

May 27, 1930.

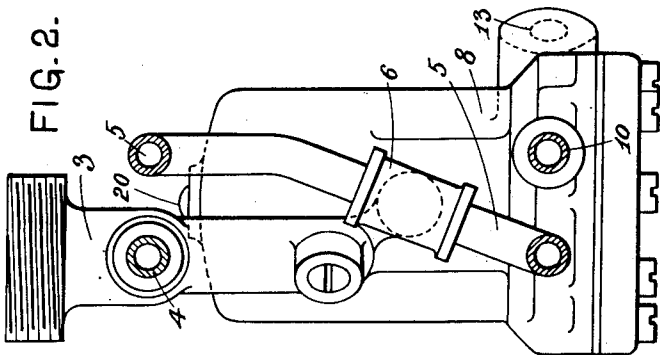
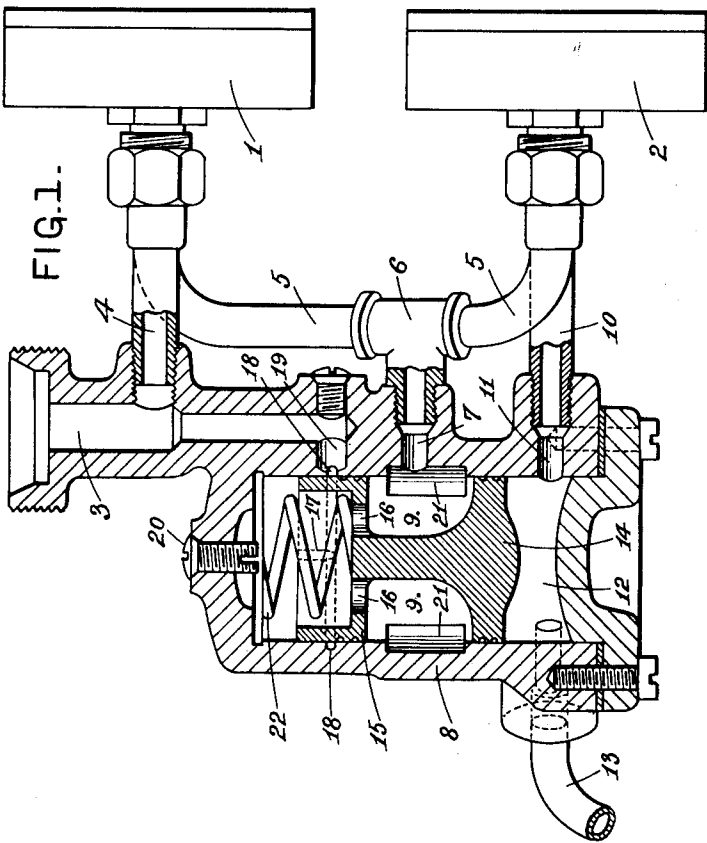
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1,760,070

PUMPING APPARATUS

Filed April 6, 1927

2 Sheets-Sheet 1



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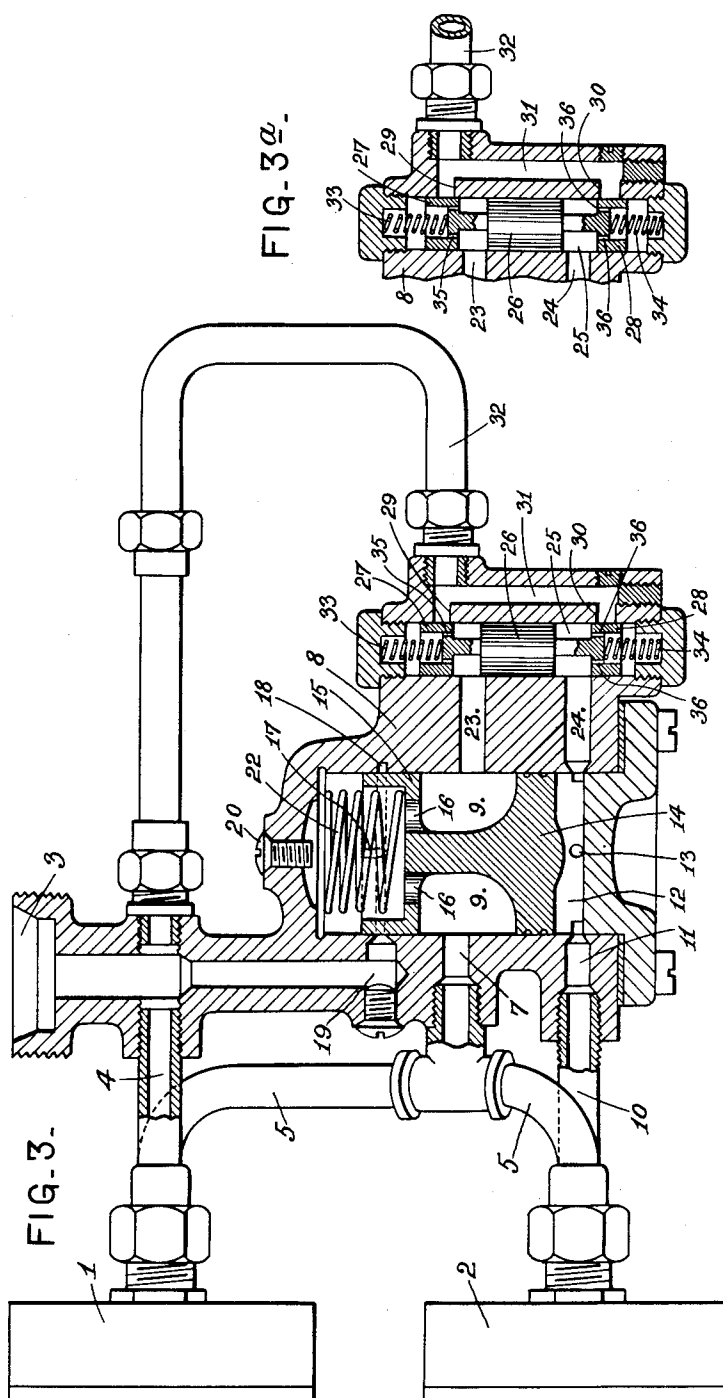
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PUMPING APPARATUS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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PUMPING APPARATUS

Application filed April 6, 1927, Serial No. 181,396, and in Great Britain November 17, 1926.

This invention relates to pumping apparatus for viscous or other liquids, of the kind described in British Patent No. 182,154, dated 28th January, 1921, wherein two pumps of the gear wheel or other type are arranged in series, and are so constructed and operated that the delivery of the first pump (hereinafter called the pilot pump) is greater than that of the second pump (hereinafter called the measuring pump) which receives liquid therefrom and which is thus intended to act as a measuring device to pass the quantity of fluid required per unit of time, the surplus liquid from the pilot pump passing through a branch conduit or passage on the connection between the two pumps to one side of a pressure balance valve of the diaphragm, piston or other type, the other side of which is exposed to the pressure of the delivery pipe of the measuring pump, so that according as the pressure in the connection between the two pumps or that in the delivery from the measuring pump predominates, the diaphragm, piston or other moving member of the pressure balance valve is displaced and acts by means of a valve or regulating device to enlarge or reduce a by-pass opening through which excess liquid in the branch conduit or connection can escape back into the main supply to the pilot pump, with a view to keeping the pressure between the two pumps equal to that in the delivery pipe from the measuring pump, and of thus maintaining equal pressure on both sides of the measuring pump, so that if the delivery pressure from this pump varies, the pressure balance valve shall automatically adjust the inlet pressure to the same degree.

Such pumping apparatus are applicable for pumping viscous or other liquids generally, but are employed in particular for supplying the spinning solutions to the nozzles or jets of artificial silk spinning installations.

In the spinning of artificial silk, especially according to the dry spinning or evaporative method, large numbers of such pumping units, comprising a pilot pump, a measuring pump and a pressure balance valve are em-

ployed to supply the spinnerets with spinning solution.

In practice with such pumping units it was found that the unit is liable to become unbalanced, chiefly in consequence of failure of the pilot pump to develop all pressures it is called upon to balance in working, so that while the pressure balance of the unit may be satisfactorily maintained so long as the delivery pressure of the measuring pump does not rise above a certain limit, yet when this range is exceeded by development of pressures on the delivery side of the measuring pump which are beyond the ability of the pilot pump to balance, the pressure balance of the unit and consequently the required regularity of delivery from the measuring pump, ceases to be maintained. Unbalancing of the unit may also be caused by bad leakage past the needle valve or other regulating device whereby the diaphragm piston or other moving member of the pressure balance valve controls the by-pass orifice. The development of overlimit pressures in the measuring pump delivery may arise from various causes, for instance, in the case of spinning installations, from blocked spinneret orifices or other obstructions in the delivery. The result of such an unbalanced condition of the unit in the case of spinning installations is that the unit continues to spin under unbalanced conditions, thereby giving irregular denier of thread or filaments.

In most cases the unbalancing of the unit arises from development on the delivery side of the measuring pump, of an increased pressure beyond the ability of the pilot pump to balance, the excessive or unbalanced pressure then of course existing on the measuring pump side of the pressure balance valve, but in some cases unbalancing of the unit is caused by the development of an unbalanced excess of pressure on the other side, i. e. on the pilot pump and by-pass side of the pressure balance valve, due for instance to failure of the by-pass controlling or regulating device of the pressure balance valve to function properly in opening the by-pass.

For the purpose of obviating these difficulties it has been proposed in the specifica-

tion of British Patent No. 234,156 dated 22nd January, 1924, to combine with a pumping unit of the character before indicated and in which the pressure balance valve is of the diaphragm type, an auxiliary device exposed on its opposite sides to the pressures existing on the respective sides of the diaphragm of the pressure balance valve, and adapted to operate when an unbalanced excess of pressure is developed in the delivery of the measuring pump as compared with the delivery pressure of the pilot pump, and thereby to make a passage between the delivery side of of the measuring pump and some point or points in communication with the by-pass side of the diaphragm or feed side of the pilot pump, so that when the auxiliary device operates on the attainment of a given difference of pressure between the delivery of the measuring pump and that of the pilot pump, the pressure is released and the liquid can circulate idly in the unit and the unit ceases to deliver the liquid to the spinning jet or jets or other point of use. Further the said British Patent No. 234,156 describes how the said auxiliary release device may be further adapted also to operate and effect the release of an unbalanced excess of pressure on the other side of the diaphragm of the pressure balance valve, viz the pilot pump and by-pass side of the pressure balance valve, and thereby establish communication with the feed side of the pilot pump, thus permitting the liquid to circulate idly in the unit.

While the apparatus described in the said British Patent No. 234,156, is very successful in overcoming the before mentioned difficulties previously encountered in pumping units of the kind referred to in British Patent No. 182,154, it has been found that certain difficulties can still arise with it when working for long periods on a large scale. Thus it has been found with the apparatus of the said British Patent No. 234,156 that after a considerable period of service the needle valve or like valve usually employed for controlling or varying the orifice of the by-pass, and the seat of this valve, become scored by the constant wiredrawn flow of the fluid to such an extent as to cause marked out-of-balance effects on the respective sides of the diaphragm, which results in irregular delivery of fluid from the measuring pump, and the diaphragm of the pressure-balance valve becomes distorted in course of time in attempting to balance the pressures on the respective sides of the pressure balance valve when the needle or like valve has become so scored or damaged as to function inaccurately as a by-pass device.

The object of the present invention is to provide an improved pumping apparatus of the kind described in British Patent No. 182,154 in which the difficulties encountered

with such apparatus can be obviated entirely or much more effectively than hitherto.

According to the present invention I employ, in pumping apparatus of the kind referred to, a piston pressure balance valve the piston of which is exposed on its opposite sides respectively to the pressure of the delivery side of the pilot pump and to the pressure of the delivery side of the measuring pump, and is adapted to operate a piston or other slide valve forming the by-pass controlling member or device of the pressure balance valve, and by means of which the surplus fluid delivered from the pilot pump is by-passed back to the main supply to the pilot pump, said piston pressure balance valve being also provided or combined with means adapted to come into operation and put the delivery side of the measuring pump into communication with the feed side of the pilot pump when an excess out of balance pressure is developed on the delivery side of the measuring pump, and thereby to release the pressure and permit the fluid to circulate idly in the unit.

Means may also be provided for releasing to the feed side of the pilot pump an unbalanced excess of pressure developed on the other side of the piston of the pressure balance valve (viz the pilot pump and by-pass side thereof) thereby permitting the liquid to circulate idly in the unit when such excess out of balance pressure occurs on this side of the pressure balance valve.

For the purpose of the present invention I may employ any means adapted to operate and release an excess out of balance pressure when the same is developed, thus for example I may employ auxiliary devices of the character indicated in said British Patent No. 234,156; preferably however said means are made an integral part of the pressure balance valve, the piston and slide valve of the pressure balance valve themselves being adapted to operate under the excess out of balance pressure and to open communication between the delivery side of the measuring pump and the feed side of the pilot pump when an excess out of balance pressure occurs on the delivery side of the measuring pump, and it may also be, if so desired, to operate and release to the feed side of the pilot pump an excess out of balance pressure developed on the delivery side of the pilot pump or by-pass side of the piston of the pressure balance valve.

The accompanying drawings serve to illustrate some forms of pumping units constructed in accordance with the present invention, it being understood that these forms are given by way of illustration only and may be varied widely without departing from the spirit of the invention. In the following description the apparatus will be supposed as applied for

supplying artificial silk spinning solutions to spinning jets.

Fig. 1 is a sectional elevation of one form of pumping unit wherein the piston and slide valve of the pressure balance valve are themselves adapted to operate and release excess out of balance pressure on either side of the piston.

Fig. 2 is a side elevation of the unit shown in Fig. 1 with the pumps broken off.

Figs. 3 and 3^a illustrate two modifications wherein excess out of balance pressures are released with the assistance of auxiliary devices of the kind described in the prior British Patent No. 234,156, Fig. 3 being a sectional elevation of a modification of pumping unit provided with one form of such auxiliary pressure release device, while Fig. 3^a is a sectional detail view of another form of such auxiliary pressure release device supposed as applied in a pumping unit in all other respects similar in construction to Fig. 3.

Referring to Figs. 1 and 2, 1 is the pilot pump and 2 is the measuring pump the pilot pump 1 having a delivery greater than that of the measuring pump as before mentioned. 3 is the supply pipe or header for the spinning solution to the unit. 4 is the feed pipe leading from the supply pipe 3 to the pilot pump 1. 5 is the delivery pipe from the pilot pump 1 this pipe forming the connection between the pilot pump 1 and the measuring pump 2, and communicating via the branch connection constituted by the T piece 6 and the passage 7 in the valve casing 8, with the upper chamber 9 of the pressure balance valve on the by-pass side of the piston of the pressure balance valve, the surplus solution from the pilot pump 1 passing to the upper chamber 9 by this branch connection. 10 is the delivery pipe from the measuring pump 2, this pipe communicating via the passage 11 in the valve casing 8 with the lower chamber 12 of the pressure balance valve. 13 is the outlet from the chamber 12, leading to the spinning jet or jets supplied by the unit. 14 is the piston of the pressure balance valve, working in the cylindrical bore of the valve casing 8, this piston being formed with a slide valve member 15 perforated with holes or slots 16 in the bottom and having one or more saw cuts 17 in its periphery which form, with the annular groove 18 and the passage 19 in the casing 8, the by-pass for controlling the flow of the surplus solution from the pilot pump back to the header or supply pipe 3.

In normal operation, the spinning solution passes from the supply pipe or header 3, through the feed pipe 4 to the pump 1 which delivers the solution to the pipe 5 from which a part of it passes to the measuring pump 2 and thence through the delivery pipe 10, the passage 11 and the lower chamber 12 of

the pressure balance valve to the outlet 13 and thence to the spinning jet or jets, the surplus solution from the pilot pump 1 being by-passed back from the pipe 5 to the supply pipe or header 3 via the branch connection 7, the upper chamber 9 of the pressure balance valve, the holes or slots 16, and saw-cut 17 of the slide valve, the annular groove 18 and the passage 19. 20 represents a screw plug provided in the top of the valve casing 8. On starting up the unit, this screw plug may be removed to allow any air to escape from the upper chamber 9, the plug being replaced when the upper chamber of the balance valve has become filled with the spinning solution. 21, 21 are recesses formed in the wall of the valve casing 8 and referred to later.

Any normal out of balance pressure developing on either side of the pressure balance valve piston 14 will cause the slide valve member 15 to move with the piston 14 and enlarge or restrict the orifice formed between the saw-cut 17 and the annular groove 18 and hence increase or restrict the amount of solution by-passed back to the header or supply pipe 3 and thus equalize the pressures on the respective sides of the pressure balance valve.

Should an abnormal or excess out of balance pressure develop on the delivery side of the measuring pump (due for instance to the jet or jets becoming partially choked) the consequent increasing of pressure in the lower chamber 12 causes the piston 14 and the slide valve 15 to rise at first to such a position that the orifice between the saw-cut 17 and the annular groove 18 becomes closed, and hence the surplus solution from the pilot pump is prevented from escaping back to the header 3. The piston 14 then rises further as the pressure in the lower chamber 12 rises owing to the measuring pump 2 continuing to deliver solution into the lower chamber 12, the piston 14 continuing to rise until the lower edge of the slide valve 15 uncovers the groove 18, thus releasing the solution under pressure in the chamber 9 to the annular groove 18 and the header 3 via the passage 19. This release causes the piston 14 to rise further (and usually more rapidly) until its bottom edge uncovers the recesses 21 in the casing 8, thus allowing the solution in the lower chamber 12 and further solution from the measuring pump 2 to escape past the piston 14 through the recesses 21, and thence through the groove 18 and passage 19 to the header 3; at the same time the portion of the delivery from the pilot pump 1 which passes by the branch passage 7 to the upper valve chamber 9 escapes back to the header 3 through the groove 18 and passage 19, the groove 18 having been uncovered by the lower edge of the slide valve 15 as before mentioned. The piston 14 and the slide valve 15 remain in this position, with the solution from both pumps

freely circulating back to the header 3, and the unit ceases to deliver solution to the spinning jet or jets until the cause of the out of balance condition is removed. On removal of the cause of the out of balance condition the piston 14 and slide valve 15 are restored to their normal position, being pressed down into position by the spring 22. It should be noted that the spring 22 plays no part in the functioning of the valve under normal conditions, and that it only comes into compression when the piston rises under the effect of an abnormal or excess out of balance pressure on the delivery side of the measuring pump.

In the converse and less usual case where an excess out of balance pressure develops on the by-pass side of the piston 14 of the pressure balance valve, the piston 14 will move down under the effect of this pressure together with the slide valve 15, to such an extent that the top edge of the slide valve 15 uncovers the annular groove 18, and the solution from the pilot pump 1 will then circulate freely through the pipe 5, passage 7, upper valve chamber 9, holes or slots 16, annular groove 18 and passage 19 back to the header 3, and the unit will therefore cease to deliver spinning solution to the jet or jets until the cause of the out of balance condition is removed. In the unit shown in Fig. 1 the piston and slide valve work in a uniform bore; it is of advantage however when great sensitivity of control is required, to have the valve casing bored to two different diameters and to have the piston working in the larger bore and the slide valve working in the smaller bore.

Referring to Figure 3, this likewise shows a form of pumping apparatus provided with means for releasing any excess out of balance pressure developed on either side of the measuring pump, but in this form there is employed as the means for releasing excess out of balance pressure on the delivery side of the measuring pump an auxiliary device of the class referred to in prior British Patent No. 234,156, adapted to release excess out of balance pressure developing on the delivery side of the measuring pump, any excess out of balance pressure developing on the feed side of the measuring pump being released by the slide valve carried by the piston pressure balance valve.

The pumping unit is similar in the main to that shown in Fig. 1, but the bore of the valve casing is without recesses such as 21. In normal operation the unit functions in a manner precisely similar to the form shown in Fig. 1, the spinning solution passing from the supply pipe or header 3 through the pipe 4 to the pilot pump 1 which delivers the solution to the pipe 5, from which a part of it passes to the measuring pump 2, and thence through the delivery pipe 10, the passage 11,

and the lower chamber 12 of the pressure balance valve to the outlet 13 and thence to the spinning jet or jets, the surplus solution from the pilot pump 1 being by-passed back from the pipe 5 to the supply pipe or header 3 via the branch connection 7, the upper chamber 9 of the pressure balance valve, the holes or slots 16 and the saw-cut 17 of the slide valve 15, the annular groove 18 and the passage 19. On starting up the unit the screw plug 20 may be removed to allow any air to escape from the upper chamber 9 of the balance valve, the plug being replaced when the upper chamber of the balance valve has become filled with the spinning solution. Any normal out of balance pressure developing on either side of the pressure balance valve piston 14 will cause the slide valve member 15 to move and enlarge or restrict the orifice formed between the saw-cut 17 and the annular groove 18 and hence increase or decrease the amount of solution by-passed back to the header or supply pipe 3 and thus equalize the pressures on the respective sides of the pressure balance valve.

In the modification under description the casing 8 is provided with ports 23 and 24 leading respectively from the upper chamber 9 and lower chamber 12 of the pressure balance valve to an auxiliary valve chamber 25 in which works an auxiliary piston valve 26 having upper and lower valve extensions 27, 28 arranged to control the respective ends 29, 30 of a release port 31 in the casing 8, this port being connected to a branch pipe 32 communicating with the header or supply pipe 3 and thus to the feed side of the pilot pump. Springs 33, 34 are fitted between the valve extensions 27, 28 and the ends of the auxiliary valve chamber 25, and small holes 35 and 36 are provided in the valve extensions 27 and 28 respectively. In normal working the springs 33, 34 keep the auxiliary piston valve 26 in an intermediate position in which its extensions 27, 28 close the ends 29, 30 of the release port 31, as shown in Fig. 3, but when a given overlimit pressure on the delivery side of the measuring pump relatively to the by-pass side is exceeded, the auxiliary piston valve 26 moves up with its extensions 27, 28 under the effect of the pressure exerted through the port 24 on its lower face. In this movement the upper valve extension 27 is adapted by its construction to open connection between the port 23 on the by-pass side and the end 29 of the release port 31 a fraction before the lower valve extension 28 makes communication between the lower port 24 and the lower end 30 of the release port 31; this increases the out of balance condition and allows the auxiliary valve to shoot up, thereby opening the lower end 30 of the release port 31 by the lower valve extension 28 and allowing the solution to be released from the delivery side of the measuring pump

through the holes 36 in the valve extension 28 and the port 31 to the branch pipe 32 and the feed side of pilot pump. The solution will then circulate idly in the unit and the delivery from the spinning jet or jets served by the unit will cease until the cause of the out of balance condition is obviated or removed. The auxiliary piston 26 may be restored to its neutral position by obviating the cause of the out of balance condition and removing the pressure from both pressure balance chambers 9 and 12 in any way e. g. by stopping the pumps.

In the converse case where an excess out of balance pressure is developed in the upper chamber 9 of the pressure balance valve (i. e. the by-pass side of the pressure balance valve piston) the auxiliary piston valve 26 moves downwards under the effect of this pressure acting through the port 23 and the lower valve extension 28 uncovers the lower end 30 of the release port 31, thus allowing the spinning solution to escape from the lower chamber 12 of the pressure balance valve via the ports 24, 31 and the branch pipe 32 back to the header 3. On the pressure being thus released from the lower chamber 12 of the pressure balance valve, the piston 14 of the pressure balance valve moves down until the top edge of the slide valve member 15 uncovers the annular groove 18, thus allowing the solution in the upper chamber 9 to escape back freely to the header 3. The pistons 14 and 26 remain in these positions with the solution from both pumps freely circulating back to the header 3 and the unit ceasing to deliver solution to the spinning jets until the cause of the out of balance condition is removed. In the form shown in Fig. 3 it will be seen that the upper extension 27 of the auxiliary piston valve 26 is of such length that when this valve has moved down to its fullest extent under the excess out of balance pressure the upper valve extension 27 still seals the end 29 of the release port 31.

Referring now to Fig. 3^a, this as before mentioned, illustrates another form of pressure release device according to the prior Patent 234,156, supposed as applied in a pumping unit in all other respects similar to that shown in Fig. 3, the only difference being that the auxiliary release device of Fig. 3^a is adapted to serve in releasing excess out of balance pressures developed on either side of the piston 14 of the pressure balance valve.

From Fig. 3^a it will be seen that while the parts are otherwise the same as in Fig. 3, the upper extension 27 of the piston 26 of the auxiliary pressure release device is of such length that in the downward movement of the piston 26 under the action of an excess out of balance pressure developed on the upper or by-pass side of the pressure balance valve piston 14 and acting through the port 23, the upper extension 27 of the piston 26

does not keep the upper end 29 of the release port 31 sealed from the port 23, but permits release of the pressure from the upper pressure balance valve chamber 9 to the release port 31 and the feed side of the pilot pump in a similar manner to that in which the lower extension 28 functions to release pressure from the delivery side of the measuring pump when excess out of balance pressure develops on this side. In normal working, the springs 33, 34 keep the piston valve 26 of the auxiliary pressure release device in an intermediate position in which the ends 29, 30 of the release port 31 are closed as in the figure. When an excess out of balance pressure develops on the delivery side of the measuring pump, the auxiliary piston valve 26 moves up under the pressure exerted from the lower pressure balance valve chamber 12 through the port 24, and the valve functions as described with reference to Fig. 3, the upper valve extension 27 opening connection between port 23 on the by-pass side of the piston 14 of the pressure balance valve and the end 29 of the release port 31 a fraction before the lower valve extension 28 makes communication between the lower port 24 and the lower end 30 of the release port 31, thus increasing the out of balance condition and causing the auxiliary valve to shoot up and open the lower end of the release port by the lower valve extension 28, whereupon the solution is released from the delivery side of the measuring pump through the holes 36 on the valve extension 28 and the port 31 to the branch pipe 32 and the feed side of the pilot pump as in Fig. 3.

Conversely when an excess out of balance pressure develops in the upper pressure balance valve chamber 9, the auxiliary piston valve 26 moves down under the pressure exerted through the port 23; the lower valve extension 28 of the auxiliary valve now opens connection between the end 30 of the release port 31 and the port 24 in connection with the lower pressure balance valve chamber 12 a fraction before the upper piston valve extension 27 makes communication between the upper end 29 of the release port and the port 23 from the upper pressure balance valve chamber 9; the out of balance condition is thus increased and causes the piston to shoot down. Communication is now established between the port 23 and the end 29 of the release port through the holes 35 in the upper valve extension 27, and the liquid is released from the upper pressure balance valve chamber 9 to the branch pipe 32 and the feed side of the pilot pump. At the same time the piston 14 of the pressure balance valve moves down until the top edge of the slide valve member 15 uncovers the annular groove 18, thus allowing the solution in the upper chamber 9 of the pressure balance valve to escape back freely to the header. Thus any excess out of balance pressure developing on the

feed side of the measuring pump is released by the auxiliary device and by the pressure balance valve.

It will be seen that in this modification the auxiliary release valve device functions in a similar manner in either direction. In either case when the pressure is released by the auxiliary release valve through the pipe 32 the delivery of the spinning solution to the spinning jet or jets fed by the unit ceases until the cause of the out of balance conditions is obviated or removed. The auxiliary piston 26 may be restored to its neutral position by removing the cause of the out of balance condition and by removing pressure from both upper and lower pressure balance valve chambers in any way e. g. by stopping the pumps.

What I claim and desire to secure by Letters Patent is:—

1. In pumping units of the kind hereinbefore referred to for delivering artificial silk spinning solutions to spinning jets or other applications, comprising a pilot pump of major delivery, a measuring pump of smaller delivery connected in series therewith, and a by-pass for surplus liquid from the feed side of the measuring pump to the feed side of the pilot pump, the combination with the pilot pump and measuring pump and the by-pass, of a pressure balance and by-pass controlling valve, comprising a piston member and a by-pass controlling slide valve member operated by said piston member, said piston member being subjected on its opposite faces respectively to the pressure of the delivery side of the pilot pump and to the pressure of the delivery side of the measuring pump, and said slide valve member being adapted to regulate the by-pass by its movement under normal variations of pressure on the respective sides of the piston member; and means for establishing communication between the delivery side of the measuring pump and the feed side of the pilot pump when an excess out-of-balance pressure is developed on the delivery side of the measuring pump, whereby the excess out-of-balance pressure is released and the liquid permitted to circulate idly in the unit and the delivery from the unit to the point of use ceases.

2. In pumping units of the kind hereinbefore referred to for delivering artificial silk spinning solutions to spinning jets or other applications, comprising a pilot pump of major delivery, a measuring pump of smaller delivery connected in series therewith, and a by-pass for surplus liquid from the feed side of measuring pump to the feed side of the pilot pump, the combination with the pilot pump and measuring pump and the by-pass, of a pressure balance and by-pass controlling valve, comprising a piston member and a by-pass controlling slide valve member operated by said piston member, said piston member being subjected on its opposite faces respec-

tively to the pressure of the delivery side of the pilot pump and to the pressure of the delivery side of the measuring pump, and said slide valve member being adapted to regulate the by-pass by its movement under normal variations of pressure on the respective sides of the piston member; and means for establishing communication between the delivery side of the measuring pump and the feed side of the pilot pump when an excess out-of-balance pressure is developed on the delivery side of the measuring pump, and for establishing free communication between the delivery side of the pilot pump and the feed side of the pilot pump when an excess out-of-balance pressure develops on the delivery side of the pilot pump, whereby in either case the excess out-of-balance pressure is released and the liquid permitted to circulate idly in the unit, and the delivery from the unit to the point of use ceases.

3. In pumping units of the kind hereinbefore referred to for delivering artificial silk spinning solutions to spinning jets or other applications, comprising a pilot pump of major delivery, a measuring pump of smaller delivery connected in series therewith, and a by-pass for surplus liquid from the feed side of the measuring pump to the feed side of the pilot pump, the combination with the pilot pump and measuring pump and the by-pass, of a pressure balance and by-pass controlling valve, comprising a piston member and a by-pass controlling slide valve member operated by said piston member, said piston member being subjected on its opposite faces respectively to the pressure of the delivery side of the pilot pump and to the pressure of the delivery side of the measuring pump, and said slide valve member being adapted to regulate the by-pass by its movement under normal variations of pressure on the respective sides of the piston member, and a communication for permitting escape of liquid from the delivery side of the measuring pump to the feed side of the pilot pump, said communication being closed in normal operation of the pressure balance valve and being adapted to be established by said piston member and slide valve member in their movement under an excess out-of-balance pressure developed on the delivery side of the measuring pump, thereby establishing communication between the delivery side of the measuring pump and the feed side of the pilot pump when an excess out-of-balance pressure is developed on the delivery side of the measuring pump, whereby the excess out-of-balance pressure is released and the liquid permitted to circulate idly in the unit and the delivery from the unit to the point of use ceases.

4. In pumping units of the kind hereinbefore referred to for delivering artificial silk spinning solutions to spinning jets or

other applications, comprising a pilot pump of major delivery, a measuring pump of smaller delivery connected in series therewith, and a by-pass for surplus liquid from the feed side of the measuring pump to the feed side of the pilot pump, the combination with the pilot pump and measuring pump and the by-pass, of a pressure balance and by-pass controlling valve, comprising a piston member and a by-pass controlling slide valve member operated by said piston member, said piston member being subjected on its opposite faces respectively to the pressure of the delivery side of the pilot pump and to the pressure of the delivery side of the measuring pump, and said slide valve member being adapted to regulate the by-pass by its movement under normal variations of pressure on the respective sides of the piston member; and a communication for permitting escape of liquid from the delivery side of the measuring pump to the feed side of the pilot pump, said communication being closed in normal operation of the pressure balance valve and being adapted to be established by said piston member and slide valve member in their movement under an excess out-of-balance pressure developed on the delivery side of the measuring pump, thereby establishing communication between the delivery side of the measuring pump and the feed side of the pilot pump when an excess out-of-balance pressure is developed on the delivery side of the measuring pump, whereby the excess out-of-balance pressure is released and the liquid permitted to circulate idly in the unit and the delivery from the unit to the point of use ceases, said slide valve member and piston member being also adapted in their movement under an excess out-of-balance pressure developed on the delivery side of the pilot pump, to establish free communication between the delivery side of the pilot pump and the feed side of the pilot pump, whereby said excess out-of-balance pressure is likewise released and the liquid permitted to circulate idly in the unit and the delivery from the unit ceases.

5. In a device for feeding a spinning solution to an artificial silk spinning machine, the combination with a pilot pump and a measuring pump of a connection leading from the delivery side of the pilot pump to the feed side of the measuring pump, a pressure balance valve casing, a by-pass leading from the connection between the pilot pump and the measuring pump to an intermediate portion of said pressure balance valve casing, a feed inlet to said pilot pump, a connection between said feed inlet and one end of said pressure balance valve casing, a connection from the delivery side of the measuring pump to the other end of said pressure balance valve casing, an outlet from this last named end of the casing, a piston and a slide

valve member operatively connected thereto in said casing, the piston normally occupying a position to prevent communication between the discharge connection of the measuring pump and the by-pass leading to the connection between the pilot pump and the measuring pump but capable of moving to a position to establish said communication, the slide valve member normally occupying a position to permit communication between said feed inlet to the pilot pump and the by-pass leading to the connection between the pilot pump and the measuring pump but capable of moving to a position to close said communication.

6. In a device for feeding a spinning solution to an artificial silk spinning machine, the combination with a pilot pump and a measuring pump of a connection leading from the delivery side of the pilot pump to the feed side of the measuring pump, a pressure balance valve casing, a by-pass leading from the connection between the pilot pump and the measuring pump to an intermediate portion of said pressure balance valve casing, a feed inlet to said pilot pump, a connection between said feed inlet and one end of said pressure balance valve casing, a connection from the delivery side of the measuring pump to the other end of said pressure balance valve casing, an outlet from this last named end of the casing, a piston and a slide valve member operatively connected thereto in said casing, the piston normally occupying a position to prevent communication between the discharge connection of the measuring pump and the by-pass leading to the connection between the pilot pump and the measuring pump but capable of moving to a position to establish said communication, the slide valve member having an opening in communication with said by-pass connection and adapted normally to register with a passageway communicating with the connection between the pilot pump and the measuring pump, said slide valve member being capable to move to a position wherein the said opening in the slide valve member does not register with said passageway.

In testimony whereof I have hereunto subscribed my name.

EDWARD KINSELLA.