March 13, 1962 E. L. TOWLE 3,024,730

FLOW CONTROL MEANS FOR A PUMPING STATION

Filed June 24, 1960 3 Sheets-Sheet 1

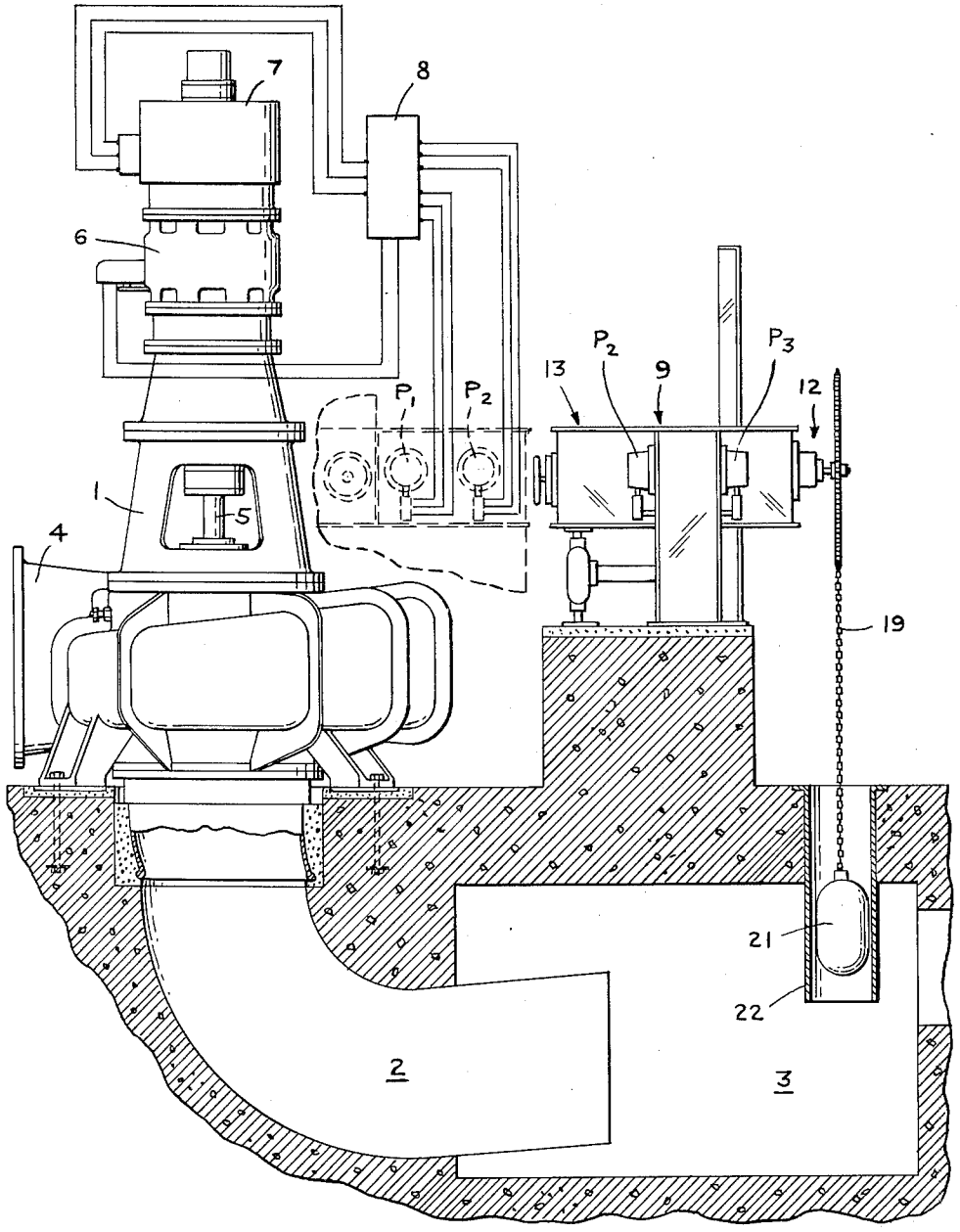

FIG. 1

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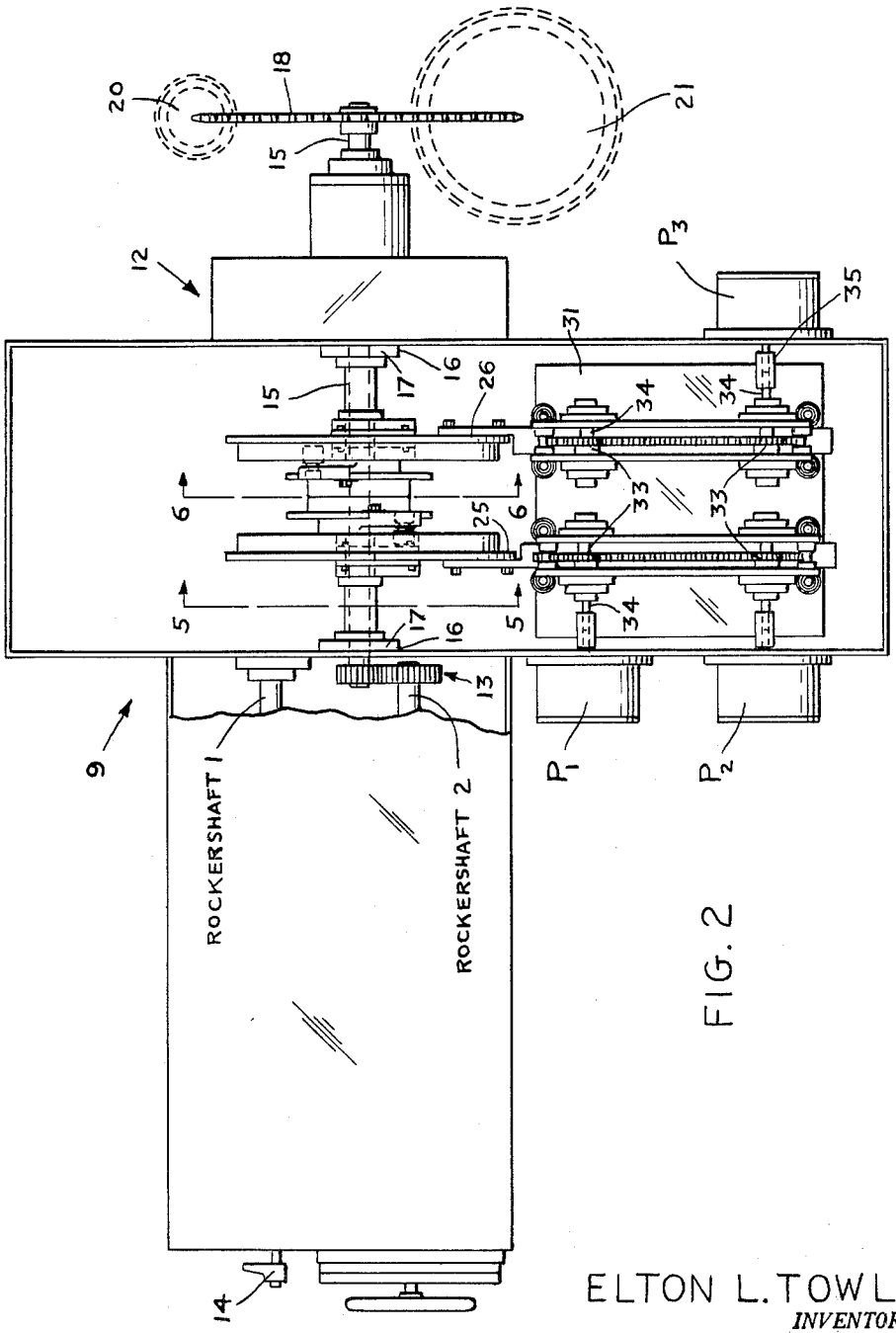

FIG. 2

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March 13, 1962 E. L. TOWLE 3,024,730

FLOW CONTROL MEANS FOR A PUMPING STATION

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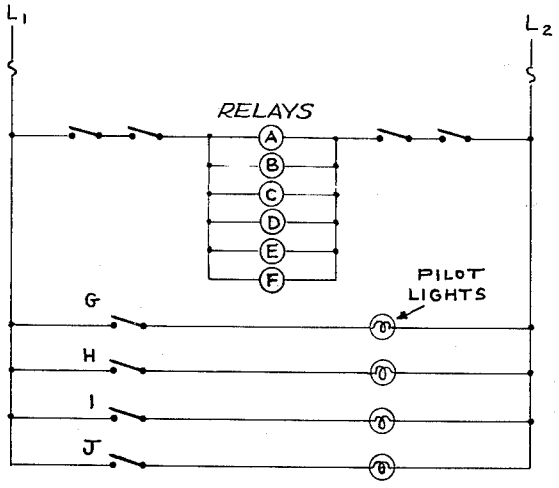

FIG. 3

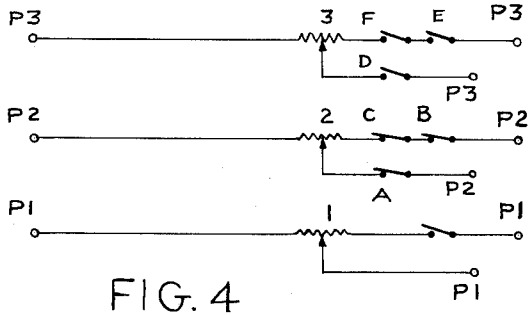

FIG. 4

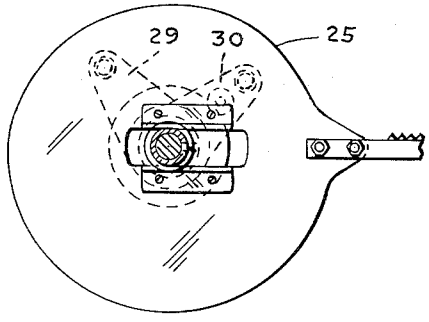

FIG. 5

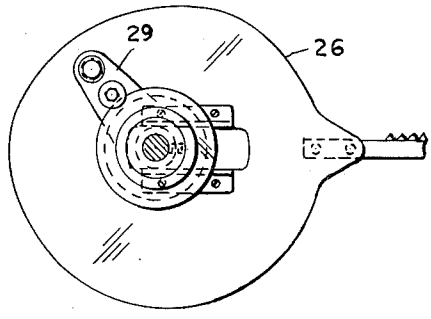

FIG. 6

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United States Patent Office 3,024,730 Patented Mar. 13, 1962

3,024,730
FLOW CONTROL MEANS FOR A PUMPING STATION

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Filed June 24, 1960, Ser. No. 38,670
12 Claims. (Cl. 103—11)

This invention relates to a pumping station and more particularly to a flow control means of the type shown in United States Patent 2,791,179 granted to Oscar H. Dorer on May 7, 1957.

The control means of the foregoing patent is particularly effective in providing a station, having nominal variable flow thereto, with the greatest possible power savings.

This is accomplished, as is more fully described in the above mentioned patent, with the provision of means whereby the capacity of a pump or a series of pumps may be varied in accordance with the flow into the station. Said another way, the foregoing control eliminates the impractical, expensive and costly operation of a station which results from the operation of all pumps in such a system at maximum speed or capacity when flow to said station does not require such pumping capacity. Furthermore, the above control accomplishes the desired variation in pumping capacity by adjusting the pumps when more than one is operative so that they operate in parallel as is more fully detailed in said patent.

In certain installations due to location and peculiar flow conditions to and from the station, it is at times desirable to permit operation of the pumps in either independent or parallel manner.

The present invention contemplates the embodiment of a control in a pumping station including means which permit the operation of the pumps in either parallel or independent fashion to thereby provide the advantages of the controls shown in United States Patents 2,733,660 and 2,791,179.

Accordingly, it is an object of this invention to provide an improved flow control which permits optimum power saving in a pumping station.

With the foregoing objectives in view, and others as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a pumping station provided with the improved flow control, and the features forming the invention will be specifically pointed out in the claims.

In the drawings—

FIGURE 1 is a diagrammatic view of a pumping unit showing the present invention embodied therein and having a phantom front view to more clearly show the manner in which the electric control members are connected to the pump.

FIGURE 2 is a top view partly in section of the flow control.

FIGURE 3 is a schematic wiring diagram of the flow control.

FIGURE 4 is a schematic wiring diagram of the electric control members of the flow control.

FIGURE 5 is a part section taken on lines 5—5 of FIGURE 2 and showing the offset relation of the cam rollers.

FIGURE 6 is a part section taken on lines 6—6 showing the cam roller.

Referring more particularly to the drawings, FIGURE 1 thereof illustrates a pumping system embodying the

present invention wherein the pump 1, which may be of any approved type of centrifugal pump applicable for use in the pumping conditions to be met, has its suction 2 connected to a source of liquid to be pumped (not shown), in the present instance through a reservoir 3. The pump 1 discharges through its discharge outlet 4 to any suitable point of discharge. The driving shaft 5 of the pump 1 is connected to a magnetic drive or speed regulating means 6 which is in turn driven by an electric motor 7.

The pumping system herein illustrated employs an electrical control 8 in connection with the magnetic drive 6, of the character illustrated in Patent 2,733,660, to provide adjustable, pre-selected speed of the shaft 5, and consequently of the pump 1. A liquid level operated control means 9 (generically shown in FIGURE 1 and specifically shown in FIGURES 2 to 6) in association with the electric control 8 will provide control of the speed operation of the pump 1 in substantially stepless speed variations, the steps in speed variation being so small as to be unnoticeable.

The magnetic drive and electrical control hereinabove referred to are well known in the art and purchasable on the open market. Accordingly, it is to be understood that other applicable variable speed torque transmitters or other applicable electrical controller than that shown herein and referred to above may be employed without departing from the spirit of the invention.

The fluid level variance operated flow control means 9 shown in FIGURE 2 which operates or moves the arms of the variable resistance members P1, P2 and P3 shown as potentiometer rheostats function to adjust the speed of operation of the pump 1 and a second pump as hereinafter described through a magnetic drive as was described in the above prior patents.

The flow control means 9 comprises indicator means generally designated 12 for measuring the level in suction reservoir 3 and control means 13, connected to the indicator means as hereinafter described, to signal the speed regulating means of magnetic drive 6 through electric controller 8 to vary the output of the pumps by varying the power flow from the motor 7 to the shaft 5.

To provide a pumping station having the control afforded by both controls of prior Patents 2,733,660 and 2,791,179 and as is clearly indicated in the schematic circuits shown in FIGURES 3 and 4; one pump in the station is connected to potentiometers P2 and P3 whereas another pump is connected to potentiometer P1 as shown.

More particularly movement of the indicator means will signal the control means to start the pump associated with potentiometers P2 and P3 and arrangement of switches on rocker shafts 1 and 2 as will be understood by one skilled in this art when considered in connection with the description in above prior patents provides a circuit which permits current flow through potentiometer P3 due to the incorporation in said circuit of normally closed relays A, B and C. Thusly continuous movement of indicator means 12 due to a rise of level in reservoir 3 will move the potentiometer P3 to a position whereby greater excitation passes to magnetic control 6 to cause pump 1 to increase in speed. If the level continues to rise pump 1 is signaled to maximum speed and at which time mercury switch means mounted on rocker shaft #2 (not shown) of the type shown in Patents 2,733,660 and 2,791,179 interrupt the excitation through potentiometer P3 and switch same to P2 which is set to operate pump 1 at lower speed. During this switch from P3 to P2 a similar switching event occurs which starts another pump, also controlled by a speed regulating means as the unit described hereinabove, which is controlled through potentiometer P1. Thusly both pumps in the event of rising

level continue to have their speeds increased substantially uniformly to therefore equate inflow into the station with the outflow.

In the event that it is deemed desirable to start the second pump, that is the pump that is controlled by potentiometer P1 into operation at low speed and maintains the pump associated with potentiometer P2 and P3 at full speed switching means of the mercury type may be conveniently mounted on rocker shaft 1 and moved manually as by manipulating lever 14 to nullify the switching from potentiometer P3 to P2 as was outlined hereinabove.

While two pumps are shown as being operative in the present station it will be understood that additional pumps may be added and operated within the concepts outlined herein.

In order to achieve the above described type of operation indicator means of the type shown in application Serial No. 711,919 filed January 29, 1954, now United States Patent No. 2,950,683, form the pith of the flow control 9 and comprises a shaft 15 supported from suitable pedestals 16 by bearings 17. A sprocket wheel or rotary element 18 is keyed on the shaft 15 and includes means for imparting rotation thereto such as a chain 19 as is clearly shown in FIGURE 1 of the drawings. The chain 19 has a counterweight 20 attached to one end thereof and the other end is connected by any well known manner to a float 21 which is located in a float tube or float well 22. The bottom of or open lower end of the float tube extends into the suction reservoir 3 below the normal level of liquids therein so that variances in the level of liquid in the suction reservoir 3 will move the float 21. Movement of the float under variances of the liquid level in the suction reservoir 3 will, through the sprocket chain 19, rotate the sprocket 18 and the shaft 15.

To convey variances of the fluid level in the suction reservoir to the speed control means 6 flow control 9 includes control means 13 operatively connected to the shaft 15 of the indicator means 12.

The action of the indicator means 12 is transmitted to the potentiometer P3 through a first cam and rack arrangement 26 connected to the shaft 15 of the indicator means as was described in detail in the above mentioned patents and application. Similarly potentiometers P1 and P2 are adapted to adjust excitation to the second pump and the recycle position of the first pump through a second cam and rack arrangement 25. Both cams have a cam groove or cam track (not shown) in one face thereof which is provided with eccentric variable speed sectors and concentric constant speed sectors as was the case with the cams of the above prior patents and application.

Cam rollers 29 and 30 as shown in FIGURES 5 and 6 engage in the cam track. The cam rollers are attached to their respective rack bars and slidably carried by a suitable support 31, and is preferably ball bearing mounted.

The racks as was the case with the above application are carried by rack bars and mesh with pinions 33 carried by shafts 34 of the potentiometers. The shafts 34 are rotatably supported by the support 31 and are connected by suitable couplings 35 to the arm operating pins of the potentiometer, three of which are shown in the drawings.

While three variable resistance means are shown in the drawings for regulating the excitation to two respective speed regulating means and thusly control the speed of two different pumps, it is to be understood that within the realm of reasonableness any number of pumps may be employed in the system with which the flow control means is used.

Generally operation of the contemplated flow control is much like the operation described for flow controls of the above prior patents and application, thusly the float rises and falls with variances in the liquid level in the reservoir 3. This rise and fall of the float moves the chain 19 which rotates the sprocket 18 which in turn rotates the cams 25 and 26. Due to the offset relation of cam rollers 29 and 30 as is shown in FIGURE 5 and positioning of roller 29 so that it is in an eccentric portion of cam 26 so that rack associated therewith is moved by shaft 15 to move potentiometer P3 to a position permitting excitation of the speed regulating means and at the same time movement of rocker shaft #2 by the shaft actuates the pump into operation. With the positioning of roller 30 into a concentric portion of the track of cam 25 no motion is transmitted to the potentiometers P1 and P2. Thusly only one pump is in operation and follows the rise and fall of the liquid level in reservoir 3 to equate inflow and outflow.

As soon as inflow has reached a stage wherein it is greater than the capacity of the first pump and depending on the position of switch means on rocker shaft 1 rocker shaft 2 moves to actuate another switch on shaft #2 (none of which are shown as they are described in detail in the above prior patents) to switch operation of the first pump from potentiometer P3 to P2 and also start the second pump all at about the same speed. Should it be desired to maintain the operation of the first pump on potentiometer P3 rather than switching same to P2; a mercury switch is manually manipulated by arm 14 on rocker shaft #1 whereby relays A, B and C remain closed and D, E and F remain open and therefore the first pump continues to run at maximum speed. The second pump is started in similar fashion and excitation of current to its associated speed regulating means is controlled by potentiometer P1.

The mercury switches and their operating mechanism may be of any approved form. Examples are shown in detail in the above patents. The switches being electrically connected to terminals mounted in the flow control and to any signal mechanism as indicated above. FIGURE 3 schematically shows mercury switches G, H, I, and J mounted on rocker shaft 2 all set to indicate through pilot lights whether or not pumps are operating.

While the control method and apparatus is shown in the drawings as applied to a vertical shaft pumping unit, it is equally adaptable to a horizontal shaft pumping unit, and in systems employing a plurality of pumps the programming of speed control may be arranged so that with increasing liquid levels in the reservoir succeeding pumps will be started and/or speed of the operating pumps increased in any desired sequence, and the sequence of starting and stopping of the pumps may be arranged in different order if desired.

The starting of speed chamber of the pump or pumps may be arranged to become effective at various liquid levels in the reservoir 3 or at different degrees of variance in the liquid level. All such changes or settings of the apparatus are possible through the manipulation of control means 13 and the various other setting adjustments provided for as hereinbefore described.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. Variable flow control means for use with a pumping system having a suction reservoir, said pumping system including a pump, driving means for said pump and speed regulating means operatively interconnecting said pump to said driving means for varying the power flow from said driving means to said pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, first and second control means interconnecting said indicator means to said speed regulating means and one of said control means being operative to vary the pump output when the level in said reservoir varies from a preselected level and the other control means being inoperative, and switching

means connected to said first and second control means and to switch control of said pump from the operative control to the inoperative control when the reference level in said reservoir varies from a preselected level.

2. Variable flow control means for use with a pumping system having a suction reservoir, said pumping system including a pump, driving means for said pump and speed regulating means operatively interconnecting said pump to said driving means for varying the power flow from said driving means to said pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, first and second control means interconnecting said indicator means to said speed regulating means and one of said control means being operative to vary the pump output when the level in said reservoir varies from a preselected level and the other control means being inoperative, switching means connected to said first and second control means and to switch control of said pump from the operative control to the inoperative control when the reference level in said reservoir varies from a preselected level, and means connected to said switching means for nullifying the action of said switching means as desired whereby said operative control continues acting to vary pump output.

3. Variable flow control means for use with a pumping system having a suction reservoir, said pumping system including a pump, driving means for said pump and speed regulating means operatively interconnecting said pump to said driving means for varying the power flow from said driving means to said pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, first and second control means interconnecting said indicator means to said speed regulating means and one of said control means being operative to vary the pump output when the level in said reservoir varies from a preselected level and the other control means being inoperative, said first and second control means both including a cam operatively interconnecting the indicator means to the speed regulating means, both cams having track portions and operative to signal said speed regulating means to vary the pump output when the level in said reservoir varies from a predetermined level, said cams provided with over and under travel portions for nullifying the signal from said indicator means during other preselected levels, and switching means connected to said first and second control means and to switch control of said pump from the operative control to the inoperative control when the reference level in said reservoir varies from a preselected level.

4. Variable flow control means for use with a pumping system having a suction reservoir, said pumping system including a pump, driving means for said pump and speed regulating means operatively interconnecting said pump to said driving means for varying the power flow from said driving means to said pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, first and second control means interconnecting said indicator means to said speed regulating means and one of said control means being operative to vary the pump output when the level in said reservoir varies from a preselected level and the other control means being inoperative, said first and second control means both including a cam operatively interconnecting the indicator means to the speed regulating means, both cams having track portions and operative to signal said speed regulating means to vary the pump output when the level in said reservoir varies from a predetermined level, said cams provided with over and under travel portions for nullifying the signal from said indicator means during other preselected levels, switching means connected to said first and second control means and to switch control of said pump from the operative control to the inoperative control when the reference level in said reservoir varies from a preselected level, and means connected to said switching means for nullifying the action of said switching means as desired whereby said operative control continues acting to vary pump output.

5. In the device claimed in claim 4 wherein the indicator means includes a rotary element operatively connected to said cam, a float movable by variances in the reservoir level, means operatively interconnecting said float to said rotary element so that float movement is transmitted to said rotary element and a panel operatively interconnected between said rotary element and the cams for indicating the level in said reservoir.

6. In the device claimed in claim 4 wherein the both cams include racks operatively interconnected to the cams, a plurality of variable resistance means connected to said speed regulating means to regulate the excitation of said speed regulating means, actuating members connecting one rack to one of the variable resistance means and the other rack to other predetermined variable resistance means for operation of said variable resistance means on movement of said rack, and said indicator means including a rotary element, a float movable by variances in the reservoir level, means operatively interconnecting said float to said rotary element so that float movement is transmitted to said rotary element and a panel operatively connected between said rotary element and the cams for indicating the level in said reservoir.

7. Variable flow control means for use with a pumping system having a suction reservoir, said system including a first and second pump, constant speed driving means for said first and second pumps and speed regulating means operatively interconnecting each pump to its respective driving means and for varying the power flow from said constant speed driving means to the pumps, said variable flow control means including indicator means having a rotary element, a float movable by variances in the reservoir level, means interconnecting said float to said rotary element so that float movement is transmitted to said rotary element, a panel connected to said rotary element for indicating the level in said reservoir, first and second control means interconnecting said rotary element to the speed regulating means connected to the first and second pumps and one of said control means being operative to vary the output of said first pump when the level in said reservoir varies from a preselected level and the second control means being connected to both pumps and inoperative relative the regulation of the first pump but operative to vary the output of the second pump at a predetermined reference level in said reservoir, said first and second control means both including a cam operatively interconnecting the rotary element to a respective speed regulating means, both cams having track portions and each operative respectively to signal said speed regulating means to vary the pump output when the level in said reservoir varies from a predetermined level, said cams provided with over and under travel portions for nullifying the signal from said indicator means during other preselected levels, mercury switches operatively connected to each cam to stop and start said pumps, cams operated by the first cam for operating certain of said mercury switches in accordance with predetermined variances of level in the reservoir, cams operated by the second cam for operating other mercury switches according to predetermined variances of level in the reservoir, switch means connected to said first and second control means, and a cam connected to the rotary element for actuating said switch whereby operation of said first pump is switched from said first control to said second control when the reference level in said reservoir varies from a preselected level.

8. Variable flow control means for use with a pumping system having a suction reservoir, said system including a first and second pump, constant speed driving means for said first and second pumps and speed regulating means operatively interconnecting each pump to its respective driving means and for varying the power

flow from said constant speed driving means to the pumps, said variable flow control means including indicator means having a rotary element, a float movable by variances in the reservoir level, means interconnecting said float to said rotary element so that float movement is transmitted to said rotary element, a panel connected to said rotary element for indicating the level in said reservoir, first and second control means interconnecting said rotary element to the speed regulating means connected to the first and second pumps and one of said control means being operative to vary the output of said first pump when the level in said reservoir varies from a preselected level and the second control means being connected to both pumps and inoperative relative the regulation of the first pump but operative to vary the output of the second pump at a predetermined reference level in said reservoir, said first and second control means both including a cam operatively interconnecting the rotary element to a respective speed regulating means, both cams having track portions and each operative respectively to signal said speed regulating means to vary the pump output when the level in said reservoir varies from a predetermined level, said cams provided with over and under travel portions for nullifying the signal from said indicator means during other preselected levels, mercury switches operatively connected to each cam to stop and start said pumps, cams operated by the first cam for operating certain of said mercury switches in accordance with predetermined variances of level in the reservoir, cams operated by the second cam for operating other mercury switches according to predetermined variances of level in the reservoir, switch means connected to said first and second control means, a cam connected to the rotary element for actuating said switch whereby operation of said first pump is switched from said first control to said second control when the reference level in said reservoir varies from a preselected level, and means connected to the switch means for nullifying the action thereof as desired whereby said first control continues acting to vary the output of said first pump.

9. In the device claimed in claim 8 wherein both cams include racks operatively interconnected to the cams, a first variable resistance means connected to the first speed regulating means, a second electric variable resistance means connected to the second speed regulating means and actuating members connecting the racks to the first and second variable resistance means.

10. In the device claimed in claim 8 wherein the means connected to the switch means comprises a manually movable cam.

11. Variable flow control means for use with a pumping system having a suction reservoir, said system including a first and second pump, constant speed driving means for each of said pumps and speed regulating means operatively interconnecting each of said driving means to its corresponding pump for varying the power flow from the driving means to the pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, a first control means including a variable resistance means interconnecting said indicator means to the speed regulating means of said first pump and normally operative to signal said speed regulating means to vary the output of said first pump during changes in the level in said reservoir, a cam for said first control means interconnecting said indicator means to said variable resistance means, mercury switches connected to said first cam to stop and start said first pump, other cams operated by the first cam for operating said mercury switches, a second control means including first and second variable resistance means and said first variable resistance means being connected to said first pump and the second variable resistance means being connected to the second pump and said first variable resistance means being normally inoperative, mercury switches connected to the second cam to start and stop said second pump, cam means connected to the second cam to operate the last mentioned mercury switches, and switch means connected to the variable resistance means of said first control means and the first variable resistance means of said first control means and the first variable resistance means of the second control means cam means connected to the indicator means for actuating the switch means whereby control of excitation of said first speed regulating means is switched from the first control means to the second control means when the reference level in said reservoir varies from a preselected level.

12. Variable flow control means for use with a pumping system having a suction reservoir, said system including a first and second pump, constant speed driving means for each of said pumps and speed regulating means operatively interconnecting each of said driving means to its corresponding pump for varying the power flow from the driving means to the pump, said variable flow control means including indicator means for measuring the level in said suction reservoir, a first control means including a variable resistance means interconnecting said indicator means to the speed regulating means of said first pump and normally operative to signal said speed regulating means to vary the output of said first pump during changes in the level in said reservoir, a cam for said first control means interconnecting said indicator means to said variable resistance means, mercury switches connected to said first cam to stop and start said first pump, other cams operated by the first cam for operating said mercury switches, a second control means including first and second variable resistance means and said first variable resistance means being connected to said first pump and the second variable resistance means being connected to the second pump and said first variable resistance means being normally inoperative, mercury switches connected to the second cam to start and stop said second pump, cam means connected to the second cam to operate the last mentioned mercury switches, switch means connected to the variable resistance means of said first control means and the first variable resistance means of the second control means cam means connected to the indicator means for actuating the switch means whereby control of excitation of said first speed regulating means is switched from the first control means to the second control means when the reference level in said reservoir varies from a preselected level, and means connected to the last mentioned switch means for nullifying the action thereof as desired whereby said first control continues acting to vary the output of said first pump.

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