

Oct. 27, 1936.

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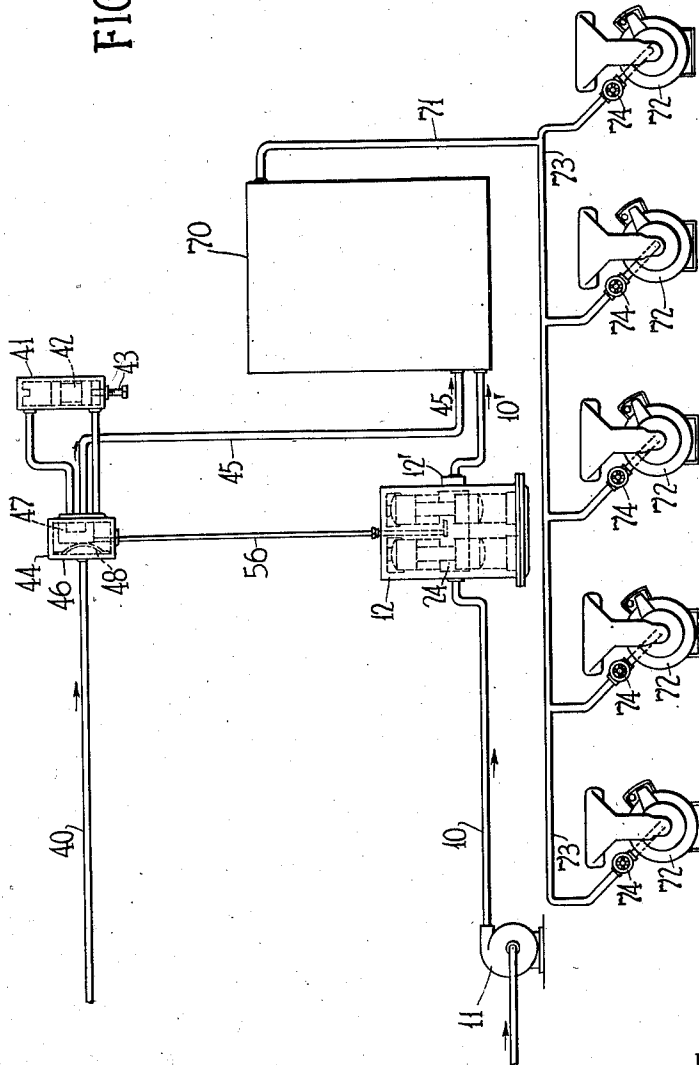
2,058,889

FEEDING AND TREATING SYSTEM FOR FLUIDS

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4 Sheets-Sheet 1

FIG. 1



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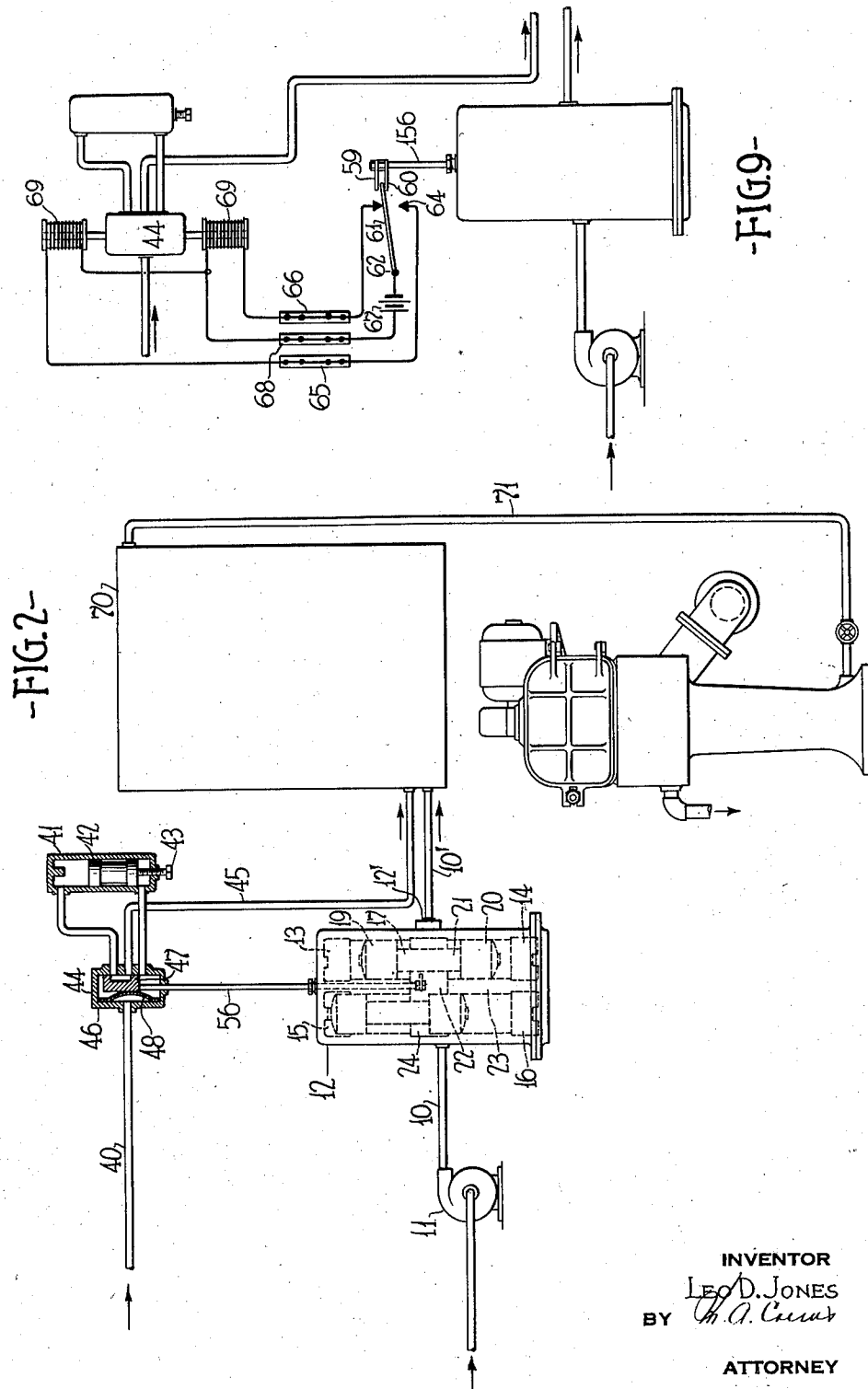
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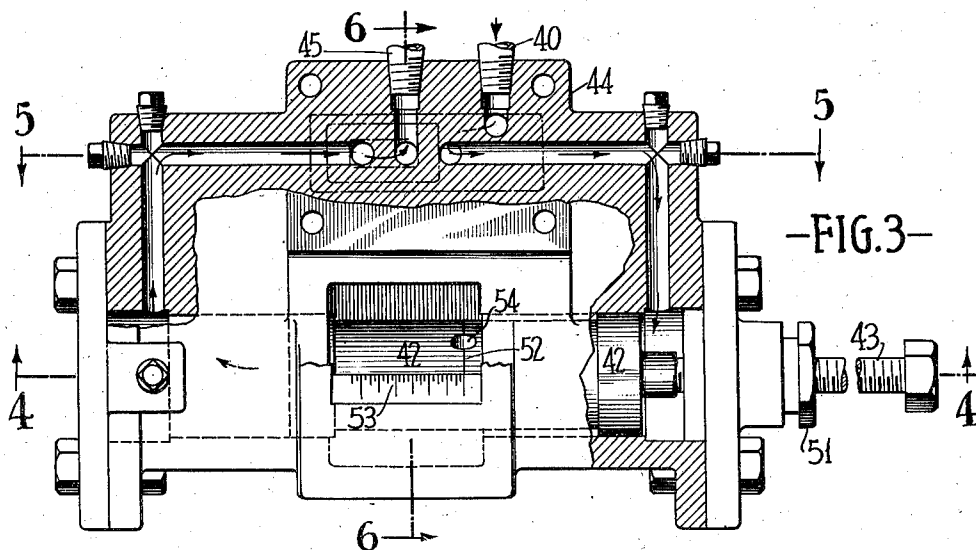
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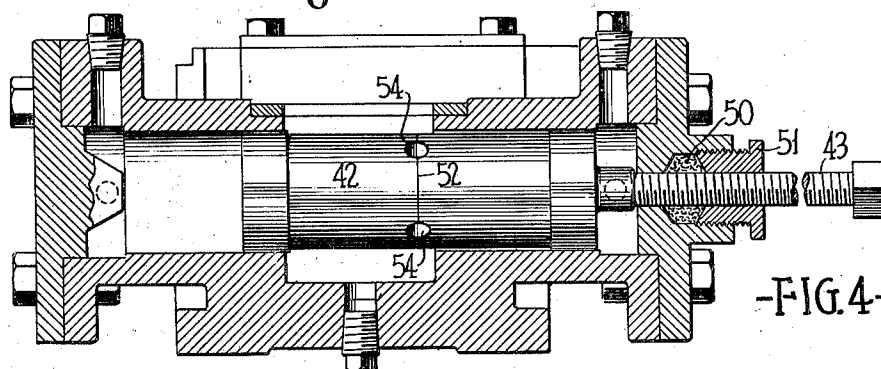
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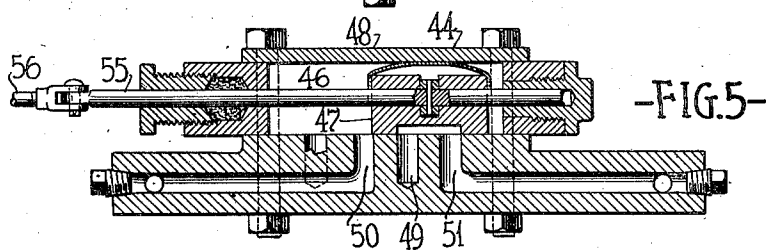
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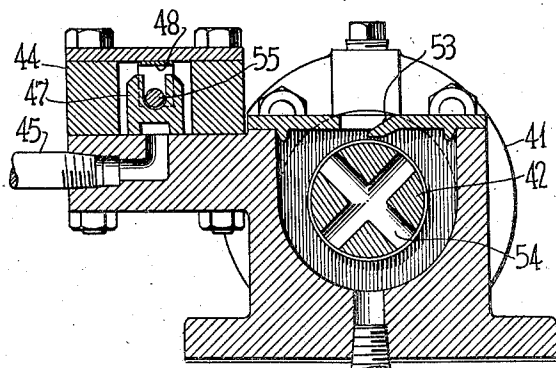
-FIG.3-



-FIG.4-



-FIG.5-



-FIG.6-

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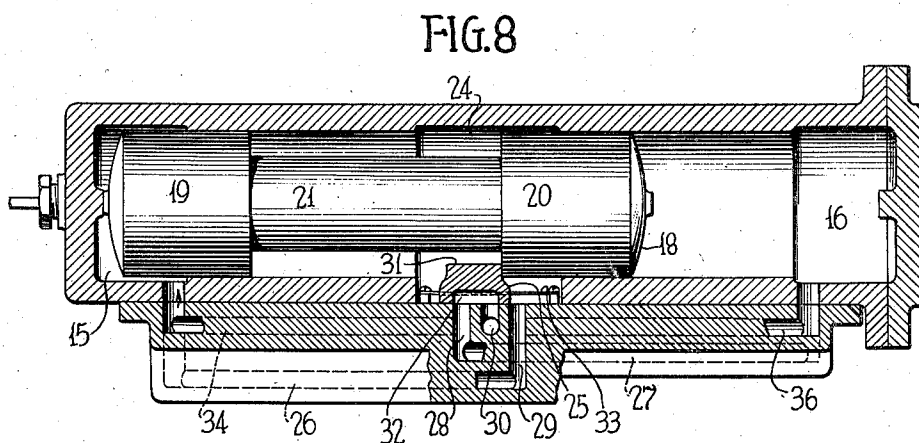
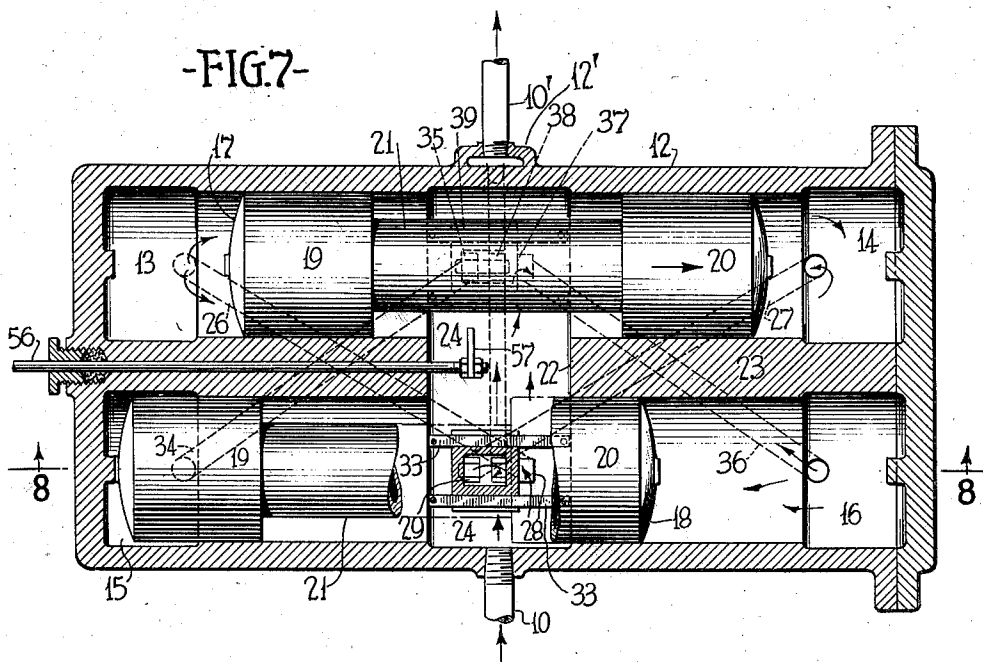
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FEEDING AND TREATING SYSTEM FOR FLUIDS

Filed April 4, 1932

4 Sheets-Sheet 4



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2,058,889

FEEDING AND TREATING SYSTEM FOR FLUIDS

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Application April 4, 1932, Serial No. 603,152

6 Claims. (Cl. 137—164)

My invention relates to the art of feeding liquids and involves a method and apparatus for feeding a plurality of liquids in separate conduits in accurately volumetrically proportioned amounts to a mixing chamber. It was especially evolved in its relation to a system for treating one liquid with another in order to produce a mixture of the two liquids or to effect a chemical or physical change in one or both of them and thereafter passing the mixed products to a battery of machines arranged in parallel and adapted to perform a further operation upon the mixture; e. g., the separation of the mixture into its constituents.

Devices for proportioning the flow of liquids propelled by constant pressure feed devices in separate conduits have heretofore been proposed, but such devices have involved rotatable vanes. The movement of such vanes is not strictly proportional to the flow of liquid in the conduit in which the vane rotates, as it is subject to errors due to varying reaction between the liquid and the vane surface and varying resistance to the rotation of the vanes and varying amounts of work to be done by the rotation of the vanes. Varying reactions are dependent upon the viscosity of the liquid, which varies with temperature, degree of purity and other characteristics thereof; and cannot therefore be corrected by an adjustment of the apparatus. In contradistinction to such devices my apparatus effects a control of the flow of the liquids in the two systems in exactly volumetrically proportioned amounts.

In the illustrated embodiment I have disclosed the feeding of a liquid to be purified and a treating liquid to a mixing chamber adapted to effect a vigorous agitation and intimate contact for the purpose of effecting a chemical reaction between the constituents and the subsequent separation of the purified product from the resulting sludge in a battery of centrifugal separators. Such a treating system finds use in many connections. Two very important examples of such use are the acid treatment of petroleum oils and the alkali treatment of vegetable oils in the refining thereof.

In order to obtain the maximum efficiency in such a system it is desirable to have a battery of centrifugal separators arranged in parallel on the discharge end of the treating system. Where such an arrangement prevails it is frequently necessary to cut off the feed to one of the separators without disturbing the operation of the system as a whole. A particular feature of my

system is its adaptability for such operation without interfering with the proper proportioning of the liquids or forcing them through the system at a rate in excess of the ability of the centrifuges to effectively perform their separating function.

My objects have therefore been to effect a separate feed of the various constituents to a mixing chamber in exactly volumetrically proportioned amounts by an arrangement capable of effecting a restricted flow of the liquids automatically as a result of the increase in resistance to flow at the discharge end of the system without in any way impairing the functioning of the proportioning apparatus.

Further objects and advantages of my invention and the manner in which I have attained them will be apparent from a reading of the subjoined specification in the light of the attached drawings, in which—

Figure 1 is a diagrammatic view, partly in side elevation and partly in plan, illustrating the arrangement of my system,

Figure 2 is a view of my apparatus partly in side elevation and partly in section,

Figure 3 is a view in side elevation and partly in section of a measuring cylinder suitable for use in the apparatus of Figure 2,

Figure 4 is a sectional view on the line 4—4 of Figure 3,

Figure 5 is a sectional view on the line 5—5 of Figure 3,

Figure 6 is a section on the line 6—6 of Figure 3,

Figure 7 is a horizontal sectional view of a mechanism suitable for use in the apparatus shown in Figures 1 and 2 and containing parts that are positively displaced in proportion to the volume of liquid passed therethrough,

Figure 8 is a sectional view on the line 8—8 of Figure 7 and

Figure 9 shows diagrammatically a modification of the proportioning elements of the apparatus shown in Figure 1.

As above set forth, my system may be employed in the treatment of various types of substances. I anticipate that it will find one of its principal uses in the acid treating of petroleum oils and I shall therefore describe its construction and operation with reference to such treatment. This method of presentation is chosen solely for the purpose of clarity of description, and I do not have any intention of limiting the scope of my patent protection to this particular

application of my invention as it has many other potential uses.

My system involves in general, separate sources of supply from which the oil and acid are fed to a mixing chamber. Both oil and acid are preferably fed by constant pressure impelling apparatus and the oil is passed through a displacement meter before it reaches the mixing chamber. This meter is provided with moving parts which are displaced in exact proportion to the amount of oil which flows therethrough and it in turn controls a valve which controls the movement of a piston in a measuring cylinder in the acid feed line to effect a reciprocation of the piston and a consequent feed of a predetermined volume of liquid in the acid line every time a predetermined volume has passed through the oil meter. The oil and acid are thus fed to a mixing chamber in exactly correct proportions, which proportions have been previously accurately predetermined. After the acid treatment of the oil in the mixing chamber, the mixed oil and acid sludge are fed to a battery of centrifuges which effect the separation of the acid-treated oil from the sludge formed in the acid treating operation.

Referring to the drawings by reference characters, oil to be purified is fed to the conduit 10 by a device capable of supplying it at constant pressure, such for example as a centrifugal pump 11. Oil supplied through conduit 10 is passed to conduit 10' through a metering device 12 which contains a movable part or parts which are positively displaced to an extent and frequency whose product is directly proportional to the amount of oil flowing into the system. Thus, referring to Figures 7 and 8, there are a pair of cylinders 13 and 14 and a pair of cylinders 15 and 16. Within cylinders 13 and 14 there is a double-headed piston 17 comprising a head 19 engaging the walls of the cylinder 13 and a head 20 engaging the walls of the cylinder 14, these heads being interconnected by a connecting portion 21 of reduced diameter. A similar piston operates within the cylinders 15 and 16. An opening 22 is formed in the common wall 23 between the pairs of cylinders, thus forming a space 24 within the walls of the device 12 into which liquid is introduced by means of conduit 10. In the arrangement of my apparatus, every particle of liquid which passes through the pipes 10 and 10' effects a proportionate displacement of the pistons within the cylinders. To this end, a suitable valve mechanism is employed to control flow of liquid from the space 24 between the cylinders to the cylinders 13, 14, 15 and 16 and from those cylinders to the passage 25 which is formed in the body of the cylinder casing and from which liquid discharges into an opening in the hollow boss 12' to which the discharge pipe 10' of the metering device is secured. Thus, in the construction illustrated in Figures 7 and 8, passages 26 and 27, respectively, lead to cylinders 13 and 14 from ports 28 and 29, respectively, and an intermediate port 30 communicates with discharge passage 25 leading through the wall of the cylinder casing to the interior of the boss 12' which communicates with the discharge pipe 10'. Similarly, passages 34 and 36 lead from ports 35 and 37 to cylinders 15 and 16, respectively, and a similar arrangement of ports 35, 37 and 38 control the flow of liquid from the space 24 into the cylinders and from the cylinders into the passage 25 leading to the discharge pipe 10'.

Co-operating with the ports 28, 29, 30 and 35, 37, 38 are identical valve devices. Each of these

devices consists of a movable valve member having a concave lower face provided with a cavity 32 adapted to interconnect two of the ports. Thus the valve device 31 illustrated in Figure 8 of the drawings interconnects the ports 28 and 30 to permit discharge of liquid from the cylinder 14 during the scavenging thereof by the movement of the piston 20 to the right as illustrated in that figure and interconnects the ports 29 and 30 during the reverse movement of that piston to permit the scavenging of the cylinder 13. The valves are held in close engagement with the surfaces upon which they rest by the pressure of the liquid within the space 24 and this pressure may be increased by guiding the valves along spring strips 33 secured within the casing and each passing through a slot in its respective valve. These strips also restrain the valve against sidewise movement and thus not only insure a firm seating of the valve, but also serve the additional function of guiding it in its reciprocating movement. The pistons are undercut at their inner extremities to form shoulders which co-act with the valve devices to abut extensions thereon as illustrated in Figure 8. Each of the pistons thus actuates the valve controlling ingress and egress of liquid to and from the adjacent cylinder. Thus, the pistons 19 and 20 at the lower side of Figure 7 control the feed and discharge of liquid to and from the cylinders 13 and 14 and the pistons 19 and 20 at the top of that figure control the feed and discharge to and from the cylinders 15 and 16 respectively.

In the operation of the displacement device 12, liquid is supplied through pipe 10 to chamber 24. Assuming that the parts are in the position shown in Figure 7, liquid will flow through the port 28 to the cylinder 13 and through the ports 29 and 30 from the opposed cylinder 14 into the passage 25 leading to the exhaust port in the boss 12'. At this stage the port 37 communicating with the cylinder 16 is also in communication with the space 24 allowing liquid to push the lower piston 19 to the left until this piston abuts a boss in the end of the cylinder 15. The lower piston 19 will then remain in the extreme left-hand position until the upper piston 20 abuts the upper valve 31 controlling the flow of liquid into cylinder 15 to place that valve into communication with the ports 37 and 38 and place the port 35 into communication with the liquid within the space 24. As soon as the upper valve 31 has been thrown in this manner, liquid will enter the cylinder 15 and force the lower piston 19 to the right, the liquid within cylinder 16 being forced through the passage 36 and ports 37 and 38 covered by the upper valve 31 into the exhaust passage 25 and pipe 10' by this movement. Shortly after the upper piston 19 has effected the movement of the upper valve described above, this piston reaches the end of its stroke and it is retained at the right-hand end of its stroke until the lower piston 19 has come to a position in which it approaches the right-hand end of its stroke and thus throws the lower valve 31 into a position in which liquid is admitted into the cylinder 14 and allowed to be expelled from the cylinder 13 through the ports 28 and 30 covered by the lower valve 31 into the passage 25 from which the liquid leaves the metering device. It will thus be seen that each of the pistons 19 and 20 is alternately reciprocated and that every particle of oil which passes from the pipe 10 to the pipe 10' effects a corresponding displacement of one or the other of the pistons within the cylin-

ders. It will also be seen that by controlling the valves which feed one set of cylinders by the movement of the pistons in the companion set of cylinders, I have been enabled to insure the completion of the stroke of the pistons within the cylinders in every case and have also avoided any tendency of the valves to stick in intermediate positions. If but a single set of pistons were used, such sticking of the valves might well occur. It will also be noted that such an arrangement would involve an admission of liquid to the cylinder before the piston working therein had quite completed its scavenging stroke and would result in an incomplete stroke of the piston and a resulting error in the metering of the liquid.

In accordance with my invention, I control the amount of liquid, e. g. acid, fed in the pipes 40 and 45 by the movement of the pistons in the metering device. To this end I pass a packed valve rod 56 through an opening in the casing 23 intermediate the sets of cylinders and provide a projection 57 extending from this rod within the space 24 into the path of the pistons in one of the sets of cylinders. Thus, as illustrated, the arm 57 extending from the rod 56 is adapted to be alternately reciprocated in opposite directions by the pistons 19 and 20 as they approach the inner ends of their strokes. It will thus be seen that the rod 56 is reciprocated in opposite directions once for each complete cycle of the metering device; i. e., it undergoes one reciprocation every time a quantity of oil corresponding to the sum of the volumes of the cylinders 13, 14, 15 and 16 passes through the metering device. This valve stem 56 in turn controls the movement of a valve in an acid metering device which I shall now describe.

In Figures 3 to 6 there is shown in more or less detail an operative construction of measuring cylinder 41 and its associated valve mechanism 44 adapted to be controlled by the valve rod 56. Pipe 40 leads into valve chamber 46 which contains valve 47, which, as shown, is of the conventional D-valve type, being held upon its seat not only by pressure of the liquid but by the action of spring 48. Within the seat of valve 47 is port 49 with which communicates outlet pipe 45, port 50 which communicates with one end of measuring cylinder 41 and port 51 which communicates with the other end of measuring cylinder 41. It will be apparent that reciprocation of valve 47 along its seat places each end of the cylinder alternately into communication with valve chamber 46 and exhaust port 49. Adjustable stop 43 is provided with suitable packing 50' compressed by nut 51 and the central portion of piston 42 carries an index line 52 in order that the stroke, and therefore the displacement volume, of measuring cylinder 41 may be indicated on scale 53. Also, piston 42 is provided with openings 54 for the accommodation of the tool whereby piston 42 may be rotated to free it in the event that it binds for any reason, such as corrosion.

In the practice of this invention valve 47 is moved in exact correspondence with the displacement of a movable member of displacement device 12, and the frequency of reciprocation of piston 42 of measuring cylinder 41 is exactly dependent upon the volume of liquid passed through displacement device 12. Any suitable method and apparatus may be employed for effecting such movement of valve 47. In Figs. 2, 5, and 6 valve 47 is provided with a packed valve rod 55 which is directly connected to packed rod 56 extending into metering device 12.

In the construction shown in Fig. 9 packed rod 156 is similar in construction and arrangement to rod 56 and the movement thereof is utilized to actuate one or more switches controlling the energization of electric motors which effect reciprocation of valve 47. Thus, in Fig. 9 rod 156 is shown as provided with arms 59 and 60 between which is located switch arm 61 pivoted at 62. Reciprocation of rod 156 will alternately bring switch arm 61 into contact with switch points 63 and 64. Switch point 64 is connected to one binding post of bus-bar 65 and switch point 63 is connected to one binding post of bus-bar 66. One terminal of battery 67 is connected to switch arm 61 and the other terminal thereof is connected to one binding post of bus-bar 68. Bus-bars 65, 66, and 68 may be provided with any suitable number of binding posts. Valve rod 155 extends out of both ends of valve casing 44 and cooperating with opposite ends of valve rod 155 are solenoids 69, each of which has one of its terminals connected to bus-bar 68 and its other terminal to bus-bar 65 or 66. Thus, reciprocation of rod 156 will effect alternate energization of solenoids 69 and reciprocation of piston 42 of measuring cylinder 41 will correspond exactly with the reciprocation of piston 17 of displacement device 12.

For the acid-treatment of oil in accordance with this invention, oil flowed through pipe 10 and acid supplied through pipe 40 and pipes 11 and 45 are discharged into a mixer 70 from which the resulting oil containing dispersed acid is conducted after a suitable period through pipe 71 to a battery of centrifugal separators 72 in which the sludge and residual acid are separated from the oil and discharged separately therefrom. In the event that duplications of the mixing and agitating steps are desired, or in the event that it is desired to add water to the acid-oil mixture prior to separation of sludge therefrom, measuring cylinder 41 may be duplicated and the operation of all such measuring cylinders may be controlled by movement of a moveable part in displacement device 12. For example, measuring cylinders having solenoid operated valves may be duplicated and the circuits of the solenoids may be connected to binding posts of bus-bars 65, 66 and 68.

A very important feature of my invention consists in the arrangement by which the stroke of the piston 42 may be adjusted either before or during the operation of the system. Thus, in the treatment of petroleum the proportion of acid and oil necessary may be accurately predetermined from laboratory analysis or from a brief experimental run through the system and the screw 43 set to deliver the desired quantity of acid from the computation of the volumes of the cylinders within the metering device 12 and the corresponding reading taken upon the scale 53. The relative volumes of the two liquids fed to the mixture may be thus adjusted by a setting of the screw 43, but once this screw is set the volumes delivered will always bear exactly the same proportion to each other.

In the acid treating of oil the mixed sludge and treated oil is delivered through the pipe 71 into a pipe 73 from which it is fed in parallel to a battery of centrifugal separators 72 each controlled by a valve 74. When, for any reason, it is desired to use less than the complete battery of centrifuges, one or more of these separators can be disabled by closing the valve 74 controlling the feed of liquid thereto. Such a closing of one or more of the valves will effect a diminution of

the flow of the oil through the pipes 10 and 10' in almost direct proportion to the number of centrifuges so disabled. It will be noted that the disablement of one or more centrifuges in this manner and the resulting diminution of flow in the pipes 10 and 10' will effect an absolutely proportional volumetric diminution of flow in the acid feeding line. As the pistons within the casing 12 and 41 are all idler pistons and connected to no positive operating mechanism whatever, they are capable of responding instantly to variation in flow caused by increased or decreased resistance in the discharge end of the system produced in the manner described above or in analogous manners in different types of systems. In the consideration of this matter, it is important to remember that the feeding devices for both oil and acid are of a type in which a substantially constant pressure is maintained under all practical working conditions. When this type of impeller, e. g., a centrifugal pump or a constant head of liquid, is used, the amount of liquid flowing within the system is inversely proportional to the resistance within the system, in accordance with well known laws of hydraulics, and I am accordingly enabled to control the volume of liquid flowing within the feed pipes by the resistance to flow imposed by the discharge end of the system. The principal resistance in this connection is in the feed nozzles of the centrifugal separators.

From the above description it will be obvious that I have attained every one of the objects of my invention. I have not only devised an arrangement in which the volume of flow into the mixer from the several feed pipes is accurately proportioned in desired amounts, but I have also effected an arrangement in which a restriction at the discharge end of the system effects a corresponding volumetric diminution of flow in both of these pipes. The resistance to flow may, therefore, be fixed at any desired amount without disturbing the desired proportion of the liquids, and this resistance may be changed at the discharge end without necessitating any rearrangement whatever in the feeding and proportioning mechanism.

In the above discussion, I have described two specific arrangements of apparatus in accordance with my invention. I wish it to be understood, however, that this description is to be taken in an illustrative rather than in a limiting sense, and I do not intend to be limited thereby except in accordance with the terms of my subjoined claims as interpreted in the light of the broad generic spirit of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A feeding system for liquids comprising separate conduits for a plurality of liquids, impelling means for feeding a liquid in one of said conduits, a metering device comprising a piston operative in a cylinder in the conduit fed by said impelling means and in which the piston has a movement proportionate to the passage of liquid through said conduit, a valve mounted for actuation by said piston and a cylinder connected with a source of supply of an auxiliary liquid constituting a part of a second conduit and a piston operative within said auxiliary liquid cylinder and effecting a proportionate flow of auxiliary liquid to the liquid fed in the first mentioned conduit, said second cylinder, piston and valve being adapted to effect feed of auxiliary liquid upon movement of the auxiliary liquid piston in both directions.

2. A feeding system for fluids comprising a conduit for a fluid, a metering device in said conduit including a cylinder and a piston having a movement in said cylinder in direct proportion to the volumetric flow of fluid in said conduit, a second conduit associated with a source of supply of a second fluid, a cylinder forming a part of said second conduit, a piston mounted for reciprocation within said second cylinder, and valve means operated positively by the movement of the first mentioned piston and controlling the flow of fluid into and out of said second cylinder.

3. A feeding system for fluids comprising a conduit for a fluid, a metering device in said conduit including a cylinder and a piston having a movement in said cylinder in direct proportion to the volumetric flow of fluid in said conduit, a second conduit associated with a source of supply of a second fluid, a cylinder forming a part of said second conduit, a piston mounted for reciprocation within said second cylinder, and valve means including a D valve operated positively by the movement of the first mentioned piston and controlling the flow of fluid into and out of said second cylinder.

4. A feeding system for fluids comprising a conduit for a fluid, a metering device in said conduit including a cylinder and a piston having a movement in said cylinder in direct proportion to the volumetric flow of fluid in said conduit, a second conduit associated with a source of supply of a second fluid, a cylinder forming a part of said second conduit, a piston mounted for reciprocation within said second cylinder, and valve means positively operated by the movement of the first mentioned piston for alternately admitting fluid to opposite ends of the second cylinder and simultaneously allowing fluid to escape from the end of the cylinder opposite that at which fluid is being admitted.

5. A feeding system for fluids comprising a conduit for a fluid, a metering device in said conduit including a cylinder and a piston having a movement in said cylinder in direct proportion to the volumetric flow of fluid in said conduit, a second conduit associated with a source of supply of a second fluid, a cylinder forming a part of said second conduit, a piston mounted for reciprocation within said second cylinder, and unitary valve means positively operated by the movement of the first mentioned piston for alternately admitting fluid to opposite ends of the second cylinder and simultaneously allowing fluid to escape from the end of the cylinder opposite that at which fluid is being admitted.

6. A feeding system for fluids comprising a conduit for a fluid, a metering device in said conduit including a cylinder and a piston having a movement in said cylinder in direct proportion to the volumetric flow of fluid in said conduit, a second conduit associated with a source of supply of a second fluid, a cylinder forming a part of said second conduit, a piston mounted for reciprocation within said second cylinder, and a D valve positively operated by the movement of the first mentioned piston for alternately admitting fluid to opposite ends of the second cylinder and simultaneously allowing fluid to escape from the end of the cylinder opposite that at which fluid is being admitted.