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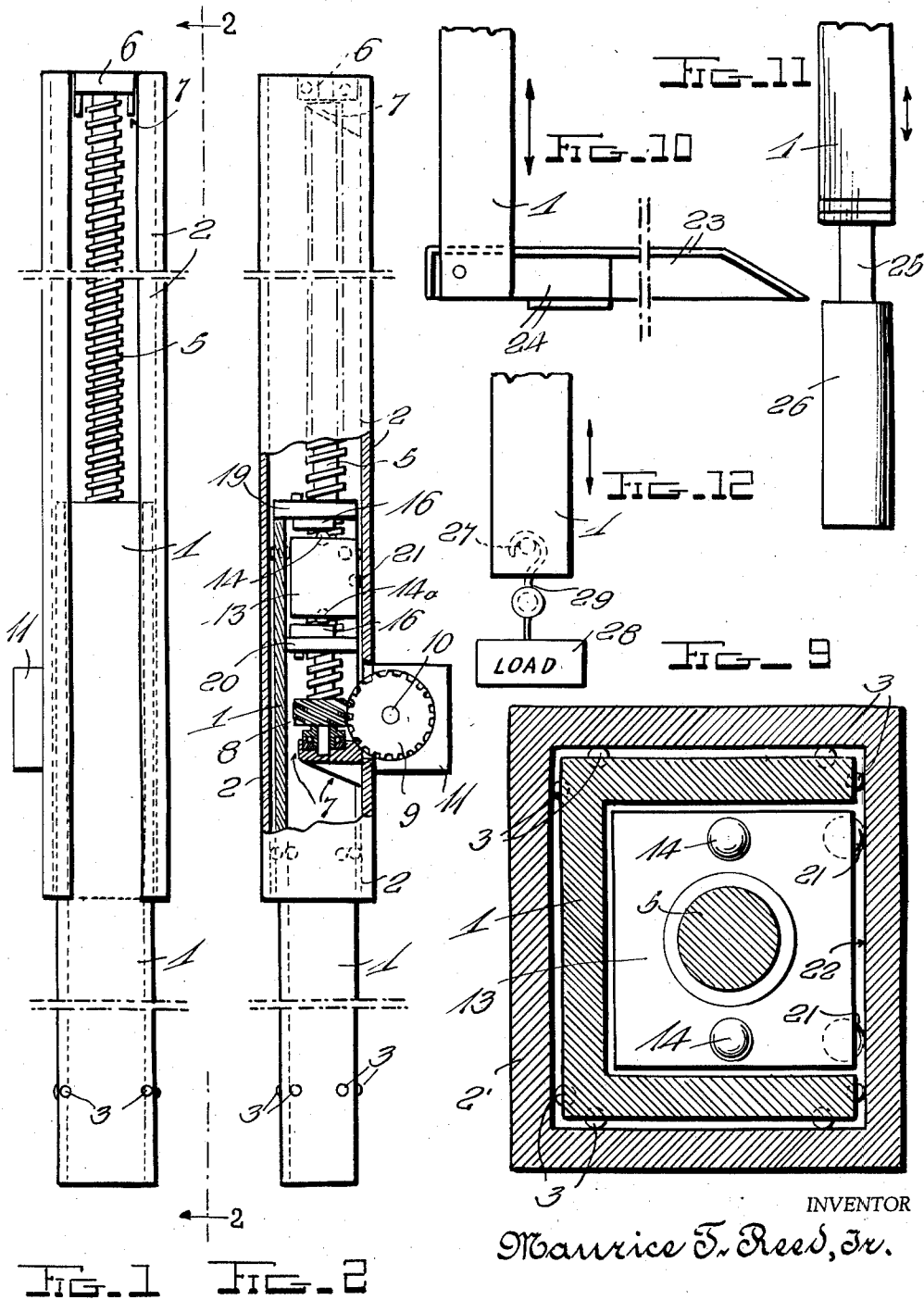
M. T. REED, JR

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ANTI-FRICTION FORCE COLUMN

Filed Feb. 6, 1958

3 Sheets-Sheet 1



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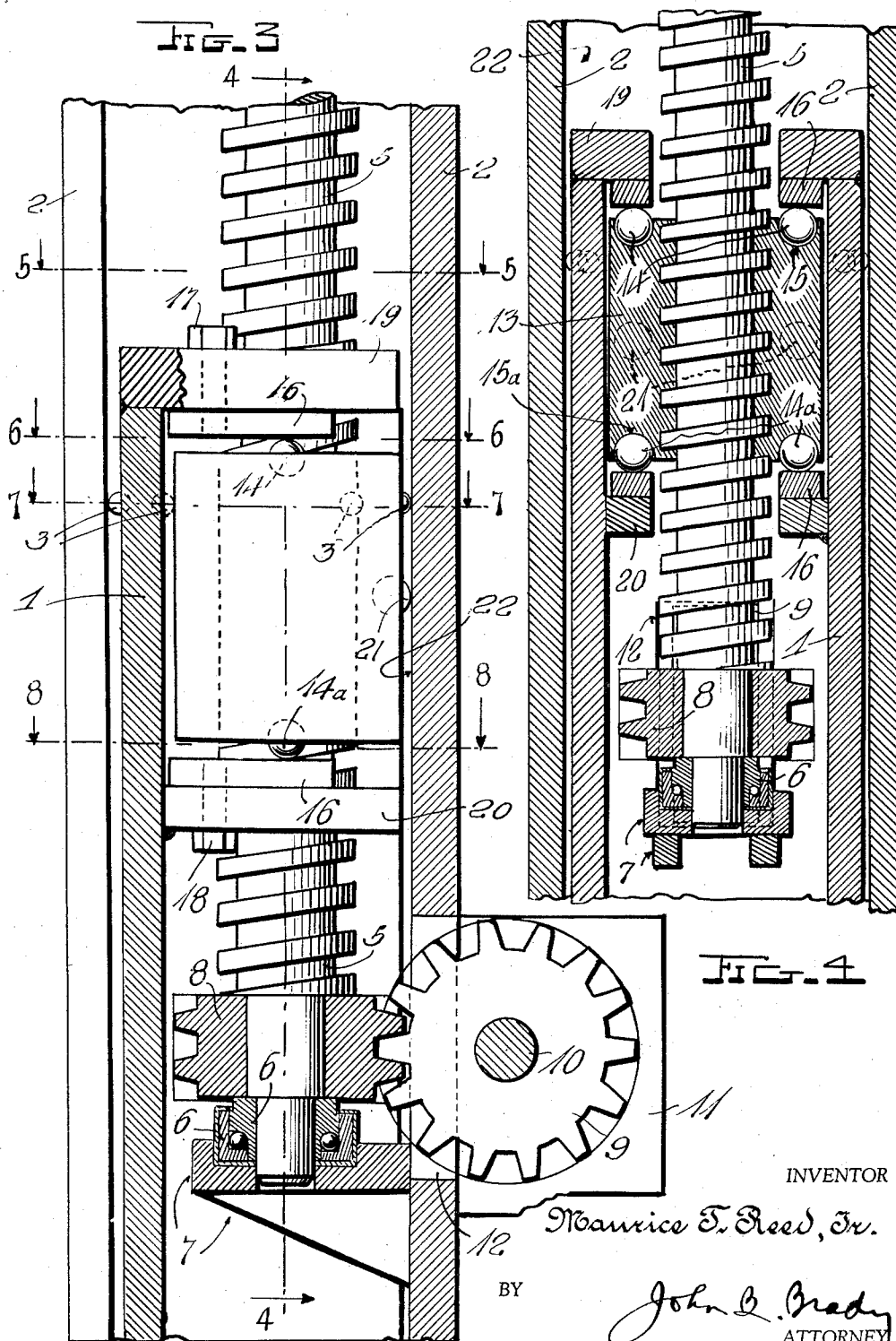
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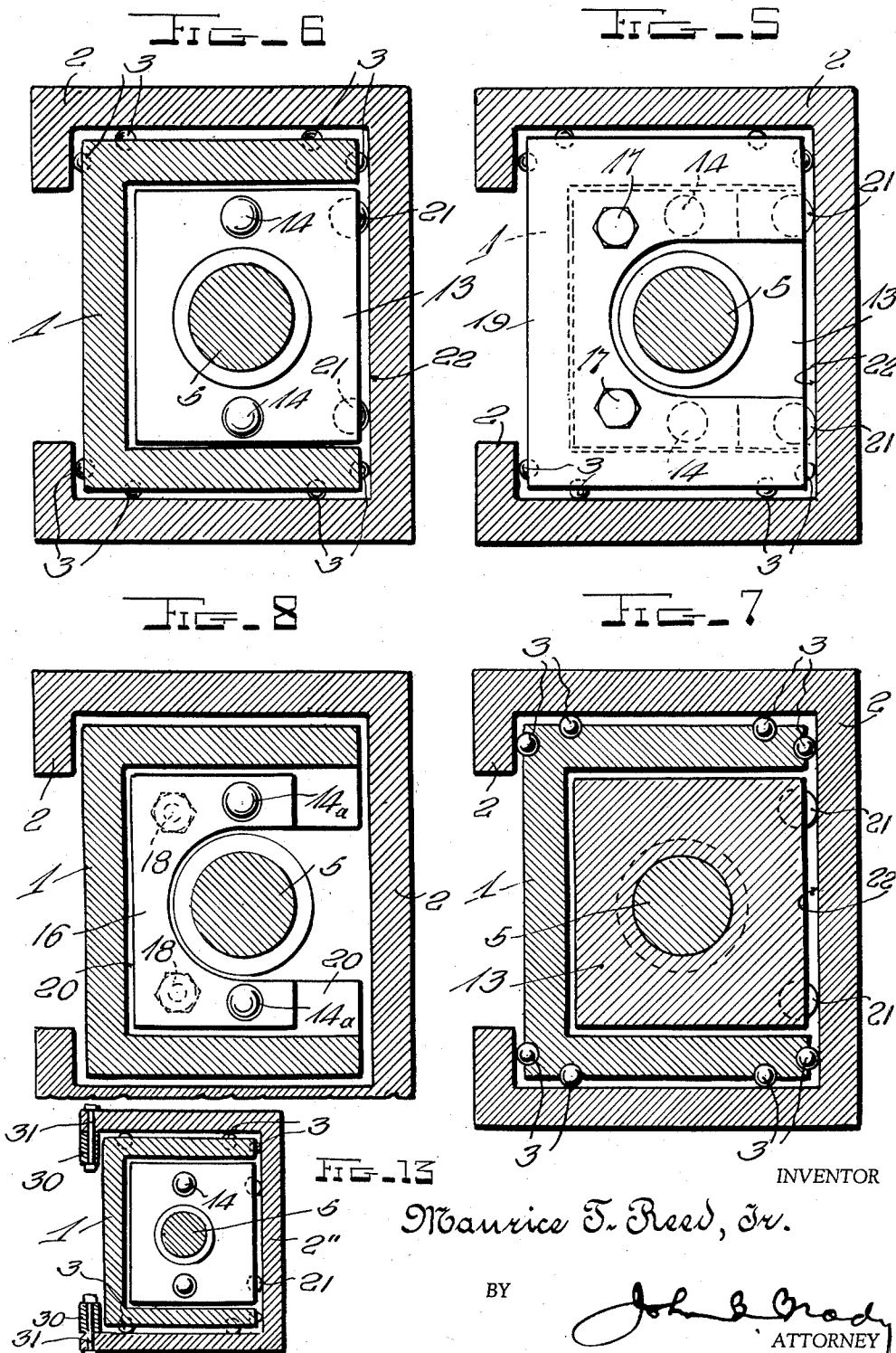
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ANTI-FRICTION FORCE COLUMN

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Application February 6, 1958, Serial No. 713,585

9 Claims. (Cl. 74—424.8)

My invention relates broadly to lifting columns and more particularly to a screw-driven type lifting column wherein a drive screw rotationally mounted on an outer column imparts force to and controls the longitudinal movement of a smaller inner column within the larger outer column, said inner column containing anti-friction devices to prevent it from binding within the outer column.

One of the objects of my invention is to provide a construction of screw-driven lifting column in which no load developed torque or load developed bending movement can be transferred from the load carrying column to the drive screw.

Another object of my invention is to provide a construction of lifting column in which an inner column of square-shaped cross-section requires very little power to raise and lower within a larger outer column of polygonal-shaped cross-section due to anti-friction devices around the periphery of and at symmetrical distances along the length of the inner column.

Still another object of my invention is to provide a construction of screw-driven lifting column which is inexpensive in manufacture, easier to maintain and is more reliable than existing hydraulic lifting columns, and is applicable wherever a hydraulic lifting column is applicable.

A further object of my invention is to provide a construction of screw-driven lifting column in which the inner load lifting column is coupled to the lifting drive screw by a simple drive screw lift nut device carrying load transfer coupling ball bearings.

Other and further objects of my invention reside in a simplified construction and mounting for anti-friction devices in a drive screw structure and a method for transferring all load or force only along the center axis of the drive screw as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Fig. 1 is a vertical elevational view of the anti-friction column of my invention looking at the partially open side of the outer polygonally-shaped column and the back of the inner polygonally-shaped column, and showing the inner column substantially in its lower limit with respect to the outer column, the view being foreshortened to indicate that the lengths of the columns are not restricted;

Fig. 2 is a side elevational view partly in section, taken substantially along line 2—2 of Fig. 1, the view being foreshortened as in Fig. 1, and particularly showing the manner in which the inner column is coupled to and driven by the drive screw mounted on the outer column;

Fig. 3 is an enlarged view of a fragmentary portion of Fig. 2, particularly showing the manner in which the inner column is coupled to the drive screw and the manner in which the drive screw is mounted to the outer column and coupled to the driving means;

Fig. 4 is a vertical sectional view taken substantially along line 4—4 of Fig. 3;

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Fig. 5 is a cross-sectional view taken substantially along line 5—5 of Fig. 3;

Fig. 6 is a cross-sectional view taken substantially along line 6—6 of Fig. 3;

Fig. 7 is a cross-sectional view taken substantially along line 7—7 of Fig. 3;

Fig. 8 is a cross-sectional view taken substantially along line 8—8 of Fig. 3;

Fig. 9 is a cross-sectional view of a modified form of my invention corresponding to the cross-sectional view I have shown in Fig. 6;

Fig. 10 is a side elevational view of the lower end of the inner column showing a lift platform attached thereto for one application of the anti-friction force column of my invention;

Fig. 11 is a side elevational view of the lower end of the inner column connected to a plunger and cylinder type load illustrating another application of my invention; and

Fig. 12 is a side elevational view of the lower end of the inner column and illustrating another application of my invention as a load lifting derrick, and

Fig. 13 is a cross-sectional view of another modified form of my invention corresponding to the cross-sectional views I have shown in Figs. 6 and 9 and particularly showing soft metal bearing strips fastened to the inside walls of the outer channel for the inner column to slide on rather than to roll on by means of the anti-friction ball bearings.

My invention is directed to the construction of anti-friction force column wherein the longitudinal travel of one steel polygonally-shaped column rolling within a larger steel polygonally-shaped column is controlled by motion imparted to it by the rotation of a screw longitudinally disposed within both columns and mounted on the larger outer steel column. A reasonable clearance is provided between the two columns and ball bearings embedded in the four peripheral sides of the inner column allows this column to roll within the larger outer steel column with very little friction resistance.

The basic purpose of my invention is to provide a construction for a lifting column which can exert large forces in either an upward or downward direction; in other words it can lift loads upwardly or it can push downwardly to exert downward pressure on various applications. The anti-friction force column of my invention can have many broad applications in industry. For example, if two of these columns are welded and braced to a battery powered carriage, a lift truck is constructed. Another application which I anticipate is to use these lifting columns mounted horizontally to push and pull horizontally for example under a truck bed to actuate a lever arrangement to lift the truck bed itself to serve as a dump truck or in other applications requiring push and pull horizontal forces. Two of these lifting columns can be used to construct an extremely powerful and heavy-duty tailgate loader, of the type set forth in my copending application Serial Number 714,893, filed February 12, 1958, for Screw Driven Tailgate Loader, which would be rated for thousands of pounds of lifting capacity. Another application which I anticipate would be to bolt, weld, or attach in some manner these anti-friction force columns to various panels in the construction industry or to floors and to lift these items up as a jack arrangement to the desired height. Properly mounted, these columns may be used to operate a crane mechanism to lift large loads over various heights and around a radius of 360 degrees. These columns can also be used in an automobile type service station lift wherein an automobile is raised for greasing and maintenance purposes. From these several examples, it can be seen that almost any basic application that requires a lifting or a downward pressing action, where at present some other

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mechanical device is being used to provide the force, the anti-friction force columns of my invention can be used.

The lifting columns of my invention are much less expensive to manufacture than a hydraulic mechanism since the lifting force is developed without the usually necessary requirement of accurately machined surfaces. In addition, the lifting columns can be subjected to various strains and not result in a binding or galling of the lifting parts due to the ball bearing embedded surfaces. This is not true of hydraulic systems which have to be carefully maintained for the hydraulics to operate properly. By allowing a reasonable clearance between the inner column and the outer column the assembly can be made and used in considerable unsupported lengths. By this I mean that even though the columns may bend slightly, since they are separated by anti-friction devices, the inner column will bend with the outer column and with clearance between the two columns which exceeds that projection of the respective anti-friction ball bearings, there is no way that the columns can bind on each other; therefore, the lifting force will still be effective even though the columns are bent.

Referring to the drawings in more detail, it can be seen that the anti-friction force column of my invention consists basically of two columns of substantially square section; an inner steel square column designated by reference character 1 and a larger outer steel square column shown at 2. In each case the cross-section of the square columns are not complete four-sided squares, but are substantially U-shaped sections; the inner square column 1 having one complete side omitted and the outer square column 2 having the center section of one side omitted. The inner square column slides within the outer square column in such a manner that the open side of each of their respective square cross-sections face away from each other.

Disposed about the exterior periphery at symmetrical distances along the length of the inner steel square column 1 are mounted magnetized hardened steel ball-shaped members or bearings 3. A pair of ball bearings 3 are mounted on each peripheral side of the inner square column in the vicinity of the edges thereof, the bearings for the omitted side being mounted on the faces formed by the thickness of the material from which the inner square column is constructed. These hardened steel anti-friction ball bearings 3 bear on the four inside surfaces of the outer steel square column permitting the inner square column to roll within the outer square column with the least possible friction, and without bearing of any metal-to-metal surfaces of the two respective columns. Another purpose served by anti-friction ball bearings 3 is that they provide trouble-free operation of one column traveling within another even though the dimension specifications for the columns are not rigidly complied with during their manufacture. Normally deviation of the dimensions would result in one column binding within the other but the small bearing points presented by the anti-friction ball bearings permit the surfaces to roll over each other since there is much less resistance due to rolling friction to overcome. Due to the much reduced friction very little power is required to lift a very large load. The hardened steel anti-friction ball bearings fit into recesses 4 drilled or formed into the column faces such that the greater volume of each ball bearing is beneath the column surface. Since the ball bearings are magnetized they will not under any conditions become dislodged from or vibrate out of the inner column when it is displaced downwardly below the outer square column where there are no surfaces to retain them. By magnetizing the ball bearings the process for retaining the bearings in their recesses, such as peening, is eliminated and replaced by an extremely inexpensive method which permits the bearings to rotate in their recesses when lubricated.

Vertical drive screw 5, longitudinally disposed within

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both square channels and particularly within the inner square channel 1, is mounted at each end to outer square channel 2 by thrust bearings 6 which are mounted perpendicular to the axis of the drive screw 5, and are welded by means of mounting assemblies 7, on both ends of outer steel column 2 so that they clear the interior faces of inner steel square column 1.

Mounted on the lower end of drive screw 5, perpendicular to the center axis of said drive screw and just above lower thrust bearing 6, is helical gear 8 which is engaged and driven by matching helical gear 9 disposed on drive shaft 10 outside the columns which in turn is driven by driving means 11. Externally disposed helical gear 9 gains access to drive helical gear 8 disposed within the columns through slot 12 provided in the back wall of outer square column 2 for this purpose. In the several figures for illustrative purposes, the driving means has been shown coupled by means of a pair of helical gears to the lower end of the drive screw 5. The driving means can just as well be coupled to the top or opposite end of drive screw 5, the only criterion being individual application and convenience. Likewise, the means for coupling the driving means to the drive screw does not necessarily have to be by means of helical gears as shown, but can be any type gearing or chain drive arrangement which would be more suitable to the individual installation.

Lift member or nut 13 disposed on drive screw 5 in close spatial relation to the interior faces of the inner square column 1 consists of a square block of hard metal having a threaded hole therethrough, which threads match and mate with the drive screw threads. As drive screw 5 is rotated by the driving means 11 through gears 8 and 9, lift nut 13 will travel either up or down said drive screw, the direction of travel corresponding to the respective direction of drive screw rotation. The upper and lower surfaces of lift nut 13 each contains a pair of magnetized hardened steel coupling ball-shaped members or bearings 14 and 14a respectively, fitted into bearing recesses 15 and 15a respectively, along a line through the drive screw center axis and parallel with the back wall of outer square column 2, to which the drive screw is mounted, each ball of each pair being disposed on opposite sides of said drive screw. Like the anti-friction ball bearings 3 discussed earlier the greater volume of each coupling ball bearing 14 and 14a is beneath the surface of the lift nut and is held in its recess 15 or 15a only by its individual magnetic field.

The upper and lower pairs of lift nut coupling ball bearings 14 and 14a bear on identical hardened steel wear plates 16 bolted at 17 and 18 respectively, to upper restraining plate 19 which is welded perpendicular to the end of inner square column 1, and lower restraining plate 20 welded perpendicular to the three interior walls of the inner square column. Identical slots are provided in both hardened steel plates 16, upper restraining plate 19, and lower restraining plate 20 so as to provide ample clearance for drive screw 5 thus preventing any physical bearing between said drive screw and said aforementioned members. Since lift nut 13 is confined between the two restraining plates welded to the inner square column, any movement of the lift nut in either an upward or downward direction along drive screw 5 is imparted to the inner square column. The purpose of the lift nut coupling ball bearings 14 and 14a is to transfer load in an upward and downward direction, respectively, from the inner square column to the center axis of the drive screw, and transfer force from the driving screw to the inner square column in both an upward and downward direction without allowing transfer of torque or bending moment from the inner square column 1 to drive screw 5 or the surface of lift nut 13. Since the coupling ball bearings 14 and 14a are mounted in a longitudinal plane through the drive screw center axis and provide only small pivot points of contact between the lift nut on the drive screw

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and the hardened steel plates on the inner square column, as opposed to an area of contact, all load which is transferred to the drive screw through the coupling ball bearings is transferred directly along the longitudinal center axis of the drive screw by load vectors which are always parallel to the drive screw center axis. Thus no load developed torque or load developed bending moment can be transferred to the drive screw from the inner square column.

To prevent lift nut 13 from turning with drive screw 5, due to the torque which develops between the screw thread and the nut, and thus binding said drive screw and the inner and outer columns, two magnetized hardened steel ball-shaped members or bearings 21 similar to those previously described are inserted in recesses on the lift nut surface which is opposite to and parallel with the back wall of outer square column 2. These ball bearings 21 are located along the horizontal center line of the lift nut back surface with one ball bearing being disposed on either side of drive screw 5 in planes running parallel with the side walls of the columns and vertically through the center of coupling ball bearings 14 and 14a on the same respective sides of said drive screw. The purpose of ball bearings 21 is to serve to balance the beforementioned torque which develops between the screw-thread and the lift nut by bearing against the interior surface of the outer square column back wall 22, resulting in holding the nut stationary in the horizontal plane and thus preventing it from turning. As the lift nut 13 travels up and down, drive screw 5 according to the rotation of said drive screw, ball bearings 21 bear or roll against the interior surface of the outer square column back wall designated at 22.

I have illustrated a modified form of my invention in Fig. 9 in which outer steel square column 2' is a complete four-sided square. In the standard form of my invention outer steel square column 2 was not completely enclosed, that is, a portion of one side was left open to allow for an attachment at the bottom of the inner steel square column 1 to travel up and down the length of the outer column when the end of the inner column to which it is attached is retracted inside the outer column. This can best be illustrated by reference to Fig. 10 where bracket 24 is welded to the lower end of inner column 1 and a lift platform 23 is attached to this bracket. As the inner square column is raised within the outer square column to a height such that the end of the inner square column is retracted within the outer column the open side of the outer column provides a clearance slot for the bracket welded to the inner column, thus permitting the bracketed end of the inner column to be retracted well within the outer column. In other applications, for example, where a roller chain, log chain, or a cable, or where an attachment is made to a cylinder, as shown in Fig. 11, where all attachments are on the end of the inner column and act along the longitudinal axis of the inner column, it is not necessary to provide an open side on the outer square column and the modified form as shown in Fig. 9 can be utilized. This modified form is also applicable where considerably long unsupported lengths of anti-friction force columns are required since the completely enclosed square column is more capable of resisting bending forces than the type with one open side.

In Figs. 10, 11 and 12 I have illustrated three applications of my invention. Fig. 10 illustrates a lift platform 23, attached by means of bracket 24 to the lower end of inner steel square column 1. In this application the lift platform is attached between two anti-friction force columns and is a lifting and lowering device of the type set forth more fully in my copending application Serial No. 714,893, filed February 12, 1958, for Screw Driven Tailgate Loader.

In Fig. 11, I have shown the lower end of the inner square column 1 attached to the plunger member 25 of a cylinder 26. In this application the cylinder can be

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either a compression-type load requiring column 1 to push plunger member 25 downward, or a tension-type load requiring column 1 to pull plunger member 25 upward.

In Fig. 12 I have illustrated the lower end of the inner column 1 adapted for use as a derrick by providing a member shown at 27 to which load 28 may be attached by means of a hook 29. The hook may be permanently attached to the lower end of the column 1 if it is desirable for the particular application.

I have illustrated another modified form of my invention in Fig. 13 in which outer steel square column 2'' is channel-shaped with soft metal strips indicated at 30, made of brass, aluminum, or other soft metal, fastened to its interior side surfaces by means of bolts 31 or other suitable means. These soft metal bearing strips 30 eliminate the need for anti-friction ball bearings 3 on the surface of inner square column 1 opposite said soft metal strips. Tests indicate that where light loads are carried by a force column, for example loads of approximately 500 to 600 pounds, the soft metal bearing strips 30 are very satisfactory and afford a cheaper construction. It is true that the sliding frictional forces between strips 30 and inner column 1 are greater than the rolling frictional forces accompanying the anti-friction ball bearings 3, but where light loads are used, such as those for which this modified construction is applicable, this difference is negligible.

Any power which would be applied to the columns of my invention would be a power consisting of high torque and a low revolution per minute rate with a very significant reduction in the drive screw itself or a mechanical advantage in the screw drive itself in the approximate vicinity of seven, eight, nine or ten. This torque would then be multiplied by this multiple and thus result in extremely high upward and downward forces.

I have found the force column of my invention as herein set forth highly practical in its construction and operation, and while I have described my invention in certain of its preferred embodiments, I realize that modifications may be made, and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A force column comprising in combination an outer column of polygonal cross-section having a hollow center, an inner column of smaller polygonal cross-section having a hollow center with one side thereof open disposed within the hollow center of said outer column and movable along the longitudinal axis of said outer column, anti-friction means disposed between said inner and outer columns, a drive screw rotatively mounted within the hollow center of said inner and outer columns and on said outer column parallel with the longitudinal axis of said outer column, driving means for rotating said drive screw in a clockwise and counterclockwise direction, a lift member of polygonal cross-section disposed on said drive screw in close spacial relation with the interior walls of the hollow center of said inner column and the interior wall of the hollow center of said outer column on which said drive screw is mounted, restraining members mounted on and perpendicular to said inner column at either end of said lift member, and coupling means between said restraining members and the ends of said lift member.

2. A force column as set forth in claim 1 in which said anti-friction means are disposed in the surface of one of said columns and extend into contact with the opposite surface of the other of said columns.

3. A force column as set forth in claim 1 in which said anti-friction means consist of ball-shaped members of magnetic material disposed in recesses of magnetic material in the surface of one of said columns, said ball-

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shaped members being magnetically retained in said recesses.

4. A force column as set forth in claim 1 in which said anti-friction means consist of ball-shaped members, the greater volume of each ball-shaped member being disposed beneath the surface of one of said columns in a recess in the surface of said column.

5. A force column as set forth in claim 1 in which said restraining members extending in planes normal to said inner column and traversing the hollow center of said inner column provide drive screw clearance notches therein.

6. A force column as set forth in claim 1 in which said coupling means between said restraining members and the ends of said lift member consist of ball-shaped members.

7. A force column as set forth in claim 1 in which said coupling means are maintained in recesses on the surfaces of said lift member, which are normal to the longitudinal axis of said drive screw, by said corresponding restraining members.

8. A force column as set forth in claim 1 in which said coupling means are disposed in the surfaces of said lift member which are normal to the longitudinal center axis

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of said drive screw, in a plane containing the longitudinal center axis of said drive screw and which is parallel to the wall of said outer column on which said drive screw is mounted.

9. A force column as set forth in claim 1 in which said lift member contains recesses on the rear surface thereof, opposite the interior wall of the hollow center of said outer column on which said drive screw is mounted, which lie in a plane parallel with the end surfaces of said lift member and equi-distant from said end surfaces, said recesses containing the greater volume of ball-shaped members disposed therein and extending into contact with said opposite interior wall of the hollow center of said outer column on which said drive screw is mounted.

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