Sept. 23, 1969 G. W. GALLOWAY ET AL 3,468,398

MULTISTAGE LINEAR MOTOR WITH MEANS FOR LOCKING THE STAGES THEREOF AGAINST RELATIVE ROTARY MOVEMENT

Filed Jan. 8, 1968

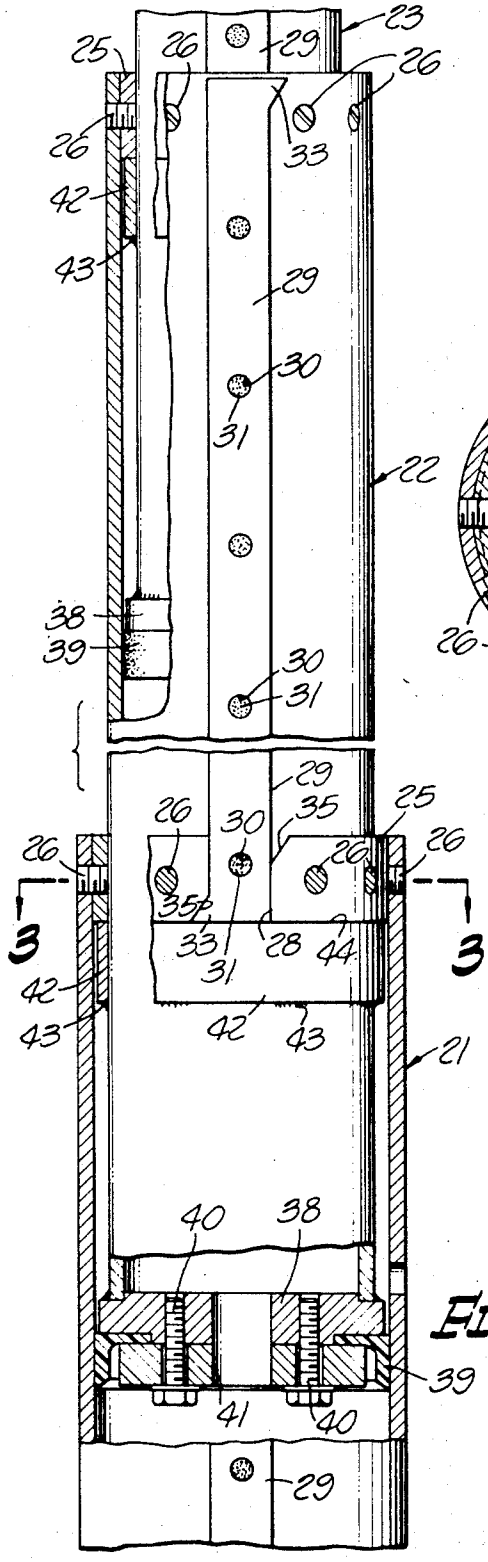


FIG. 2.

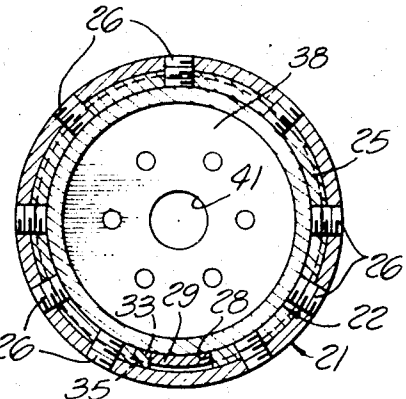


FIG. 3.

FIG. 1.

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United States Patent Office

3,468,398

Patented Sept. 23, 1969

3,468,398

MULTISTAGE LINEAR MOTOR WITH MEANS FOR LOCKING THE STAGES THEREOF AGAINST RELATIVE ROTARY MOVEMENT

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Filed Jan. 8, 1968, Ser. No. 696,432

Int. Cl. E04g 1/22; F01b 7/20

U.S. Cl. 182—141 12 Claims

ABSTRACT OF THE DISCLOSURE

A multistage linear motor particularly suited for use to support a vertically adjustable mast for a workmen's station and having simple lock means for locking the components of the mast against relative rotary movement when stages thereof are extended or retracted. In one typical application, the motor assembly is mounted rigidly upright on a mobile frame for use by a workman while supported at the top of the mast in different extended positions thereof.

This invention relates to linear motors and more particularly to an improved multistage motor of the axially extendable type and featuring positive means for locking stages of the motor against relative rotatary movement in either the extended or retracted positions of its respective stages.

Multiple stage linear motor assemblies of a wide variety of designs have been proposed heretofore, including those having provision for minimizing relative rotary movement of the telescoping components. Such anti-rotation provisions are particularly desirable and essential when the motor is being used as a hoist or mast to support workmen at different elevations. Typically, these anti-rotation safeguards make use of elongated keys fixed lengthwise of all inner stage members and slidable through close fitting passage means facing inwardly of the cooperating larger diameter tubular members. Such an interlock is fairly satisfactory if manufactured to close tolerances for motors of one or a very limited number of stages. Even in these cases the engaging surfaces of the key and its guide passage are subject to wear permitting an increasing amount of play and rotary movement as the wear increases. In the case of motors having multiple stages, play associated with working tolerances and wear are cumulate with the result that the workmen's station at the free end of the mast or motor can twist through an arc of very substantial size. Furthermore, the permitted movement is double the magnitude of the actual play if movement starts with the parts positioned in one extreme rotary position. For this reason, the total movement can reach highly objectionable proportions under these conditions. It will also be recognized that the permitted movement operates to aggravate conditions because of the higher impact and wear forces imparted to the contacting surfaces as wear and play increases and when the rotary movement occurs rapidly and/or under high load conditions.

The foregoing factors have imposed definite limitations on the practical lengths for linear motors for use in applications where the aforementioned relative movement is objectionable or hazardous to personnel or property.

It is therefore a primary object of the present invention to provide an improved linear motor of one or more stages featuring positive means effective at either the extended or retracted positions of the components to hold the components positively against relative rotary movement. Typically, such locking means comprises a key fixed

to a length of the smaller diameter component and having appropriately shaped tongue means at its opposite ends adapted to nest within complementally shaped notch means formed in a suitably positioned part of the cooperating stage components, as for example, the sides of the passage through which the key reciprocates. Desirably, the tongue and notch are of wedge shape with one side of the wedge making an acuate with the longitudinal axis of the motor and serving to cam the locking components snugly and immovably together as the motor moves into either its fully extended or its fully retracted position. Associated with the tongue there preferably is a safety stop ring encircling the smaller diameter tube and accurately positioned to abut the adjacent surface of the bearing ing providing with the notches and passage through which the locking key moves. This arrangement supplements the action of the notch and tongue in holding the stages rigidly against relative movement.

It is therefore a primary object of the present invention to provide an improved linear motor featuring positive means for locking the components against relative movement when adjusted to one or more positions thereof.

Another object of the invention is the provision of a linear motor having elongated key means fixed to one of its parts and having close-fitting sliding movement through a passage in a cooperate component for minimizing relative rotary movement in intermediate positions of the motor and featuring internesting tongue and notch means at both extremes of motor movement for holding the parts positively against any substantial relative rotary movement.

Another object of the invention is the provision of a multi-stage mast for workmen wherein each stage of the mast is provided with positive interlocking means for locking adjacent stages of the mast against relative rotary movement in the fully extended or fully retracted position of any stage thereof.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawing to which they relate.

Referring now to the drawing in which a preferred embodiment of the invention is illustrated.

FIGURE 1 is an elevation view of one preferred embodiment of the invention constructed as embodied in a multi-stage hoist equipped with a workmen's station at its upper end.

FIGURE 2 is a fragmentary sectional view on enlarged scale showing details of the construction; and

FIGURE 3 is a cross-sectional view taken along line 3—3 on FIGURE 2.

Referring more particularly initially to FIGURE 1, there is shown a hydraulically operated linear motor designated generally **10** having its larger lower end rigidly fixed in an upright position to a main frame **11** supported on wheels **12, 12**. Outrigger struts **13** are equipped with rotary screws **14** having pads **15** at their lower ends engageable with the ground and cooperating to provide a wide based firm support for main frame **11** whenever the equipment is in use. At other times the struts may be retracted and folded in known manner against the main frame, as while equipment is stored or in transit to another place of use.

As herein illustrated, motor **10** is usable to support a workmen's station or cage **18** secured to its upper free end. Motor **10** comprises any suitable number of stages, as **20, 21, 22, 23**, sized to telescope axially of one another in well known manner. The upper end of each stage is provided with a combined retainer and bearing ring **25** held detachably assembled to the tubular section by snug fitting set screws **26**, this ring being secured in place af-

ter the tubes have been assembled. Each ring **25** has a passage **28** having a close sliding fit with the opposite parallel sides of a key **29** extending for substantially the full length of the exterior of all except the largest stage **20**. Key **29** is secured to the sections in any suitable way, the mode here shown utilizing a series of holes **30** filled with brazing or welding material **31**.

The opposite ends of each of keys **29** are provided along their diametrically opposed corners with a suitably shaped tongue **33** which is accurately shaped complementally to a notch **35** formed in the opposite ends of each of the passages **28** through bearing rings **25**. As herein shown by way of example, tongues **33** are wedge shaped with one side wall forming an acute angle with respect to the longitudinal axis of keys **29**. The corresponding side wall of each of notches **35** is of identical shape as tongues **33** with the result that the tongues preferably have a snug fit throughout their length with the particular one of the notches with which it is paired. Owing to the acute angle of the tongues and notches, it will be apparent that the movement of any stage to its fully extended or its fully retracted position results in the firm seating of one of the tongues in one of the notches. As pressure is applied to the assembly to extend the motor, the tongue at the lower end of stage **22** enters the similarly shaped notch at the upper end of a surrounding tube and acts to forcibly cam key **29** to the right as viewed in FIGURE 2. In this position one edge of key **28** is held pressed firmly against the adjacent side wall of passage **28**, and the tongue **33** on the other edge of the key is held firmly and immovably pressed against the side wall of notch **35**. Accordingly, stages **21** and **22** are forcibly held against rotary movement in either direction. Hydraulic pressure applied to the interior motor from its lower end acts on the piston heads **38** at the lower end of each stage to maintain the components locked in this non-rotary position. In this connection it is pointed out that each piston is provided with a resilient sealing gasket **39** held in assembled position, as by cap screws **40**. Each piston also includes a passage **41** to transmit fluid lengthwise of all stages.

Preferably, the lower end portion of each tubular section is also provided with an accurately constructed and positioned safety stop ring **42** secured to the tubing as by welding **43**. The entire upper end edge **44** of this ring is positioned to abut the adjacent end of bearing ring **25** throughout its girth precisely as wedge tongue **33** seats fully within notch **35**. In this way the powerful pressures acting to hold the motor extended are distributed throughout the girth of bearing ring **25** thereby avoiding having the full load carried by tongue **33**. Additionally, this arrangement is highly effective in stabilizing the mast against lost motion longitudinally thereof and aids very materially in rendering it highly rigid and stable.

When one or more stages of the motor are retracted the upper one or ones of wedges **33** seat in the upwardly facing ones of notches **35** and the weight of overlying portions of the mast are highly effective in holding the wedge shaped tongues firmly and positively seated. It will also be evident that the described locking tongues and notches are not subject to wear in use as are the relatively sliding side walls of passages **28** and the adjacent lateral edges of keys **29**. In consequence, the descrcibed anti-rotation locking device remains highly efficient and effective throughout the life of the motor and virtually eliminates all possibility of rotary movement between motor stages when the locking components are engaged.

While the particular multistage linear motor with means for locking the stages thereof against relative rotary movement herein shown and disclosed in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of the construction or design herein shown other than as defined in the appended claims.

We claim:

1. In a linear motor of the type having a plurality of tubular sections having a close telescopic fit axially of one another together with means for moving said sections between first and second axially separated positions thereof; that improvement for locking said tubular sections against relative rotary movement when in one of said positions which comprises: complementally shaped notch means and tongue means each rigidly fixed to a respective one of said tubular sections in position to move into and out of snug interlocking engagement as said tubular sections approach and recede from said one position, said notch means and said tongue means cooperating when fully engaged to lock said tubular sections positively against relative rotary movement and being readily disengageable from locked position by limited axial movement of said tubular member toward the second of said positions.

2. A linear motor as defined in claim **1** characterized in that said tubular sections are provided with complementally shaped notch means and tongue means at each of said first and second positions of said tubular sections.

3. A linear motor as defined in claim **1** characterized in the provision of close fitting key and groove means extending lengthwise of said tubular members between said first and second positions thereof and cooperating to limit relative rotary movement of said tubular sections while positioned in partially extended positions between said first and second positions.

4. A linear motor as defined in claim **3** characterized in that said tongue means is located near one end of said key means and in that said notch means is located near one end of the groove means slidably seating said key means.

5. A linear motor as defined in claim **4** characterized in that said key means is provided with tongue means near each end thereof and that the groove means slidably seating said key means includes separate notch means positioned to seat a respective one of said tongue means depending upon which of said first and second positions is occupied by said tubular sections.

6. A linear motor as defined in claim **5** characterized in that said groove means extends transversely of annular bearing ring means positioned between the telescoped ends of said tubular sections.

7. A multi-stage linear motor assembly adapted to be operated under load between a fully contracted position and different extended positions in a plurality of which positions all stages are positively locked against relative rotary movement about the axis of said motor assembly, said motor assembly comprising a plurality of tubular sections assembled in axially-adjustable fluid-tight telescopic relation and including ring means between the overlapping ends of adjacent sections, elongated key means fixed to and extending lengthwise of all except the largest of said tubular sections and having a close sliding fit with a passage extending crosswise of said ring means, and the opposite ends of said passage having oppositely facing notches each adapted to seat snugly an associated complementally shaped tongue means fixed to the opposite ends of each of said key means when an adjacent pair of said sections is in either the fully extended or the fully retracted positions thereof.

8. A linear motor assembly as defined in claim **7** characterized in that said interlocking notch and tongue means are wedge shaped with one side of the wedge extending axially of said key means at an acute angle to the adjacent lateral edge of said key means whereby the contacting inclined sides of a notch and a wedge cooperate in forcing the key means against that side of said passage which is spaced remotely from said notch means.

9. A linear motor assembly as defined in claim **8** characterized in the provisions of a plurality of fastener means mounted in the exposed outer ends of said tubular sections

for holding said ring means detachably assembled to said sections.

10. A linear motor assembly as defined in claim **9** characterized in the provision of safety stop means spaced backwardly from the innermost end of said tubular sections and fixed thereto and cooperating with said ring means to safeguard against over extension of said tubular sections.

11. A linear motor assembly as defined in claim **10** characterized in that said safety stop means is positioned to abut against the adjacent end face of the associated one of said ring means as the adjacent notch means fully seats the cooperating one of said tongue means and cooperates therewith to stabilize the stages of said motor against both relative sidewise and rotary movement.

12. A linear motor assembly as defined in claim **11** characterized in that the larger diameter end of said motor

assembly is rigidly supported in an upright position on a mobile rigid frame, and in that the upper smaller end of said motor assembly is provided with a workmen's supporting means rigidly secured thereto.

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U.S. Cl. X.R.

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