June 28, 1938. F. S. BARKS 2,122,020

PUMPING APPARATUS

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FIG. 1.

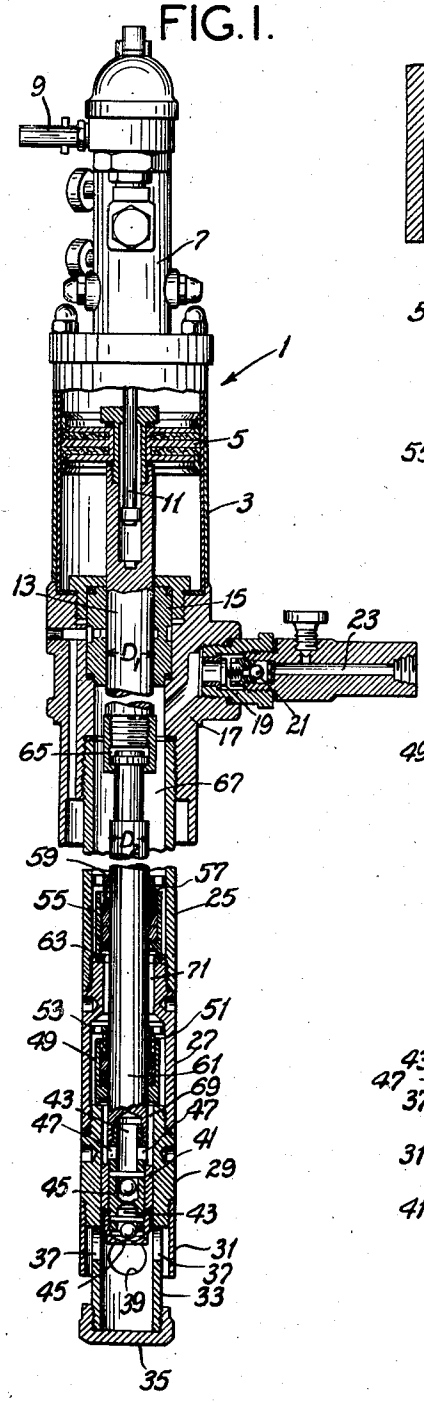



FIG. 2.

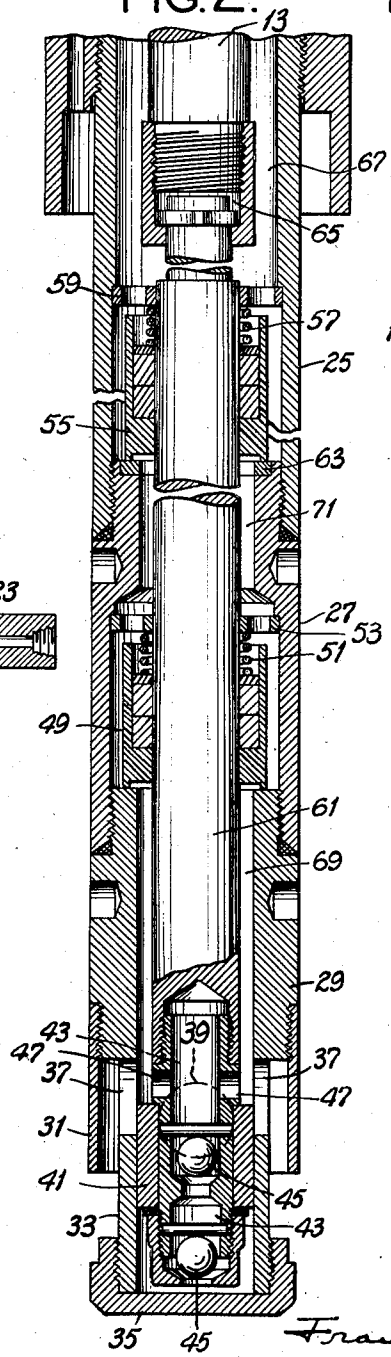
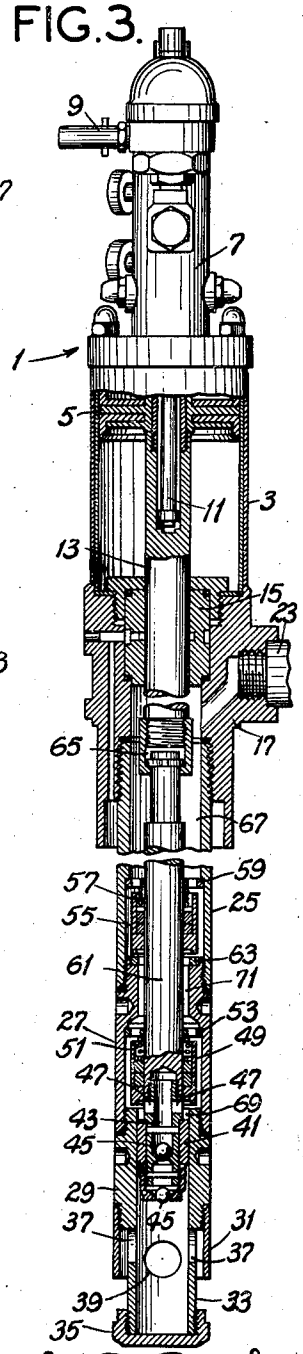



FIG. 3.

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# UNITED STATES PATENT OFFICE

2,122,020

## PUMPING APPARATUS

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4 Claims. (Cl. 103—195)

This invention relates to pumping apparatus, and with regard to certain more specific features, to high-pressure, lubricant pumps.

This invention is an improvement upon the structure set forth and described in United States Patents 1,925,832 and 1,963,783, issued to Alexander P. Fox, on September 5, 1933, and June 19, 1934, respectively.

Among the several objects of the invention may be noted the provision of a lance or well type of pump having a single motor unit with a suction tube applicable to original drum containers and the like for withdrawing fluid such as lubricant, and having the advantages usually obtained by a two-stage compression without the usual complication inherent in effecting the same; the provision of apparatus of the class described which will successfully pump heavy and viscous lubricants at high pressure and at suitable rate without losing prime; the provision of apparatus of the class described which provides a substantially continuous flow of lubricant rather than an intermittent one; the provision of apparatus of the class described which will execute fewer strokes per unit of time and thus be subject to less wear, and which nevertheless has a greater volumetric capacity measured in weight of fluid delivered per unit of time; and the provision of apparatus of this class which will be light in weight and simple in construction. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structure hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which is illustrated one of various possible embodiments of the invention,

Fig. 1 is a vertical section of the apparatus illustrating a down stroke, certain valve parts being shown in elevation;

Fig. 2 is a fragmentary view, similar to Fig. 1 but enlarged, showing the arrangement of parts after the completion of the down stroke; and,

Fig. 3 is a view similar to Fig. 1 showing the arrangements of parts at the completion of an up stroke.

Similar reference characters indicate corresponding parts throughout the several views of the drawing.

The present invention is characterized in general by the showings in said Patents 1,925,832 and 1,963,783, to the extent that these show a lubricant pump consisting of motor unit attached to lance-like cylinder adapted to be inserted through openings in the heads of lubricant drums and the like, the motor being adapted to be air operated to operate a pump in said lance-like cylinder to effect a suction of lubricant from the container for delivery to suitable receiving receptacles.

As is disclosed in said Patent 1,963,783, viscous lubricant may be effectively pumped by a two-stage compression arrangement, the two motorizing means for the two-stage compression being carried on the pump cylinder. While the method shown in said Patent 1,963,783 has been successful, it has required the use of two complete air motor cylinders in connection with the lubricant pump cylinder. The present invention entirely eliminates one of these cylinders, uses only one pressure stage and produces a lighter, neater and more economical and reliable device which incorporates all of the functional advantages of the apparatus shown in said Patent 1,963,783.

Referring now more particularly to Fig. 1, there is shown at numeral 1 an air motor or engine of the same general type as that shown in Fig. 4 of said Patent 1,925,832, the same having a cylinder 3 with a working piston 5 therein and suitable valve gear 7. An inlet connection 9 for compressed air is used to serve air to the air motor through the valve gear 7. The piston 5 receives air pressure alternately on opposite sides thereof and at suitable intervals by means of said valve gear 7. The valve gear is operated by means of a valve stem 11 having lost motion connection with the parts associated with the piston 5. Further description of the air engine and its associated valve gear will not be given, inasmuch as the construction is known from said Patent 1,925,832. Patent 1,963,783 further shows duplicate engines of the same character for effecting two-stage compression.

The purpose of the air engine 1 is to reciprocate a piston rod 13 which is attached to the piston 5, said rod 13 passing through a packing gland 15 in a main body 17. The body 17 carries a pair of outlet check valves 19 and 21 opening outwardly to permit the outward passage of lubricant under pressure but to prevent the return of the same. The check valves 19 and 21 lead to a suitable outlet 23 to which a hose or the like may be fastened to deliver compressed lubricant to desired points.

Other features of the body 17, including the manner of cooperation with the opening in the lubricant drum or the like will not be described,

inasmuch as they have been made clear in said patent.

Threaded to the bottom of the body 17, and adapted to extend into the lubricant drum (not shown) is a pump cylinder 25 providing a main chamber 67. The cylinder 25 includes a lower continuation 27 and threaded below the continuation 27 is a second pump cylinder 29 which carries a protective sleeve 31 for guarding against the entry of bodies such as bolts, nuts or the like which may have fallen into the lubricant.

Another downward extension from the priming cylinder 29 is a priming cup 33 having an enclosing cap 35 and inlet openings 37 and 39. The openings 39 are positioned slightly lower than the openings 37.

Within the cylinder 29 is a piston 41 having a lap fit with the interior of the cylinder 29. The piston 41 has an opening 43 therethrough in which are upwardly opening check valves 45. The opening 43 communicates with the interior of the cylinder 29 above the piston 41 by lateral outlets 47.

Seating on the upper end of the pumping cylinder 29 is a check valve 49 which is pressed to a seat by means of a spring 51 reacting from a fixed spider 53 having suitable openings permitting upward passage of lubricant.

Seating on the upper end of the hollow extension 27 is a similar valve 55 which is forced to a seat by means of a spring 57 reacting from a spider 59 which also has suitable openings for the upward passage of lubricant. Each of the valves 49 and 55 is packed around a plunger 61 which serves to transmit motion from the piston rod 13 to the piston 41.

The seat 63 for the upper valve 55 is of the insert variety; whereas the seat for the lower valve 49 is integral.

The piston rod 13 and the plunger 61 are connected by a flexible joint connection 65, the purpose of which is to obviate the requirement of exact concentricity between the said piston rod and said plunger 61 with its piston 41. However, they are substantially coaxial or concentric.

In operation the body 17 is applied to the opening of a lubricant drum, whereupon the cylinder 25 and its extensions 27, 29 and 33 become immersed in the lubricant. The cap 35 is at or adjacent the bottom of the drum and the inlets 37 and 39 are near the bottom of the contained lubricant. A pressure air line is attached to the fitting 9, and upon opening a suitable air valve, the air engine 1 is actuated to reciprocate the piston 5, provided a valve, used in connection with the line from the outlet 23, is open.

The above results in reciprocation of the piston rod 13 and of the plunger rod 61, as well as of the piston 41 in cylinder 29. Let it be assumed in Figure 1 that the piston 5 is travelling downwardly and that the device is primed. Under these conditions the valves 55 and 49 are forced to their respective seats by the effect of the downward movement of plunger 61 within the respective valve packings, by means of valve springs 57 and 51 respectively and by means of engendered pressure above them. The reason for the pressure will be explained hereinafter.

At this time a charge of lubricant may be presumed to have been pushed upon a previous stroke into the interior 67 of cylinder 25. The diameters $D_1$ and $D_2$ of the piston rod 13 and plunger 61 respectively, are so related that the volumetric displacement of the rod 13 as it enters said chamber 67 is greater than that of the volumetric displacement of rod 61 as it leaves said chamber 67. Because the larger volumetric displacement of the piston rod 13 is being substituted for the smaller volumetric displacement of the receding plunger 61, the volume of chamber 67 is reduced, and an amount of lubricant is displaced from the space 67 which is equal to the difference in said volumetric displacements. The displaced lubricant is forced out through the said valves 19 and 21 to and through the outlet 23.

At the same time that the above described discharge of lubricant is taking place upon the down stroke, the downward movement of the plunger 61 forces down the piston 41 in cylinder 29. At this time it may be presumed that the priming cup 33 has been filled with lubricant by the suction of the last upward stroke of the piston 41, and by the effect of the hydraulic head of the lubricant in the drum, the lubricant having flowed in, through the openings 37 and 39. The priming period for the cup 33 is, advantageously, unusually long, because the mere suction effect of the piston 41 is not depended upon for complete priming. Priming continues after the piston 41 has reached the top of its stroke, and as it partially descends. Thus very viscous lubricant may be pumped at high rates, inasmuch as full prime is assured on each stroke.

As the piston 41 descends, a vacuum is created in the space 69 above the piston, thereby drawing in lubricant from the drum, through the ports 37, 39, through valves 45 and spaces 43 and 47. This action continues as long as the inlet ports 37 and 39 are not completely covered by the piston 41.

At a later stage of the descent, the lower edge of the piston 41 reaches the lower edge of the lowermost port 39, thereby trapping a charge of lubricant in the priming cylinder or cup 33. As the piston further descends (Fig. 2) this trapped lubricant is forcibly squeezed through the open check valves 45. At first substantially all of this lubricant is forced upwardly through the passages 43, 47 and into the space 69 to insure complete filling of the latter. This is because the length of the piston 41 is about equal to the distance from the bottoms of the lower inlets 39 to the tops of the upper inlets 37. Hence, as the compressive action starts, all ports are substantially closed. As it continues, the upper ports 37 are slightly opened by the descending upper edge of the piston 41. Nevertheless, the opening action of the ports is not great enough to prevent lubricant from continuing to be forced toward the space 69. The excess lubricant runs out through the upper ports 37 as they open.

It should be understood that the length of the piston 41 need not be such that the ports 37 and 39 are completely covered, although this is true in the present embodiments, but only substantially long enough that the piston substantially obstructs the ports for at least a short period. The action is not one of a primary maintained stage of compression in the cylinder 69, but a positive priming means for said cylinder 69.

Thus the function of the cup 33 is to positively prime the cylinder 69 under pressure of piston 41 as its lower edge crosses the lower edges of port 39. The function of the upper edge of the piston 41 crossing the upper edges of the ports 37 is to provide a by-pass overflow to the supply to prevent a hydraulic hammer in the space 69. By this means can be eliminated any requirement for a fine calculation as to the volume of fluid to be transmitted from cylinder 33 to the space

69. The process is one of forcing fluid from the cylinder 33 up to the space 69 with back flow through the inlet ports 37.

If the length of the piston 41 be slightly shorter than the distance between the top of the hole 37 and the bottom of the hole 39, then during all of the positions of the piston in the priming pump, wherein fluid is compressed through the valve 45, there is a back flow through the inlets 37. This would merely reduce the initial pressure with which the lubricant is forced through the valves 45 to the cylinder 69, but nevertheless would insure that the lubricant be placed under priming pressure in the cylinder 69 with overflow thereof to the portion 37.

Thus, considering the entire pump, or the down stroke a charge of lubricant is forced from the space 67 out through the outlet 23, and at the same time a trapped charge of lubricant is urged into the space 69 above the piston 41.

The next action is for the piston rod 13 to move upwardly from the position shown in Fig. 2 to the position shown in Fig. 3. This also causes upward movement of the plunger 61 and piston 41. As the piston 41 moves upwardly, the valves 45 close and urging of lubricant starts in the space 69. At the beginning, this urging effects continued overflow action through the port 37, but finally, when the upper edge of the piston 41 reaches the upper edges of the ports 37, the piston 41 urges the lubricant in the space 69 to open the valves 49 and 55, thus transferring lubricant from the space 69 up to the space 67. The term "urging" is here used for reasons which will appear.

The space 71 under the valve 55 and above the seat of the valve 49 is in the nature of a transmission line, the member 27 forming an adapter, by means of which the length of the device may be adapted to drum depth. This space 71 could be entirely eliminated; also the extra check valve 49, without changing the mode of operation. One of the check valves 45 or 19 or 21 may also be eliminated, so far as the basic theory of the device is concerned.

It will further be seen that as the piston 41 rises, the piston rod 13 also rises and is withdrawn from the chamber 67. At the same time the plunger 61 moves into the chamber 67. Inasmuch as the diameters $D_1$ and $D_2$ of the piston rod 13 and of the plunger 61 respectively are arranged to give a difference in volumetric displacement, there will be provided in the space 67 an extra available volume for lubricant which must be supplied by the incoming lubricant. Hence, in order that lubricant may be moved to the passage 23 upon the up stroke, the volumetric displacement of the piston 41 in chamber 69 is made twice that of said difference in volumetric displacements between the piston rod 13 and plunger 61. Thus, not only is the added space in chamber 67 filled by suction (the increasing suction space being provided by the difference in volumetric displacement between piston rod 13 and plunger 61), but, an equal amount of lubricant is pumped into the outlet 23 upon the up stroke. Thus the differential suction effect of rod 13 and plunger 61 aids the piston 41 in "urging" some (one half) of the fluid from cylinder 69 to chamber 67. If it were not for the compressive action of the piston 41 on that excess of fluid that goes to the outlet 23 by reason of the greater volumetric displacement of the piston 41 in cylinder 69, the differential effect would alone draw a charge of fluid from cylinder 69 to chamber 67. The advantage of this will appear.

From the above it will be seen that the difference in volumetric displacement between the piston rod 13 and plunger 61 provides the means by which lubricant is forced from the passage 67 upon a down stroke; and the fact that the volumetric displacement in cylinder 69 is greater than that of said difference (twice) accounts for the pumping of lubricant upon the up stroke. Thus the device is double acting (but not a two-stage) and a substantially continuous flow of lubricant is attained from the outlet. It should be understood that the dimensional relationships set forth above are optional, and that it is possible, within the scope of the invention, to so relate them that the amount of lubricant pumped on the up and down stroke is different, although substantially continual. For instance, if the volumetric displacement of the piston 41 in cylinder 69 were merely greater than the difference in volumetric displacements between piston rod 13 and plunger 61, and not necessarily double, this would result in a different flow upon the up stroke than upon the down stroke but a flow nevertheless. It is believed that the arrangement herein disclosed, however, is preferable, because a substantially continuous and a substantially constant flow is most desirable. The criterion for this condition is that the volumetric displacement of piston 41 in cylinder 69 shall be twice the difference in volumetric displacements between the rod 13 and plunger 61 in chamber 67.

Another way of stating the operation based upon said dimensional relationship is that the volumetric displacement of the piston 41 in the cylinder 69 causes a displacement of a given amount of lubricant into the chamber 67. At the same time one-half of this displacement is absorbed by the increase in volume of said chamber 67 by reason of the recession therefrom of the difference in volumes of the piston rod 13 and the plunger 61, and the other half of this displacement passes to the outlet 23. On the downstroke there is forced from the outlet 23 a volume of lubricant corresponding to the difference in volumetric displacements between the piston rod 13 and the plunger 61.

An important advantage of the invention is in the action of the priming cup 33. This cup is evacuated upon the up stroke of the piston 41. During the relatively long interval that this stroke is completed and part of the down stroke is accomplished, the cup has time to become filled by the relatively slow flowing viscous lubricant. The volume of the cup is relatively large, compared to the volumetric displacement of piston 41 in chamber 69. Hence an ample charge is obtained therein, even with slow rates of flow of viscous lubricant. This means that there is always available an ample charge.

Furthermore, upon movement of the piston 41 into the said ample charge in the priming cup 33, there is assured by the throttled overflow action the existence of a pressure at least equal to that of atmospheric pressure upon the priming lubricant to force it into the cylinder 69. At the same time no hydraulic hammer is encountered because of said throttled overflow action of the compressed fluid through the gradually opening ports 37. Furthermore, as said ports open wider, the resistance to reciprocation of the pump is reduced, this being after the requirement for priming pressure has passed.

Another advantage of the invention is that if

the piston 41 becomes scored or otherwise worn so as to leak excessively under pressure, nevertheless pumping will be accomplished. This is because the difference in volumetric displacement between the piston rod 13 and the plunger 61 in the chamber 67 results (under these conditions) in a tendency to partial evacuation therein which draws lubricant through the valves 55 and 49 from the cylinder 69 without the aid of piston 41. Under these conditions the valves 55 and 49 are also aided in the lifting thereof by the upward movement of the plunger 61 as suction is effected into the chamber 67. Then upon the down stroke, this charge is forced to the outlet 23.

Under said leaking conditions, as under non-leaking conditions, there are two units of lubricant in the chamber 69. One unit leaks back past the leaky piston 41 as said piston rises, while the other goes into the space 67 by suction. Under these leaky conditions the device is a single stroke apparatus which pumps lubricant intermittently on every down stroke, there being no delivery upon the up stroke.

However, when the piston is not scored or leaky, assuming two units of lubricant in the cylinder 69, upon the up stroke of the piston 41, one unit goes into and is retained in the chamber 67, while the other units go through said chamber 67 to the outlet 23. On the down stroke the other unit which was retained in the space 67 is pushed to the outlet 23.

A further advantage is that if one of the valves 55 or 49 fouls, the other will be operative to complete an effective pumping. If both of the valves 55 and 49 leak, the effect is of the nature of the effect obtained by having a leaking piston 41, except that, in this case, the up stroke of the piston 41 is the effective one to force out lubricant; whereas the down stroke is the one which tends to fail to a degree depending upon the amount of leakage downwardly through said valves 55 and 49.

It should be understood that the principles of the invention may be carried out by apparatus in which there is not necessarily a direct alignment between the members 13, 61, and 41. This direct alignment is merely incidental to a structure of optimum form and convenience in manufacture.

Another advantage of the invention is that fewer strokes per unit of time are necessary at a given air pressure compared with machines made with equal sized air cylinders and otherwise comparable.

For example:

Operating at 150 pounds of air pressure, the improved apparatus herein described makes 44 strokes per minute at a maximum pressure of 4,900 pounds per square inch on the lubricant. It executes 4.09 strokes per ounce of lubricant delivered; giving 10.75 ounces of lubricant delivered per minute.

Comparable apparatus made according to the old principle, also operating at 150 pounds per square inch air pressure made 62 strokes per minute to produce the same maximum pressure of 4,900 pounds per square inch on the lubricant. The strokes per ounce of lubricant delivered were 8.26; giving 7.5 ounces of lubricant delivered per minute.

Thus, the new apparatus saves in strokes per minute, which reduces wear on the apparatus and requires less operating air. At the same time the capacity of the machine increases, as measured in ounces of lubricant pumped per unit of time.

From the above, it will be seen that this device is essentially of the single compression stage variety. No intermediate pressure is maintained at any stage between the atmospheric pressure of the lubricant in the drum and the final pressure at the outlet 23. The resisting pressure in outlet 23 is communicated both to the cylinder 69 when the piston 41 is pumping on the up stroke, and to the chamber 67 when the differential members 13 and 61 are pumping on the down stroke. Both chambers 69 and 67 communicate with the outlet upon compresion. In two-stage apparatus this is not true.

As to the possible super-atmospheric pressure engendered by compressing from cup 33 to cylinder 69, this is only temporary for priming, and upon the up stroke of piston 41 compression starts from atmospheric in cylinder 69. With some designs the super-atmospheric pressure of prime is not even necessary, the function of the priming cup then being merely the prevention of a drop in pressure due to suction in cylinder 69 as the piston 41 descends. This accomplishes the same purpose of adequate prime with many lubricants. Variation in the design in this respect is accomplished by variation in lengths of the piston 41, as compared to the distance between the tops of ports 37 and the bottoms of ports 39.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a pump, a cylinder, a hollow piston therein, a priming cup having an opening adapted to receive fluid for delivery to the cup, said piston having valve means, the piston crossing said opening upon movement toward the cup, the piston being adapted to enter said cup and having a length such as to instantaneously close said opening upon continued movement to force fluid through the piston to said cylinder and upon further continued movement to place said cylinder into communication with said opening whereby lubricant under pressure is delivered both to the cylinder for charging and to said opening for overflow, a chamber having a communication with the cylinder, valve means in the communication, and a reciprocating differential means having portions of different volumetric displacements passing through said chamber and organized to reciprocate with said piston, said chamber having an outlet, a valve in said outlet, said piston pumping through said valves in the communication to said chamber and having a displacement adapted to force lubricant through said outlet and to supply lubricant to the chamber, said differential means effecting increase of volume of the chamber while said piston forces lubricant thereto, the decreased volume of said chamber effected by said differential means upon a reverse stroke effecting a compression of lubricant through said outlet.

2. In a pump, a cylinder, a hollow piston therein, a priming cup having openings adapted to receive fluid to flow to the cup, said piston having

plural check valves opening from the cup toward the cylinder, the piston crossing said openings upon movement thereof, the length of the piston being adapted to fit said cup and upon movement thereto to instantaneously close said openings to force fluid through the piston to said cylinder and upon continued movement to place said cylinder into communication with said openings, whereby lubricant under pressure is delivered both to the cylinder for charging and to said opening for overflow, a chamber having a communication with the cylinder, plural valve means in the communication, and a reciprocating member having portions of different volumetric displacements passing through said chamber and organized to reciprocate with said piston, said chamber having an outlet, valves in said outlet, said piston pumping through said valves in the communication to said chamber and having a displacement adapted to force lubricant through said outlet and to supply lubricant to the chamber upon the differential means effecting increase of volume of the chamber, the decreased volume of said chamber effected by said differential means upon reverse stroke effecting compression of lubricant through said outlet.

3. A pump comprising a body having a chamber with an outlet, a check valve in the outlet, a reciprocating engine upon said body, a reciprocating piston rod extending from said engine into said chamber, a plunger attached to said piston rod within the chamber and extending therefrom, said plunger and piston rod having different volumetric displacements in the chamber, whereby upon movement in one direction the volume of the chamber is decreased and upon movement in the reverse direction said volume is increased, said chamber having an inlet, a check valve at said inlet opening inwardly to the chamber, a cylinder attached to said body, a piston in said cylinder attached to said plunger, said piston having a hollow portion communicating with said cylinder, a check valve in said hollow portion opening toward the cylinder, a priming cup associated with said cylinder and adapted to receive said piston, fluid-receiving openings associated with the priming cup and adapted to be traversed by said piston to trap fluid in the cup, said piston exposing portions of the opening as it passes, whereby fluid is forced in part to the cylinder and in part back through said opening, the volume-reducing effect of the differences in displacement of said piston rod and plunger at this time forcing fluid from the chamber, and upon reversal of movement said piston moving fluid from said cylinder to the chamber, the volumetric displacement of said piston in the second cylinder being enough to supply the increase in volume of the chamber caused by said differences in volumetric displacement of said piston rod and plunger, and normally to force fluid to said outlet associated with the chamber.

4. In a pump, a cylinder, a hollow piston therein, a priming cup having an opening adapted to receive fluid for delivery to the cup, said piston having valve means opening from the cup, the front edge of the piston crossing said opening upon movement toward the cup, the piston being adapted to enter said cup and having a length such as instantaneously substantially to throttle said opening upon movement in order to substantially force fluid through the piston to said cylinder and upon further movement to place said cylinder in substantial communication with said opening whereby lubricant under pressure is delivered both to the cylinder for charging and to said opening for overflow, a chamber having a communication with the cylinder, valve means in the communication, and a reciprocating differential means having portions of different volumetric displacements passing through said chamber and organized to reciprocate with said piston, said chamber having an outlet, a valve in said outlet, said piston having a displacement adapted to force lubricant through said outlet and to supply lubricant to said chamber, said differential means effecting increase of volume in said chamber while said piston forces lubricant therethrough, the decreased volume of said chamber effected by said differential means upon a reverse stroke effecting a compression of lubricant through said outlet.

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