Nov. 21, 1933. F. O. W. LOOMIS ET AL 1,935,884

EMULSIFYING APPARATUS

Filed June 3, 1931 2 Sheets-Sheet 1

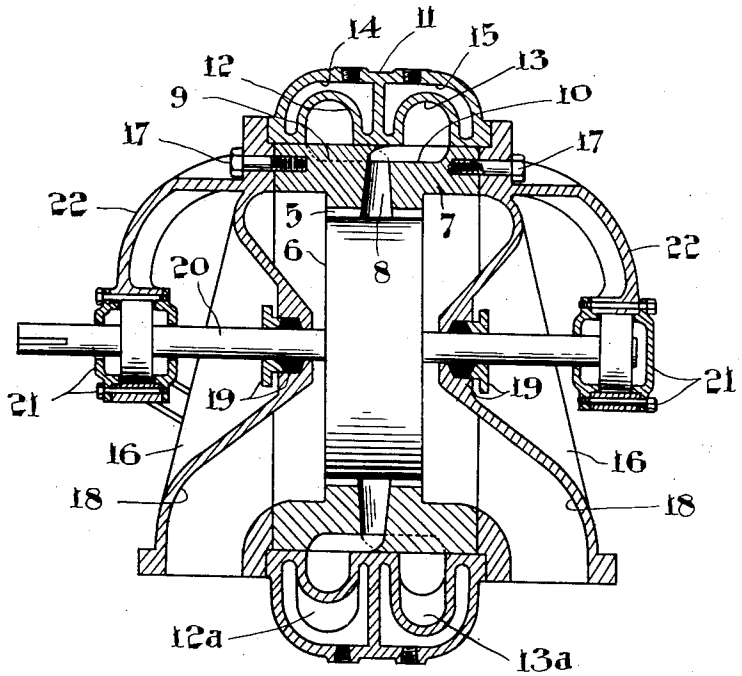


FIG. 1

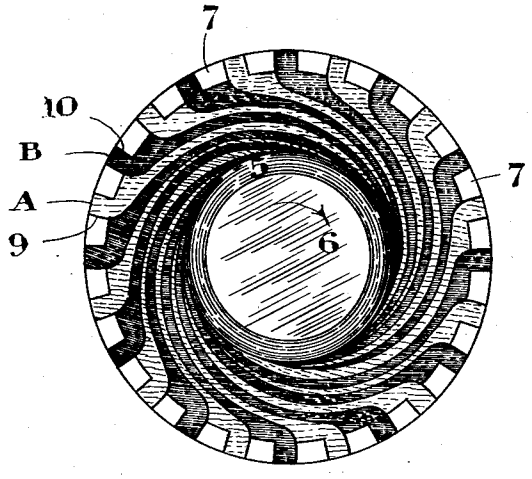


FIG. 2

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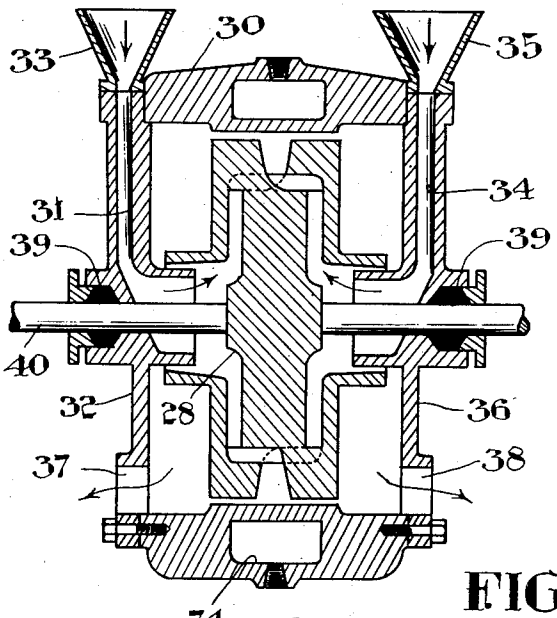


FIG. 3

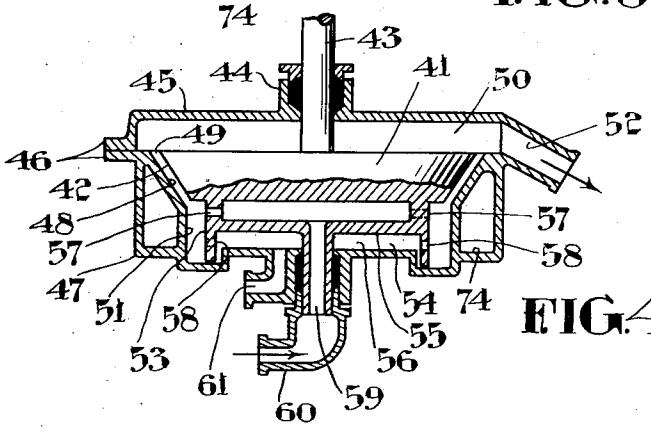


FIG. 4

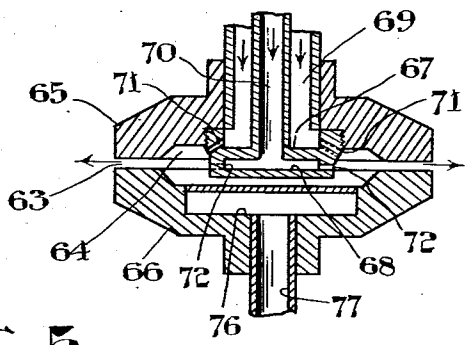


FIG. 5

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EMULSIFYING APPARATUS

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7 Claims. (Cl. 259—9)

This invention relates to apparatus for making various kinds of emulsions; colloidal mixtures; and similar preparations.

As herein disclosed, the invention is particularly useful for practising that process of emulsification which consists in making a suspension of one liquid or semi-solid generally termed the "internal phase" in another liquid generally termed the "external phase", the two liquids being normally immiscible or repellent to one another. With the aid of this invention the desired result is achieved in a highly efficient and satisfactory manner by the formation of minute droplets of the "inner phase" suitably suspended or dispersed in the "outer phase". This is accomplished by splitting the two phases into a plurality of separate streams which are directed into a drawing chamber communicating with a relatively small gap reserved between a stator and a high speed rotor or between two rotors revolving in opposite directions. The streams are fed to the drawing chamber in such manner that the streams of one phase enter the chamber between the streams of the remaining phase, with the result that a more or less definite stratification of the two phases is maintained as the various streams pass through the drawing chamber to the gap communicating therewith. This method of feeding the two liquids or phases through the drawing chamber serves, in conjunction with the shearing action at the gap, to provide a superior type of emulsion possessing all of the characteristics necessary for use in the manufacture of bituminous road surfacing materials and other uses.

Proceeding now to a more detailed discussion of the invention, reference will be had to the accompanying drawings wherein we have shown several different forms of apparatus capable of being used for carrying the invention into practical effect. In these drawings;

Fig. 1 is a view in vertical section of a preferred form of apparatus.

Fig. 2 is a graphic view illustrating the emulsifying action of the apparatus shown in Fig. 1.

Figs. 3, 4 and 5 are views similar to Fig. 1, but showing various modified forms of apparatus.

In the construction shown in Fig. 1, a relatively small annular gap 5 is reserved between the periphery of the rotor 6 and the inner opposing surface of the stator 7. A radial drawing chamber 8 of annular form is provided in the stator 7 and communicates at the inner surface of the stator with the gap 5. The outer surface of the stator is provided with two annular series of axially extending feed grooves 9 and 10 located at opposite sides of the drawing chamber 8 and communicating therewith, the grooves of the two series being alternately arranged around the circumference of the stator, as indicated in Figure 2. The grooved surface of the stator is surrounded by a frame 11 equipped with separate distributing channels 12 and 13. The channel 12 delivers to the grooves 9 and is provided with a suitable inlet 12*a*. The channel 13 delivers to the grooves 10 and is provided with an inlet 13*a*. The inlets 12*a* and 13*a* are preferably directed in opposite directions as indicated in Fig. 1 and are connected with suitable feed pumps (not shown) which may be bolted to or cast integral with the frame 11. The frame 11 is also formed with hollow spaces or jackets 14 and 15 for the circulation of heating or cooling fluids to control the temperature conditions necessary to the proper carrying out of the emulsification process for which the apparatus is designed.

End plates 16 are bolted to opposite sides of the stator 7 as indicated at 17. Each end plate is suitably shaped to provide discharge passages 18 leading from opposite sides of the gap 5. The plates 16 are equipped with packing glands 19 engaging the central portion of the rotor shaft 20, the outer portions of which are supported in bearings 21 carried by spiders 22 fixed to or formed integral with the outer surfaces of the plate 16.

The apparatus described above functions in the following manner: The rotor 6 is driven at a high rate of speed and the two liquids or phases are pumped into the distributing channels 12 and 13 through the inlets 12*a* and 13*a*, one phase entering the channel 12 and the other phase entering the channel 13. When the channels are filled the two phases are forced through the feed grooves 9 and 10 into the drawing chamber 8. The emulsification process is carried out within the drawing chamber 8 and the gap 5 and the finished emulsion is discharged from the gap through the discharge passages 18. From observation and tests it appears that the alternate arrangement of the two sets of feed grooves 9 and 10 causes a definite stratification of the phase streams which is maintained during progress of the streams through the drawing chamber to the gap 5, this condition being graphically represented in Fig. 2 wherein the rotor and the stator, together with the drawing chamber and the feed grooves, are shown diagrammatically. In this figure the streams of one liquid or phase entering the drawing chamber from the grooves 9 are in-

dicated by the letter A while the streams of the remaining liquid or phase entering the drawing chamber from the opposing grooves 10 are indicated by the letter B. Due to the alternate arrangement of the two sets of grooves 9 and 10, the drawing chamber 8 is filled with a spinning ring or body of liquid consisting, as shown in Fig. 2, of alternate layers of each liquid or phase. When the drawing chamber is filled, this stratified liquid ring or body tends to rotate with the rotor and, consequently, the alternating streams A and B tend to assume the spiral form indicated in Fig. 2. The peripheral velocity of the streams A and B is gradually increased as these streams travel inwardly through the drawing chamber from the feed grooves 9 and 10 to the gap 5. This peripheral velocity increase ranges from a zero value at the point where the streams enter the drawing chamber to the velocity of the rotor at the point where the streams are brought into engagement with the rotor surface. In this way a very satisfactory drawing action is obtained which produces alternate layers of minimum practical thickness, the thickness of each layer being only one-thousandth of an inch. This will be readily understood when it is considered that the peripheral velocity of the rotor is about 10,560 feet per minute, whereas the volume capacity of each of the grooves 9 and 10 is only about 125 cubic inches per minute. The drawing action of the rotor consequently produces a very desirable attenuation of the alternate films or layers of liquid established in the drawing chamber 8. The centrifugal force set up in the spinning ring of liquids established in the drawing chamber also tends to stabilize the entire action and to prevent disruption of the layer formation. As the liquids enter the gap 5 in the form of alternate layers of extreme thinness they are emulsified almost instantly when subjected to the shearing forces set up between the stator and the rotor.

In the modified construction shown in Fig. 3, the drawing chamber 23, feed grooves 24 and 25 and the distributing channels 26 and 27 are formed in the rotor 28, the drawing chamber being in communication with a gap 29 provided between the periphery of the rotor and the opposing inner surface of the stator 30. One liquid or phase is supplied to the distributing channel 26 through a passage 31 formed in an end plate 32 bolted or otherwise secured to one side of the stator 30. The passage 31 is arranged with its inlet end communicating with a hopper 33 and its outlet end extending into the portion of the rotor forming the distributing channel 26. The remaining liquid or phase is delivered to the distributing channel 27 through a passage 34 having its lower end communicating with said channel and its upper end communicating with a feed hopper 35, said passage 34 being formed in an end plate 36 bolted or otherwise fastened to the remaining side of the stator 30. The action of this apparatus is substantially the same as that shown in Figure 1 and the finished emulsion coming from the gap 29 is discharged through suitable outlet openings 37 and 38 formed in the end plates 32 and 36. In this construction the end plates 32 and 36 carry bearings (not shown) supporting the rotor shaft 40 which passes through the packing glands 39.

In the construction shown in Figure 4 a disk rotor 41 having a sloping periphery 42 is carried by a vertical shaft 43. This shaft is suitably mounted and passes through a packing gland 44 formed in the upper section 45 of a two part casing generally indicated at 46. The lower casing section 47 presents a sloping surface 48 spaced from the periphery of the rotor 41 to provide an intervening gap 49 communicating with a discharge chamber 50 and a drawing chamber 51. The discharge chamber 50 is formed between the casing section 45 and the upper surface of the rotor 41 and is provided with an outlet 52. The drawing chamber 51 has its outer side and bottom walls formed by the casing section 47 and its inner side wall formed by an annular flange 53 depending from the bottom surface of the rotor 41. A feed chamber 54 is formed within the flange 53 between the bottom surface of the rotor 41 and an opposing wall 55 cast integral with the flange 53. A second feed chamber 56 is formed within the flange 53 between the wall 55 and the opposing portion of the casing section 47. The flange 53 is provided with a series of openings 57 placing the feed chamber 54 in communication with the drawing chamber 51 and with a second series of openings 58 also placing the feed chamber 56 in communication with the drawing chamber 51. The two sets of openings 57 and 58 are staggered so that the openings of one set are positioned between the openings of the remaining set. The wall 55 separating the chambers 54 and 56 is provided with a tubular extension 59 passing downwardly through an opening in the bottom wall of the casing section 47 and providing an inlet to the chamber 54, the lower end of said tubular extension 59 being suitably connected by an elbow 60 to a supply pipe (not shown). The chamber 56 is also provided with an inlet 61 cast integral with the bottom wall of the casing section 47. In the operation of this form of apparatus the two liquids or phases are supplied to the chambers 54 and 56 through the inlet connections 59 and 61 and pass from said chambers through the openings 57 and 58 into the drawing chamber 51. From the chamber 51 the two phases or liquids are drawn into the gap 49 and emulsified before being discharged through the discharge chamber 50 and the discharge outlet 52.

In the construction shown in Fig. 4 the gap 63 and the drawing chamber 64 are formed between the opposing surfaces of a pair of oppositely revolving rotors 65 and 66. The rotor 65 is equipped with feed chambers 67 and 68 provided with inlet connections 69 and 70 for the introduction of the two phases or liquids. The liquid or phase supplied to the chamber 67 passes into the drawing chamber 64 through the opening 71 while the liquid or phase supplied to the chamber 68 passes into the drawing chamber through the openings 72, the two sets of openings 71 and 72 being relatively staggered as indicated on the drawings.

In all of the different forms of apparatus described in the foregoing it will be noted that the two liquids or phases are split up into a plurality of streams and introduced into the drawing chamber in such manner that the streams of one phase enter the drawing chamber between adjacent streams of the remaining phase. In actual practice it has been found that this method of splitting up and feeding the two phases into the drawing chamber gives results which are not obtained by feeding the two phases into the drawing chamber through a common inlet.

In the construction shown in Figures 3 and 4 the stators are provided with hollow spaces or jackets 74 corresponding to the hollow spaces or jackets 14 previously described.

In the construction disclosed in Figure 5, a similar hollow space or jacket 76 is formed in the

rotor 66 in communication with a hollow rotor shaft 77.

Having thus described our invention, what we claim is:

1. An emulsifying apparatus comprising relatively movable surfaces spaced apart to provide an intervening gap, a drawing chamber communicating with the gap and liquid feed passages for delivering two different liquids or phases into the drawing chamber so that each phase is split up into a plurality of small streams entering the drawing chamber between similar streams of the remaining phase.

2. An emulsifying apparatus comprising relatively movable surfaces spaced apart to provide an intervening gap, a drawing chamber in communication with said gap, two series of feed passages communicating with said chamber, the passages of one series being staggered with respect to the passages of the other series, means for supplying one liquid or phase to the drawing chamber through the feed passages of one series and means for supplying another liquid or phase to said chamber through the feed passages of the remaining series.

3. An emulsifying apparatus comprising a rotor, a surrounding stator spaced from the rotor to provide an intervening gap, a drawing chamber in the stator communicating with the gap and means for feeding two liquids or phases to the drawing chamber including provision for splitting each phase into a plurality of separate streams entering the drawing chamber between similar streams of the remaining phase.

4. An emulsifying apparatus as claimed in claim 3 in which the two phases are separately fed into the drawing chamber through two series of feed passages, the passages of one series being staggered with respect to the passages of the remaining series.

5. An emulsifying apparatus comprising a rotor, a surrounding stator spaced from the rotor to provide an intervening gap, a drawing chamber in the stator communicating with the gap, two series of feed passages located at opposite sides of the drawing chamber in communication therewith, the passages of one series being staggered with respect to the passages of the remaining series, means for supplying one liquid or phase to the drawing chamber through one series of passages and means for supplying another liquid or phase to the drawing chamber through the remaining series of passages.

6. An emulsifying apparatus comprising a rotor, a surrounding stator spaced from the rotor to provide an intervening gap, a drawing chamber in the rotor communicating with the gap and means for feeding two liquids or phases to said drawing chamber, said means including provision for splitting each phase into a plurality of separate streams entering the drawing chamber between streams of the remaining phase.

7. An emulsifying apparatus comprising relatively movable surfaces spaced apart to form between them a relatively small gap and a drawing chamber communicating with said gap, and means for feeding two liquids or phases into the drawing chamber, said means including provision for splitting each phase into a plurality of separate streams entering the drawing chamber between similar streams of the remaining phase.

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