Oct. 25, 1932. E. KINSELLA 1,884,739

PUMPING APPARATUS

Filed Dec. 1, 1928 3 Sheets-Sheet 1

FIG. 1.

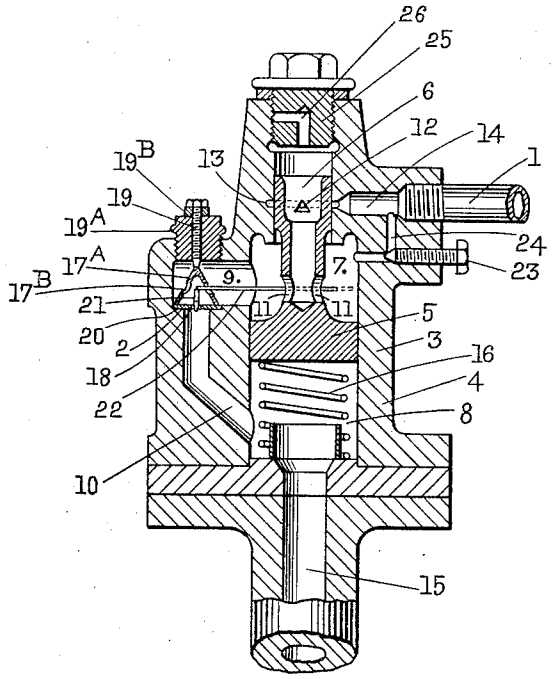
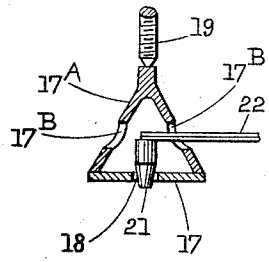


FIG. 2.



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FIG. 3.

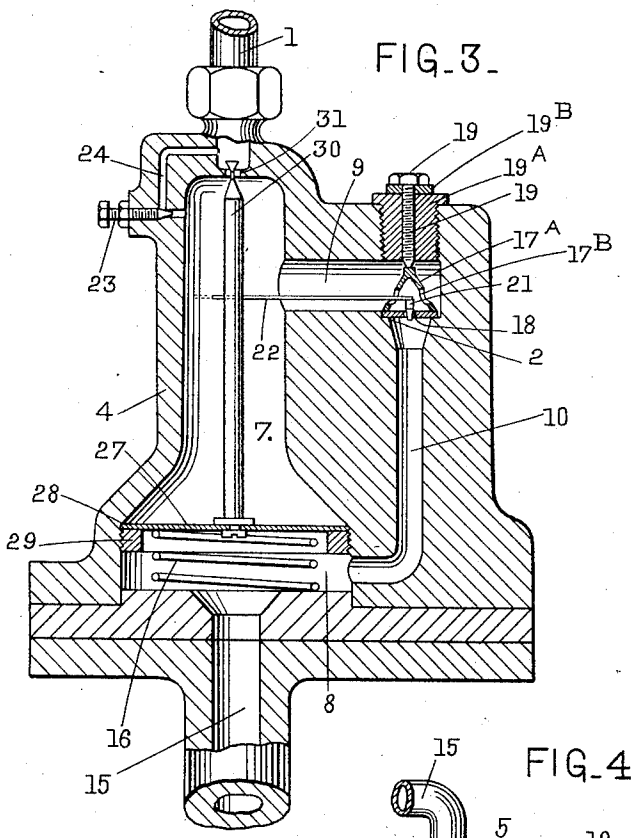
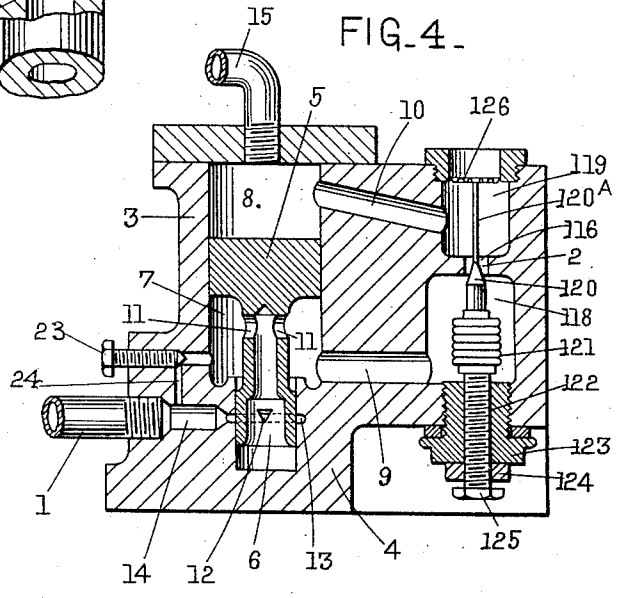


FIG. 4.



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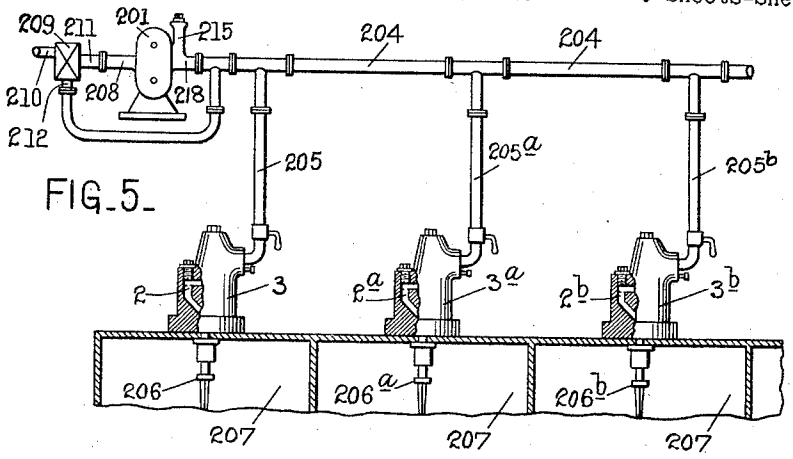


FIG. 5.

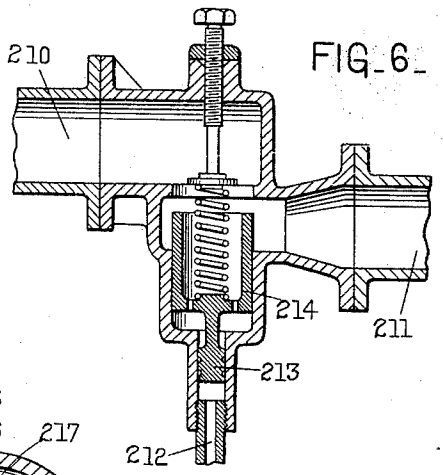
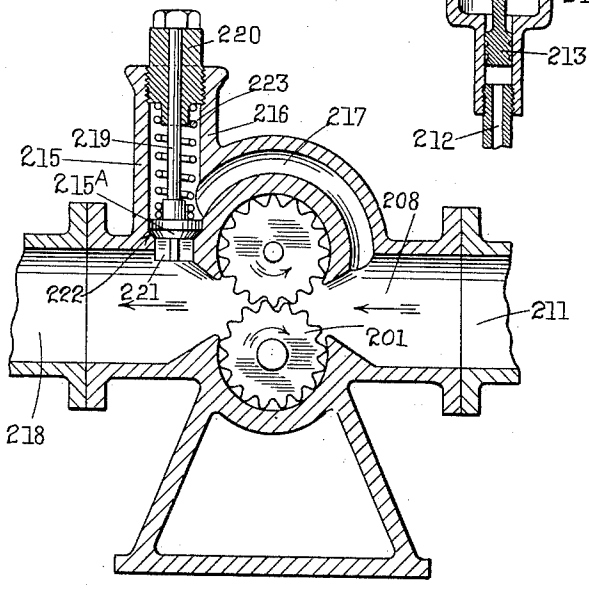


FIG. 6.

FIG. 7.



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Patented Oct. 25, 1932 1,884,739

UNITED STATES PATENT OFFICE

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PUMPING APPARATUS

Application filed December 1, 1928, Serial No. 323,148, and in Great Britain December 17, 1927.

This invention relates to pumping apparatus for delivering artificial silk spinning solutions or other applications (especially such applications as require liquids or solutions to be delivered under pressure with a high degree of regularity).

Pumping apparatus according to the present invention comprises a source of pressure communicating with one or more static measuring devices, the communication from the source of pressure to each static measuring device being made through one side of a pressure balance valve, the motor member of which pressure balance valve is subjected on this side to the pressure of the inlet side of the static measuring device and is subjected on the other side to the pressure of the delivery side of the static measuring device and of the spinning jet or jets or other points of use, which motor member carries or is arranged to operate a valve member of the pressure balance valve to control the amount of spinning solution or other liquid fed to the static measuring device from the source of pressure. With such apparatus the spinning solution or other fluid may be delivered with a high degree of regularity.

Any suitable means may be employed to provide a definite and substantially unvarying pressure difference across the static measuring device i. e. between the two sides thereof,—irrespective of the pressure required to overcome the resistance of the point of use,—and for compensating for the drop in pressure occurring in the spinning solution or other fluid in its passage through the static measuring device, and thus by this compensation enabling a balance of pressures to be established against the respective sides of the motor member of the pressure balance valve. For instance the piston, diaphragm or other motor member of the pressure balance valve may be adapted to work against the pressure of a spring, or for instance the piston of the pressure balance valve may be adapted to work against the force of gravity.

Apparatus according to the invention may comprise one or any desired number of measuring or flow controlling units fed from a single source of pressure and each comprising a static measuring device with its appurtenant pressure balance valve arranged in combination as referred to.

In performing the invention, I may employ any suitable means as the source of pressure, as for instance one or more pumps of the gear wheel, piston, ram or other type, one or more pressure vessels or one or more rams, or any other known means for supplying liquids under pressure, and in the case of spinning artificial silk or other operations requiring a high degree of regularity of delivery, I preferably employ one or more pumps of the gear wheel type as the source of pressure.

Preferably, especially in the spinning of artificial silk or other operations requiring delivery of the spinning solution or other fluid to a large number of jets or other points of use, I employ a number of the measuring or flow controlling units with their static measuring devices each communicating as referred to with a single or common source of pressure, and preferably I employ one measuring or flow controlling unit for each artificial silk spinning nozzle or other point of use.

If desired, any suitable means may be provided for the purpose of ensuring uniformity of pressure in the delivery from the source of pressure, thus, for example, one or more release valves may be provided in the line or lines leading from the source of pressure. Or for example there may be provided one or more piston, diaphragm or other control valves adapted to operate under the pressure of the delivery from the source of pressure and control the supply of spinning solution or other fluid to the pump or other source of pressure; or there may be provided, instead of or in conjunction with such control valve or valves, one or more valves adapted to operate under an excess of pressure in the delivery from the source of pressure and by-pass the excess from the line or lines leading from the source of pressure back to the inlet of the source of pressure. Further, if desired, in addition to any of such means, one or more air vessels may be provided in the

line or lines leading from the source of pressure.

The accompanying drawings serve to illustrate forms of execution of the present invention, it being understood that they are given only by way of example and are in no way limitative.

Figure 1 shows in vertical section one form of measuring or flow controlling unit constructed in accordance with the invention.

Figure 2 is a sectional view of part of the apparatus shown in Figure 1 and showing the static measuring device on an enlarged scale.

Figure 3 shows in vertical section a form of measuring or flow controlling unit similar to that shown in Figures 1 and 2, but the unit shown in Figure 3 comprises a pressure balance valve of the diaphragm type.

Figure 4 shows in vertical section a form of measuring or flow controlling unit similar to that shown in Figures 1 and 2, but in the unit shown in Figure 4 a heavy piston working against gravity is employed in the pressure balance valve instead of a piston working against a spring; and as the temperature compensator device a valve operated by a spirit capsule is employed instead of a valve operated by a bi-metal strip.

Figure 5 is a diagrammatic view illustrating apparatus according to the invention applied to a metier or cabinet for the spinning of artificial silk by the dry or evaporative method of formation.

Figure 6 is a vertical sectional view of the valve 209 diagrammatically shown in Figure 5, this valve being utilized to ensure uniformity of pressure in the delivery from the source of pressure.

Figure 7 is a vertical sectional view of the pump 201 and by-pass valve 215 diagrammatically shown in Figure 5.

Referring to Figures 1 and 2, 1 is the supply pipe leading from the source of pressure (not shown in the figure) which may for instance be a pump of the gear wheel type and which may feed any desired number of measuring or flow controlling units constructed in accordance with Figure 1, for instance through a common header or main supply pipe. 2 indicates the static measuring device, this in the case illustrated being of the orifice type. 3 is the piston pressure balance valve. The casing 4 of the piston pressure balance valve is formed with two bores of different diameters, and has a piston 5 working in the lower and larger bore, which piston carries a hollow slide valve member 6 working in the upper and smaller bore. The casing may, if desired, be bored to a uniform diameter instead of to two different diameters, but I have found the form shown to be advantageous when dealing with artificial silk spinning solutions or other fluids requiring great sensitivity of control. The piston 5 divides the interior of the valve casing 4 into an upper chamber 7 and a lower chamber 8, these chambers communicating respectively by the ports 9 and 10 with the inlet and delivery of the static measuring device 2. The upper chamber 7 also communicates with the supply pipe 1 (and hence with the source of pressure) via the holes 11 in the hollow slide valve member 6, the interior of this member, a hole or holes such as 12 in the slide valve member 6, an annular groove 13 in the casing 4, and the port 14 opening from the supply pipe 1. The lower chamber 8 communicates via the port 15 with the spinning jet or jets or other point of use served by the unit. The slide valve member 6 may be provided with any desired number of holes 12 (one or more) which may be of any suitable shape or form, for instance triangular or rectangular, and by the positioning of this hole or holes relatively to the annular groove 13 the slide valve member controls the amount of spinning solution or other fluid fed from the source of pressure to the static measuring device.

It will be seen that the source of pressure communicates with the static measuring device 2, the communication to the static measuring device being made through one side of a pressure balance valve 3, the motor member (piston 5) of which is subjected on this side to the pressure of the inlet side of the static measuring device 2 and on the other side to the pressure common to the delivery side of the static measuring device 2 and to the spinning jet or jets or other points of use, the motor member (piston 5) operating the slide valve member 6 to control the amount of fluid fed to the static measuring device from the source of pressure.

The static measuring device 2 (shown on a larger scale in Figure 2) comprises a disc 17 which is formed with an orifice 18, which orifice constitutes the true static measuring device. The disc 17 is held between the annular shoulder 20 in the casing 4 and the conical cage member 17A formed with holes 17B. The cage member 17A is pressed against the disc 17 by means of a screw 19 passing through the screw plug 19A and provided with a lock nut 19B. If desired the disc 17 may be simply brazed or soldered to the shoulder 20 and the member 17A be omitted, but the method above described for fitting the disc 17 permits of readily changing the disc 17.

The piston 5 works against the pressure of the spring 16, the pressure of this spring serving to establish the desired pressure difference across the static measuring device 2, and, by serving to compensate for the drop in pressure occurring in the spinning solution or other fluid in its passage through the static measuring device, enabling a balance of pres-

sures to be established against the respective sides of the piston 5.

In normal operation the spinning solution or other fluid passes from the source of pressure to the supply pipe 1, through the port 14, annular groove 13, and the hole or holes 12 into the hollow slide valve member 6, thence out through the holes 11 into the upper chamber 7 of the piston pressure balance valve, and through the port 9, through the holes 17B, through the orifice 18 of the static measuring device 2, the port 10, the lower chamber 8 of the pressure balance valve and the port 15 to the spinning jet or jets or other point or points of use.

With the arrangement shown, substantially only the correct amount of spinning solution or other fluid required is permitted to be fed to the static measuring device, as any pressure in the upper chamber 7 in excess of the pressure in the lower chamber 8 (i. e. the pressure of the fluid in the lower chamber plus the pressure of the spring 16) causes the piston 5 to move downwards and reduce the amount of fluid admitted, by restricting the aperture between the hole or holes 12 and the annular groove 13, the piston 5 moving downwards until a balance of pressures is created on the respective sides of the piston 5; conversely, if the resistance in the spinning jet or other points of use rises (due for instance to partial choking) it means that the pressure in the lower chamber 8 must also rise to overcome this resistance; this causes the piston 5 to move upwards and increase the aperture between the hole or holes 12 and the annular groove 13 sufficiently to restore the balance of pressures, the pressure of the fluid in each of the chambers 7 and 8 being higher than before. So long as the total pressures against the respective sides of the piston 5 are equal, the pressure on the delivery side of the static measuring device is always substantially that required to feed the measured quantity of fluid to the spinning jet or jets or other points of use.

If an abnormal or excess out-of-balance pressure develops on the delivery side of the static measuring device (due for instance to a spinning jet or other point of use becoming badly choked) such that the resistance in the delivery rises above the pressure capacity of the header, the piston 5 and slide valve member will move up sufficiently to close the aperture between the hole or holes 12 and the annular groove 13, thus cutting off communication between the source of pressure and the static measuring device, the unit ceasing to deliver the spinning solution or other fluid to the spinning jet or jets or other points of use until the cause of the out-of-balance condition is removed.

Conversely, if an abnormal or excess out-of-balance pressure develops in the supply from the source of pressure, the piston 5 will descend to such an extent that the aperture between the hole or holes 12 and the annular groove 13 is closed, thereby cutting off the communication between the static measuring device and the source of pressure, the unit ceasing to deliver until the cause of the out-of-balance condition is removed.

In the form shown in this figure means are provided to ensure constant delivery from the unit under variation of temperature when employing liquids (especially solutions of cellulose acetate or other cellulose derivatives in volatile solvents) the viscosity of which decreases with an increase of temperature. As such means a small valve 21 operated by the bi-metal strip 22 (for example of brass and iron) is provided to control the orifice 18 of the static measuring device, the valve 21 being fixed to one end of the bi-metal strip 22 the other end of which is fixed to the casing 4. Any increase in temperature causes the bi-metal strip to lower the valve 21 to restrict the aperture between the valve 21 and the orifice 18, and conversely, decrease in temperature causes the bi-metal strip to raise the valve 21 and enlarge the aperture between the valve 21 and the orifice 18.

For starting up the unit when the valve 6 is closed—for instance when starting up the unit initially or after removal of the cause of either of the before mentioned abnormal or excess out-of-balance conditions—the screw valve member 23 is temporarily opened to allow fluid to pass from the supply pipe 1 via the passage 24 into the upper chamber 7. Fluid so passing into the chamber 7 passes via the static measuring device to the lower chamber 8 and moves the piston 5 to open the valve 6 and put the unit in operation.

The apparatus shown in Figure 1 is provided with a screw plug 25 provided with a channel 26. On first starting the unit or on restarting the unit after it has become emptied of fluid, the plug 25 may be unscrewed sufficiently for the channel 26 to communicate with the atmosphere, thus enabling air in the unit to be displaced by the spinning solution or other fluid, and when the unit is full of fluid the plug 25 is screwed down to close the channel 26.

Referring to Figure 3, this figure shows a form of measuring unit similar in form and operation to that shown in Figures 1 and 2, similar numerals in Figure 3 indicating corresponding parts in Figures 1 and 2, but in Figure 3 a diaphragm operating a double conical valve member is employed to control the communication between the source of pressure and the static measuring device. The diaphragm 27 is held between the annular shoulder 28 of the casing 4 and the threaded ring 29, and carries a double conical valve member 30 operating in the throat 31. Under normal conditions of operation the control of the communication between the supply

pipe 1 (and hence the source of pressure) and the static measuring device 4 is effected by the positioning of the upper cone of the double conical valve member 30 relatively to the throat 31.

It should be noted that the lower cone of the conical valve member 30 is situated at a relatively large distance from the throat 31 and this lower cone only functions to restrict the throat 31 when an abnormal or excess out-of-balance pressure occurs in the lower chamber 8.

The double conical valve member 30 is arranged to cut off the communication between the source of pressure and the static measuring device when an excess out of balance pressure develops either on the delivery side of the static measuring device or in the supply from the source of pressure. In the former case the diaphragm acting under the excess out of balance pressure moves up sufficiently for the lower cone of the double conical valve member 30 to close the throat 31, whilst in the latter case the diaphragm acting under the excess out of balance pressure moves down sufficiently for the upper cone of the double conical valve member 30 to close the throat 31, thereby in each case cutting off communication between the source of pressure and the static measuring device, the unit ceasing to deliver until the cause of the excess out of balance pressure is removed.

For starting up the unit when the throat 31 is closed either by the upper or lower cone of the double conical valve member 30—for instance when starting up the unit initially or after the removal of the cause of either of the before mentioned out-of-balance conditions—the screw valve member 23 is temporarily opened to allow fluid to pass from the supply pipe via the passage 24 into the upper chamber 7. Fluid so passing into the chamber 7 passes via the static measuring device to the lower chamber 8 and moves the diaphragm 27 and hence the double conical valve member 30 to open the throat 31 and put the unit in operation.

Figure 4 shows a form of measuring or flow controlling unit similar to that shown in Figure 1, similar numerals in Figure 4 denoting corresponding parts in Figure 1. In the form shown in Figure 4, however, the static measuring device 2 is of a somewhat different form being constituted by a circular orifice 116 between the bores 118 and 119 (which communicate respectively with the ports 9 and 10) in the casing 4, and the orifice 116 is provided with a temperature compensating device operated by a collapsible metal capsule, which device will be hereinafter more fully described. Further, in the form shown in Figure 4 the piston 5 does not operate against a spring but is of substantial weight and operates against gravity.

The piston 5 thus serves to establish the desired pressure difference across the orifice 116 and serves to compensate for the drop of pressure occurring in the spinning solution or other fluid in its passage through the static measuring device, and thus enables a balance of pressures to be established on the respective sides of the piston 5.

In normal operation and also in the cutting off of the communication between the static measuring device 2 and the source of pressure on development of an excess out of balance pressure in either the chamber 8 or the chamber 9, the piston 5 and slide valve member 6 operate in a similar manner to the corresponding parts shown in Figure 1, though of course their direction of movement in any particular circumstance will be opposite, since the unit shown in Figure 4 is inverted to enable the piston 5 to operate under gravity for the purpose hereinbefore indicated.

In the form shown in Figure 4 means are provided to ensure constant delivery from the unit under variations of temperature when employing liquids (especially solutions of cellulose acetate or other cellulose derivatives in volatile solvents) the viscosity of which decreases with an increase of temperature. As such means a small valve 120 operated by the collapsible metal capsule 121 is provided to control the orifice 116 of the static measuring device. The valve member 120 is fixed to the collapsible metal capsule 121, which contains a quantity of paraffin oil, methylated spirit, ether or other suitable liquid, the capsule being fixed to a threaded rod 122 passing through the plug 123 in the casing 4. By adjusting the nut 125 and the lock nut 124 the position of the valve member 120 may be adjusted or set relatively to the orifice 116. The valve member 120 is also fitted to or formed with a rod 120A which is fitted to the diaphragm 126, which diaphragm is exposed on its upper face to the pressure of the atmosphere and on its lower face to the pressure of the fluid in the chamber 119, the diaphragm thereby serving to obviate operation of the valve member 120 under changes of pressure in the spinning solution or other fluid. Should the temperature of the fluid in the unit increase the metal capsule 121 is expanded by vapor of the liquid contained therein and raises the valve member 120 to restrict the orifice 116 by the required amount; conversely, if the temperature of the fluid in the unit decreases the metal capsule 121 is contracted and increases the aperture between the valve member 120 and the orifice 116 by the required amount.

For starting up the unit when the valve 6 is closed, for instance when starting up the unit initially or after removal of the cause of either of the before mentioned excess out-of-balance conditions—the screw valve member 23 is temporarily opened to allow fluid to pass from the supply pipe 1 via the port

24 into the lower chamber 7 to raise the piston 5 and put the unit into operation.

Figures 5, 6 and 7 illustrate diagrammatically a form of the invention applied to a metier or cabinet for the spinning of artificial silk by the dry or evaporative method of formation. In the form shown in these figures the pressure of the delivery from the source of pressure is kept uniform by means of a control valve adapted to operate under the delivery from the source of pressure to control the supply of fluid to the source of pressure and by means of a by-passing valve adapted to operate under an excess pressure in the delivery from the source of pressure to by-pass the excess back to the inlet to the source of pressure. If desired the by-passing valve may be omitted, but we have found its use to be advantageous with artificial silk solutions (or other solutions) the viscosity of which may cause the control valve to be sluggish in action, especially under sudden changes of pressure in the delivery from the source of pressure.

In Figure 5, 201 is a pump of the gear wheel type and constitutes the source of pressure, 3, 3*a*, 3*b* are the pressure balance valves (shown partly broken away in the figure) and 2, 2*a*, 2*b* the static measuring devices of the respective measuring or flow controlling units, these measuring or flow controlling units being constructed and adapted to operate precisely as described in reference to Figures 1 and 2, or Figure 3 or Figure 4.

The spinning solution passes from the source of pressure 201 via the header or supply pipe 204 to the branch pipes 205, 205*a*, 205*b* and thence respectively through the pressure balance valves 3, 3*a*, 3*b* and their respective static measuring devices 2, 2*a*, 2*b* to the spinning jets 206, 206*a*, 206*b* supplied by the respective measuring or flow controlling units, these jets extruding the solution into the spinning metier or cabinet 207 where the artificial silk filaments are formed by the evaporation of the volatile solvent in the known manner. Should the supply of fluid from one or more of the branch pipes 205, 205*a* or 205*b* to the respective static measuring devices be cut off due to development of an excess out-of-balance pressure in either the upper or lower chamber of the respective pressure balance valves, the delivery from the unit or units concerned will cease until the cause of the out-of-balance condition is removed.

The means for ensuring uniformity of pressure in the delivery from the source of pressure consists in a control valve 209 of which Figure 6 is a sectional elevation on an enlarged scale, and a by-passing valve 215 which is shown together with the source of pressure 201 on a larger scale in vertical section in Figure 7. Referring to Figures 5 and 6 the controlling valve 209 is shown in connection with the header 204 and with the inlet 208 to the source of pressure, this valve being adapted to operate under the pressure of the delivery from the source of pressure to control the supply of spinning solution to the source of pressure. The valve 209 has three ports 210, 211 and 212 of which ports 210 is connected to the supply of spinning solution, 211 to the inlet to the pump 201 forming the source of pressure, and 212 to the header 204. The controlling valve 209 comprises a piston 213 and a slide valve 214 carried thereby (see Figure 6); the spinning solution from the source of supply (not shown) passes through the port 210 and thence through the port 211 to the inlet 208 of the pump 201 forming the source of pressure. Should the pressure in the delivery from the source of pressure rise (due for instance to the development of an excess out-of-balance pressure in either upper or lower chamber of one or more of the pressure balance valves or to otherwise stopping the supply to one or more of the measuring or flow controlling units) the pressure of the delivery from the source of pressure, acting through the port 212 causes the piston 213 and slide valve 214 carried thereby to rise, thus restricting the supply of spinning solution to the pump 1 forming the source of pressure. Similarly any decrease in the pressure of the delivery from the source of pressure causes the piston 213 and the slide valve 214 to descend, thus increasing the supply of spinning solution to the source of pressure.

Referring to Figures 5 and 7, the gear wheel pump 201 constituting the source of pressure is provided with a by-passing valve 215 this valve having a valve member 215*a* working in the bore of the casing 216 of the pump 201 and controlling the port or channel 217 between the inlet port 208 and the outlet port 216. The valve member 215*a* is guided by its stem 219 working in the guide 220 and by its lower extension (of cruciform section) 221 working in the bore of the casing 216, and is pressed on to its seating 222 by the spring 223. Should the controlling valve 209 be sluggish in action or fail to prevent an excess pressure from developing in the delivery from the source of pressure the excess pressure acting through the outlet port 218 raises the valve member 215*a* off its seating 222 against the pressure of the spring 223 and releases the excess pressure through the channel or port 217 back to the ports forming the inlet to the source of pressure.

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

1. Apparatus for delivering artificial silk spinning solutions or other fluids, comprising a source of pressure, at least one flow controlling unit itself comprising a static measuring device being an orifice of determined dimensions and a communication between said

static measuring device and the source of pressure, the flow controlling unit itself comprising besides said static measuring device a pressure balance valve, whereof the pressure balance valve comprises (*a*) a motor member subjected on the one side to the pressure of the inlet side of the static measuring device and on the other side to the pressure common to the delivery side of the static measuring device and to the delivery from the flow controlling unit and (*b*) a valve member operatively connected to said motor member and arranged to control the supply of fluid to the static measuring device of the flow controlling unit and means for establishing a given pressure difference across the static measuring device and for compensating for the drop in pressure of the fluid in its passage through said device, thereby enabling a balance of pressures to be established on the respective sides of the motor member of the pressure balance valve.

2. Apparatus for delivering artificial silk spinning solutions or other fluids comprising a source of pressure, at least one flow controlling unit and a communication between the same and the source of pressure, the flow controlling unit itself comprising a pressure balance valve and a static measuring device being an orifice of determined dimensions, the inlet side of which static measuring device communicates with said source of pressure through one side of said pressure balance valve, the pressure balance valve comprising (*a*) a motor member subjected on the one side to the pressure of the inlet side of the static measuring device and on the other side to the pressure common to the delivery side of the static measuring device and to the delivery from the flow controlling unit and (*b*) a valve member operatively connected to said motor member and arranged to control the supply of fluid to the flow controlling unit, and means for establishing a given pressure difference across the static measuring device and for compensating for the drop in pressure of the fluid in its passage through said device, thereby enabling a balance of pressures to be established on the respective sides of the motor member of the pressure balance valve.

3. Apparatus according to claim 2 and wherein the valve member of the pressure balance valve is arranged to close the communication between the source of pressure and the flow controlling unit when an excess out of balance pressure develops on the delivery side of the static measuring device.

4. Apparatus according to claim 2 and wherein the valve member of the pressure balance valve is arranged to close the communication between the source of pressure and the flow controlling unit both when an excess out of balance pressure develops on the delivery side of the static measuring device and when an excess out of balance pressure develops on the inlet side of the static measuring device.

5. Apparatus according to claim 2 and comprising as means for establishing the given pressure difference across the static measuring device and for compensating for the drop in pressure of the fluid in its passage through said device, a spring acting upon the motor member of the pressure balance valve.

6. Apparatus according to claim 2 and wherein said flow controlling unit further comprises a compensating device adapted to operate under variations of temperature to control the orifice forming the static measuring device and thereby secure constant flow through said device under variations of temperature.

7. Apparatus according to claim 2 and wherein said flow controlling unit further comprises a compensating device adapted to operate under variations of temperature to control the orifice forming the static measuring device and thereby secure constant flow through said device under variations of temperature, said compensating device comprising a valve member controlling said orifice and a bi-metal strip secured on the one end and carrying said valve member on the other end.

8. Apparatus according to claim 2 and comprising a plurality of flow controlling units connected to a common source of pressure and means for ensuring uniformity of pressure in the delivery from the source of pressure.

In testimony whereof I have hereunto subscribed my name.

EDWARD KINSELLA.