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R. J. SHORT

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PROPORTIONING DEVICE FOR LIQUIDS

Filed Dec. 13, 1933

2 Sheets-Sheet 1

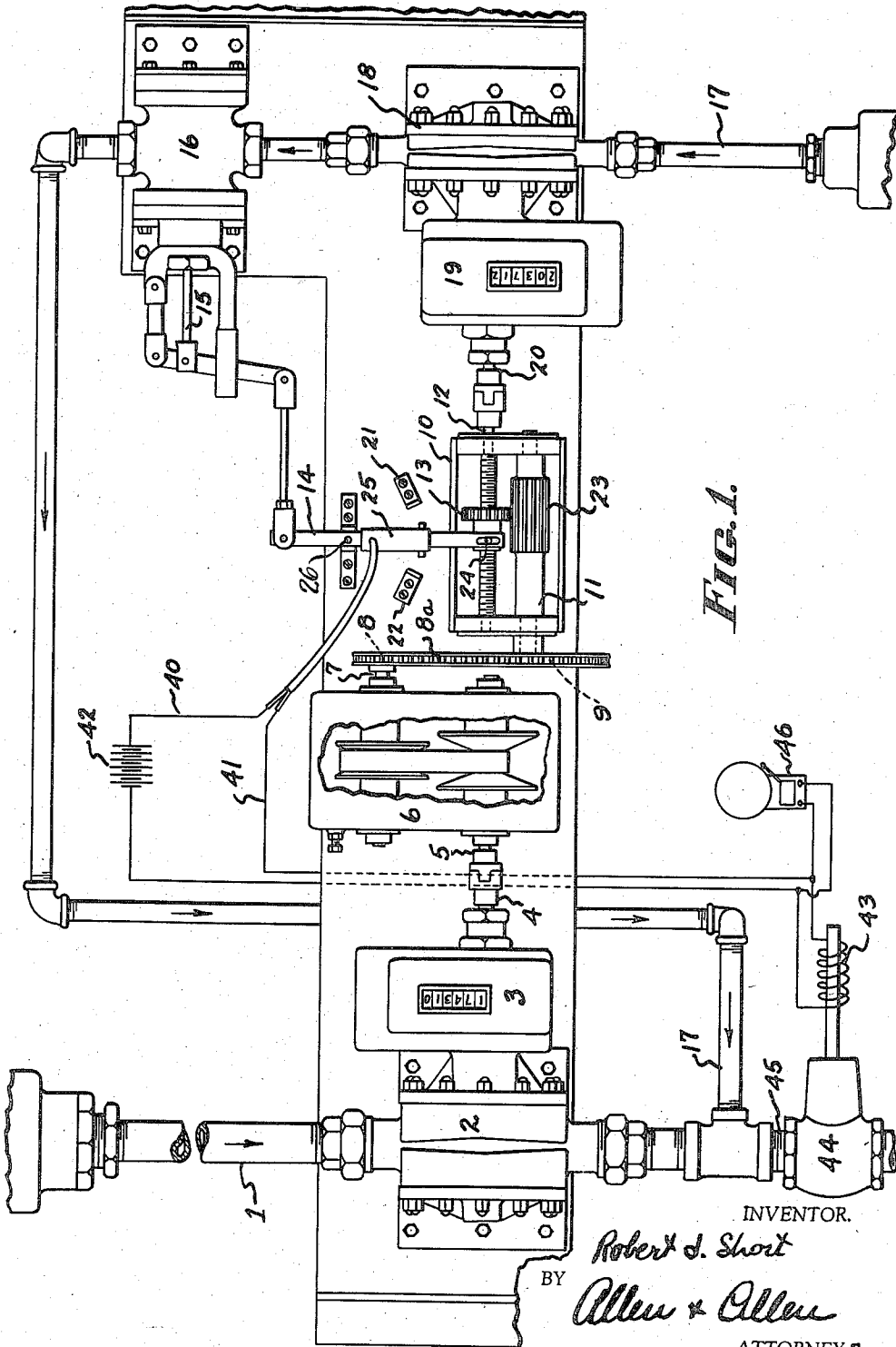


FIG. 1.

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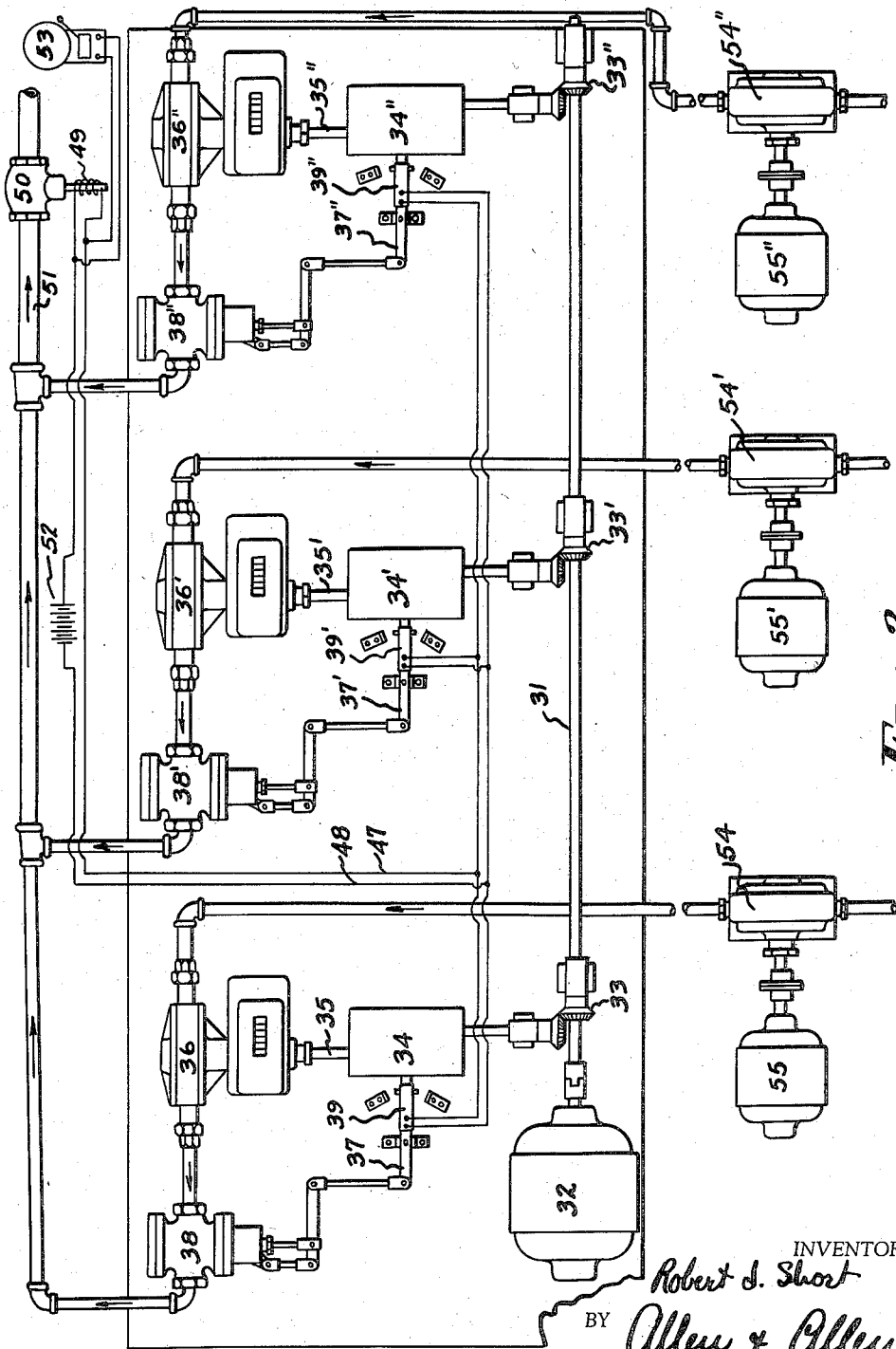


FIG. 2.

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## UNITED STATES PATENT OFFICE

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## PROPORTIONING DEVICE FOR LIQUIDS

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9 Claims. (Cl. 137—164)

This invention relates to a device for delivering two or more liquids simultaneously in definite proportions to each other, which can be varied at will.

5 The object of the invention is to provide a device of this character that will be smooth, positive and reliable in operation, adjustable to deliver different proportions as desired within reasonable limits, and which will stop all flow automatically if for any reason any one liquid stops flowing or exceeds predetermined proportions.

10 In many industrial operations it is desirable to continuously mix two or more liquids in definite, and sometimes variable, proportions. The continuous proportioning of molten kettle soap and silicate of soda or sal soda solution in soap making, of crude vegetable oil and caustic soda solutions for use in the continuous refining of vegetable oils, or of petroleum oils and sulfuric acid, are example of the use of this device, and many others might be mentioned.

15 Various devices have been proposed for accomplishing this object; some give a pulsating flow instead of a smooth continuous flow; some of the devices cannot be closely controlled or cannot be readily adjusted to change from one proportion to another, and none, as far as I am aware, will automatically stop the flow if the flow of one of the liquids becomes interrupted. These difficulties are all overcome in my improved device.

20 My device, in its simplest form, as applied to two liquids consists essentially in the use of a suitable differential whose primary shafts are caused to rotate by the flow of the respective liquids and whose secondary member actuates a valve or other suitable control device controlling the flow of one of the liquids so that it will always flow in the desired proportion to the primary liquid, and furthermore, an electrically operated valve or other suitable device so arranged as to stop the flow of the primary liquid whenever the secondary liquid stops flowing or exceeds predetermined proportions. The stopping of the primary liquid will automatically stop the entire device. Various modifications of this principle may be used; and for the purpose of an exemplary disclosure some of the preferred forms of the device and methods of applying same are more fully set forth herein. The accompanying drawings will make these parts and their interrelated action clear.

Reference is made to these drawings, wherein:—

55 Figure 1 shows one form of my device.

Figure 2 shows a modified form thereof.

Referring to Figure 1, a pipe line through which the primary liquid is supplied is indicated at 1. This liquid flows through a device 2, having a rotatable member which is caused to rotate in pro-

portion to the flow of the liquid through it. This device may conveniently be a meter device of known type having a counter 3 to indicate the quantity of liquid passing through the device in a given time. The shaft 4 of the rotatable member, which is caused to extend from the casing of the meter device, is connected to a shaft 5 of a variable speed transmission 6. The driven shaft 7 of the variable speed transmission carries a sprocket wheel 8 which is connected by a suitable chain 8a, to a sprocket wheel 9 attached to one of the primary shafts 11 of the differential mechanism 10. The sprocket wheels 8 and 9 may be varied in their relative size to obtain the required speed in the differential with reference to the flow of the liquid. The variable speed transmission may be omitted and sprocket wheel 8 may be attached directly to the shaft 4 if it is not desired to provide for readily changing the proportions of the two liquids from time to time. The variable speed transmission may be of any well known type.

17 indicates a pipe through which the secondary liquid is delivered to the device. This liquid passes through a meter device 18 having a rotatable member, similar in construction to the device 2. It may be provided with a counter 19 for indicating the quantity of fluid passing in a given time. 20 indicates the shaft of the rotatable member of device 18, or an extension of same, which is adapted to drive, either directly, or through suitable gear or chain and sprocket means the secondary primary shaft 12 of the differential 10. A change-speed drive may also be employed, if required, to give the required speed 35 on the shaft 12 of the differential, with reference to the speed of shaft 11, when the secondary liquid is flowing at the desired rate.

The particular type of differential mechanism is not a limitation upon my invention. In my specific embodiment, the first primary shaft 11 carries a wide faced gear 23. The second primary shaft 12 of the differential is threaded as shown, the threads extending substantially from end to end thereof inside the housing of the differential. Mounted on said threaded shaft 12 is a gear or secondary member 13 threaded internally to match the thread on shaft 12, so that its axis is concentric with the axis of the threaded shaft 12. The teeth in gear 13 engage with the teeth of gear 23. The hub of gear 13 is grooved and fitted with a collar provided with pins 24, so arranged that the end of a lever 14 must move longitudinally with the gear 13 around a fulcrum 26 upon an external support, not shown. The lever 14 is connected through a suitable linkage and lever to the stem 15 of a valve 16 which is located in the pipe line carrying the secondary liquid. 25 indicates diagrammatically an electrical switch or switches arranged to be moved

by the lever 14, against abutments 21 and 22, so that an electrical contact will be made when the lever moves to an extreme position either to the right or to the left. The closing of these contacts can be made by known means to operate valves for stopping the flow of the liquids, and/or suitable signals. For this purpose I have shown a switch 25 connected by leads 40 and 41 in one of which a source of current 42 is inserted, to the solenoid 43 of a magnetically operated valve 44 in the outlet line 45 of the device. I have likewise shown a signaling means 46 connected in parallel with the solenoid. It will be noted that the valve 44 is in the line 45 beyond the point of entry of the delivery line 17 for the secondary fluid.

Figure 2 shows a somewhat different application of my invention adapted to the proportioning of any number of liquids, three liquid delivery lines being shown. 31 represents a shaft driven by a motor or other suitable device 32, preferably a variable speed motor. On the shaft 31 are mounted bevel gears, 33, 33', 33'', each of which drives one of the two primary shafts in each of the differentials 34, 34', 34''. These differentials operate like those described and shown in Fig. 1. A separate differential is required for each liquid handled. The second primary shaft 35, 35', 35'' of each of these differentials is driven by the rotatable shaft of a meter through which the respective liquid passes, 36, 36' and 36'', as is explained above. The secondary member of each differential is attached to a lever 37, 37' and 37'', operating a control valve 38, 38' and 38'', in the pipe line carrying the liquid connected with each respective differential, this operation being exactly the same as was explained under Fig. 1. In this arrangement the simplest way to change the proportions of the different liquids is to change the beveled gears 33, 33' and 33'', which operate the respective differentials at suitable speeds relative to each other. Variable speed transmissions may also be used at these points.

Each of the levers 37, 37', 37'' may bear a switch 39', 39'' connected in parallel to leads 47 and 48, which in turn are connected to the solenoid 49 of a cut-off valve 50 in the delivery line 51. There will be a suitable source of current as at 52 for actuating the solenoid and a signalling device 53 may likewise be connected into the circuit. I have shown in Fig. 2 pumps 54, 54', 54'' actuated by motors 55, 55', 55'' for feeding the pipes for the delivery of the controlled liquids to the delivery pipe 51.

The principle of operation of the device of Figure 1 is as follows, assuming two liquids are to be mixed:

The flow of the primary liquid causes the rotating member or meter 2 to rotate in direct relation to the amount of liquid flowing, and through the intervening sprockets, speed transmission device, etc., causes the first primary shaft 11 of the differential to rotate at a certain speed. Likewise, the flow of the secondary liquid causes the second primary shaft 12 of the differential to rotate at a certain speed, and by proper selection of the sprocket wheels, etc., the two primary shafts of the differential will revolve at the correct speeds with reference to each other, only when the flow of the two liquids is in the required proportion to each other. The construction of the differential shown is such that if these two primary shafts rotate at the required speed relation, the member 13 on the threaded shaft will maintain its position without longitudinal movement along the shaft

12, but if the primary shafts fail to rotate at the required speed, then the difference in speed of rotation will cause the member 13 to move in a longitudinal direction to the right or to the left along the threaded shaft, the direction depending on which shaft is moving faster. The lever attached to this secondary member 13 is thereby caused to move in the same direction as the member 13 and through a suitable fulcrum will operate the stem of the balanced control valve to open or close same as required, thus increasing or decreasing the flow of the secondary liquid through the rotatable member 18 until the desired proportional rate of flow is again restored, whereupon the two primary shafts of the differential will again rotate at the proper speeds, with the member 13 in a position of equilibrium. By suitably adjusting the length or position of the lever arms, a proper setting is obtainable so that with the secondary member of the differential in a central position on the shaft 12, the control valve 16 is opened to the degree required for delivering the secondary liquid in the desired proportions when the primary liquid is flowing at its normal rate. The two liquids, after passing through the apparatus through separate pipes, may then join into a common pipe for discharge to a mixing device, or may be delivered separately, as desired. If the rate of flow of the primary liquid is changed by throttling at any point in the system, it is obvious that the device will automatically compensate for this through the differential by causing the rate of flow of the other liquid to change correspondingly, so as to maintain the same proportions of the two liquids. Likewise, any throttling of the discharge line carrying the mixed liquids will reduce the total flow without permitting the proportions of the two liquids to vary. If the flow of the secondary liquid is changed to an amount greater than can be compensated for by the operation of the differential and its control valve, the electrical device will then so operate as to stop the flow of both liquids until the cause of the trouble is corrected.

It is, of course, possible so to design this type of differential that the two primary shafts, instead of rotating at identical speeds, will rotate at different speeds while maintaining secondary member 13 in its proper longitudinally stationary position of equilibrium. This could be the case, for example, if the gear 23 were made with a different diameter and different number of teeth from secondary member 13. Such a variation, however, would be considered equivalent to the differential as described for all intents and purposes. It is also obvious that any other type of differential can be used than the one described, provided only that it has two driven primary shafts co-acting on a secondary member in such a way that the motion of the latter, whether rotary or longitudinal, can be used to control the secondary liquid. My invention is not limited to the use of the type of differential shown, but covers the use of any differential in substantially the manner described in connection with a suitable means of control. If the rotatable members 2 and 18 have any difficulty in driving the shafts of the differential without permitting slippage or leakage of liquid through same, "torque amplifiers" of known type may be installed to supply the power needed to drive the differential shafts, but this is not ordinarily necessary.

It is also to be understood that other means of power transmission than a lever or levers, as shown and described, may be used between the

secondary member of the differential and the stem of the control valve or other control means. A rotary screw motion or a worm and gear type of transmission may be used, or any other of the many known mechanical means for accomplishing this object. My invention is not limited to the use of the lever, therefore, but is intended to cover any means of transmitting motion from the secondary member of the differential to the stem of the control valve or to the pump or to other control means in such a way as to control the flow of the liquid.

The relative proportions of the two liquids can readily be changed to any desired point within the limits of the apparatus by changing the variable speed transmission apparatus as desired. When necessary to make changes outside the limits of the variable speed device, the substitution of suitable sized gears or sprockets in the system will accomplish the result within any desired range. The relative sizes of rotatable members, or meters, pipe lines, and valves, will naturally be selected in accordance with the relative amounts of the different liquids to be handled so as to obtain suitable speeds of rotation of the shafts within the desired range for use in this device.

Three or more liquids may be mixed or delivered proportionally under the arrangement shown in Fig. 1 by adding another differential and balanced control valve (etc.) for each additional liquid, together with another variable speed transmission if desired, and so arranging the apparatus that the primary liquid drives one primary shaft in each added differential in addition to driving a primary shaft in the original differential, and the secondary primary shaft of each added differential is driven from a rotatable member in the pipe line supplying said additional liquid, while the secondary member of each added differential controls a balanced valve in pipe line supplying said additional liquid.

It is also possible to operate as shown in Fig. 2 when any number of liquids are required to be delivered proportionally. Variable speed transmission devices may be used on each of the differentials in this system also, if desired. Furthermore, by the use of a variable speed motor in driving the main shaft, it is possible to increase or decrease the total quantity of liquids delivered, within the limits of the motor, without changing the proportions of any one liquid to another.

It is obvious that when the proportions of two or more liquids are permanently fixed, the use of a variable speed transmission device becomes unnecessary and in that case both primary shafts of the differential can be driven directly from the shafts of the rotatable members 2 and 18 (see Fig. 1) by suitable gears, or by a chain and sprocket, etc., as desired. Likewise in the arrangement of Fig. 2, when the proportion is permanently fixed, any number of liquids can also be delivered in the required fixed proportions.

In order to prevent the continued flow of the primary liquid when the flow of the secondary liquid is interrupted for any reason, or when the required proportions cannot be maintained, a suitable electrical switch is provided. This may most conveniently be placed on the lever operating the balanced control valve, so as to operate as follows: If the flow of the secondary liquid stops or if its relative rate exceeds or falls below a desired point, the secondary member 13 of the differential will then automatically travel in a longitudinal direction along the shaft 12 far

enough to operate the electric switch, which will then operate a suitable electrically controlled valve stopping the flow of the primary liquid, or of both liquids; or it may be arranged to cut off the current supplying the motors which operate the pumps supplying the two fluids. Either method, therefore, stops the apparatus entirely and it will not resume operation until the trouble is corrected. This feature is important, and, I believe, has never been accomplished in any prior proportioning device.

This apparatus is easily constructed at moderate cost, is simple and positive in its action, gives a smooth flow of both liquids without pulsations, can be readily adjusted to any desired proportions of two or more liquids, and will not permit any flow if the desired proportions for any reason cannot be maintained.

Liquids of practically any kind or degree of viscosity can be handled satisfactorily in this device. Even liquids containing suspended matter forming a so-called sludge will operate satisfactorily, provided the said materials will flow like a liquid.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a device for proportioning the flow of liquids, means for delivering a controlling liquid, motive means actuated by the flow of said liquid in said controlling liquid delivery means in proportion to said flow, means for delivering a controlled liquid, motive means actuated by the flow of said controlled liquid in said controlled liquid delivery means in proportion to said flow, an equilibrium motion device having a plurality of primary driven parts and a secondary part adapted for movement upon the disturbance of a given relationship of motion of the primary driven parts, individual motion transmitting connections between said motive means and said primary parts, a valve in the delivery means of said controlled liquid, a connection between said valve and said secondary part, and means actuated by said secondary part for stopping the flow of said liquids when said secondary part exceeds a given range of movement.

2. A device for controlling the flow of a secondary liquid in definite proportion to the flow of a primary liquid and for stopping the flow of the primary liquid when the flow of the secondary liquid exceeds predetermined limits, comprising in combination a rotatable member in the line of flow of each liquid adapted to rotate in definite relation to the amount of liquid flowing, a control valve in the line of flow of the liquid to be controlled, a suitable differential, power transmitting means between the different elements; so arranged that each of the said rotatable members causes one of the primary shafts of the differential to rotate, said primary shafts being caused to rotate at such a ratio of speed to each other as will hold the secondary member in a stationary position when the two liquids are flowing in the desired proportions but will cause movement in the secondary member of said differential when the said ratio is disturbed; said movement in the secondary member of the differential being of such nature as to actuate the said control valve so as to permit the liquid under control to flow again in the desired proportion, and an electrical device comprising an electrical switch actuated by the movement of the secondary member of the differential and an electrically controlled valve on a line carrying the primary

liquid; so arranged that when the flow of the secondary liquid exceeds predetermined limits the movement of the secondary member of the differential will actuate the electrical switch causing an electric current to close a valve in the line carrying the primary liquid.

3. A device for controlling the flow of a secondary liquid in any desired proportion to the flow of a primary liquid, comprising in combination a rotatable member in the line of flow of each liquid adapted to rotate in definite relation to the amount of liquid flowing, a control valve in the line of flow of the liquid to be controlled, a suitable differential, power transmitting means between the different elements including a variable speed transmission between one of the rotatable members and the corresponding primary shaft of the differential; so arranged that each of the said rotatable members causes one of the primary shafts of the differential to rotate, said primary shafts being caused to rotate at such a ratio of speed to each other as will hold the secondary member in stationary position when the two liquids are flowing in the desired proportions but will cause movement in the secondary member of said differential when the said ratio is disturbed; said movement in the secondary member of the differential being of such nature as to actuate the said control valve so as to permit the liquid under control to again flow in the desired proportion, the desired proportion being adjustable by means of the variable speed transmission; valve means in the line of flow of the primary liquid and means actuated by said secondary member for closing said valve means when said secondary member exceeds a given range of movement.

4. A device for controlling the flow of a secondary liquid in definite proportion to the flow of a primary liquid, comprising in combination means for combining said primary and secondary liquids, a rotatable member in the line of flow of each liquid adapted to rotate in definite relation to the amount of liquid flowing, a control valve in the line of flow of the liquid to be controlled, a suitable differential, power transmitting means between the different elements; so arranged that each of the said rotatable members causes one of the primary shafts of the differential to rotate, said primary shafts being caused to rotate at such a ratio of speed to each other as will hold the secondary member of the differential in a stationary position when the two liquids are flowing in the desired proportions but will cause movement in the secondary member of said differential when the said ratio is disturbed; said movement in the secondary member of the differential being of such nature as to actuate the said control valve so as to permit the liquid under control to flow again in the desired proportion; valve means in the line of flow of the combined primary and secondary liquids actuated by said secondary member of the differential for closing said valve means when said secondary member exceeds a given range of movement.

5. A device for controlling the flow of liquids in definite proportions to each other, comprising in combination means for combining the proportioned liquids, a rotatable member in the line of flow of each liquid adapted to rotate in definite relation to the amount of liquid flowing, a control valve in the line of flow of each liquid, suitable

differentials equal in number to the number of liquids to be controlled, power transmitting means between the different elements; so arranged that each of the said rotatable members causes one of the primary shafts of its respective differential to rotate while the second primary shaft of each of the differentials is caused to rotate by the application of power from an outside source, the two primary shafts of each differential being caused to rotate at such a ratio of speed to each other as will hold the secondary member of the differential in a stationary position when the respective liquid is flowing in the desired proportion, but will cause movement in the secondary member when the said ratio is disturbed; said movement in the secondary member of the differential being of such nature as to actuate the respective control valve so as to permit the respective liquid to again flow in the desired proportion, valve means in the line of flow of the combined liquids, and means actuated by said secondary member for closing said valve means when said secondary member exceeds a given range of movement.

6. In a device for proportioning and combining liquids, delivery means for the combined liquids, delivery means for the liquids to be proportioned, a plurality of equilibrium motion devices, one for each of said liquids, said devices comprising a plurality of primary driven parts and a secondary member adapted to be moved upon the disturbance of a given relationship of motion of the primary parts, motive means actuated by each of said liquids and adapted for motion in proportion to the flow of liquid therethrough, a motion transmitting connection between each of said motive means and one of said primary driven parts in the equilibrium motion device actuated by each of said liquids, valves in each of said delivery means for the liquids to be proportioned and a motion transmitting means between each of said valves and the secondary member of the equilibrium motion device associated with said delivery means for the liquids to be proportioned, a prime mover, a motion transmitting connection between said prime mover and the other of said primary driven parts of each equilibrium motion device, valve means in the line of flow of the combined liquids actuated by said secondary member for closing said valve means when said secondary member exceeds a given range of movement.

7. In a liquid proportioning device having a member movable in response to variations from given liquid proportions, means activated by said member for stopping the flow of the liquids when the proportions of said liquids exceed predetermined limits.

8. In a liquid proportioning device having a member movable in response to variations from given liquid proportions, electrical means activated by said member for stopping the flow of the liquids when the proportions of the said liquids exceed predetermined limits.

9. In a liquid proportioning device having a plurality of conduits, means for causing liquid flow in each, a member movable in response to variations in proportions of the liquid in each conduit, and means activated by said member to shut off the flow in both conduits upon movement of said member beyond a predetermined limit.

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