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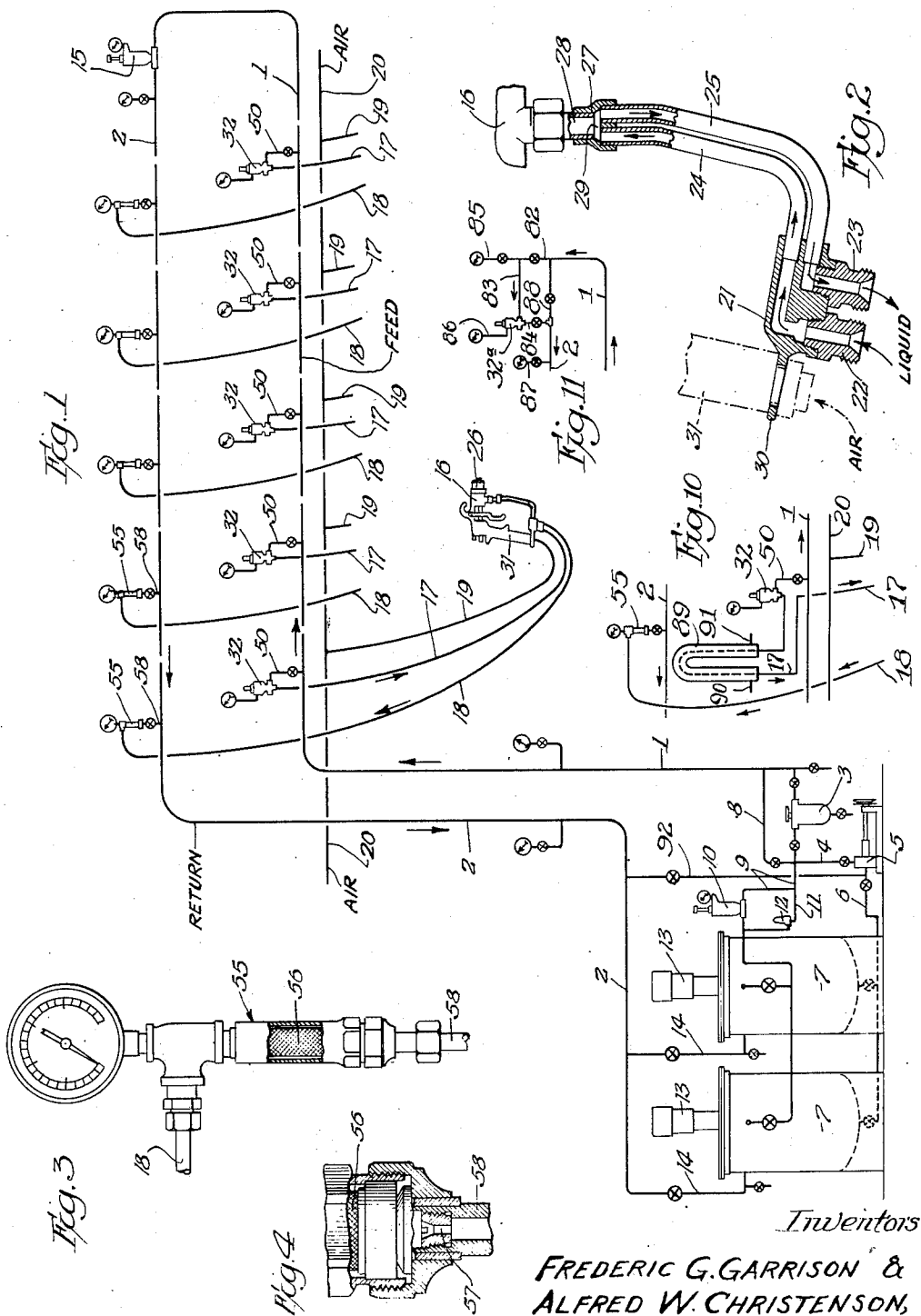
F. G. GARRISON ET AL.

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MEANS FOR DISTRIBUTING AND CIRCULATING LIQUID MATERIAL

Filed Dec. 24, 1938

2 Sheets-Sheet 1



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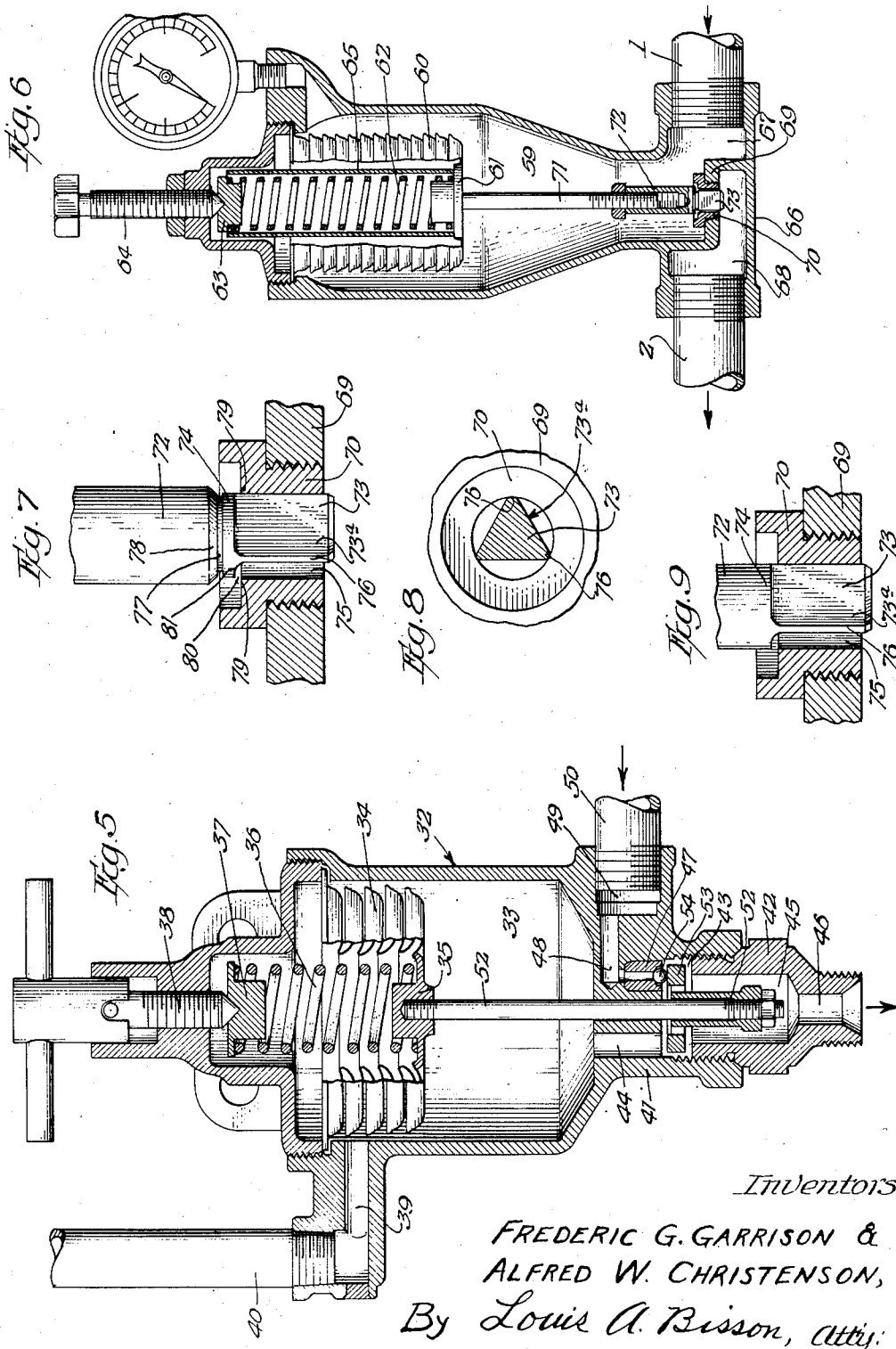
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UNITED STATES PATENT OFFICE

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MEANS FOR DISTRIBUTING AND CIRCULATING LIQUID MATERIAL

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3 Claims. (Cl. 91-45)

The present invention relates to systems for distributing fluidal material, including various coating materials, such as paints, enamels, lacquers, or the like, and has reference more particularly to a system of the circulating type.

Coating materials are supplied under pressure through pipe lines extending along stations where the material is applied to the objects at the stations, as by means of spray guns, there being a pipe line for each character of material, and a spray gun at each station for each pipe line. The spray guns are usually connected by supply ducts, such as hoses, to the pipe lines at the stations. At such times as when any of the spray guns are not being operated (to spray) the material in the supply duct to such gun remains dormant and there is a settling of the pigment or like particles thus forming a sediment. When next the gun is put into operation there is at first a spraying of material of improper character or condition, and if applied immediately to the surface of the object to be coated or treated, the job is spoiled. To avoid this, it is necessary to initially project the material to one side until the duct is cleared of the dissociated components of the material therein before the proper material arrives at the gun, thus causing a waste of material and loss of time. Moreover, just when the improper material is cleared and the proper material arrives at the gun involves an element of judgment on the part of the workman, which is very uncertain and inaccurate.

The present invention comprehends the provision of a novel means for distributing the material with a constant circulation of the material so that at any and every point of the system the material is homogeneous and of correct condition and character for immediate use, without any waste, at any instant the gun is to be operated. The circulating and the maintaining of the proper condition of the material continue regardless of whether or not the gun is being operated.

More particularly, each pipe line is in the form of a main circuit comprising a supply main or circuit portion and a return main or circuit portion, with regulating valves for sustaining the proper pressures in the circuit portions as also to maintain a circulating flow of the material in the line. Also, for each gun at each station for each line there is a shunt or cross-circuit wherein there is a continual flow of the material from the station point of the supply circuit portion to the corresponding point of the return circuit portion and by way of the gun, together with

regulating means for sustaining the predetermined pressure at the gun and for maintaining the flow of material in the cross circuit. By keeping the material in motion or movement in these ways, it has no chance to settle and form any sediment, and it is always in proper condition for use at any instant when call is made therefor at the gun.

The invention also comprehends novel regulating means connected in the system for sustaining the predetermined pressures therein and for maintaining a circulation as explained herein.

Other objects, advantages, capabilities, features, or the like are comprehended by the invention as will later appear and as are inherently possessed by the invention.

Referring to the drawings:

Fig. 1 is a diagrammatic view of the circulating distributing system;

Fig. 2 is a view partly in elevation and partly in section, on an enlarged scale, of the by-pass circulating connection to the spray gun;

Fig. 3 is a view in elevation with parts shown in section of a pressure control unit in each circulating by-pass;

Fig. 4 is a fragmentary sectional view, on an enlarged scale, of the orifice part of the pressure control unit shown in Fig. 3;

Fig. 5 is a sectional view, on an enlarged scale, of a pressure regulator connected in each circulating by-pass to each spray gun;

Fig. 6 is a sectional view on an enlarged scale, of a modulating valve for regulating the pressures in each circuit on both sides of the valve, such as on the feed or supply side and the return side;

Fig. 7 is a fragmentary part sectional view, on an enlarged scale, of the valve part of the modulating valve;

Fig. 8 is a bottom plan view of the means shown in Fig. 7;

Fig. 9 is a view similar to Fig. 7 of an alternative form of valve means;

Fig. 10 is a fragmentary diagrammatic view of part of the system showing the use of heating means for heating the material in the cross-circuits before the material proceeds to the spray gun; and

Fig. 11 is a similar view showing an alternative construction at the end of the system where the material passes from the supply circuit portion to the return circuit portion and using a control valve of the pressure reducing type for main-

taining a uniform pressure on the discharge side thereof and in the return circuit portion.

Referring more in detail to the drawings, the diagram of Fig. 1 shows schematically a circuit illustrative of any number of circuits, each alike and each circulating a liquid or similar material of given character, such as a paint of a certain color, or other characteristic. Each circuit comprises a main feed pipe line 1 and a main return pipe line 2.

The feed line 1 is connected by way of a suitable filter 3 and a pump discharge main 4 to a suitably operated pump 5. The pump has an intake 6 connected to the lower end of one or more material containers 7. A by-pass pipe 8 may be connected to the pump discharge pipe 4 and the feed main 1 to by-pass the material whenever it is necessary to clean the filter.

From the pump discharge 4 runs a feed back pipe 9 by way of a modulating valve 10 to and into the upper part of the tank 7, for the feed-back or recirculation of the material in excess of that needed in the main line 1, the modulating valve 10 being so adjusted as to maintain a given pressure in the main line 1 and also to vary the surplus return or feed-back flow of material to the tank 7 inversely with the demand made on the main line 1. There is also connected a relief circuit 11 with a suitable relief valve 12 between the pump discharge 4 and the tank 7 so that should the pressure increase to an unsafe point, the material will be released to the tank 7 by the opening of the relief valve.

Each container 7 has a suitable agitator (not shown) operated by a suitable motor 13 on the container for constantly maintaining the material in homogeneous condition. The return line 2 is connected by way of valved pipes 14 to the upper part of the tanks 7. At the end of the feed line circuit portion 1 and at the beginning of the return line circuit portion 2 is connected a modulating valve 15 which may be so adjusted as to maintain the desired pressures in the feed main 1 and the return main 2 by automatically regulating or varying the flow of material from the feed to the return main so that there will be maintained a continual flow of material in the circuit under all conditions of demand on the main circuit portion 1, it being important that there be no cessation of circulation in the circuit. While a modulating valve 15 is shown, it is to be understood that in lieu thereof an orifice means, such as is shown in Fig. 4 and later described, may be used, particularly when there is no great fluctuation in pressure in the main circuit portion 1, so long as there is always a flow in the circuits so as to maintain a continual circulation of the material, and for the purpose of maintaining such low pressure in the return circuit portion 2 as will always be below the pressure of the material passing thereto from the cross-circuits of the guns, later more fully described.

Along the line of each circuit are connected any number of spray guns 16; a gun to each spray station, and each gun is connected by a material supply duct 17, such as a hose, to the feed main 1 at a point corresponding to the spray station for that gun, and also is connected by a material by-pass or cross-circuit duct 18, such as a hose, leading to the return main 2 at a point also corresponding to the spray station. The gun is also connected by an air supply duct 19, such as a hose, to a pressure air supply main 20,

also at a point corresponding with the spraying station.

The material ducts 17 and 18 are connected to the gun 10 by the means more fully shown in Fig. 2. This means comprises a double ported fitting 21 to which are connected couplings 22 and 23 for the ducts 17 and 18 respectively. From the fitting 21 extend pipes or tubes 24 and 25 which are connected at their upper ends to the gun 16 as close as possible to the nozzle 26 (Fig. 1) of the gun, by way of a coupling means 27 secured to the material inlet 28 for the gun. A chamber 29 is provided in the coupling 27 with which communicate both tubes 24 and 25. The fitting 21 has an apertured extension 30 through which the air duct 19 may extend for connection to the air passage carried by the gun handle 31.

Heretofore, the material supply ducts from the supply main to the guns constituted dead ends when the guns were not being operated. When flow ceased in such dead ends the material particles, such as the pigment particles, would settle in the form of sediment or the like. When a gun was next operated the material first projected from the gun would be of improper character. It was necessary for the workman to turn the gun to one side and project sufficient material to the extent or point where the properly conditioned material could then be sprayed. This resulted in waste of material and time of the workman. Moreover, just when the material of proper condition or character arrived at the gun nozzle was left to the judgment of the workman who was not skilled to determine that. Besides, since he was limited for time he would not wait long enough, and the job would be spoiled.

By the present invention the material is constantly circulating in the connections to the gun, regardless of the gun being idle or used. The flow is from the main 1 by way of the duct 17, coupling 22, one of the passages in the fitting 21, tube 24, to chamber 29, and thence to tube 25, the other passage in the fitting 21, coupling 23, and duct 18 to the return main 2. By also connecting the chambered coupling 27 as close to the nozzle 26 as possible, there is but a negligible amount of material in the passage from the coupling 27 to the tip of the gun nozzle, and there can be no settling of the material particles, the passage being small. In this way, there is always available at the gun nozzle, when the gun is operated, a homogeneous material with the correct proportion of the suspended particles to the vehicle therefor.

In each supply duct 17 is connected a pressure regulating valve 32 at the point of connection of the duct 17 with the supply main 1. See Figs. 1 and 5. This valve is shown in detail in Fig. 5. It so controls the pressure of the material at the gun that the material is sprayed initially at the same pressure as during the spray interval of time so that there is no spurt at the start of spraying.

This valve comprises a chamber 33 in which is suitably clamped a Sylphon bellows 34 having an end plate 35 acted upon by a spring 36 pressed by a pressure cap 37 abutting the end of an adjusting screw 38 suitably threaded in the upper end of the device. From the chamber 36 runs a gauge passage 39 to a gauge tube 40.

The lower end of the chamber 36 has an extension 41 to which is connected a coupling means 42. The extension has a chamber 43 communicating with the chamber 36 by way of a passage

44 and directly in communication with a chamber 45 provided in the coupling 42, the latter having an outlet 46 leading to the supply duct 17. In the extension 41 is provided a ported valve seat member 47 in communication with a passage 48 leading from inlet 49 in which is connected a pipe or duct 50 in turn connected to the supply main 1.

To the plate 35 of the bellows is secured a rod 51 which extends slidably in a bored part of the extension 41 and has secured at its lower end a hub 52 of a valve retainer 53 of spider form. On the retainer 53 is freely supported a ball valve 54 operative in a recessed lower end of the member 47 and adapted to control the port thereof.

As the bellows 34 contracts or expands under variations of pressure of the material in the chamber 33, the retainer 53 rises or falls accordingly to raise or lower the valve 54, so as to control the flow of material through the ported member 47. The device is so designed as not to entirely shut off the flow of material through the member 47.

By the present invention there is maintained a given pressure of the material at the gun, as for example fourteen pounds per square inch, regardless of the rate of flow of the material to or by the gun and irrespective of the gun being used or not used, and also indifferent to the pressures in the main circuit portion 1. When the pressure of the material at the gun tends to rise above the point to which the spring 36 has been adjusted by the screw 38, that pressure reacts by way of the passage 46, chambers 45 and 43, passage 44 and chamber 36, so as to be effective on the bellows 34 and thus raise the valve retainer 53 and ball valve 54 to throttle (not to shut off) the inflow of material through the ported member 47, thus bringing the pressure of the gun to the predetermined value. When the pressure at the gun tends to drop, as when the gun is operated to spray, immediately the bellows expands under the influence of the spring 36, and immediately the valve 54 is moved down and more material is admitted so as to maintain the given pressure at the gun. The action is instantaneous and smooth without any vibration of the valve or the like, the action being very sensitive and within a very small fraction of a pound variation in pressure.

The cross-return duct 18 is connected to and at the return main 2 by way of a pressure control unit 55 shown conventionally in Fig. 1 and in detail in Figs. 3 and 4. It includes a filter 56 for intercepting any loose particle, such as a scale from the inside of the pipe, as would clog the control orifice 57 (Fig. 4) in the outlet part of the device, and a duct part 58 connected to the return main 2. The material flows by way of duct 18 into the device and downwardly through the filter 56, and thence through the orifice 57 which is of predetermined diameter, such as one-sixteenth of an inch, although any other size may be used depending upon the pressure and flow conditions desired in the system. It is so designed that there will be a constant flow of the material in the cross-circuit 17-18, yet with no serious loss in pressure at the gun. Also, it is designed so that the pressure on the discharge side of the orifice 57 will always be less than the lowest pressure that will be used at the gun, such as four pounds, so that there will always be a cross-flow through the cross-circuit 17-18.

At the turn between the supply circuit portion 1 and the return circuit portion 2 is provided (in the illustrative embodiment) a modulating valve

15 (Fig. 1) for controlling the pressure and flow conditions in both portions of the circuit. Also, there is a like valve 10 in the surplus return or feed-back line 9 to the tank 7. This valve is shown in detail in Figs. 6, 7, 8 and 9 of the drawings.

It comprises a chamber 59 within which is a Sylphon bellows 60 suitably clamped at its upper end to the upper end of the device, as shown. The bellows 60 has a pressure plate 61 at its lower end, against which acts a spring 62 having a pressure cap 63 at the upper end of the spring and in abutment with an adjusting screw 64 suitably threaded in the upper end of the device. A tube 65 secured at its lower end to the plate 61 may surround the spring 62 to give it lateral support in case the spring tends to buckle.

The lower end of the chamber 59 leads into a valve casing 66 having inlet and outlet chambers 67 and 68 divided by a partition 69 in which is secured, as threaded, a ported valve member 70, the chambers 67 and 68 being connected to circuit ducts or remains 1 and 2 respectively.

To the bellows plate 61 is secured a valve stem 71 which is threaded at its lower end for adjustable securement of a valve shank 72 of a valve member 73. The valve member 73 has a cylindrical portion 74 at its upper end to fit with a closeness of a thousandth of an inch or less clearance within the cylindrical valve port 75 provided in the valve member 70 when the valve member 73-74 is moved downwardly. The valve portion 73 is provided with one or more flats 73^a (three in the illustrative embodiment) produced by milling the cylindrical extension of the valve portion 74, the upper ends of the flats curving upwardly and radially to end in the lower circular edge of the portion 74, as shown, the vertical edges 76, so to speak, being of arc form, or arc parts of the cylindrical surface of the extension of the portion 74. Above the part 74 the movable valve member may have a neck 77 and above that a conical portion 78 the surface of which may abut the inner, upper edge 79 of the valve member 70, so as to act as a stop for the downward movement of the movable valve assembly, if it should move down that far. The conical part 78 also may act as a closing seat. It is to be understood, however, that the movable valve is to move normally in a range whereby the conical part 78 will normally be always spaced away from the rim edge 79. It will abut or seal only under abnormal conditions.

The neck 77 and the conical part need not be present and the shank part 72 may be of the same diameter as the valve part 74 and be an upward extension thereof, as in the form of device shown in Fig. 9.

Heretofore, it was necessary to supply the material in the supply main at a comparatively high pressure, such as 180 pounds per square inch, so as to allow for the maximum demand on the line, but that resulted in irregular pressures at the guns, even though pressure regulators might be used at the supply source with some attempt at maintaining the pressure at some normal level.

By the present invention, a much lower pressure is necessary in the supply main, such as 85 pounds per square inch or the like, it being understood, however, that the pressure may fluctuate over a wide range without affecting the proper operation of the system. This requires less power, and reduces the tendency to leakage at the pumps and other parts. By constantly

circulating the material and cross-circulating, and using modulating valves, the proper pressure may be maintained regardless of variations in flow. For example, if we assume that the demand increases, the modulating valve 15 will act to let through less material to the return circuit portion 2. At the same time the modulating valve 10, at the tanks, also will act to let through less surplus or feed-back to the tanks, leaving more of the material from the pump to go to supply the demand. Since the modulating valve operates on pressure factors, it will be seen that the modulating valve 15, set or adjusted for a given pressure, such as 85 pounds in the supply main, will act to hold back, so to speak, the material at 85 pounds, and only let through what material may be necessary for return. It even can substantially, but not entirely, stop flow in the return, there being always some return of material by way of the cross-circuits 17-18 irrespective of whether or not the guns are in operation.

The adjusting screw 64 of the modulating valve 15 is so adjusted as to control the flow whereby there will be the given pressure, such as 85 pounds in the line portion 1 and a given maximum, such as 4 pounds or less in the return line portion 2. Normally, there is always a flow of material through the port 75 and the cylindrical port 80 between the rim edge 79 and the lower rim edge 81 of the valve part 74, but as the pressure in the chamber 59 tends to increase the orifice 80 will be widened and more material will flow through until the pressure returns to the given pressure when the orifice will be narrowed to its normal opening. Likewise, when the pressure tends to drop in the line portion 1 below the given valve, the orifice 80 will be narrowed and less material allowed to pass through until the pressure returns to normal and then the orifice 80 will widen to normal. This valve operates very quickly and smoothly without any vibrations, and very sensitively within a very small fraction of a pound of pressure variation. The modulating valve 10 at the tanks operates likewise.

In operation the pump 5 feeds the material under pressure by way of the duct 4 and filter 3 (or by-pass 8), to the supply circuit portion 1, and to such an amount as to maintain a flow of material at given pressure in the circuit 1-2, in the cross-circuits 17-18, and the feed-back or surplus return circuit 9, besides meeting the demand at the guns. Should there be a tendency for the pressure in the line 1 to drop by reason of increased demand at the guns or otherwise, that tendency will be felt immediately by the modulating valves 10 and 15, the former immediately acting to reduce the flow of the material to the tank 7 so that the portion of the material which would otherwise pass to the tank 7 will be fed to the line 1, and the latter, that is, the modulating valve 15, will also immediately act to reduce the flow of material to the line 2 so that the portion of material which would otherwise pass to the return 2 will be held back, so to speak, in the line 1. Any tendency to increase the pressure in the line 1 will be counteracted by a converse action of the valves 10 and 15.

While one tank 7 may be used whereby the material is drawn off at the bottom of the tank and the returning material (circuits 9 and 2) is fed back in the top of the tank, two or more

tanks may be used. As for example, the material may be drawn from one tank and the returning material fed in the other tank, and when the one tank is nearly empty and the other is nearly full, suitable valves (shown conventionally as circles with crosses therein) will be manipulated, so that the material will be drawn from the other tank, and the returning material fed to the one tank. Other manipulable valves are also shown conventionally by circles with crosses therein.

During the use of the device or system, besides there being a continual flow of material in the circuit 1-2, there is also a continual cross-flow of the material in all cross-circuits 17-18, whether or not the guns are being operated, so that there will always be homogeneous material available at each gun at any instant the gun may be put into operation.

While the system above described is shown with the use of automatically operating valves 15 and 10, respectively, at the end of the system and in the by-pass or feed-back between the pump and supply source, the system may satisfactorily operate with a hand operated throttle type of valve in the by-pass 9 if desired. However, the use of the automatically acting valve 10 is more convenient.

In a system of this kind there may be any number of various conditions existing at different instances of time, depending upon the demand made on the volume of material for any particular job, and frequently it may be difficult to control the flow through each hose 17-18 and the pressure at each spray gun at such times when other guns are being opened and closed.

To readily accommodate for such occurrences, the present invention comprehends in part the use of the back pressure regulator 55 in each cross-circuit 17-18, which regulator comprises a fixed or given sized orifice 57 so that the flow through it will depend upon the difference of pressures on both sides of that orifice; and in part upon the automatic regulating valve at the end of the system with a similar valve in the by-pass or feed-back 9.

In Fig. 11 is shown the end of the system provided with a pressure reducing type of valve 32^a, of the same kind and construction as valve 32 used in the cross-circuits 17-18, but of larger capacity. This valve 32^a is connected to the circuit part 1 by way of valved pipes 82 and 83, the latter being connected to the inlet of the valve 32^a; and is connected to the circuit part 2 by way of a valved pipe 84. Suitable gages may be connected respectively to pipes 82-83, valve 32^a and return duct 2, by way of valved pipes 85, 86 and 87. A valved by-pass pipe 88 may also be connected between the pipes 82 and 2, as shown in Fig. 11.

By using the pressure reducing type of valve 32^a in lieu of the modulating valve 15 at the end of the system, the pressure in the return circuit part 2 will be maintained constant instead of maintaining the pressure constant in the circuit part 1 on the feed side of the valve, as in the case of using the modulating valve 15. The valves 32 also being of the pressure reducing type will also maintain a constant pressure in the cross-circuits 17-18. The regulator 55, which has a fixed orifice 57, controls the rate of flow of material in the cross-circuit 17-18, the flow through it depending upon the difference of pressures on the two sides of the back pressure regulator 55. If the pressure in the hose 18 changes there will also

be a change in volume of material discharged into the return circuit part 2, which in turn will produce or tend to produce a variation in pressure in the circuit portion 2, but this will immediately be accommodated for by the valve 32^a acting to change the pressure back to that predetermined by the setting of the valve 32^a. Also, there will be a tendency to vary the pressure at the gun, but this will also be immediately accommodated for by the valve 32 acting to change the pressure back to that predetermined by the setting of the valve 32. In other words, there is an automatic balancing occurring when there is a variation of demand on the system.

To illustrate, the modulating valve 10 in the feed-back 9 may be set so that material supplied to the supply circuit part 1 will have a pressure therein of forty pounds when all the guns are opened, and a pressure of sixty pounds when all the guns are closed. The valve 32^a will be so set as to maintain a pressure of say twenty pounds in the return circuit portion 2 for paints of average viscosity. The regulating valves 32 may be set at thirty pounds so that they will properly operate with higher pressures in the line 1, as between forty and sixty, regardless of the variations in pressure in such range, or even of higher pressures. If the pressure in line 1 should rise above that (sixty) then the modulating valve 10 acts to feed back more material so as to bring down the main line pressure.

The back pressure regulator 55, in such case, would have the orifice 57 of such size as to maintain the desired flow of material through the cross-circuit 17-18 and also maintain what might be termed the balance of pressures on both sides of the regulator 55. Assuming that as many as twelve guns are opened, pressures in the line 1 may drop from sixty to forty-five pounds, but the pressure at the guns will not vary; it will remain constant.

In operation, when a gun is opened the valve 32 immediately acts to pass more material to the gun circuit 17-18, effecting a slight drop in pressure in the line part 1. Modulating valve 10 immediately acts to reduce the feed-back, so that some of the material that would be otherwise bypassed is now fed into the main line 1. Since there is a slight reduction in the material returned to the line part 2, when the gun is opened, the pressure in the return 2 will tend to fall slightly and the valve 32^a will open slightly to make up for this and bring the pressure in the return line 2 back to the predetermined value. As more guns are opened, this process is repeated and the pressure in the main line 1 will continue to drop until it reaches the minimum (such as forty pounds) when all guns are open.

From tests conducted with pressure values as given above, by way of example, it was found that there was no variation of pressure in the return line 2 as the guns were opened or closed. The pressure in the supply line 1 fell steadily as the guns were opened from sixty pounds (no gun open) to forty-five pounds (with twelve guns open). The pressures at the open guns remained constant (as 24.5 pounds) as other guns were opened, regardless of the number of guns that were opened. The pressure at the closed guns remained constant (as 27.4 pounds) when other guns were opened regardless of the number of them opened. Stable conditions are obtained by the use of the regulator 32^a at the end of the system.

In case it be desired to increase or decrease

the flow of material through all cross-circuits 17-18, it is only necessary to raise or lower, respectively, the setting of the valve 32^a whereby the pressure across the back pressure regulators 55 will be changed and the flow therethrough varied as desired.

When spraying materials that are desired to be applied hot, or which by reason of their properties are more easily sprayed when hot, heating means may be used to supply the desired temperature to the material. In Fig. 10 is conventionally shown a fragment of the system including a cross-circuit 17-18, the circuit part 17 of which is enclosed in and passes through a jacket 89 having inlet and outlet ducts 90 and 91 for the flow of the heating fluid or medium through the jacket and around the enclosed section of the duct 17, this part of the duct 17 being preferably a pipe instead of a hose. When heating is used, it is desirable to return the material from the return pipe 2 directly to the intake of the pump instead of to the tanks 7, such direct return being by way of the valved duct 32. This is preferable to prevent the escape of thinners which might occur if the material were fed back to the tanks 7. Also, with material of this kind, it is desirable not to maintain it hot too long before using, so by returning it directly to the pump, the material in the tanks 7 is supplied to the line for "make-up" only as the material is consumed, whereby the amount being heated is considerably reduced.

The medium used in the heaters 89 may be at about 180° F. so that the temperature of the material may be maintained at about 165° F. Thus, the material will not be dangerously or injuriously overheated even though it should flow very slowly through the heater or even stand in the heater for some time.

The invention is not limited to the use of the pressure and temperature values given herein, such values being referred to only by way of example.

While we have herein described and upon the drawings shown an illustrative embodiment of the invention, it is to be understood that the invention is not limited thereto but comprehends other constructions, arrangements of parts, details, features, or the like, without departing from the spirit of the invention.

Having thus disclosed the invention, we claim:

1. A distributing and circulating system for liquid material comprising a main circuit means including supply and return circuit portions, a material applying device, a cross circuit portion including inlet and outlet ducts respectively connected to said supply and return circuit portions and both connected to said device, a valve connected to said inlet duct and provided with means responsive to the pressure in said inlet duct for controlling the volume of liquid flow from said supply circuit portion to said inlet duct inversely to the pressure in said inlet duct, and a flow control means connected to said outlet duct and including a constantly open passage of such restricted size that the pressure therein is always less than that at the material applying device.

2. A distributing and circulating system for liquid material comprising a circuit means including main supply and return circuit portions, means for supplying liquid under pressure to said main supply portion, one or more spraying devices, one or more cross circuit means respectively for said devices, each cross circuit means

including supply and discharge ducts respectively connected to said main supply and return circuit portions and both connected to the respective spraying device, means in said discharge duct provided with a constantly open discharge orifice of predetermined restricted cross sectional area for effecting a pressure at the discharge side of the orifice lower than the lowest pressure acting at the spraying device, and means in the supply duct for controlling the flow of liquid to said supply duct and including means responsive to the pressure in the supply duct for varying said flow inversely with said pressure in said supply duct.

3. A distributing and circulating system for liquid material comprising a main circuit means having supply and return circuit portions, means for supplying liquid under pressure to said main circuit means for continual flow of liquid material therein, a cross circuit means connected

to said supply and return circuit portions for continual flow of liquid material therein, a material applying device connected to said cross circuit means, a liquid flow control means in said cross circuit means between said material applying device and said supply circuit portion and having an opening for continual flow of liquid therethrough, means responsive to the pressure in said cross circuit for varying the size of said opening for varied flow of material inversely proportional to the pressure in the cross circuit, and means in said cross circuit between said material applying device and said return circuit portion and having an opening of given restricted constant size for continual flow of material therethrough to said return circuit portion.

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