

March 22, 1938.

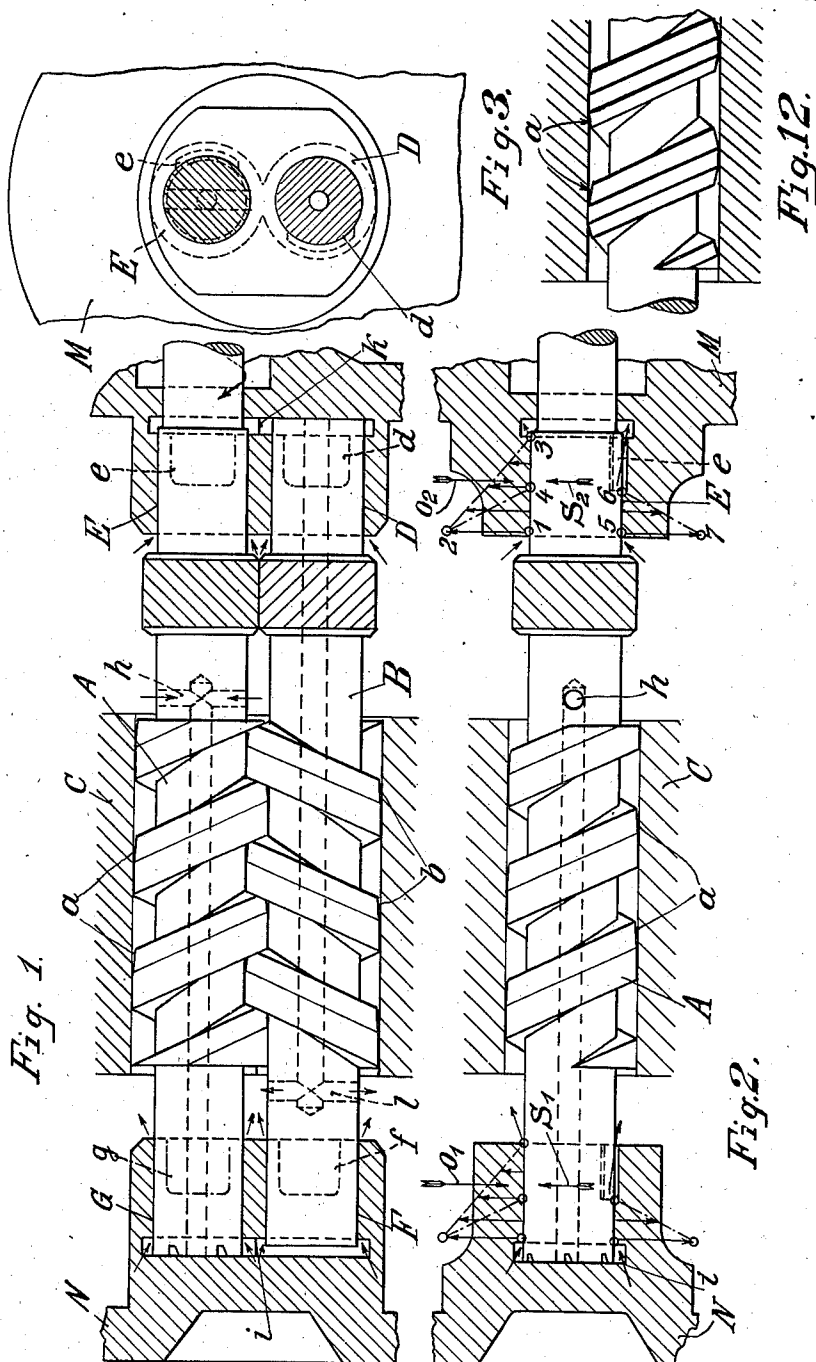
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2,111,883

PUMP

Filed Feb. 3, 1937

3 Sheets-Sheet 1



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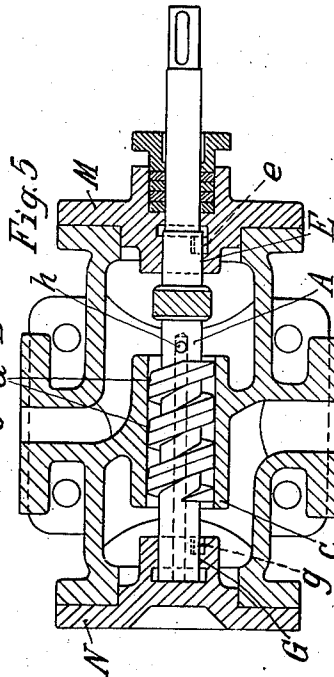
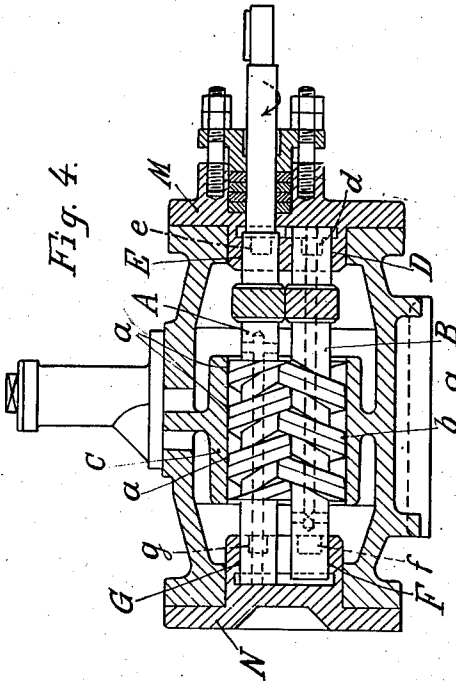
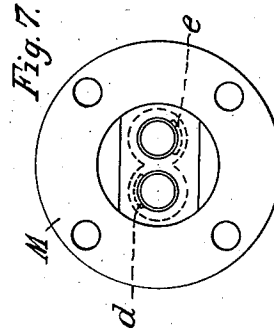
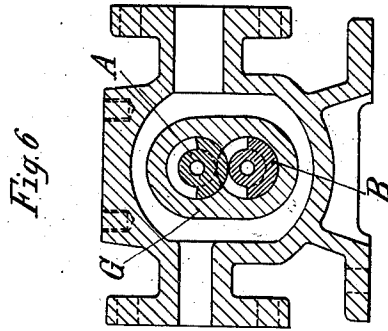
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3 Sheets-Sheet 2



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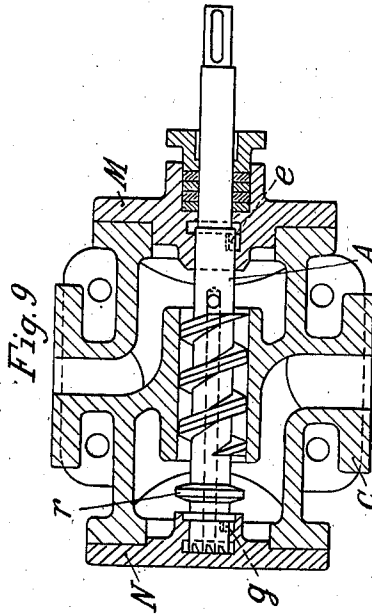
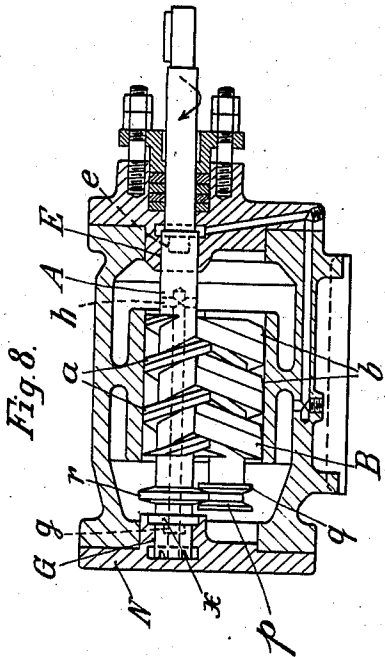
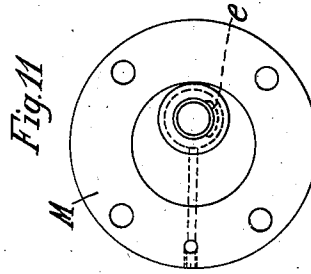
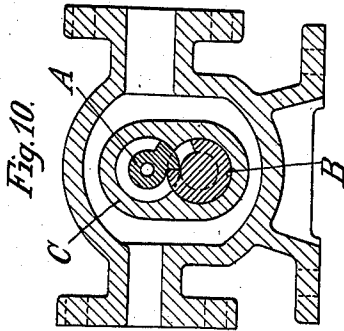
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2,111,883

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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PUMP

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In Germany April 17, 1936

7 Claims. (Cl. 103—128)

This invention relates to pumps operating with screw-spindles and has for its general object to provide an improved lubrication for such pumps as well as an improved arrangement of the moving parts thereof with a view of removing all objectionable stresses therefrom.

It is known that the screw-spindles of pumps of the aforementioned kind must be mounted to have but little play and the bearings must accordingly be made in an extremely accurate manner in order to keep the play between the tightening surfaces and edges of the casing of the pump and of the screw-spindles as small as possible to avoid any undesirable wear of the operating parts of the pump at the expense of its efficiency.

In case high pressures are used in pumps of the present kind, and more especially in case of high speeds of rotation, the bearings for the screw-spindles are being subject to large mechanical strains. In addition to this a bending of the screw-spindles may arise owing to the high pressure employed, such bending rendering it necessary to provide an undesirably large play between the screw-spindles and the casing in order to attain full safety of operation. By this, however, the volumetric as well as the total efficiency of the pump will be reduced to an undesirable degree.

A further disadvantage of pumps of this kind consists therein that owing to the high oil pressures the bearing surfaces will be subject to considerable strains owing to excessive lateral pressures that are one-sidedly imposed onto said surfaces, this resulting likewise in an undesirably large wear of the bearings.

By my invention, now, the aforementioned disadvantages are fully and successfully avoided and, in addition to this, a number of valuable advantages are attained so that it will be possible to not only render the operation of the pumps absolutely reliable but also to increase at the same time the efficiency of the pump to a quite considerable extent and, in addition, to essentially simplify the mechanical construction of the pump.

All these advantages connected with the pump forming part of my present invention will be attained on the one hand in that instead of the heretofore necessary large play in the bearings and between the surfaces and edges of the casing and the spindles, the outer diameters of the spindles are dimensioned to reduce said play to the absolutely necessary minimum, while in addition to this the threads of the spindles are

made of slightly conical conformation at their outer diameters on the side towards the pressure-space of the pumps. By so arranging the pump I attain that during contacting of the screw-spindles with the interior wall of the pump casing the heretofore sharp edge of the threads which move helically forward in axial direction along the surface of the casing will always be surrounded by liquid, thus enabling a lubricated-metallic contact to be maintained between surfaces relatively moving with respect to each other and in spite of this avoiding any corrosion and wear of said surfaces. By reason of the aforementioned slightly conical conformation of the spindles at the outer diameter of their threads in accordance with my invention, the effect will be attained that owing to the slight conical gap thus produced between the conical outer surface of the screw-spindles and the casing liquid will be drawn into this gap in accordance with the principles of the theory of hydrodynamic lubrication and the pressure of said liquid raised to a considerable value. In this manner, an actual metallic non-lubricated contact between the outer surfaces of the spindles and the inner surface of the casing will be positively avoided with the greatest degree of certainty during operation of the pump. Owing to this, moreover, the bore in the pump casing will effectively be utilized to successfully serve, so-to-speak, as an additional bearing for the screw-spindles of the pump, thus effectively releasing the main bearings from undesirable strain.

According to my invention it will even be possible to construct the side-spindle without employing special bearings therefor, if the thread of said spindle is given a conical conformation in accordance with my invention, the said spindle, now, together with the bore of the casing forming a bearing. Preferably, in this case the side-spindles are provided with a thread of greatest possible width and a rather narrow groove between said thread in order to attain a greatest possible bearing surface between these spindles and the pump casing.

As a further result of my invention the bearings constructed in this manner will partly be released from strains which may eventually arise. In particular, such release from strains is further facilitated according to my invention by providing a recess having a proper size and opening towards the suction side of the pump, this recess having the effect of unevenly distributing the oil pressure in the bearing, thus rendering it possible to equalize or counter-act the spindle-

pressure in the bearings by an appropriate oil-pressure, with the result that said side-spindle will so-to-speak be kept in a floating condition within its bearing.

5 In the accompanying drawings, I have illustrated an exemplification of pumps constructed in accordance with my invention wherein:

Figures 1 and 2 are fragmentary longitudinal sectional views taken at right angles to each other through a screw spindle pump constructed in accordance with my invention, the spindles being shown in elevation;

Figure 3 is a fragmentary transverse sectional view thereof;

15 Figures 4 and 5 are longitudinal sectional views taken at right angles to each other through a complete screw spindle pump embodying my invention;

Figure 6 is a transverse sectional view thereof;

Figure 7 is an end elevation thereof;

Figures 8 and 9 are views similar to Figures 4 and 5 but illustrating a slightly modified form of my invention;

25 Figure 10 is a transverse sectional view through Figure 8;

Figure 11 is an end elevation of Figure 9; and

Figure 12 is a fragmentary view partly in elevation and partly in section showing a slight modification of the screw spindle.

30 Referring more particularly to the drawings, the main spindle A and the side-spindle B according to my invention are of slightly conical conformation along the periphery of the spindle threads, the so provided peripheral surfaces of the spindles tapering towards the pressure-space of the pump. The spindle threads are thus of smaller diameter at the places indicated at *a* and *b* in Fig. 1, in a manner to provide between the conical surfaces of the spindles and the pump casing C but a slight conical gap into which liquid is drawn during rotation of the pump and pressure imparted to said liquid. Furthermore, recesses *d*, *e*, *f*, and *g* are provided in the bearing surfaces of the bearings D, E, F, and G, respectively, for both spindles, said recesses being of such conformation that the bearing forces arising by action of the lateral spindle pressures during operation of the pump are equalized or counteracted by the oil-pressure in the pump.

50 From the pressure-space of the pump oil is supplied to the bearing space *i* through the bore *h* in the main spindle A, said oil further flowing through the play in the bearings G and F towards the suction space of the pump, the pressure being reduced from its value in the pressure-space to its value in the suction-space. From the triangular diagrams 1, 2, 3 and 5, 6, 7 shown in Fig. 2, it may be seen that the line 2—3 and the line 6—7 represent the pressure-drop alongside the two lines representing the bearing-surfaces. From these diagrams it may further be seen that by reason of the recess *d* the pressure at the point 6 has already been reduced to the value of the pressure on the suction-side of the pump. From this it follows that the oil-pressure on either side of the bearing is of different amount due to the action of said recess *d*; more particularly, on the side of the bearing opposite said recess there prevails an oil pressure which is larger by an amount represented by the surface of the triangle, 2, 3, 4, in which 1—4 has been made equal to 5—6. By properly dimensioning and positioning the recesses *d*, *e*, *f*, and *g* according to my invention, it will be possible to counteract the re-

spective spindle-pressures *s*₁, *s*₂ etc. by a proper excess of oil-pressures *o*₁, *o*₂ etc. in the bearings, thus fully or partly counteracting said lateral spindle-pressures in the bearings by oil-pressure and to relieve said bearings to such an extent from strains that the spindles will be in an ideal condition of floating.

5 Figs. 4 to 6 show in proper sections the general assembly of a pump with screw-spindles, while Fig. 7 shows the bearing on the pressure-side of the pump in view. The main spindle A and the side-spindle B show on their side towards the pressure-space the slightly conical conformation of their threads at their outer diameters at *a* and *b* and the slightly conical interstice into which during rotation of the pump liquid will be drawn and subjected to high pressures so that any bare metallic contact between parts sliding upon each other will be avoided with certainty. Besides, the recesses *d*, *e*, *f* and *g* are provided in the bearing surfaces of the spindle-bearings D, E, F, and G in such a way that the bearing forces due to the lateral spindle-pressure arising during operation of the pump will be counteracted by oil-pressure.

25 Figs. 8 to 10 show likewise in proper sections a pump having screw-spindles, while Fig. 11 is a view of the bearing cover forming part of this construction. In this construction also the main spindle A and the side-spindle B without special bearing journals are likewise provided at the outer diameter of their threads at *a* and *b* with slightly conical surfaces, the same as in the constructions shown in the former figures.

In contradistinction to the constructions shown in Figs. 1-7, according to Figs. 8, 9, and 10, the side-spindle B is not driven by obliquely toothed pinions but by the lateral surfaces of the threads on the spindles in connection with a novel friction-bearing which in addition serves to secure the side-spindle B in proper axial position. At the end of the shaft of the side-spindle B there are mounted for this purpose two friction collars *q* and *p*, while the shaft of the main spindle A carries a friction collar *r* having conical side-surfaces engaging between the facing conical side-surfaces of either of said collars *q* and *p* on said side-spindle.

50 During operation of the pump the collar *r* on the main spindle A will be rolling along said collars *q* and *p* on the side-spindle B, all of said collars being of even average actuating diameters, the rolling motion being thus partly a sliding or frictional motion. In this manner the collar *r* is being pressed against the collars *q* and *p* in rolling and partly sliding engagement therewith by action of the axial forces and of the but slightly conically tapering lateral surfaces of all of said collars. In accordance with the theory of hydrodynamics, in spite of the relatively small contact-surfaces between said collar *r* and said collars *q* and *p* quite considerable axial pressures may safely be counteracted by oil-pressure without the slightest wear of any of the operating parts even after long and continuous service of the pump.

70 The axial thrust of the main spindle A is being counteracted in known manner by a journal which is provided at one end of said spindle as shown in Figs. 1 and 2, pressure-oil being supplied to said journal through the bore *h* from the pressure-space of the pump, said oil being pressed into several conically tapering transverse grooves provided at the contacting bearing surfaces as shown particularly in Figures 1 and 2. The axial pres-

sure of the side-spindle B is transmitted by way of the aforesaid collars *p*, *q* and *r* to the main spindle A and, in addition, taken up by the bearing ring *x* at the journal of the main-spindle. In the present case the bore of the casing serves as a bearing for the side-spindle B along its conical outer surface and thus secures said side-spindle in proper parallel and radial position with respect to the main-spindle A. The bearings E and G for the main-spindle A are provided according to my invention with recesses *e* and *d*, said recesses serving to receive or to counteract the lateral pressures exerted by the main-spindle A onto the bearing surfaces due to the one-sidedly acting oil pressure.

The examples of construction of the new pump described herein and shown in the drawings are not the only possible constructions, speaking in the sense of my invention. Thus, for instance, the screw-spindles may also be provided on both sides of the thread at its outer periphery with the aforementioned slightly conical surfaces *a*, as shown in Fig. 12, which may, for instance, be of importance for the reversing of the pump and the like, in order to attain proper operation of the latter in either direction of rotation.

I claim:

1. A pump including a casing, a pair of screw-spindles, to wit: a main and a side-spindle having their threads in engagement with each other and mounted in said casing with a slight play between their outer surfaces and the inner surface of said casing, and a slightly conical surface at the periphery of the threads of said spindles, to provide a slightly conical gap for lubricating liquid between said spindles and said casing.

2. A pump as specified by claim 1, in which the slightly conical surfaces are provided at one side only of said threads.

3. A pump as specified by claim 1, in which said slightly conical surfaces are provided on both sides of said threads.

4. A pump as specified by claim 1, including bearing surfaces adapted to be lubricated by pressure liquid from the pressure space of said pump, recesses in said bearing surfaces opening towards the suction side of said pump, said recesses being positioned at the side opposite to the radial spindle-pressures.

5. A pump as specified by claim 1, in which the side-spindle is mounted without end-bearings within the bore of said casing, said bore adapted to serve as the bearing surface for said spindle.

6. A pump as specified by claim 1, in which the side-spindle is mounted without end-bearings within the bore of said casing, said bore adapted to serve as the bearing surface for said spindle, said pump including a friction bearing interposed between both spindles.

7. A pump as specified by claim 1, in which the side-spindle is mounted without end-bearings within the bore of said casing, said bore adapted to serve as the bearing surface for said spindle, said pump including a friction bearing interposed between both spindles, said friction bearing including a friction member on said main spindle, said friction member engaging with a pair of friction members on the side-spindle, all of said friction members having slightly conical friction surfaces.

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