

April 23, 1963

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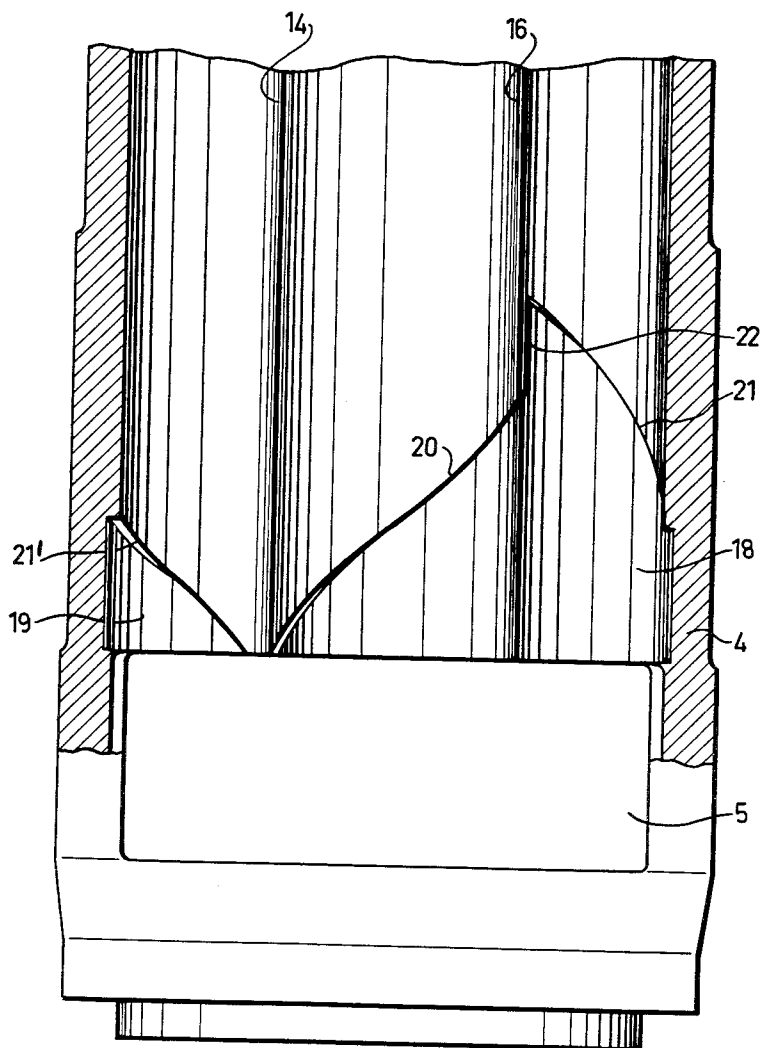
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SCREW PUMP

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4 Sheets-Sheet 2

Fig. 2



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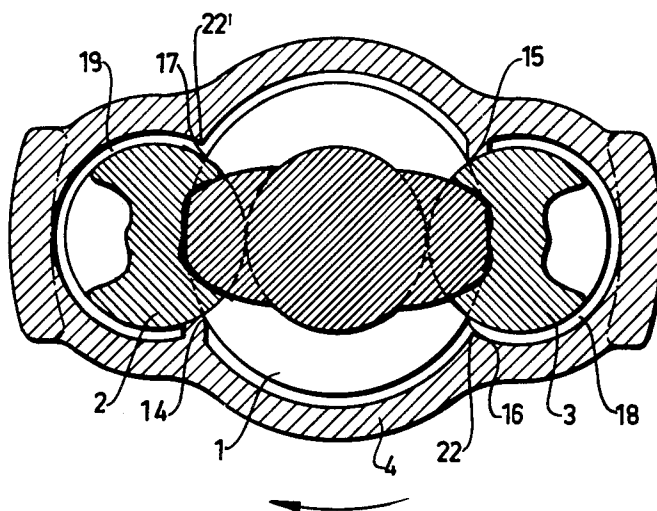
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Fig. 3



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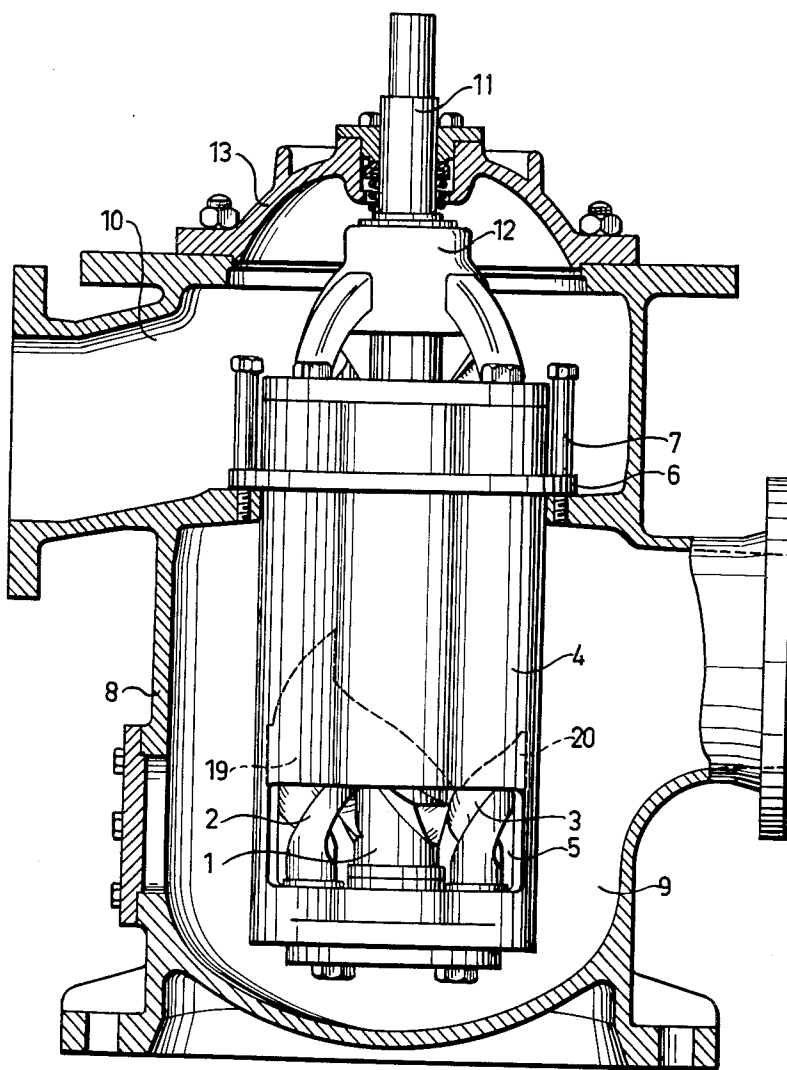
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Fig. 4



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SCREW PUMP

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1 Claim. (Cl. 103-128)

This present invention relates to screw pumps of the type comprising an assemblage of screws including a middle screw with convex thread flanks and one or more side-screws meshing with the middle screw and having concave thread flanks, the threads being of such configuration that they seal against the circumferences of cooperating screws, all said screws being sealingly enclosed in a casing.

In the operation of such a pump, the liquid being pumped is progressed axially from the inlet end or suction side of the screw assemblage to the outlet end or pressure side thereof in essentially closed chambers formed by the thread flanks and bottoms of the screws and the enclosing casing. Such a chamber is formed at the suction side of the screw assemblage when the screws are rotated and is filled with liquid while it is formed. When the chamber is fully formed, it is closed toward the suction side and on continued rotation of the screws it travels axially along the screw assemblage toward the outlet end of the screw assemblage where it is opened and the liquid is discharged. The volume of the chamber is unchanged while it progresses from the inlet to the outlet end, and provided that the pump is ideally tight, the liquid in the chamber is throughout this travel subjected to the pressure prevailing at the inlet end to be subjected to the higher pressure prevailing at the outlet end only when the chamber is opened at the outlet end. In an actual pump of this type, of course, a certain amount of leakage will occur on account of unavoidable tolerances in manufacture which result in a certain amount of play as between the screws and as between the screws and the casing, wherefore a small increase in the pressure on the liquid will occur during travel along the screw assemblage. With a sufficient accuracy in manufacture, however, this increase in pressure will be so small that substantially the entire increase in pressure occurs at the outlet end.

When the chamber is being formed, a vacuum is developed in the chamber, which causes the chamber to be filled with the liquid. It is important that the liquid can flow into the chamber with as small losses as possible and fill it completely before it is closed. In order that this shall be possible, the speed of rotation of the screws must not exceed a certain critical value. When the speed exceeds the critical value, the chamber will not be completely filled during the period of time before it is closed toward the suction side, but cavitation results, i.e. there are formed cavities in the liquid which are filled with gas or air given off by the liquid being pumped. The gas or air bubbles so formed accompany the liquid in its travel along the screw assemblage from the inlet to the outlet end. When the chamber is opened toward the outlet end and the liquid is suddenly subjected to the higher prevailing there the gas and air bubbles will be rapidly compressed. This results in noise and vibration which may be very annoying and also cause damage to the pump or other components of the installation.

That critical value depends on a number of factors, namely the dimensions and geometrical configuration of the screws, the shape of the inlet, the characteristics of the liquid being pumped, such as its viscosity, vapor pressure and its content of dissolved gases, and the particular height of suction. It has also been found that the form of the inlet to the screw assemblage is of importance. The present invention contemplates forming the inlet so

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that filling of the chambers is facilitated and occurs more rapidly whereby the value of the critical speed for a given pump is increased and the pump can be driven at a higher speed for a particular liquid and a particular height of suction without cavitation and accompanying disadvantages. This has the result that the pump can be made smaller for a given capacity or that the same pump can be used with unchanged speed at a greater suction head.

In hitherto known screw pumps the casing is so formed that fluid can enter a chamber which is being formed only in an axial direction at the inlet end of the screw assemblage which has the effect that the opening through which the liquid can enter is relatively limited. It has been found unsuitable to provide a radial inlet through the casing because the threads of the screws will throw out the liquid on account of the centrifugal action which makes a satisfactory filling difficult.

In accordance with the present invention, however, it was found possible to achieve a radial filling of the chamber without the disadvantageous effect of the centrifugal force by providing in the casing at the inlet end of the screw assemblage an internal recess the radial extension of which is small and substantially less than the radial dimensions of the threads of the screws. In order not to destroy the sealing which is produced when the chamber is closed, the recess extends axially only so far that it communicates with a chamber open axially toward the inlet end, but not with any chamber which is already closed toward the inlet end.

The invention will be described more in detail with reference to the accompanying drawings which illustrate an embodiment of the invention, and in which:

FIGURE 1 shows an elevation of the lower part of a screw assemblage with its casing, the casing being shown in longitudinal section;

FIGURE 2 shows the same view as FIGURE 1 but with the screws removed;

FIGURE 3 shows a cross-section along line III-III in FIGURE 1; and

FIGURE 4 shows at a reduced scale a pump with a screw assemblage and casing according to FIGURES 1 to 3, partly in cross-section.

The pump illustrated on the drawings is of the type comprising a driven middle screw 1 and two side-screws 2, 3, the middle screw 1 having two threads with convex flanks and the side screws also having two threads each but with concave flanks and of opposite hand to the threads of the middle screw, the threads being formed in a manner known per se so as to be in sealing relationship with each other. The screw assemblage comprising the middle screw 1 and the side-screws 2, 3 is enclosed in a casing 4 which sealingly surrounds the screw assemblage, said casing having at its lower end two symmetrical ports 5 through which the entrance of fluid to the screw assemblage takes place, the fluid being discharged through the open top end of the casing which is not visible in FIGURES 1 and 2. As seen in FIGURE 4, the casing 4 with the screws 1, 2 and 3 is by means of an attachment flange 6 on the casing and screws 7 attached in a pump housing 8 so that the lower end of the casing 4 with the ports 5 is disposed in the inlet chamber 9 of the pump housing, and the upper end is disposed in the discharge chamber 10 of the pump housing.

The middle screw 1 is driven by a motor (not shown) through a driving shaft 11 which is journaled in a bearing 12 attached to the top end of the casing 4 and extends through a cover 12 attached to the pump housing. The lower ends of the screws are journaled in any suitable manner in the bottom end wall of the casing.

As best seen in FIGURE 3, the casing is formed with a larger central bore for the middle screw 1 and two

smaller bores for the side-screws 2 and 3. At the intersections between these bores the casing forms inwardly directed edges 14, 15, 16 and 17.

To achieve the radial filling of the fluid chambers formed in the screw assemblage, as contemplated by this invention, the casing is formed with shallow recesses or pockets 18 and 19, which extend axially from the upper edges of the ports 5, i.e. from the inlet end of the casing. In FIGURE 2 the portions of the pockets 18 and 19 which are situated in the casing wall behind the screw assemblage are visible, and in FIGURE 1 those portions of the pockets which are in front of the screw assemblage are indicated by dot and dash lines. As seen therefrom, the pocket 18 is provided in one wall of the bore of the middle screw 1 and in the bore of one side-screw 2, while the pocket 19 is provided in the opposite wall of the bore of the middle screw and in the bore of the other side screw 3, the two pockets being symmetrical to each other.

In the portions thereof which are situated in the bore of the middle screw, each pocket 18 and 19 is limited in the axial direction by substantially helical curves 20, 20', respectively which are of the same hand as the threads of the middle screw and which run from a point at the inlet end of the casing close to the edge 14 or 15 respectively (i.e. the edge towards which the thread of the middle screw moves within that portion of each revolution in which that thread engages the casing up to a point on the edge 16 or 17 respectively (the edge from which the thread of the middle screw moves). The direction of rotation of the middle screw is indicated by the external arrow at the bottom of FIGURE 3. In those portions which are within the bores of the side screws 2 and 3 the pockets are limited by substantially helical curves 21, 21' which are of opposite hand to the curves 20, 20', i.e. of the same hand as the threads of the side screws, and by an axial straight line 22, 22' respectively along edge 16 or 17 respectively, said straight line connecting the two curves 20 and 21 and 20' and 21' respectively. The curves 21 and 21' start from the upper edge of opening 5 at points close to the edges 14, 15 but on opposite sides thereof with respect to the starting points of curves 20, 20'.

During operation of the pump, the pockets 18, 19 are constantly filled with fluid, which enters into them axially from the ports 5. From the pockets, the fluid can flow radially into the chamber being formed at the inlet end of the screw assemblage, and it is clearly evident from FIGURE 1 that a large area is available for the radial flow into said chamber. However, since the pockets are shallow or have small radial extension the effect of the centrifugal force is practically eliminated.

In order that no leakage of fluid backwardly toward the inlet shall take place, the communication between the pockets and the chamber in the screw assemblage ceases when the chamber is closed toward the inlet end. This requirement sets a limit for the axial extension of the pockets and determines the configuration of the limiting curves of the pocket.

It will be understood that the invention is not restricted to the embodiment shown comprising a driven two-threaded middle screw and two two-threaded side-

screws, but is generally applicable to other screw-pumps having a different number of side-screws and a different number of threads, the shape of the threads and the number of side-screws as well as the number of threads of the screws being so selected in relation to each other, in a manner known per se, that in each position of the screws there is at least one essentially closed chamber in the screw assemblage. It is known to those skilled in the art that this can be realized if the threads obtain a certain mathematically defined geometrical shape, and if the condition $G - ng + n = 0$ is satisfied, where G is the number of threads of the middle, n is the number of side-screws and g is the number of threads of each side-screw. The invention is applicable to all screw pumps of this type, including such screw pumps of this type in which not only the middle screw but also the side-screws are driven.

What is claimed is:

A positive screw pump of the type comprising a screw assemblage including a middle screw with convex thread flanks and at least one side screw meshing with the middle screw and having concave thread flanks and a casing which provides inlet and outlet chambers at the ends of the screws and which sealingly encloses said screw assemblage, said casing providing intersecting cylindrical bores accommodating the screws, the screws being such that at least one fluid chamber, of constant volume and closed with respect to said inlet and outlet chambers is formed by the thread flanks and bottoms and the casing and advances during rotation of the screws in the direction from the inlet chamber to the outlet chamber, characterized in that the casing bores at the inlet end of the screw assemblage are formed with internal recesses, the radial extent of each of which is small and has a depth substantially less than the radial dimensions of the threads of the screws and is outwardly bounded by a wall substantially concentric with the peripheries of the screws and the axial extent of which is such that each recess communicates only with the chambers which are open toward the inlet end of the screw assemblage, each recess being in continuous communication with said inlet chamber and bounded axially inwardly of said inlet chamber by helical curves conforming approximately with the helices of the screw threads at the position attained thereby in closing said fluid chamber with respect to said inlet chamber.

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