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MIXING APPARATUS

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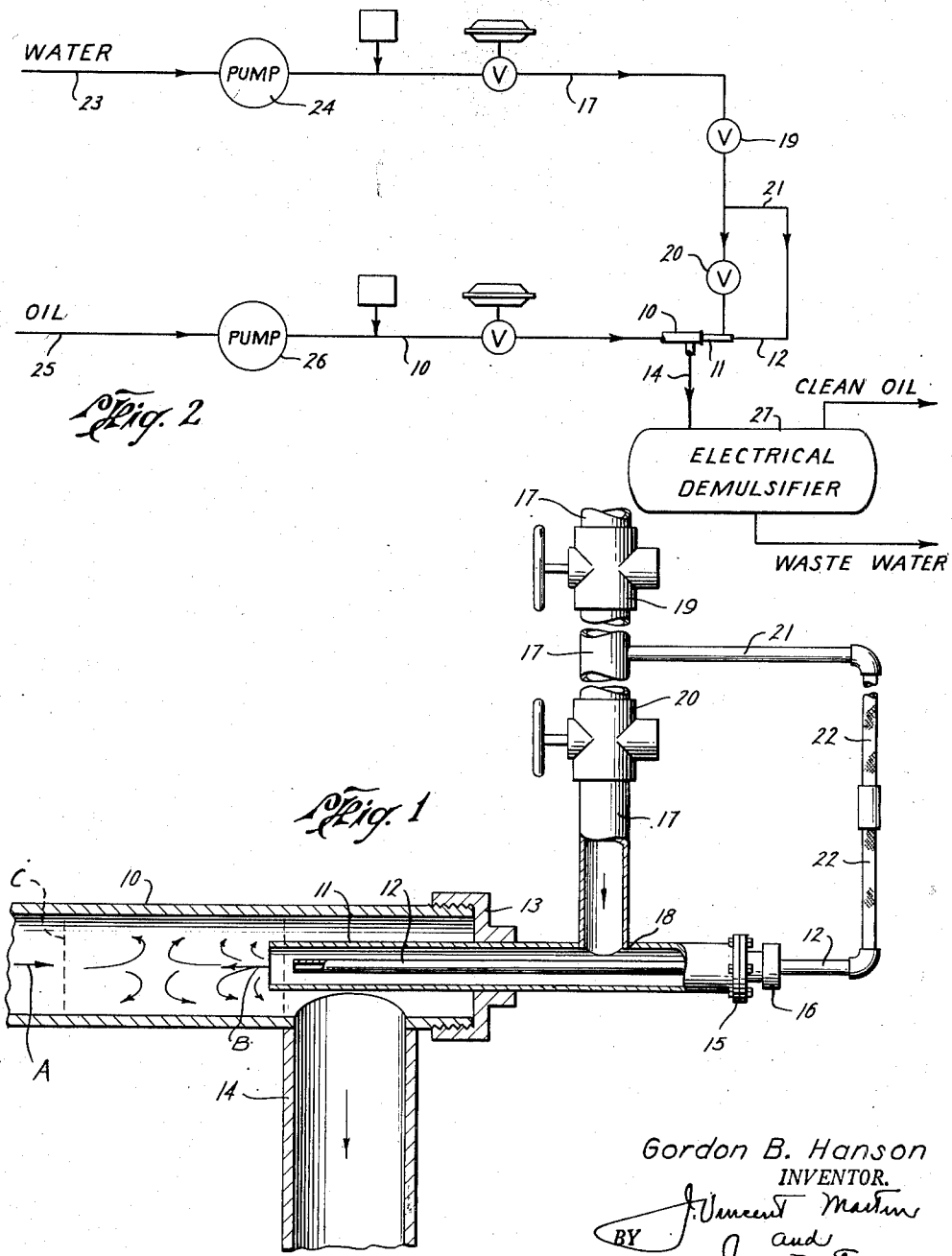


Fig. 2

Fig. 1

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MIXING APPARATUS

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1

This invention relates to new and useful improvements in mixing apparatus.

One object of the invention is to provide an improved mixing apparatus for efficiently mixing two liquids and which is particularly adaptable for use in oil purification methods wherein petroleum oil is washed with water for the purpose of removing salt, acid and other foreign substances from said oil.

An important object of the invention is to provide an improved mixing apparatus wherein the two liquids to be mixed are directed into a mixing zone from opposite sides whereby the counter-flowing liquids engage each other to create a turbulence within the mixing zone which effects a thorough mixing of said liquids; the particular arrangement which interrupts normal straight-line flow of the liquids through the flow line functioning to maintain the liquids within the mixing zone for an increased period of time to further assure efficient mixing.

Another object is to provide an improved mixing apparatus wherein the velocity of admission of one of the liquids into the mixing zone is variable and may be readily adjusted to accurately control the mixing action; the variation in the velocity of the liquid stream being possible without any change or variation in the volume of said liquid, whereby the volumetric ratio of the liquids being admixed may remain constant under varying types of mixing action to assure efficient mixing under all conditions.

A still further object is to provide a mixing apparatus, of the character described, wherein co-axial inlet pipes are disposed to conduct one of the liquids to be mixed into the mixing zone, with means for controlling the volume of liquid flowing through both co-axial pipes to control the velocity of the flow streams and with further means for adjusting the outlet end of the inner pipe with respect to the mixing zone, whereby accurate control of the mixing action in the mixing zone is obtainable.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a view, partly in section and partly in elevation of an improved mixing apparatus, constructed in accordance with the invention, and

2

Figure 2 is a diagrammatic view of an oil purification system in which the mixing apparatus has been found useful.

In the drawings, the numeral 10 designates a flow line or conductor which conducts one of the liquids to be mixed in the direction indicated by the arrow A in Figure 1. For purposes of illustration this liquid will be assumed to be oil. The other liquid, which will be assumed to be water, is conducted into one end of the line or conductor through a pair of co-axial pipe elements 11 and 12 which extend inwardly into the conductor 10 through an end cap 13 which is threaded onto the end of said conductor. The open end of the outer pipe 11 is disposed within the conductor 10 at a point beyond the outlet line 14 which extends from the conductor in a radial direction. As will be explained, the open or outlet end of the inner pipe 12 may have its position varied with respect to the end of the other pipe 11. The direction of flow through the co-axial pipes 11 and 12 is in the direction of the arrow B in Figure 1.

The oil flowing in a direction to the right in Figure 1 is directly contacted by the water emerging from the pipes 11 and 12 and the two counter-current streams upon striking each other will create a turbulence which will effect a thorough mixing of the two liquids. This turbulence is set up in a zone which is substantially defined by the dotted lines C within the conductor 10, and this zone may be identified as a mixing zone. It will be apparent that by controlling the velocity of the stream which is ejected from the small inner pipe 12, the distance of projection of the stream of water from this inner pipe into the flowing oil may be controlled; by increasing the velocity of the water ejected from the inner pipe, the projection of the stream into the flowing oil will be greater than where the velocity is decreased. The velocity of the stream ejected from the inner pipe will also control the force with which the stream of water engages the flowing oil, and this will have a definite effect on the mixing action which is created in the mixing zone C.

The contact between the water and oil and the resultant turbulence set up within the mixing zone C will effect a thorough admixture of the water and oil, and this mixture will then escape from the conductor 10 through the outlet line 14. It is pointed out that for economical purposes the mixing zone C is actually formed within the conductor 10, but if desired this mixing zone could be provided by a separate mixing

chamber to which the conductor 10 and co-axial pipes 11 and 12, as well as the outlet line 14, are connected.

The co-axial pipe assembly which introduces the water into the mixing zone, together with the controls for controlling the volume and velocity of water flowing through each of the pipes, are clearly illustrated in Figure 1. As shown in this figure, the outer pipe 11 extends through the cap member 13 and has an annular flange 15 at its outer end. A suitable stuffing box 16 is connected to the flange 15 and the inner pipe or conduit 12 extends through the stuffing box and is disposed axially within the outer pipe. The provision of the stuffing box makes it possible to adjust the inner pipe or conduit 12 longitudinally of the outer pipe 11 so that the outlet end of the inner pipe may be varied with respect to the outlet end of the outer pipe; as will be hereinafter explained, this adjustment of the inner pipe with respect to the outer pipe assists in controlling the mixing action which is produced within the mixing zone C.

The water is supplied to the outer pipe 11 of the co-axial pipe assembly through a water inlet line 17 which has one end welded or otherwise connected in a radial opening 18 in the pipe 11. A main control valve 19 is connected in the supply line 17 and controls the volume of water which may pass this valve. A second valve 20 is also connected in the water line 17 in spaced relation to the first valve 19, and the adjustment of this valve controls the volume of water which is flowing to the outer pipe 11. A radial branch pipe 21 is connected to the line 17 between the control valves 19 and 20, and this pipe has connection, preferably through a flexible hosing or conduit 22, with the outer end of the inner conduit or pipe 12. The flexible connections 22 permit the longitudinal adjustment of the inner pipe 12 with respect to the outer pipe 11.

By adjusting the main control valve 19 the total volume of water which is conducted to both the inner and outer pipes 11 and 12 is accurately controlled. Adjustment of the second control valve 20, which is between pipe 11 and branch line 21, accurately controls the volume of water which is flowing to the outer pipe 11 and at the same time controls the water which flows to the inner conduit or pipe 12. After the main valve 19 has been adjusted to fix the volume of water which is to be admixed with the oil, the valve 20 may be adjusted to control the volume of water flowing to each of the pipes 11 and 12. Since the inner pipe 12 is of considerably less diameter than the outer pipe 11, it will be evident that the velocity of flow through the inner pipe will be greater than that through the outer pipe if the volume to each pipe is the same. By adjusting the valve 20, any desired volume of water may be directed in desired ratios to the pipes 11 and 12. An increase in the water volume conducted to the inner pipe 12 will result in an increase in velocity of flow through this pipe and will at the same time reduce the velocity of flow in the outer pipe 11. Similarly, adjustment of the valve 20 to decrease the volume of water flowing to the inner pipe will increase the supply of water to the outer pipe, and this will obviously result in a change in velocities. It is thus apparent that the main control valve 19 controls the total volume of water which will be introduced by both pipes, while the control valve 20 will determine the volume of water passing through each of the pipes 11 and 12.

By controlling the velocity of the stream of water which is ejected from the inner pipe 12, it is possible to control the mixing action. If the velocity of flow of the stream flowing through the inner or small pipe 12 is increased, the stream which is discharging from this pipe will be ejected a greater distance into the mixing zone; on the other hand, a decrease in the velocity will cause the discharging stream to project a lesser distance into the mixing zone. The distance which the stream is discharged into the mixing zone has a direct bearing on the turbulence which will be created and therefore upon the mixing action. It is thus obvious that a variation in the velocity of flow of the stream through the inner pipe 12 will permit a control of the mixing action.

Further control of the mixing action may be obtained by adjusting the outlet or discharge end of the inner pipe 12 with respect to the end of the outer pipe 11. It is obvious that as the relatively high velocity stream emerges from the inner pipe, a suction effect is created which will pick up the water flowing through the outer pipe 11 and will drive this water into intimate contact with the oil in the mixing zone. The suction effect of the stream emerging from the inner pipe upon the water flowing through the outer pipe will vary in accordance with the position of the discharge end of pipe 12 with pipe 11 and thus a greater or lesser force can be imparted to the water which is being discharged through the outer pipe 11. This results in a further control of the mixing action.

The operation of the device is believed to be obvious from the foregoing. The oil is moving in a direction to the right in the conductor 10 while the water being introduced through the pipes 11 and 12 is moving in an opposite direction into the mixing zone. The volume of water being introduced through both of the pipes 11 and 12 is controlled by the main valve 19, and such valve is adjusted in accordance with the total amount of water to be admixed with oil. The valve 20 is adjusted to direct a portion of the water through the smaller or inner pipe 12 at the desired velocity; because the inner pipe is of a considerably smaller diameter than the outer pipe the flow stream discharging from the inner pipe has a higher velocity than the water emerging from the outer pipe 11. The excess velocity of the inner stream will cause the stream discharging from the inner pipe 12 to penetrate some distance into the mixing chamber where the stream will be dispersed to some extent into the oil and will then start moving back in the same direction that the oil is moving. As the discharged water begins to move with the oil the particles which have been originally broken up will be contacted by the subsequent discharging stream of water and subjected to further turbulence so that by the time the mixture has moved past the discharge end of the outer pipe 11, it has been subjected to a very considerable beating or mixing action. The amount of turbulence created in the mixing zone bears a definite relationship to the velocity of the water being ejected from the inner pipe 12, and this turbulence can be controlled by controlling the velocity of the flow stream discharging from said inner pipe. As above explained, the velocity is varied in either direction by varying the control valve 20. It is apparent that with the main control valve 19 fixed, an adjustment of the valve 20 which will increase the volume of water flowing through the inner pipe will also cause a decrease in the volume of water deliv-

ered through the outer pipe 11; however, since the energy of the stream flowing through the inner conductor increases with the increased volume, the lesser quantity of water emerging from the outer pipe 11 will be caught in the discharging stream or jet and will be driven into the mixing zone with greater and greater turbulence. This driving action, as has been explained, can be controlled to a further extent by adjusting the discharge end of the inner pipe with respect to the discharge end of the outer pipe. It is therefore obvious that the device provides an efficient mixing apparatus wherein the mixing action can be controlled to provide the desired amount of mixing in accordance with the particular liquids which are supplied and according to the results which are being sought.

The apparatus has been described as mixing oil with water, but it is pointed out that it may be applied to mixing any two liquids. If the liquids are mutually soluble, the mixture can be effected very rapidly; on the other hand, in the event that the liquids are not mutually soluble, one liquid may be dispersed into the other with any degree of fineness of the dispersed liquid merely by controlling the mixing action.

Although the mixing apparatus is applicable for any purpose where two liquids are to be mixed, it has been found particularly applicable to the mixing of oil and water for the purpose of washing petroleum oil with water to remove salt, acid and other foreign substances from the oil. In Figure 2 a diagrammatic illustration of a desalting plant wherein the mixing apparatus may be used is shown. In this figure, a water supply line 23 from any suitable source has connection with a pump 24 which pumps the water through the supply line 17. As explained the supply line has the main control valve 19 and the second control valve 20 connected therein with the branch line 21 extending from a point between said valves. Oil is supplied through a main line 25 and a pump 26 moves said oil through the conductor 10. The co-axial pipes 11 and 12 are connected in the end of the conductor. The outlet line 14 connects the conductor with an electrical treater or demulsifier 27 wherein the oil-water mixture is subjected to electrical treatment in the usual manner.

It will be evident that the oil having salt therein is brought into contact with the water with the mixing action being controlled in the mixing chamber C by the improved apparatus. By proper control of the velocity of flow through the co-axial pipes 11 and 12, together with proper adjustment of the inner pipe with respect to the outer pipe, the mixing action may be controlled to assure an intimate mixing and washing of the oil, whereby the water will pick up the salt in the oil. With the salt in solution with the water by reason of the intimate mixing the subsequent separation of the water and oil in the electrical treater 27 will remove the majority of the salt which was originally present in the oil stream. Although Figure 2 illustrates the application of the mixing apparatus to a desalting operation, it is obvious that it may be employed in other treating processes and methods where a mixing action is necessary in effecting the removal of foreign substances from the oil.

Having described the invention, I claim:

1. A mixing apparatus for mixing two liquids including, a conductor for conducting one of the liquids to be mixed therethrough, an outlet line extending from the conductor, a conducting means for discharging the second liquid to be mixed into said conductor, said conducting means comprising an inner pipe and an outer pipe surrounding said inner pipe and of larger cross-sectional area, a liquid supply line connected to the outer end of the outer pipe, a branch line extending from the supply to the inner pipe, and valve means in the supply line between the point of connection of the supply line to the outer pipe and the branch line for controlling the volume of liquid flowing to each of the inner and outer pipes and thereby controlling the velocities of flow therethrough.

2. A mixing apparatus as set forth in claim 1 together with a main flow control means in the supply line beyond the branch line for controlling the total volume of liquid flowing to both inner and outer pipes.

3. A mixing apparatus as set forth in claim 1, wherein the inner pipe is adjustable axially with respect to the outer pipe.

4. A mixing apparatus for mixing two liquids including, means defining a mixing zone, a conductor for conducting one of the liquids to be mixed into the mixing zone, a second conductor for conducting a second liquid into the mixing zone in a direction opposite to the direction of flow of the first liquid, said second conductor comprising a pair of co-axial inner and outer pipes the outer pipe surrounding said inner pipe and of larger cross-sectional area and arranged for parallel branch flow of said second liquid, an outlet line extending from the mixing zone for conducting the mixed liquids therefrom, and valve means associated with one of said co-axial pipes for controlling the velocity of flow of said second liquid flowing through said co-axial pipes to control the mixing action within the mixing chamber.

5. A mixing apparatus for mixing two liquids including, means defining a mixing zone, a conductor for conducting one of the liquids to be mixed into the mixing zone, a second conductor for conducting a second liquid into the mixing zone in a direction opposite to the direction of flow of the first liquid, said second conductor comprising a pair of co-axial inner and outer pipes the outer pipe surrounding said inner pipe and of larger cross-sectional area and arranged for parallel branch flow of said second liquid, an outlet line extending from the mixing zone for conducting the mixed liquids therefrom, means for controlling the total volume of said second liquid flowing through the pair of said co-axial inner and outer pipes, and an additional control means associated with the outer pipe of said pair of co-axial pipes for varying the velocity of flow of said second liquid flowing through each of said co-axial pipes.

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