Dec. 17, 1946. J. L. SMITH 2,412,839

CENTRIFUGAL PUMP PRIMER

Filed March 28, 1944 3 Sheets-Sheet 1

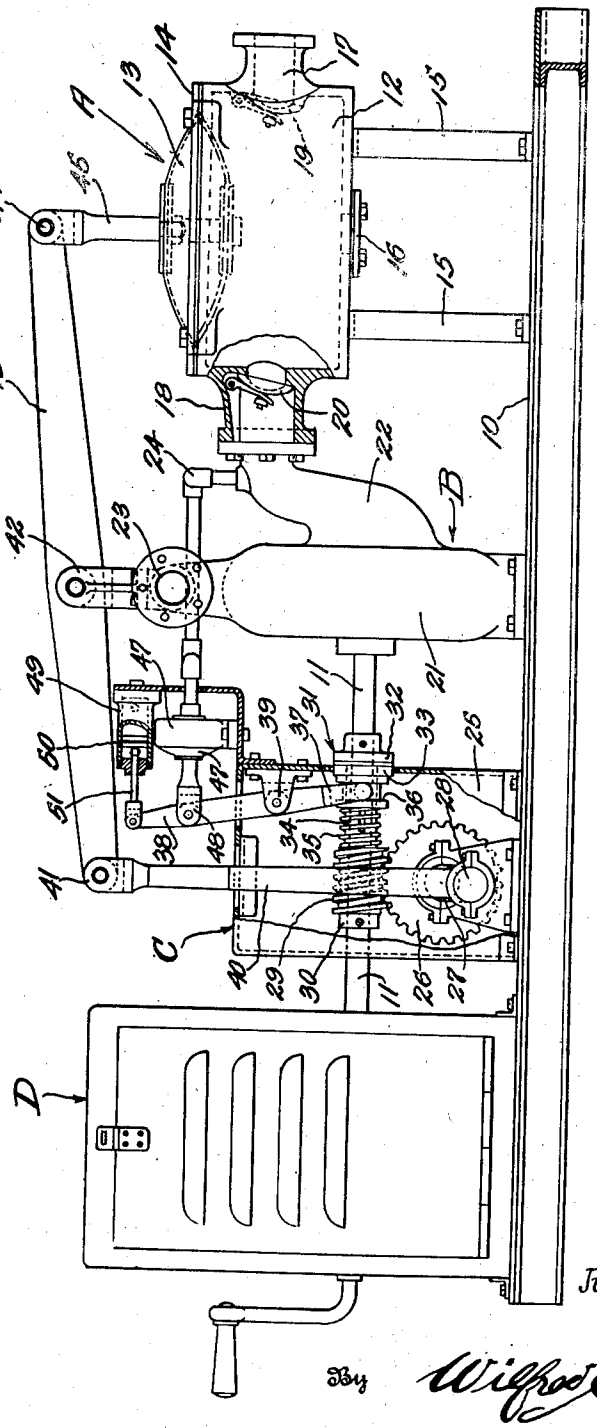


Fig. 1.

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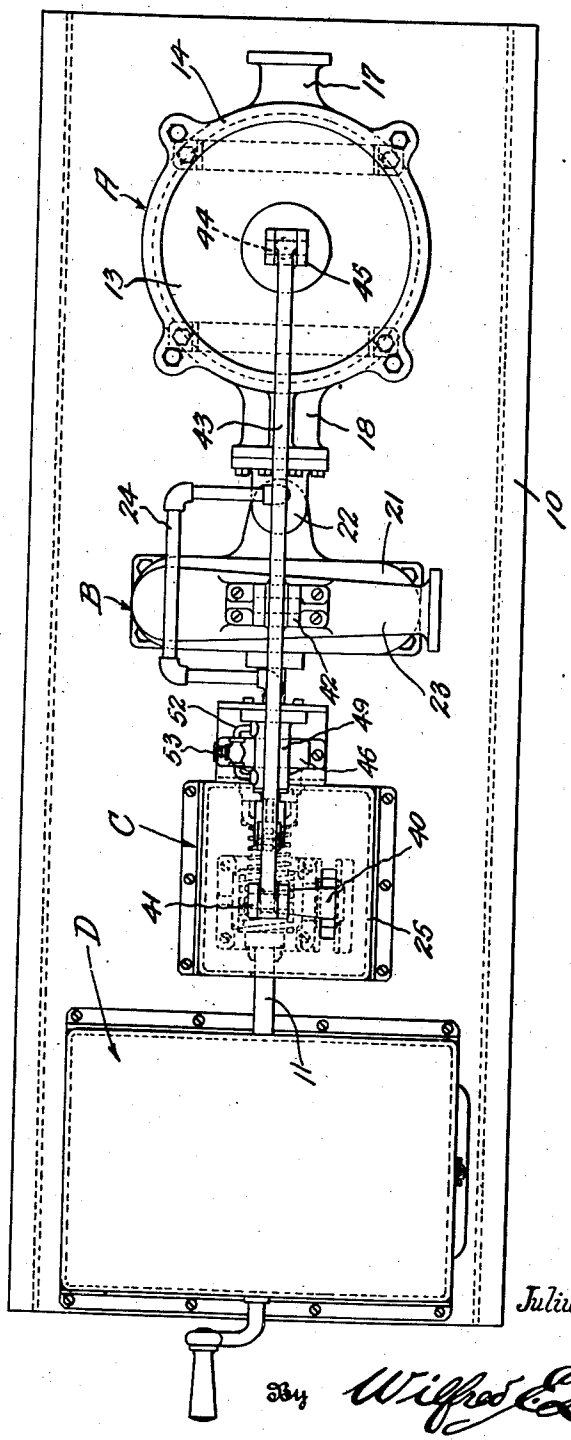
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Fig. 2.



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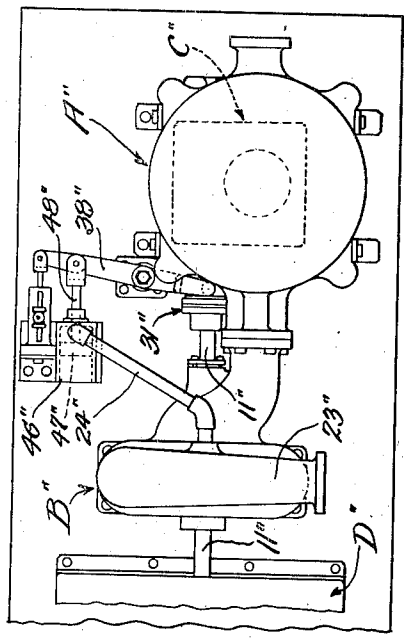


Fig. 5.

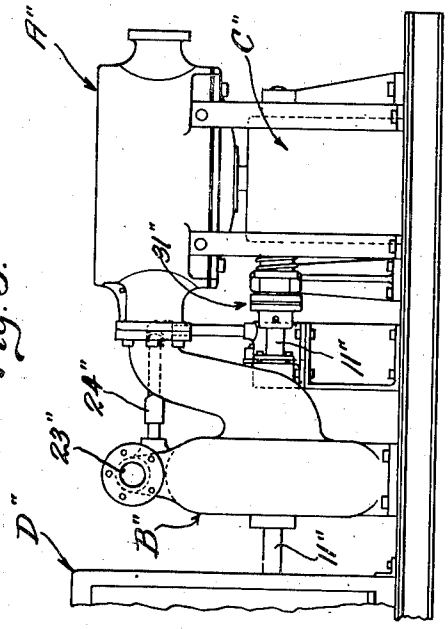


Fig. 6.

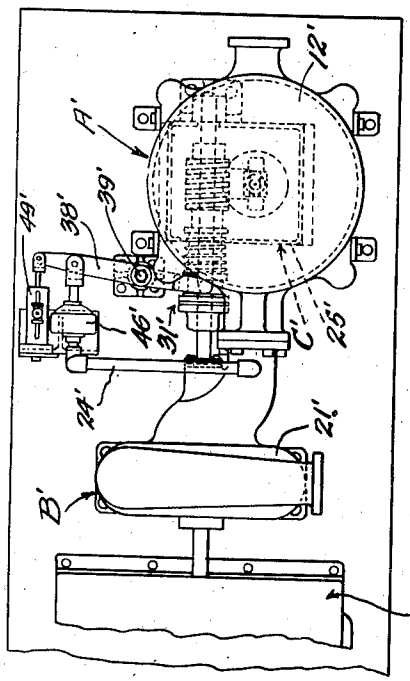


Fig. 3.

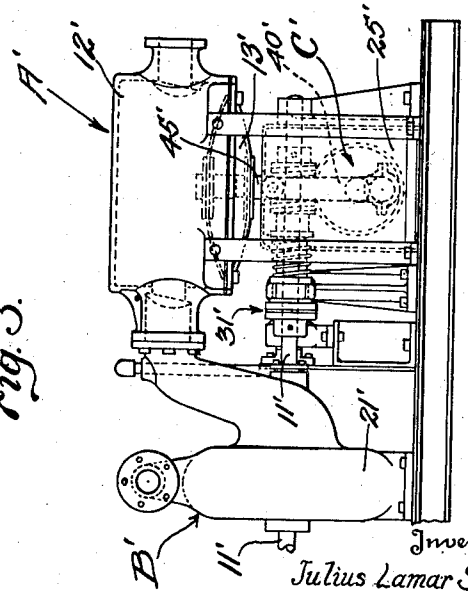


Fig. 4.

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UNITED STATES PATENT OFFICE

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CENTRIFUGAL PUMP PRIMER

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Application March 28, 1944, Serial No. 528,437

8 Claims. (Cl. 103—113)

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This invention relates generally to the class of pumps and pumping mechanisms and is directed particularly to an improved combination centrifugal and diaphragm pumping mechanism.

A primary object of the present invention is to provide a liquid pumping apparatus consisting of a combination of a rotary pump and a diaphragm pump connected together so that the diaphragm pump will function to prime the rotary pump so that the latter may operate to carry the load of the pumping operation and the diaphragm pump will take over the operation of pumping the liquid when the rotary or centrifugal pump looses its "prime" by reason of the exhaustion of the liquid supply to an extent where the rotary or centrifugal pump sucks air.

Another object of the invention is to provide a pumping apparatus in which a centrifugal pump and a diaphragm pump are coupled together so that the diaphragm pump functions initially to prime the centrifugal pump and wherein a novel means is provided for effecting the automatic discontinuance of the operation of the diaphragm pump after the centrifugal pump has been primed and is functioning to keep the liquid moving.

Still another object of the invention is to provide a pumping apparatus in which a centrifugal pump and a diaphragm pump are coupled together, with means operated by the centrifugal pump after the latter has been primed by the diaphragm pump and is pumping liquid, for stopping the operation of the diaphragm pump and keeping the latter inoperative so long as the rotary pump is pumping to its capacity.

Still another object of the invention is to provide in a pumping apparatus of the character stated, a novel clutch actuating mechanism controlled by the centrifugal pump during such time as it is operating to full capacity, for stopping and maintaining inoperative the diaphragm pump and for effecting the starting up of the diaphragm pump so that it will take over the pumping operation, in the event that the centrifugal pump loses its "prime."

Still another object of the invention is to provide a pumping apparatus including a centrifugal pump and a diaphragm pump connected together so that the diaphragm pump has its output connected with the inlet side of the centrifugal pump, with means for driving the centrifugal pump and means controlled by the centrifugal pump while it is pumping to capacity, for keeping the diaphragm pump inoperative, such means functioning to establish a driving connection between the diaphragm pump and the centrifugal pump

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driving means when the centrifugal pump, for any reason, loses its "prime" whereby the diaphragm pump then takes over the pumping operation.

A still further object of the invention is to provide in a pumping apparatus of the above described character, a novel clutch control apparatus by which the starting and stopping of the diaphragm pump is dependent upon the pumping action of the centrifugal pump and such control apparatus is operated for stopping the operation of the diaphragm pump, either by the reduction of pressure at the intake of the centrifugal pump or by liquid pressure taken from the outlet of the centrifugal pump.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming a part of the present application, it being understood, however, that the invention is not confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

Figure 1 is a view partly in side elevation and partly in vertical section of an apparatus constructed in accordance with the present invention.

Figure 2 is a view in top plan of the apparatus.

Figure 3 is a view in top plan and upon a reduced scale of another embodiment of the invention.

Figure 4 is a view in side elevation of the embodiment shown in Figure 3.

Figure 5 is a view in top plan of still another embodiment of the invention.

Figure 6 is a view in side elevation of the embodiment shown in Figure 5.

Referring now more particularly to the drawings it will be noted upon reference to Figure 1 or to Figure 2 that in the preferred embodiment of the invention the apparatus consists of four major units which are designated as follows:

A, the diaphragm pump unit;

B, the centrifugal pump unit;

C, the diaphragm pump drive and clutching and declutching unit; and

D, the power unit which may be of any suitable character and which, therefore, is not illustrated in detail but is merely represented by a housing in which may be enclosed an engine, such as a gasoline engine, an electric motor or any other suitable driving apparatus.

The numeral 10 designates a base upon which the several units may be mounted but in this connection it is to be noted that the invention is not confined to this specific arrangement or set up as it will be readily apparent that the several units may be placed upon individual supports and also that the power unit D might, under some circumstances, be remote from the other unit and connected therewith by some other means than the power shaft here shown and designated 11.

In the modified embodiments of the invention as illustrated in Figures 3 to 6 inclusive the same units are found but the units A, B and C are hooked up in a slightly different manner and the same reference letters for these units will be used primed in the specific description of the embodiments of the last mentioned figures.

In accordance with the present invention the diaphragm pump unit comprises a cylindrical chamber or receptacle 12 across the open top of which is secured the diaphragm 13 by the usual method of clamping the edge of the diaphragm to the top edge of the housing 12 by a clamp ring 14.

The diaphragm pump is supported by the legs 15 and the bottom of the chamber is provided with a clean-out opening which is closed by the removable plate 16.

At diametrically opposite locations the diaphragm pump chamber is provided with the intake and discharge nipples 17 and 18 respectively, the intake nipple being closed at its inner end by the inwardly opening flap valve 19 while the outlet nipple is closed by the outwardly opening flap valve 20.

The inlet nipple 17 of the diaphragm pump is in the form a flanged coupling with which is connected a suitable suction hose, not shown, which leads from the fluid source.

The swinging flap or check valves 19 and 20 permit the liquid such as water or the like to be taken in only through the nipple or coupling 17 and discharged only through the coupling 18 so that upon continuous up and down movement of the diaphragm a reduced pressure will be established within the chamber 12 which will result in the drawing in of liquid at one side and its discharge at the opposite side, thereby maintaining a steady flow as long as the diaphragm is actuated.

The centrifugal pump unit B comprises the pump casing 21 of usual construction, having the inlet neck or casting 22 and the outlet 23. The inlet casting 22 is secured to the discharge nipple 18 of the diaphragm pump unit and the power shaft 11 extends into the centrifugal pump casing to support and rotate therein the usual impellar blades, not shown.

In the form of the invention as illustrated in Figures 1 and 2, there is connected with the top of the intake casting 22 for the centrifugal pump, adjacent its point of connection with the diaphragm pump, a vacuum pipe line 24 by means of which the hereinafter described clutch actuating mechanism, which forms a part of the unit C, is controlled.

The unit C comprises a gear housing 25, in which is located a reduction gearing consisting of a worm gear 26 supported by a shaft 27 with which is connected a crank 28, and a worm or screw 29 which is mounted upon the power shaft 11 and is maintained in position thereon, against movement in one direction, by the collar 30.

The shaft 11 turns freely within the worm 29 and driving connection is established between the shaft and worm, to effect the rotation of the crank 28, through the medium of the clutch 31 which is here shown as comprising a disk 32 which is secured to the shaft 11 and a shiftable disk 33 which slides on a sleeve-like extension 34 of the worm 29 and has a sliding pin in connection therewith, not shown, whereby it will continually turn with the worm and may at the same time be moved axially of the shaft for engagement with and disengagement from the fixed disk 32.

A spring 35 normally urges the movable disk 33 into diving connection with the disk 32.

Carried by the clutch disk or plate 33 is the circumferentially grooved or channeled collar 36 with which is loosely coupled the fork 37 which is carried at the lower end of a clutch shift lever 38, pivoted intermediate its ends upon the supporting bracket 39. This shift lever 38 extends upwardly through the top of the gear housing 25 for connection with actuating and control units, as hereinafter described.

Also extending through the top of the gear housing 25 is a crank rod 40, the lower end of which is connected with the driving crank 28.

The upper end of the crank rod 40 is laterally offset so as to bring the bearing ears 41 at the upper end thereof, into the vertical plane of the centers of the centrifugal and diaphragm pumps and of the axis of the shaft 11.

Upon the top of the centrifugal pump casing 21 and in the vertical center thereof is mounted an upstanding bearing bracket 42 upon which is supported for oscillation, the walking beam 43. One end of this beam is pivotally coupled with the pivot ears 41 of the crank rod while the opposite end is pivotally coupled as indicated at 44, with the upper end of the diaphragm arm 45 which is connected with the diaphragm 13 in the usual manner.

The pivotal connections between the walking beam 43, the supporting bracket 42, crank rod 40 and diaphragm arm 45, preferably comprise pins and bushings which allow for the necessary free motion of the parts.

Supported adjacent the upper end of the clutch lever 38 is a vacuum cylinder 46 with which the vacuum pipe line 24 is connected as shown. This cylinder may have a movable piston therein or may be closed at one side by a diaphragm, the latter construction being shown and the diaphragm being designated 47. This movable element has connected therewith the actuating rod 48, which rod is pivotally coupled with the clutch operating lever. Consequently it will be readily apparent that upon the reduction of vacuum in the cylinder 46 the movable element 47, here shown as a diaphragm although it may be a piston, will be shifted over to effect the oscillation of the clutch lever, which movement will disengage the clutch by shifting the movable disk or plate 36 away from the fixed plate 32 thereby disestablishing driving connection between the shaft 11 and the worm 29.

Adjacent to the vacuum cylinder 46 there is mounted a dash pot cylinder 49 in which is slidably mounted the piston 50 which is connected by the rod 51 with the upper end of the clutch lever as shown. This dash pot cylinder is filled with suitable oil and the two ends of the cylinder are connected, upon opposite ends of the piston, by the by-pass pipe 52 in which is fitted the valve or cock 53. Thus it will be seen by adjusting this valve or cock the flow of oil from one side of the piston 50 to the other may be regulated so that

the rapidity of movement imparted to the clutch lever by the vacuum cylinder can be controlled.

In the operation of the apparatus as illustrated in Figures 1 and 2, when the power unit is put in operation the power shaft which drives the centrifugal pump will at once start rotating so that the centrifugal pump is immediately set in operation.

Since the clutch 31 is engaged at this time it will be seen that driving power will be transmitted from the shaft 11 through the clutch and through the worm and gear drive to the crank lever 40 thereby rocking the walking beam 43 and operating the diaphragm 13. This operation of the diaphragm pump will create a suction, reducing the pressure within the chamber 12 and causing the liquid to be drawn into and forced through the chamber into the casing or housing of the centrifugal pump by way of the inlet or intake casting 22.

The foregoing operation primes the centrifugal pump and since the rotor of the pump is already being driven by the shaft 11, the centrifugal pump will at once begin to pump the water or other liquid being supplied to it by the diaphragm pump.

As soon as the full pumping operation of the centrifugal pump becomes established there will be a reduction in pressure in the inlet casting 22 which will create a reduction in pressure in the vacuum cylinder 46 with the result that the piston or diaghragm of the vacuum cylinder will be shifted causing the clutch lever to be oscillated to effect the disengagement of the clutch 31. In this manner the driving connection between the power shaft 11 and the diaphragm pump is broken so that the diaphragm pump ceases operation.

By the provision of the dash pot, connected with the upper end of the clutch lever 38, it will be seen that there will be prevented the application of undue strains on the mechanism which might be caused by the sudden movements of the piston or diaphragm of the vacuum cylinder. The speed with which the clutch is engaged or disengaged is readily controlled by means of the cock 53 which forms a part of the dash pot.

After the centrifugal pump has been primed and is in full operation, it will continue to move the liquid through the chamber of the non-operating diaphragm pump and this action will continue until the source of liquid supply is exhausted to such an extent that the pump begins to suck air. At this time the centrifugal pump will lose its "prime" and as a result the reduced pressure which has previously existed in the casting 22 will rise to atmospheric pressure causing the movable element 47 of the vacuum cylinder to move out or to return to its original position thereby reengaging the clutch 31. This again starts the diaphragm pump operating to re-prime the centrifugal pump, or if the available supply of water or the liquid to be pumped is flowing in at a low rate, the diaphragm pump will continue to operate and remove the liquid as it comes in, forcing it out through the centrifugal pump.

In the embodiment of the invention as illustrated in Figures 3 and 4, the diaphragm pump unit is designated A', the centrifugal pump is designated B' and the driving and clutching and de-clutching unit is designated C'.

In this first modification it will be seen that the diaphragm pump is, in effect, inverted so that the diaphragm 13' faces downwardly.

The gear reduction housing 25' is disposed directly beneath the diaphragm pump and the power shaft 11' passes through the centrifugal pump housing 21' to and through the reduction gear housing which is here located upon the opposite side of the centrifugal pump from the power unit D'.

In this arrangement the crank rod of the reduction gearing, designated 40' and shown in dotted outline, is connected directly with the thrust arm 45' of the diaphragm pump. Thus it will be seen that when the clutch 31' is engaged and the power shaft 11 is rotating, movement will be applied directly from the crank rod 40' to the diaphragm 13' and the liquid which will be moved through the diaphragm pump chamber 12' will rest upon and be raised and lowered by the diaphragm in the operation of the latter.

The construction of the clutch mechanism and the gearing is exactly the same as shown in Figure 1 with the exception that the clutch lever, here designated 38', is disposed at one side of the clutch, instead of above it as in the structure of Figure 1, and is supported for oscillation upon a vertical axis 39'.

The clutch lever 38' is controlled by the vacuum or reduced pressure which exists in the intake casting of the centrifugal pump, the vacuum line here being designated 24' and leading to the vacuum cylinder 46'. Also the control for the oscillating clutch lever 38' is embodied in the oil dash pot cylinder unit 49' which functions as described in connection with the first embodiment.

A description of the operation of the arrangement shown in Figures 3 and 4 is not believed to be necessary since the mechanism operates exactly the same as in the arrangement shown in Figures 1 and 2, the only difference being that the arrangement of the elements is changed so as to bring the diaphragm pump operating mechanism into position beneath the pump so as to produce a more compact structure.

In Figures 5 and 6, while substantially the same units are employed as in the first and second embodiment, the mechanism is operated by the fluid pressure maintained by the centrifugal pump in the outlet 23'' instead of by the reduced pressure which exists in the intake casting.

In this embodiment the diaphragm pump A'' is arranged with the driving and clutching and de-clutching unit C'' located therebeneath and the centrifugal pump unit B'' has the power shaft 11'' passing directly therethrough from the power unit D'' as in the arrangement shown in Figures 3 and 4.

In this third embodiment the clutch actuating lever 38'' is made to oscillate for the release of the clutch 31'', after the pump has begun operating and pumping to full capacity, by the pressure of fluid which is carried from the outlet 23'' of the centrifugal pump, through the pressure pipe line 24'' to a cylinder 46''. Within this cylinder is a piston 47'' which is connected by the coupling rod 48'' with the clutch lever and the fluid from the pipe 24'' enters the cylinder behind the piston therein to force the piston over so as to effect the oscillation of the clutch lever 38'' and the release or disengagement of the clutch to cut off the driving connection between the power shaft and the diaphragm pump when the centrifugal pump is pumping liquid.

It will be readily apparent that with this arrangement the action of the apparatus is the same as where a vacuum line is employed for controlling the clutch. If the centrifugal pump should lose its "prime" so that the pressure in the dis-

charge side of the centrifugal pump drops, the clutch control spring will engage the clutch and cause the control lever 38 to oscillate back to the position in which it is shown in Figure 5 thereby reconnecting the diaphragm pump with the power shaft 11'' so as to start the diaphragm pump working and cause it to either re-prime the centrifugal pump or, if the liquid supply is too low for the centrifugal pump to continue its pumping operation, to itself carry on the pumping action.

From the foregoing description it will be readily apparent that the pumping apparatus herein described will function to automatically "prime" or start the centrifugal pump operating and will function continuously until all liquid has been removed from the source, the diaphragm or suction pump functioning to take over the job when the liquid has been reduced to a point or level where the centrifugal pump would lose its "prime." During the operation of the diaphragm or suction pump the liquid would be passed through the centrifugal pump as would be readily apparent and consequently if the liquid source should be replenished so that the volume handled by the suction pump is increased, such increased volume will serve to re-prime the centrifugal pump so that the latter may then take over the pumping job and the suction pump will be stopped as previously explained. The liquid, however, will continue to pass through the chamber of the suction pump to the centrifugal pump, as will be readily apparent.

I claim:

1. A pumping apparatus of the character stated comprising, in combination, a centrifugal pump having an inlet, a suction pump having an outlet and connected with the inlet of the centrifugal pump to feed the latter, a power transmitting shaft operatively coupled with the centrifugal pump, a power delivering coupling between said shaft and the vacuum pump, including a worm gear and a worm supported upon the shaft, a clutch for coupling the shaft with the worm and including a disk fixed to the shaft and a disk slidable on the shaft, means normally urging the sliding disk into operative connection with the first disk, and means operating automatically to disengage the sliding disk from the first disk to stop the operation of the vacuum pump following the priming of the centrifugal pump and the establishment of full pumping action of the latter.

2. A pumping apparatus as set forth in claim 1, in which the clutch actuating means includes a pressure responsive unit and a connection between the unit and the centrifugal pump for effecting the actuation of the pressure responsive device upon a predetermined change of pressure within the centrifugal pump.

3. A pumping apparatus as set forth in claim 1, with means for adjustably controlling the speed of operation of the clutch operating means.

4. A pumping apparatus as set forth in claim 1, in which the clutch actuating means includes a pressure responsive unit and a connection between the unit and the centrifugal pump for effecting the actuation of the pressure responsive device upon a predetermined change of pressure within the centrifugal pump, and an adjustable check means connected with the pressure responsive means for controlling the speed of operation of the pressure responsive means.

5. A pumping apparatus of the character described comprising, in combination, a centrifugal pump having an inlet, a vacuum pump having an outlet connected with the inlet for feeding liquid to the centrifugal pump, a power transmitting shaft connected with the centrifugal pump, a worm mounted upon the shaft, a driving connection between said worm and the vacuum pump for transmitting driving power from the shaft to the vacuum pump, a clutch comprising a fixed member secured to the shaft and a shiftable member operatively coupled with said worm and normally urged into engagement with the fixed member, a clutch lever connected with said clutch shiftable member and supported for oscillation, a pressure responsive unit having operative connection with said clutch lever to actuate the latter, and an operative coupling between the pressure responsive unit and the centrifugal pump for effecting the actuation of the unit upon a predetermined pressure change within the centrifugal pump.

6. A pumping apparatus of the character described comprising, in combination, a centrifugal pump having an intake, a vacuum pump having an outlet connected with said intake to feed the centrifugal pump, said vacuum pump having a pumping diaphragm, a power transmitting shaft operatively coupled with the centrifugal pump, an arm connected with said diaphragm, a worm and gear coupling between said arm and the power shaft for transmitting reciprocating motion to the diaphragm from the shaft, means for effecting the disengagement of said driving connection between the shaft and the diaphragm arm, a control element for said means, a pressure control unit operatively coupled with said control element for effecting the actuation thereof, and an operative coupling between the pressure control unit and the centrifugal pump by which the pressure control unit is actuated for the actuation of the control unit upon a predetermined change of pressure within the centrifugal pump.

7. A pumping apparatus of the character set forth in claim 6, in which said diaphragm is disposed upon the under side of the vacuum pump and above the said worm and gear coupling and said diaphragm arm extends directly downwardly for the stated operative connection with the worm and gear coupling.

8. A pumping apparatus of the character described comprising, in combination, a centrifugal pump having an intake, a vacuum pump having an outlet connected with said intake to feed the centrifugal pump, a power delivering shaft connected with the centrifugal pump, a clutch controlled operative coupling between the shaft and the vacuum pump whereby the vacuum pump is operated from said shaft, a control member connected with the clutch of said coupling for disengaging the clutch when actuated, a vacuum cylinder having a movable element operatively coupled with the clutch control means, a vacuum line connecting the vacuum cylinder and the intake of the centrifugal pump, and a dash pot control connected with the clutch controlling means for preventing too rapid movement thereof.

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