chamber F has dropped to a sufficiently low value, the initial condition is restored; the power jet returns to the collector line G and a further reciprocation of the piston is thus initiated. The resultant periodic variations of the pressure in the operative collector line G are communicated to an associated counter H. This counter may simply indicate the number of inching steps produced by the operative piston, thus assisting the operator in deciding when to switch off the inching movement by returning the switch lever D to its neutral position, or alternatively the counter H may be arranged to produce, after a prearranged or preset number of reciprocations, a signal which is arranged to restore switch D to its neutral position or to terminate the inching operation in some other manner.

What I claim is:

1. A linear actuator device comprising a bar member guided for free longitudinal coarse-setting movement relative to a frame and having at opposite sides two outwardly facing guide surfaces extending longitudinally of the bar member, a coupling member reciprocable longitudinally of the bar member and having two complementary surfaces respectively facing the two guide surfaces of the bar member with a small amount of clearance, resilient means biasing said coupling member in one direction longitudinally of the bar member, fixed stop means towards which the coupling member is thus biased, and which when fully engaged by the coupling member holds the latter in a position in which

said two complementary surfaces are substantially parallel to the longitudinal direction of said two guide surfaces so as to allow free longitudinal movement of the bar member relative to the coupling member, an actuator member operable for reciprocatory movement relative to the frame longitudinally of the bar member independently of the latter and having an engagement portion which, during movement of the actuator member in a direction opposite to said one direction, will engage the coupling member at a point spaced from the bar member beyond one of said complementary surfaces to move the coupling member out of engagement with said stop means and, in co-operation with said resilient means, tilt said coupling member so as to cause opposite end portions of said complementary surfaces to lockingly engage said guide surfaces and to thereby couple said bar member for movement by said actuator member through said coupling member in said opposite direction, and means for returning the actuator member in said one direction, while permitting the coupling member, under the action of said resilient means to follow independently of the bar member

2. A linear actuator device, as claimed in claim **1,** wherein the bar member is a cylindrical rod which is slidable along the common axis of a pair of axially aligned cylinder bores and wherein the actuator member is a pair of pistons cooperating with each of the two cylinder bores and slidable on the rod, each piston having an axially projecting boss which extends towards the other piston and whose end face is provided with said engagement portion, the coupling member comprising a pair of washers fitting with slight radial clearance on the rod, and the resilient means is a helical spring interposed between the washers to urge the washers away from each other into respective contact with the engagement portions of the two piston bosses.

3. A linear actuator device as claimed in claim **2,** wherein two stop means are provided and so arranged as to be respectively fully engaged by each washer at the fully retracted positions of the pistons, so that when each washer is held against its respective stop means by the spring, the washers are at right angles to the longitudinal direction of the rod.

4. A linear actuator device as claimed in claim **3** wherein a distance bush positioned between the two washers is of an internal radius greater than the radial distance of the engagement portion of each piston boss from the axis of the rod and of a length somewhat less than the distance between the two washers.

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