Aug. 2, 1966 J. J. MATELENA 3,263,619

MOTOR-PUMP UNIT

Original Filed Oct. 9, 1963 4 Sheets-Sheet 1

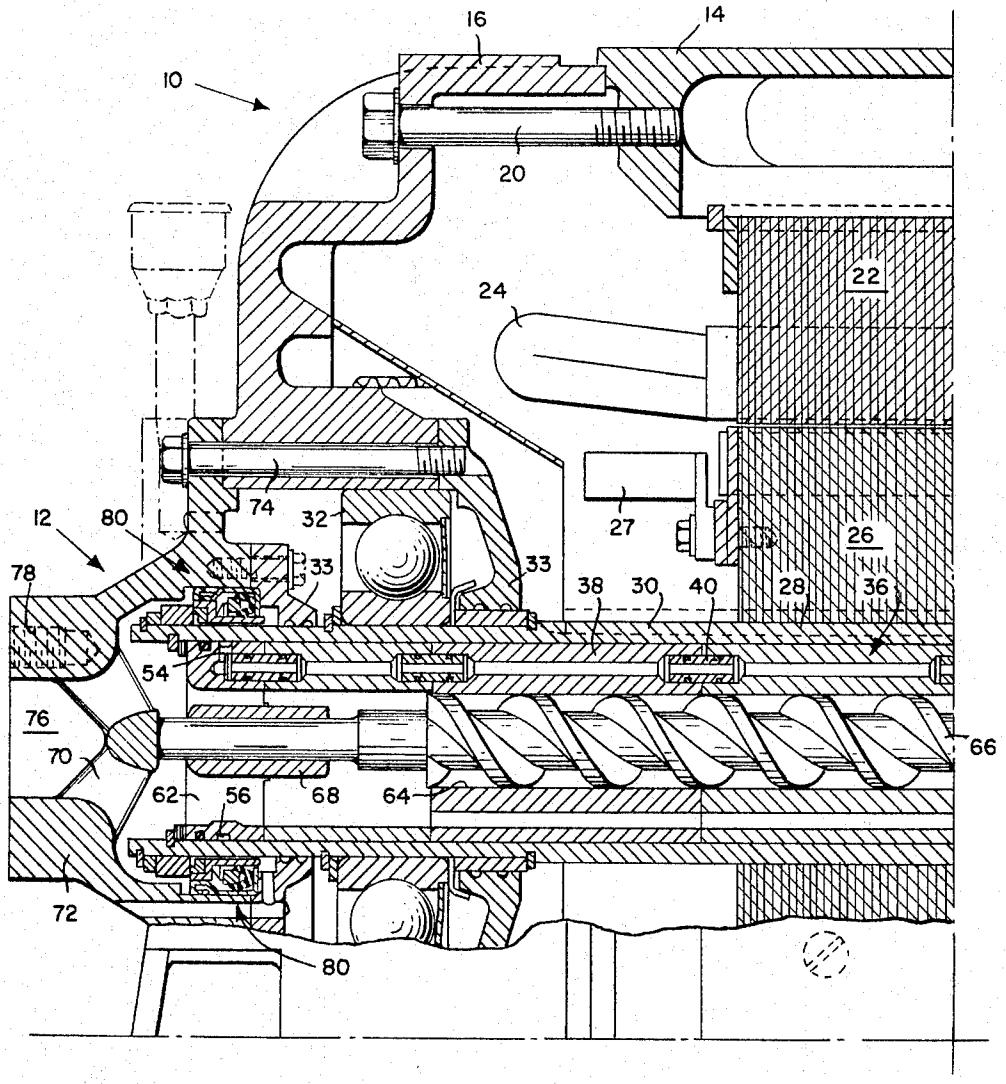



FIG. IA.

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MOTOR-PUMP UNIT

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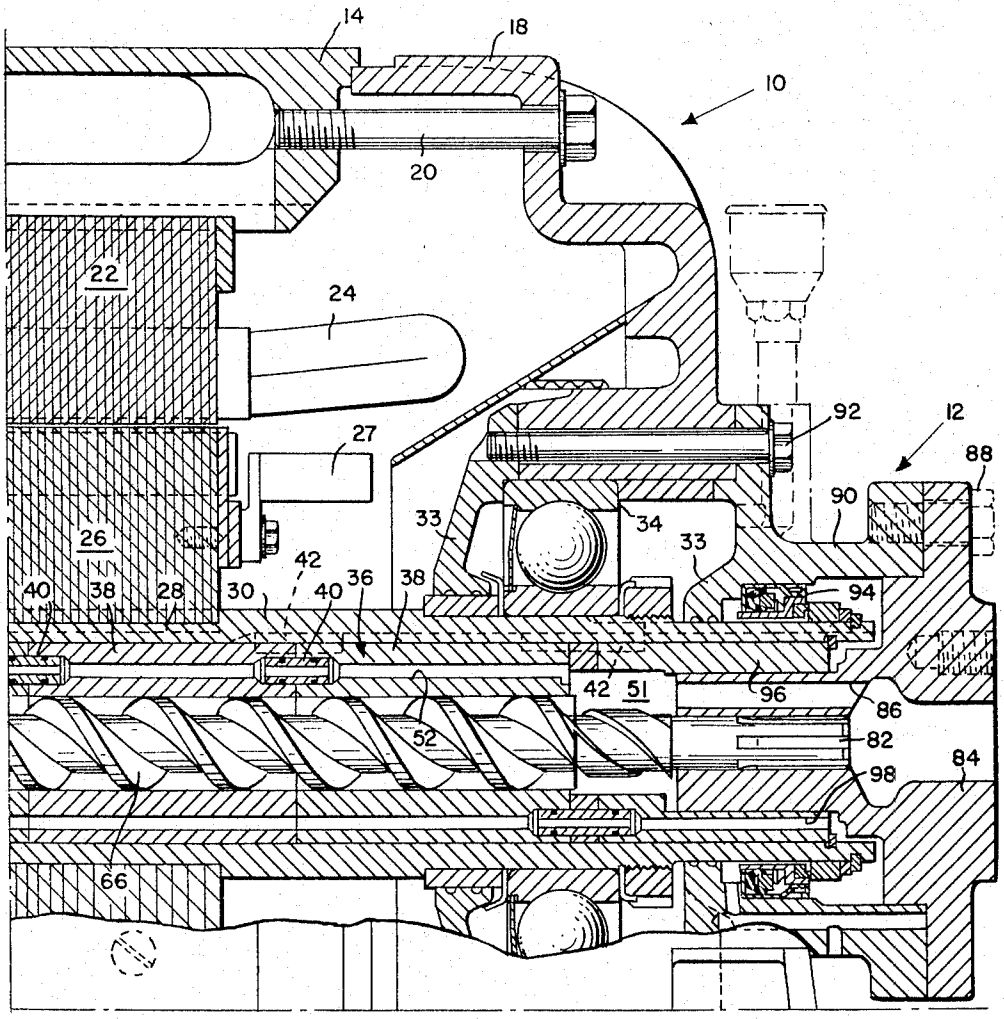



FIG. 1B.

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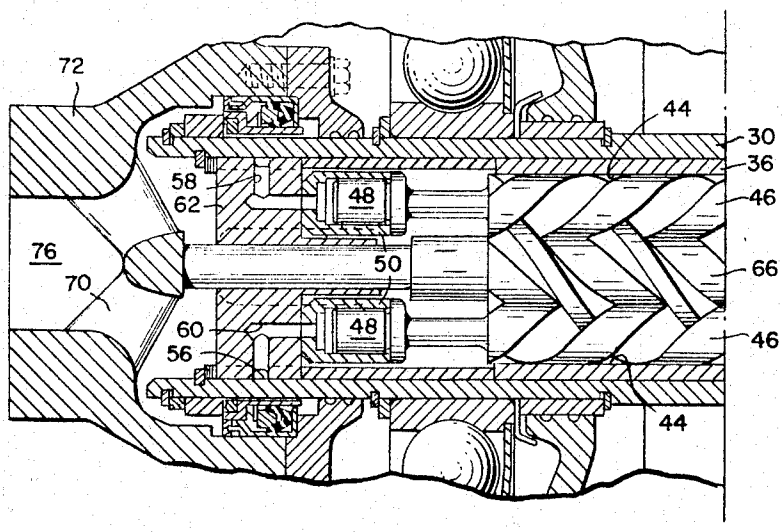



FIG. 2.

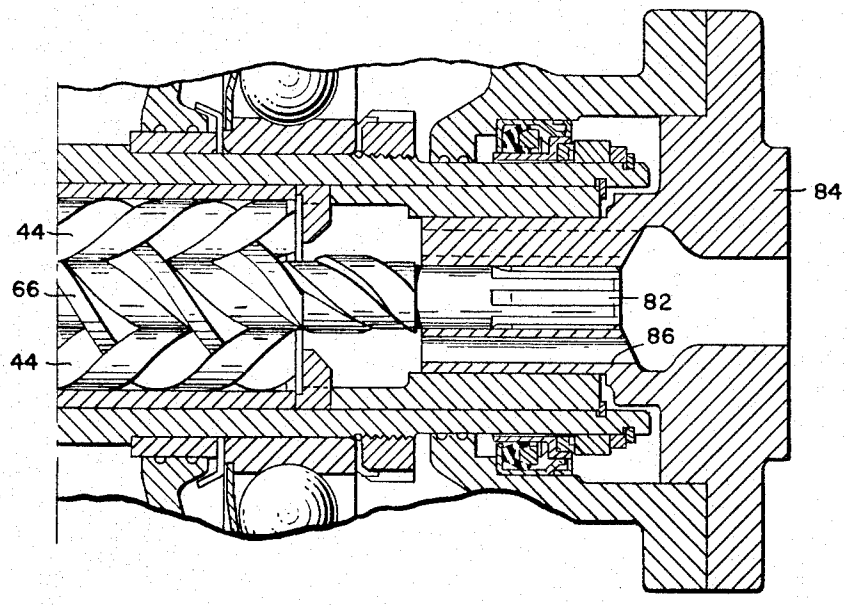



FIG. 3.

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MOTOR-PUMP UNIT

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FIG. 4.

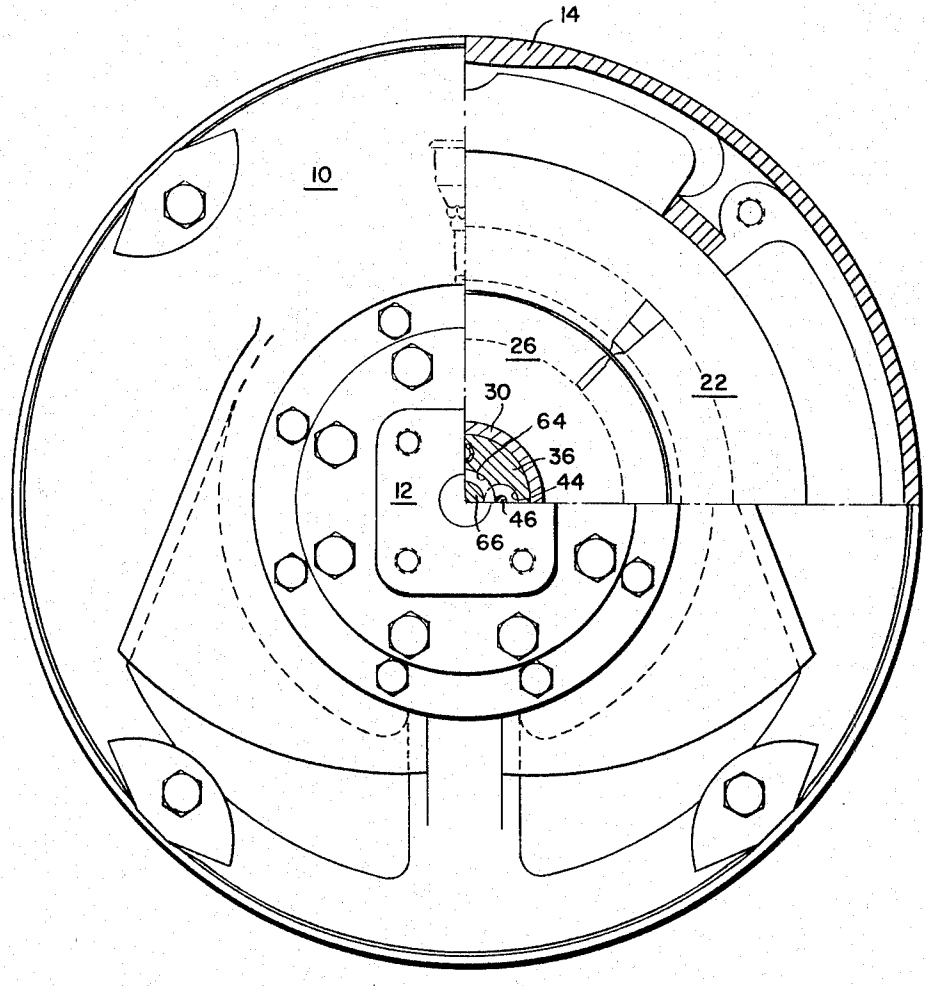
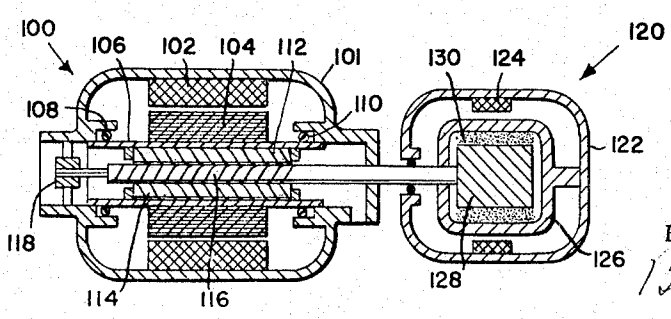



FIG. 5.




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3,263,619

# MOTOR-PUMP UNIT

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Continuation of application Ser. No. 315,042, Oct. 9, 1963. This application Oct. 4, 1965, Ser. No. 492,368
4 Claims. (Cl. 103—120)

This application is a continuation of my application Serial No. 315,042, filed October 9, 1963.

The present invention relates to multiple screw pumps such as described in Montelius Patents 1,698,802, 1,821,523, and 1,965,557 respectively dated January 15, 1929, September 1, 1931 and July 3, 1934. As described in theses patents, such multiple screw pumps conventionally include a plurality of idler screws which are journalled for rotation in a stationary housing and a centrally positioned power screw which is mechanically driven through a coupling by a motor having an output shaft axially aligned with the power screw.

In contrast to such conventional pump and motor arrangements, the present invention contemplates the incorporation of the entire screw pump assembly within the motor casing so as to provide an integral motor-pump unit the axial length of which is approximately one-half that of conventional motor and pump arrangements. Accordingly, there is also a substantial reduction in weight.

In addition to substantially reducing the size and weight of the motor-pump unit, the number of elements is also reduced since the need for a conventional motor shaft, coupling unit and separate pump casing and bearing are entirely eliminated. Furthermore, previous screw pump and motor arrangements required the power screw to extend through the pump casing so as to be externally driven and this required the use of a high pressure shaft seal to prevent the escape of the pumped fluid along the externally projecting shaft.

Yet another advantage of the present invention resides in the fact that the elimination of a shaft coupling unit also eliminates shaft alignment problems and, even more importantly, eliminates the objectionable noise which is often produced by such couplings. In this regard, the reduction of noise is an exceptionally important feature since screw pumps are often selected for a particular application due to the fact that the pumping mechanism is naturally quiet in operation as compared, for example, to reciprocating piston pumps which have large vibration characteristics. Thus, the reduction of coupling noise makes the combined motor-pump unit even better suited to those applications requiring quiet operation. Of course, the fact that the pump is entirely encased within a relatively massive motor structure further tends to damp pump vibrations so that even quieter operation is achieved.

Another advantage of the present invention is that there is achieved greatly improved center of gravity and radius of gyration values because of the reduction in weight and length.

It is therefore a general object of the present invention to provide an improved pump-motor unit having the above indicated structural and functional advantages.

It is yet another object of the present invention to provide a pump-motor unit wherein the delivery rate of



the pump may be varied in accordance with or independently of the operating speed of the driving motor.

The above objects as well as others relating more particularly to the details of construction and operation will become more fully apparent from the following description when taken with the accompanying drawings in which:

FIGURE 1A is a sectional view of the left-hand end of the combined motor-pump unit;

FIGURE 1B is a sectional view of the right-hand end of the combined motor-pump unit;

FIGURE 2 is a sectional view of the left-hand end of the motor pump unit showing the screws in plan view;

FIGURE 3 is a sectional view of the right-hand end of the motor-pump unit showing the screws in plan view;

FIGURE 4 is an end view of the motor pump unit with a portion of the casing broken away in section; and

FIGURE 5 is a simplified illustration of the pump-motor unit in combination with means for varying the delivery rate of the pump independently of the operating speed of the motor.

Referring now to the structural details of the invention as illustrated in FIGURES 1–4, the motor pump unit comprises a motor section generally indicated by numeral **10** which surrounds and supports the pump section generally indicated by numeral **12**. From the subsequent description of the invention it will become apparent that the motor section may comprise a standard motor of conventional design including both A.C. and D.C. types which may be either constant or variable speed as well as reversible if so desired. However, for purposes of description it will be assumed that the motor is a conventional squirrel cage induction motor since such motors are most often employed to drive pumps due to their high starting torque characteristics.

Motor section **10** includes an outer cylindrical casing **14** to which a pair of end plates **16** and **18** are secured by a plurality of bolts **20**. Casing **14** supports the stator **22** having conventional field windings **24**. The rotor is indicated at **26**, comprising the usual squirrel-cage conductors and associated core structure, and carries a plurality of blades **27** which circulate cooling air through the motor in the conventional manner. Rotor **26** is rigidly secured to a sleeve **30** as by keys **28** and the opposite ends of the sleeve are journalled in bearings **32** and **34** which are carried by end plates **16, 18** and provided with bearing seals **33**.

Reference is now made to the pump section **12** which includes a cylindrical pump housing **36** formed by a plurality of axially aligned sections **38** secured against rotation relative to each other by means of cylindrical connecting pins **40**. Housing **36** is keyed to sleeve **30** so as to rotate therewith by means of a plurality of keys **42** two of which are illustrated in FIGURE 1B. Of course, it will be apparent that each of sections **38** may be individually keyed to sleeve **30** if so desired, however, this is not generally necessary due to the interconnection provided by pins **40**.

The pump housing **36** is provided with a pair of lobed bores **44** in which a pair of idler screws **46** are received so as to rotate about their respective axes as in conventional screw pumps. One end of each idler screw is preferably provided with a portion forming a balancing piston **48** which is receivable within a cylinder element

50 to which high pressure fluid is supplied from the pump outlet chamber 51 through an axial passage 52 in housing 36, radial passages 54, annular groove 56, radial passages 58 and axial passages 60 the latter of which are provided in a housing member 62.

The pump housing 36 also contains a central bore 64 which intersects bores 44 throughout its length and which receives a power screw 66 having helical threads in meshing engagement with the helical threads on the idler screws.

As most clearly shown in FIGURES 1A and 2, the left end of power screw 66 extends through a bearing sleeve 68 forming a portion of housing member 62 so that this member and the pump housing 36 are free to rotate about the power screw. Externally of sleeve 68, the end of the power screw abuts, in view of the pressure difference across the screw, a spider support 70 formed as an integral portion of a casing member 72 the latter of which is stationarily secured to the motor casing 16 by a plurality of bolts 74.

Casing member 72 forms the pump inlet passage 76 and is provided with means such as threaded bores 78 whereby the inlet pipe connections may be made to the motor-pump unit. In addition, casing member 72 supports a seal assembly 80 which engages the external surface of sleeve 30 so as to seal the pump inlet from the motor section.

Referring now to FIGURES 1B and 3, the right end of power screw 66 is splined at 82 so as to be non-rotationally secured to a casing member 84 having a plurality of pump outlet passages 86 extending parallel to and circumferentially about the power shaft. Casing 84 is connected by a plurality of bolts 88 to a second casing 90 which, in turn, is connected to the motor casing 18 by a plurality of bolts 92. Casing 90 supports an outlet pump seal assembly 94 which surrounds and engages rotary sleeve 30 the latter of which is spaced from casing 84 by means of a bearing sleeve 96 so that the sleeve and pump housing 36 are free to rotate relative to the stationary casing 84. In order to further prevent the passage of high pressure pump fluid into the motor section, a bleed passage 98 is provided in sleeve 96 which leads through the pump housing 36 back to the pump inlet and thereby provides an escape for the high pressure fluid which passes between casing 84 and sleeve 96.

From the foregoing description of the motor-pump structure it will be readily apparent that rotation of the motor rotor 26 rotates sleeve 30 and the pump housing 36 carrying the idler screws 44 so that the latter execute a planetary motion about the stationary power screw. As a result, closed pumping chambers formed by the interengaging screw threads travel axially along the screws in a manner identical to the operation of a conventional screw pump wherein the power screw is rotated within a stationary casing carrying the idler screws.

In the foregoing description it was assumed that the pump housing 36 was driven at substantially constant speed by induction motor 10. On the other hand, it will be readily apparent that a variable speed motor may be employed so as to rotate the pump housing at various speeds and thereby provide a variable rate of pump delivery. However, the present invention also provides for variable delivery rates even though the pump housing is driven at constant speed by a constant speed motor. In brief, this may be accomplished by permitting the central power screw to rotate along with the pump housing but at variable speeds less than the constant speed at which the pump housing is rotated by the motor.

FIGURE 5 schematically illustrates one arrangement whereby the speed of the power screw may be varied from zero up to the speed of the housing in order to vary the delivery rate of the pump. In this system, the motor-pump unit 100 is substantially identical to that previously described and includes a motor casing 101 carrying a stator 102 within which the motor rotor 104 is supported by the pump housing 106 journalled for rotation in bearings 108 and 110. Housing 106 carries a pair of idler screws 112 and 114 which rotate with the housing as in the previous embodiment. Housing 106 also includes a central bore which receives the power screw 116 one end of which is journalled for rotation in bearings 118. The opposite end of the power screw extends through the pump outlet casing and is connected to an electromagnetic brake generally indicated 120.

Brake 120 is entirely conventional and includes a casing 122 supporting a stationary excitation coil 124 surrounding a stator 126 within which a rotor 128 is adapted to rotate, rotor 128 being secured to power shaft 116. The gap between stator 126 and rotor 128 is filled with finely-divided ferromagnetic particles suspended in oil which have insignificant frictional effect so long as coil 124 is not energized. However, upon the passage of an excitation current through coil 124, a magnetic field is produced across the gap so that the particles cling to each other forming "chains" creating a magnetic bond between the stator and rotor. Thus, the power screw 116 may be held completely stationary or permitted to rotate along with the pump housing at varying speeds depending upon the amount of current supplied to the excitation coil. As a result, the volumetric output of the pump may be varied from the maximum which occurs when the power screw is held stationary to a substantially zero output which occurs when the power screw is unretarded and therefore fully rotates along with the pump housing and idler screws at a substantially equal speed.

Although a magnetic particle type brake has been shown for purposes of illustration, it will be readily apparent that other types of brakes including mechanical friction brakes may be employed to retard to varying degrees as desired the rotation of the power screw. Furthermore, although it is preferred that the brake be capable of holding the screw completely stationary, it will be apparent that a dynamic brake may be employed to retard rotation of the power screw in varying degrees without holding it completely stationary.

Numerous other modifications and alterations will become readily apparent to those skilled in the art and it is to be understood that the invention is not to be limited other than as specifically set forth in the following claims.

What is claimed is:

1. In combination, an electric motor including an annular rotor, a pump housing mounted within said annular rotor so as to rotate therewith, a plurality of idler screws, means mounting said idler screws within said housing for rotation about their respective axes, a power screw positioned centrally of said idler screws in meshing engagement therewith so as to form pumping chambers, and means for restraining rotation of said power screw whereby said pumping chambers advance axially along said power screw upon rotation of said housing and planetary movement of said idler screws about said power screw.

2. The combination of claim 1 in which said means restraining rotation of said power screw comprises brake means arranged to control the speed of rotation of the power screw relative to the speed of rotation of said housing.

3. In combination, a motor having a casing, bearing means supported by said casing, a cylindrical pump housing supported by said bearings for rotation about the longitudinal axis thereof, said motor including an annular stator supported by said casing and an annular rotor surrounding said housing, means securing said housing to said rotor so as to rotate therewith about said axis, a power screw having a longitudinal axis coincident with the axis of said housing, means connected to said motor casing for supporting said power screw and for restraining its rotation, a plurality of idler screws circumferentially spaced about said power screw in meshing engagement

therewith so as to form pumping chambers, and means mounting said idler screws in said housing for planetary movement about said power screw upon rotation of said housing by said rotor so as to axially advance said pumping chambers.

4. The combination of claim 3 in which said means for restraining rotation of said power screw comprises brake means arranged to control the speed of rotation of the power screw relative to the speed of rotation of said housing.



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