

[54] **LINEAR ACTUATOR WITH YOKE
ACTUATED PITCH CONTROL**

[75] Inventor: Wenzel Zaruba, East Patterson, N.J.
[73] Assignee: Textol Systems, Inc., Calstadt, N.J.
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Related U.S. Application Data

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[52] U.S. Cl. 74/25, 308/36.1
[51] Int. Cl. F16h 21/16
[58] Field of Search 74/25, 606; 308/36.1

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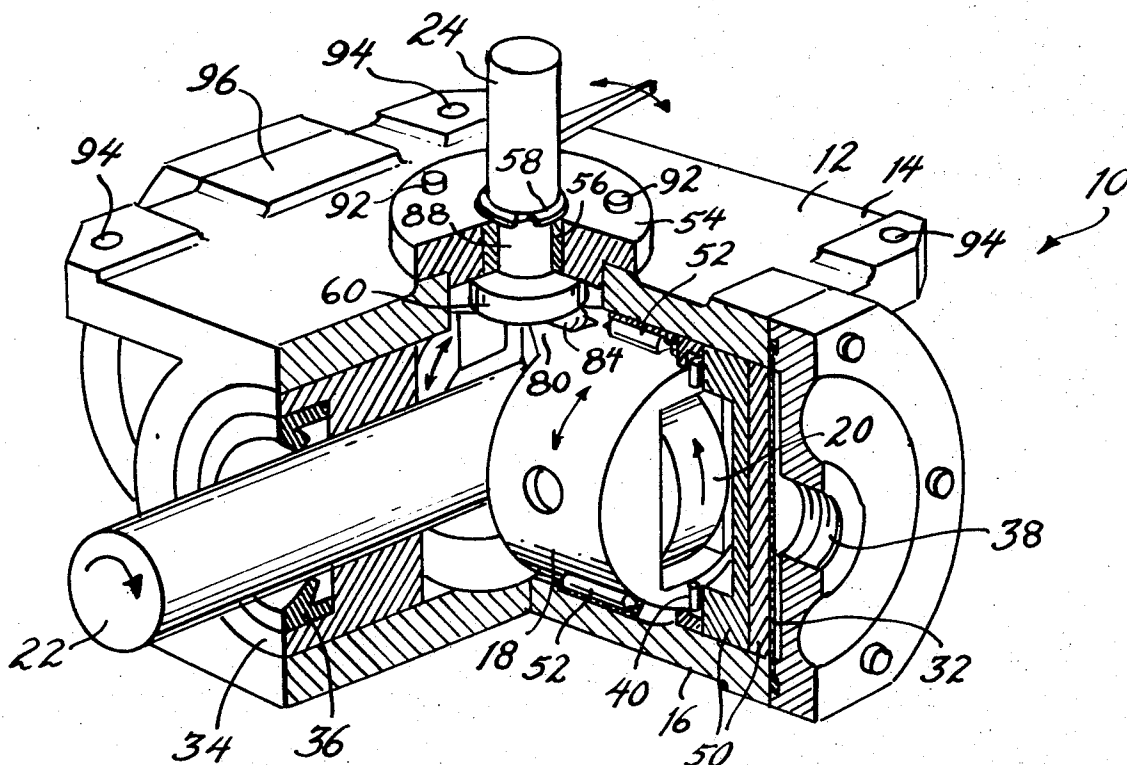
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Primary Examiner—William F. O'Dea
Assistant Examiner—Wesley S. Ratliff, Jr.
Attorney—Caesar, Rivise, Bernstein & Cohen

[57] **ABSTRACT**

A linear actuator with yoke actuated pitch control having a housing for receiving a plurality of yokes each including a wheel, the housing further having an opening to permit the passage of a rotatable power driven shaft with each of said wheels being resiliently urged against said shaft and means being provided to vary the pitch of the wheels with respect to said shaft. Each of the pitch varying means are interconnected to a control shaft that extends from the housing. The control shaft is turned by movement of a lever connected to the control shaft which affords a relatively large mechanical advantage. The pressure of the wheels against the power shaft is changed by means of fluid pressure. The entire device is contained in an impervious housing.

9 Claims, 14 Drawing Figures



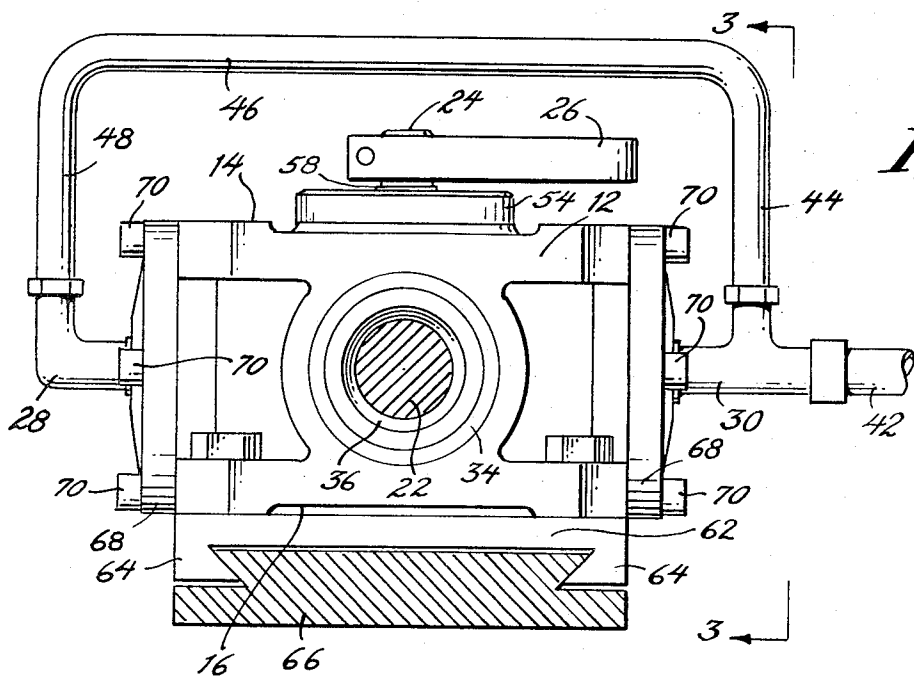


Fig. 2.

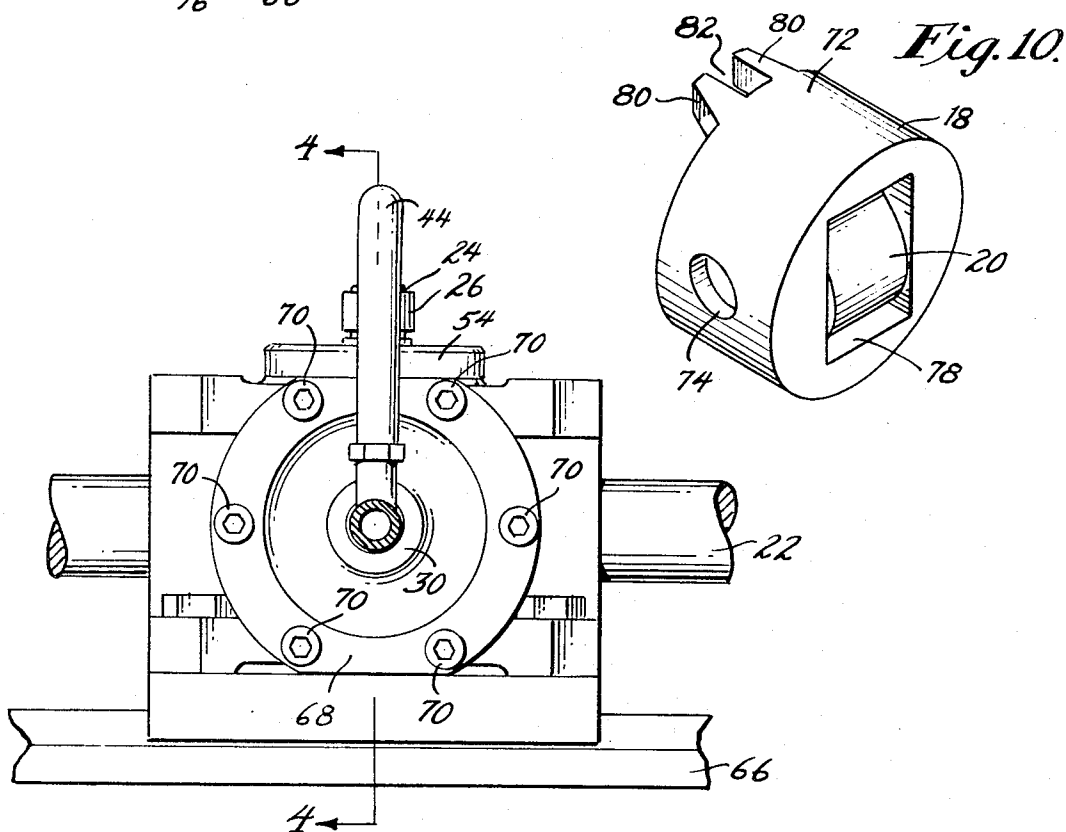


Fig. 3.

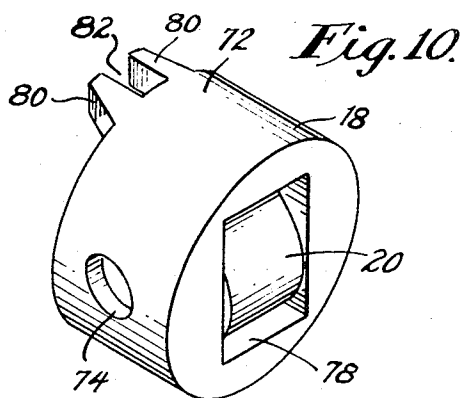
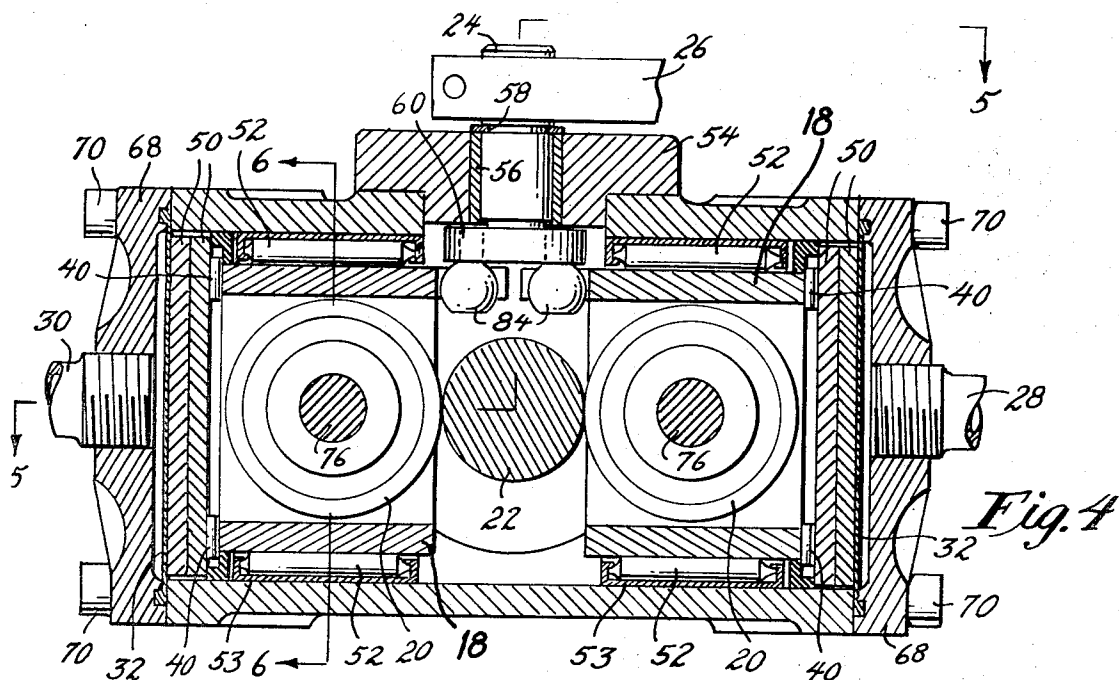
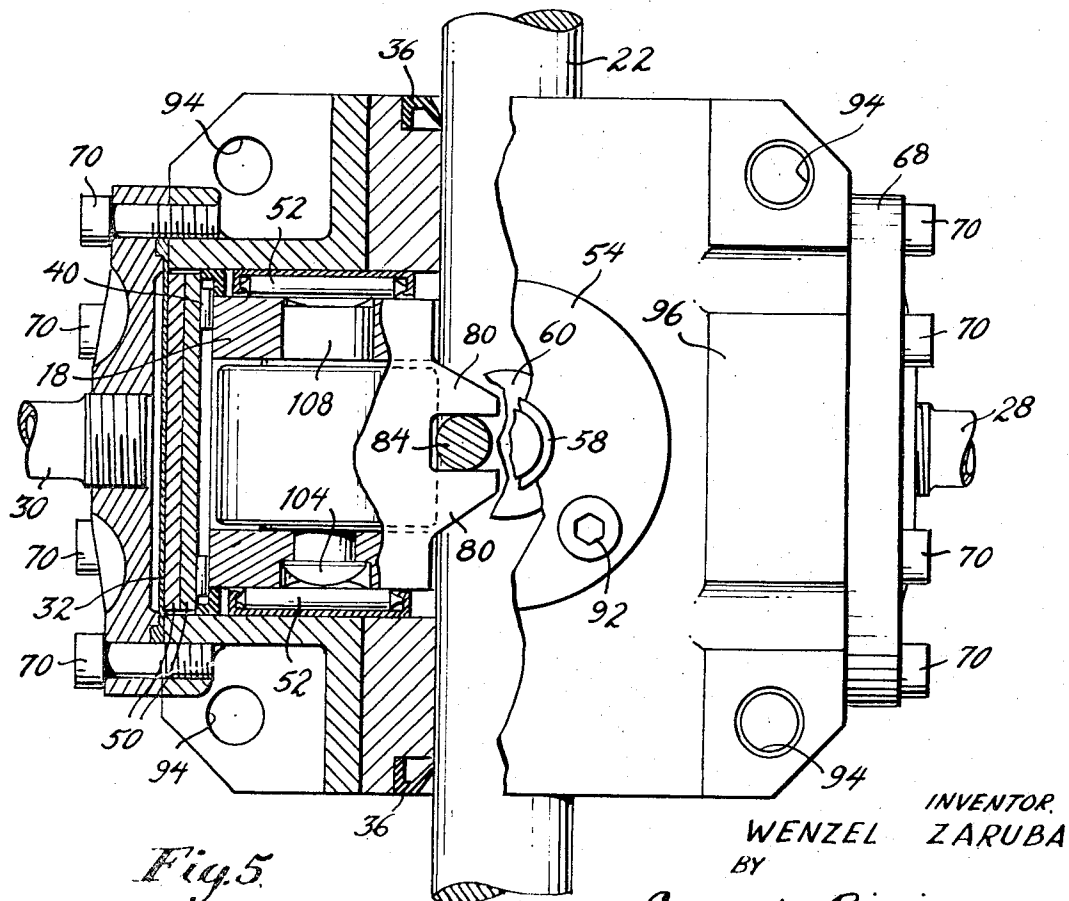


Fig. 10.

INVENTOR.
WENZEL ZARUBA
BY

Caesar, Rivise,
Bernstein & Cohen
ATTORNEYS.



INVENTOR.
WENZEL ZARUBA
BY
Caesar, Rivise,
Bernstein & Cohen

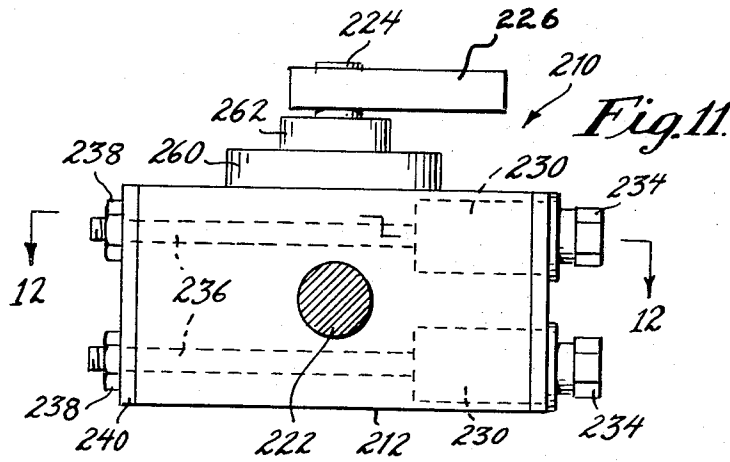
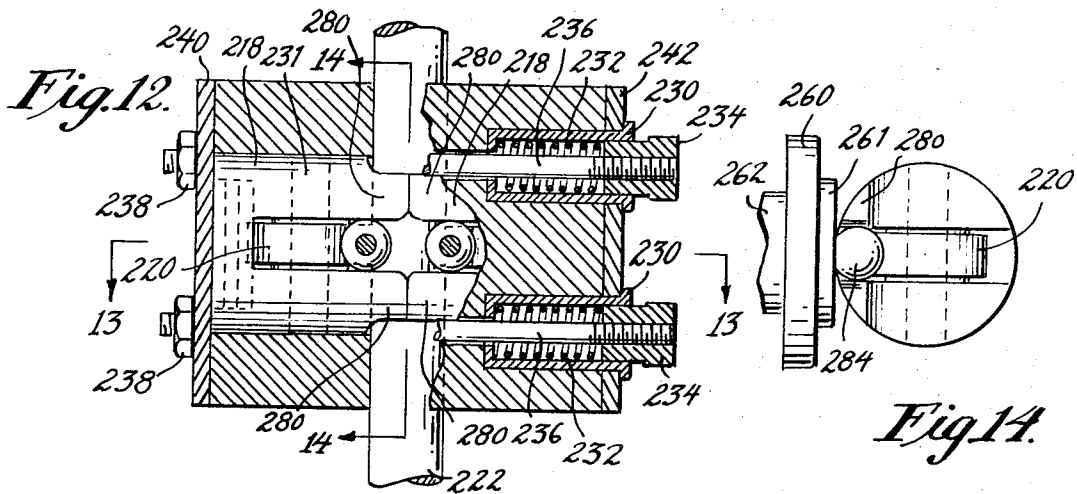
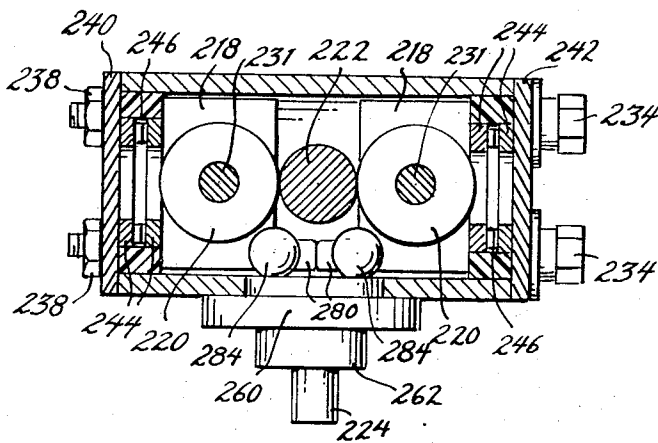


Fig. 13.

Fig. 14.

INVENTOR.
WENZEL ZARUBA
BY
Caesar, Rivise,
Bernstein & Cohen
ATTORNEYS.

LINEAR ACTUATOR WITH YOKE ACTUATED PITCH CONTROL

This application is a continuation-in-part application based on presently pending U. S. application Ser. No. 851,421 filed August 19, 1969, now U.S. Pat. No. 3,638,504.

This invention relates to a linear actuator with yoke actuated pitch control, and presents certain significant advantages from a practical commercial standpoint.

Until recently, linear actuators were provided with a screw drive so that rotational movement would be used to initiate linear movement.

However, the shortcomings of a screw drive were long recognized. First, the ratio of linear displacement to angular displacement could be changed only by securing a screw drive having threads of a different pitch. Second, the thrust of the shaft will remain constant for the rate of rotation of the shaft. Also, the direction of linear movement can be changed only by changing the direction of shaft rotation.

The foregoing difficulties were overcome by devices shown in both Zaruba U.S. Pat. No. 3,473,393 and Steibel U.S. Pat. No. 3,475,972.

In the Zaruba patent there was provided a linear actuator which comprised a plurality of wheels in contact with a rotating shaft, with the pitch of the wheels being adjustable and changeable in order to change the rate of movement and direction of linear displacement of the rotating shaft.

In Zaruba co-pending Application Ser. No. 851,421, filed Aug. 19, 1969, there are introduced several improvements including a pressure controlled diaphragm by which the pressure of the wheels against the shaft could be varied from a remote source, and thus the thrust of the linear actuator could be varied from a remote source.

With the principle of the modern linear actuator now established, it has become important to develop economies in the device in order to hasten its use in industry.

In recently filed Application Ser. No. 50,620 filed June 29, 1970 entitled Reciprocating Linear Actuator (Inventors: Wenzel Zaruba and Jan Sehnal) there was disclosed and claimed a linear actuator wherein the housing was made of special sheet metal construction, and the wheels were urged against the power shaft by a single spring in a special novel arrangement. However, this device, like the devices referred to hereinabove, was composed of a series of parts and elements that were exposed generally to the environment. Where the environment tends to foul moving parts, such prior devices presented a real possibility of becoming inoperative rather quickly or posing recurring maintenance problems. For instance, in the garment industry there is much lint and dust in the air which must be kept away from moving parts.

It is therefore an object of the present invention to provide a linear actuator with yoke actuated pitch control which constitutes a completely sealed unit.

Still another object of the present invention is to provide a linear actuator with yoke actuated pitch control wherein the pitch of the power shaft contacting wheels can be varied by movement of a control shaft that turns rather easily because of a relatively large mechanical advantage.

Another object of the present invention is to provide a linear actuator with yoke actuated pitch control in which the pressure of the wheels against the power shaft can be varied from a remote point.

Still another object of the present invention is to provide a linear actuator with yoke actuated pitch control in which the pitch of the wheels can be varied even when the power shaft is rotating.

The foregoing as well as other objects of the invention are achieved by providing a linear actuator with yoke actuated pitch control which has a housing to receive a plurality of yokes, each of which include a wheel. The housing also has an opening to permit the passage of a power shaft. The wheels may be resiliently urged against the shaft and means are provided to vary the pitch of the wheels with respect to the power shaft even when the power shaft is rotated.

The pitch varying means are interconnected to a control shaft that extends from the housing with the control shaft being turned by movement of a linear actuator to the control shaft which affords a relatively large mechanical advantage. The entire device is contained in an impervious housing with the passage of the power shaft and control shaft into the housing being through protective sealing devices.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view, with certain portions broken away for the sake of clarity, of a linear actuator with yoke actuated pitch control constituting an embodiment of the present invention;

FIG. 2 is an end elevational view of the device of FIG. 1 and showing the fluid means for varying the pressure of the wheels against the power shaft;

FIG. 3 is a sectional view taken along the lines 3—3 of FIG. 4;

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 3;

FIG. 5 is a sectional view taken along the lines 5—5 of FIG. 4;

FIG. 6 is a sectional view taken along the lines 6—6 of FIG. 4;

FIG. 7 is a bottom elevational view of the pitch control device;

FIG. 8 is a sectional view taken along the lines 8—8 of FIG. 7;

FIG. 9 is a fragmentary view showing the portion of the pitch control device;

FIG. 10 is a perspective view of the yoke by itself;

FIG. 11 is an end elevational view of a modified form of the invention;

FIG. 12 is a sectional view taken along the lines 12—12 of FIG. 11;

FIG. 13 is a sectional view taken along the lines 13—13 of FIG. 12; and

FIG. 14 is a sectional view taken along the lines 14—14 of FIG. 12.

Referring now in greater detail to the various figures of the drawing wherein like reference characters refer to like parts there is shown generally at 10 a linear actuator with yoke actuated pitch control constituting a first embodiment of the present invention.

As seen in FIG. 1, linear actuator 10 basically comprises a housing 12 including top face 14 and bottom face 16. The housing 12 receives two yokes 18 (see FIG. 4) each of which includes a wheel 20. The housing 12 further includes an opening to permit the passage of rotatable power shaft 22 with each of the wheels 20 being in contact with the power shaft 22. The pitch of the wheels 20 against the power shaft 22 may be varied by rotation of control shaft 24 to which all of the wheels 22 are linked, with movement of the control shaft 24 being achieved by turning of the control lever 26 attached thereto (FIG. 2).

The pressure of the wheels 20 against the power shaft 22 is varied by means of fluid pressure acting through fittings 28 and 30 (see FIG. 2) to provide fluid pressure that is operative against the diaphragm 32 which conveys the force of the fluid pressure to each of the wheels 20.

With further reference to FIG. 1 it will be seen that the power shaft 22 passes through openings in the housing 12 into which is fitted a bronze bearing 34 at each end and a seal 36 is provided.

An individual yoke 18 can be seen in FIG. 10 into which is rotatably mounted a wheel 20. Returning to FIG. 1, the outer end of the housing adjacent each wheel 20 is provided with a fluid opening 38 that communicates with the diaphragm 32. Thrust bearings 40 are provided to transmit the inward fluid pressure to the wheel 20 and to urge it against the power shaft 22.

With reference to FIG. 2 (end elevation) it will be seen that fluid pressure (air or hydraulic liquid) is exerted through supply pipe 42 that communicates with the T-fitting 30. A bypass pipe 44 is provided that has a straight run 46 that terminates at end pipe 48 which is secured to elbow fitting 28. In this embodiment of the invention there is the necessity to have only two fluid pressure sources since only two wheels 20 are being urged against the power shaft 22. However, it follows that the number of fluid pressure sources may be increased through standard piping connections in the event a greater number of wheels 20 are being urged against the power shaft 22.

The details of the utilization of fluid pressure against the diaphragm 32 in order to increase or decrease the pressure exerted by wheels 20 against power shaft 22 are set forth in co-pending Application Ser. No. 851,421, and it is clear from the present disclosure and drawings that fluid pressure is exerted inwardly upon the diaphragm 32 which in turn acts upon washers 50 (FIG. 4) in order to transfer the inward pressure to the thrust bearings 40 which in turn will contact the yokes 18 which support wheels 20 and urge them against the power shaft 22.

With reference again to FIG. 1 it will be seen that the yokes 18 are rotatably supported in needle bearings 52 (held in retainers 53) in order to facilitate the turning action of the yokes 18 as will be discussed hereinafter.

The control shaft 24 passes through the flange 54 and particularly through bronze bearing 56 with a retaining ring 58 being provided in order to hold the yoke together and to have a sealing function. The control shaft is connected at its lower end to pivot plate 60 as will be discussed hereinafter.

With reference again to FIG. 2 it will be seen that the housing 12 of the linear actuator is supported by a sad-

dle including a lower horizontally disposed wall 62 and a pair of triangular-shaped depending projections 64. The saddle is supported by a slide 66 which includes a dove-tailed upper surface that fits between the projections 64. Thus, the saddle can slide longitudinally along the slide 66. It is also to be noted that the fittings 28 and 30 communicate with end plates 68 that are secured to the housing 12 by bolts 70.

With reference to FIG. 10 the basic details of a yoke 18 can be seen wherein the yoke 18 is essentially composed of a cylindrical body 72 having a pair of openings 74 to permit the passage of wheel supporting pins 76 (FIG. 4).

It will be further seen from FIG. 10 that the yoke possesses a rectangular cut out area 78 in order to receive a wheel 20. Finally, the yoke 18 includes a pair of projections 80 that define a retaining slot 82 for control balls 84 (FIGS. 5 and 9). It will be seen that the control balls 84 are actually spherical tips extending from a shank 86 that is secured within pivot plate 60. Since control shaft 24 is but an extension of lug 88 to which the pivot plate 60 is secured, it follows that when the control shaft 24 is turned by movement of control lever 26, pivot plate 60 is also turned. This also causes the turning movement of the control balls 84 in a circular arc as may be best understood by reference to FIG. 7. This turning movement will continue until the lateral planar surface 89 of plate 60 abuts the stop 90 which depends vertically from flange 54.

As seen in FIG. 1, the flange 54 through which the control shaft 24 passes is stationary and is secured to the top face 14 of the housing 12 by means of bolts 92. The housing also carries openings 94 at its corners and central areas 96 between the openings 94.

Certain internal details of the wheels 20 can be seen from FIG. 6 including inner race 98, outer race 100 and needle bearings 102. With reference to FIGS. 5 and 9 it will be seen that a fastening bolt having a head 104, shank 106 and nut 108 passes through the yoke 18 to secure it in place.

It will be seen from FIG. 1 that each of the control balls 84 is held captive between a pair of projections 80 extending from a yoke 18. The projections 80 of the other yoke 18 fit about the other control ball 84 which is shown in FIG. 7 as being diametrically opposed to the first control ball 84. Thus, the projections 80 of one yoke always follow the projections of the other yoke, but are 180° out of phase with each other. It follows that the wheels 20 will always be inclined against the power shaft in an equal and cooperative manner in order to obtain a desired degree of linear actuation as set forth in U. S. Pat. No. 3,473,393.

Attention is now called to a modified form of the invention as set forth in FIGS. 11 to 14 wherein spring pressure is relied upon in order to urge the wheels against the power shaft. It will be seen that the device 210 in FIG. 11 includes a housing 212 which receives yokes 218 containing wheels 220 (suspended from pins 231 that are secured in the yokes 218) that are urged against power shaft 222. A control shaft 224 is provided with control lever 226.

It will be appreciated that the housing 212 can be provided as a single molded piece with openings to receive bushings 230 that hold pressure springs 232 which are in turn retained by caps 234. As further seen

in FIG. 12, elongated rods 236 pass entirely through the housing 212, with each end of the rods 236 being threaded. The threads at one end of the rods 236 receive the caps 234 (which are internally threaded). The threads at the other end of the rods 236 receive nuts 238, with suitable end plates 240 and 242 being provided.

It will be seen that the pressure of the springs 232 is conveyed to the end plate 242 by means of threaded attachment of caps 234 to the rods 236.

With reference to FIG. 13 it will be seen that each yoke 218 is provided as a separate yoke and slid into a central opening in the housing 212. Washers 244 and interposed thrust bearing 246 are now provided, followed by the assembly of the bushings 230, springs 232, end plates 240 and 242, rods 236, end caps 234 and nuts 238. It will be further seen from FIG. 13 that the pressure exerted on end plate 242 as discussed hereinabove is transferred directly to the washers 244 and thrust bearings 246 which in turn conveys the pressure to the right hand yoke 218. Since the washers and thrust bearings are also present outwardly of the left end wheel 220 as seen in FIG. 13, such wheel is also biased against power shaft 222.

The control shaft 224 is connected to control balls 284 in essentially the same way as shown in FIGS. 8 and 9. The control shaft 224 extends through a pivot plate 260 which has a raised central section 262 and a depending rim 261 (FIG. 14) to which the balls 284 are attached. Each of the yokes 218 has projections 280 (FIG. 12) which interfit about one of the control balls 284.

It can be seen from the foregoing that the housing 212 can be provided in a single piece which can be molded. Since each of the wheels 220 are actuated by the control shaft 224 so that each of the wheels 220 are disposed properly against the power shaft 222, it follows that the degree of linear actuation can be varied. Similarly, the pressure of the wheels 220 against the power shaft 222 can be varied through adjustment of the cap 234.

If either the yoke 18 or wheels 20 need replacement, it is necessary only to remove bolts 70 of the end plate 68 and the entire yoke assembly can be removed from the bore of the housing 12. Thus, it can be seen that no other part of the linear actuator assembly is affected when removing the yoke assembly for repair of the same.

The bushings 34 which are provided about shaft 22 are press fit into the longitudinally extending bore of the housing 12. Therefore, the bushing 34 can be removed where a change in size of shaft 22 is to be accommodated by the housing 12 of the linear actuator. That is, where a larger diameter of drive shaft is used in combination with the linear actuator, the bushing 34 shown in FIG. 1 is pressed out and a bushing having a larger opening therein is replaced therefor.

The bushing replaced for bushing 34 would be otherwise similar having a recess therein for the receipt of a seal 36. In order to accommodate a larger diameter shaft, the washers or discs 50 are changed in thickness in order to accommodate the change in diameter of the shaft. That is, where a smaller diameter of shaft is used, the thickness of the washers 50 is increased. Similarly, the increasing of the diameter of the shaft requires thinner washers 50.

Finally, it is to be noted that the control balls 84 may be regarded as control means. The shape of the balls 84 enables a continuous contact with the projections 80 so that there is no lost motion when reversing the pitch of the wheels. It will be further seen that the control means are located sufficiently away from the outer end of the control shaft so as to afford a relatively large mechanical advantage.

Without further elaboration, the foregoing will so fully illustrate my invention that others may, by applying current or future knowledge, readily adapt the same for use under various conditions of service.

What is claimed as the invention is:

1. A linear actuator with yoke actuated pitch control comprising a housing having a plurality of openings, a plurality of yokes rotatably mounted in said openings in said housing, each of said yokes including a wheel, said housing having an opening to permit the passage of a rotatable power driven shaft with each of said wheels being urged against said shaft and means to vary the pitch of said wheels with respect to the axis of said power shaft, said means including a control shaft extending through a sealed opening in said housing outwardly of said housing, said control shaft being rotatable about its longitudinal axis and including means located entirely within said housing to change the position of said yokes and thereby vary the pitch of said wheels with respect to said power shaft, and means for closing off the openings where said yokes are mounted to provide a completely sealed unit.

2. The invention of claim 1 including thrust bearings positioned outwardly of said yokes, and said means for closing off the openings where said yokes are mounted comprises a plate.

3. The invention of claim 1 wherein a control lever is attached to said control shaft.

4. The invention of claim 1 wherein said housing includes a bushing at each of the longitudinal ends thereof, said bushings being press fit into said housing and being replaceable so that different sizes of power drive shafts can be utilized with said linear actuator housing.

5. A linear actuator with yoke actuated pitch control comprising a housing having a plurality of openings, a plurality of yokes rotatably mounted in said openings in said housing, each of said yokes including a wheel, said housing having an opening to permit the passage of a rotatable power driven shaft with each of said wheels being urged against said shaft and means to vary the pitch of said wheels with respect to the axis of said power shaft, said means including a control shaft extending through a sealed opening in said housing outwardly of said housing, said control shaft including means located entirely within said housing to change the position of said yokes and thereby vary the pitch of said wheels with respect to said power shaft, and means for closing off the openings where said yokes are mounted to provide a completely sealed unit, said yokes each including projections and said control means being a plurality of spheres held captive in said projections whereby the pitch of said wheels is changed simultaneously.

6. The invention of claim 5 wherein said wheels are oriented with respect to the axis of said power shaft in order to be additive with respect to each other and contribute to linear actuation in the same sense.

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7. The invention of claim 6 wherein said yokes are rotatably mounted within needle bearings.

8. A linear actuator with yoke actuated pitch control comprising a housing having a plurality of openings, a plurality of yokes rotatably mounted in said openings in said housing, each of said yokes including a wheel, said housing having an opening to permit the passage of a rotatable power driven shaft with each of said wheels being urged against said shaft and means to vary the pitch of said wheels with respect to the axis of said power shaft, said means including a control shaft extending through a sealed opening in said housing outwardly of said housing, said control shaft including means located entirely within said housing to change the position of said yokes and thereby vary the pitch of

said wheels with respect to said power shaft, and means for closing off the openings where said yokes are mounted to provide a completely sealed unit, said actuator further including a fluid sensitive diaphragm in each of said openings and a source of fluid pressure in order to convey fluid pressure to said diaphragms whereby the exertion of fluid pressure against said diaphragms is conveyed to said yokes to urge said wheels against said power shaft to the extent of said fluid pressure.

9. The invention of claim 8 wherein air is utilized as a fluid, with means being provided to vary the air pressure.

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