Oct. 31, 1950 J. G. SUTHARD ET AL 2,527,689

APPARATUS FOR MIXING

Filed Dec. 11, 1946

Fig. 1

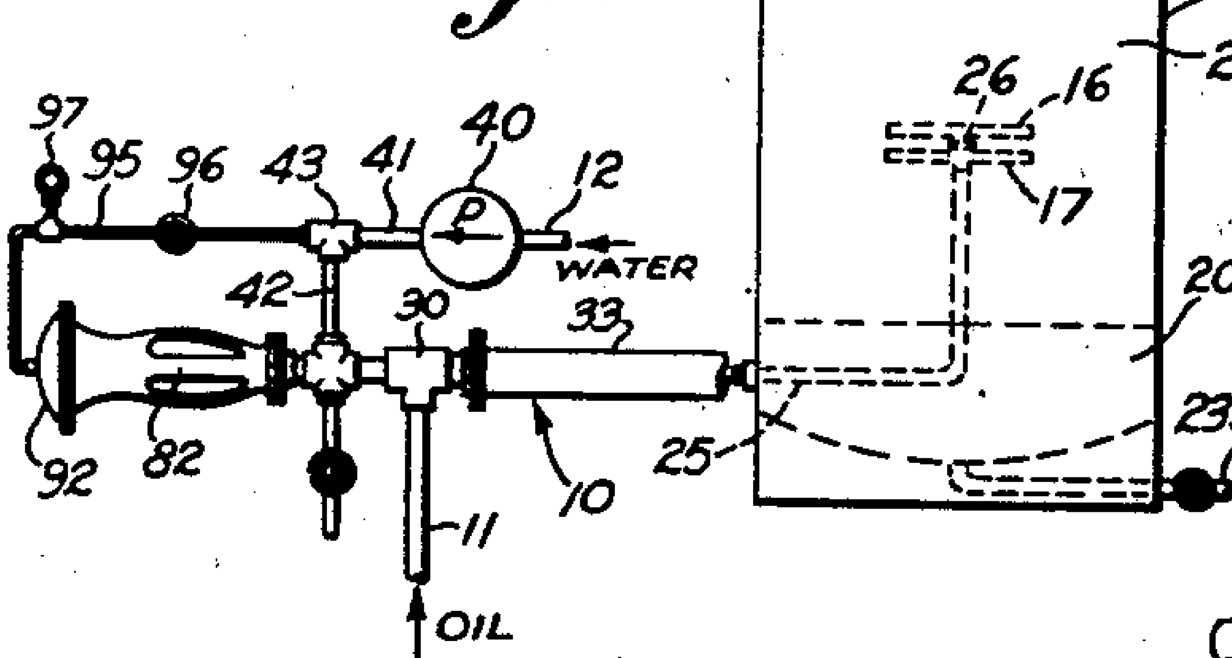


Fig. 4

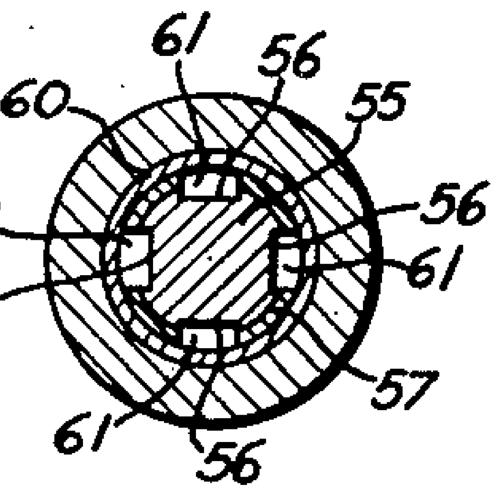


Fig. 3

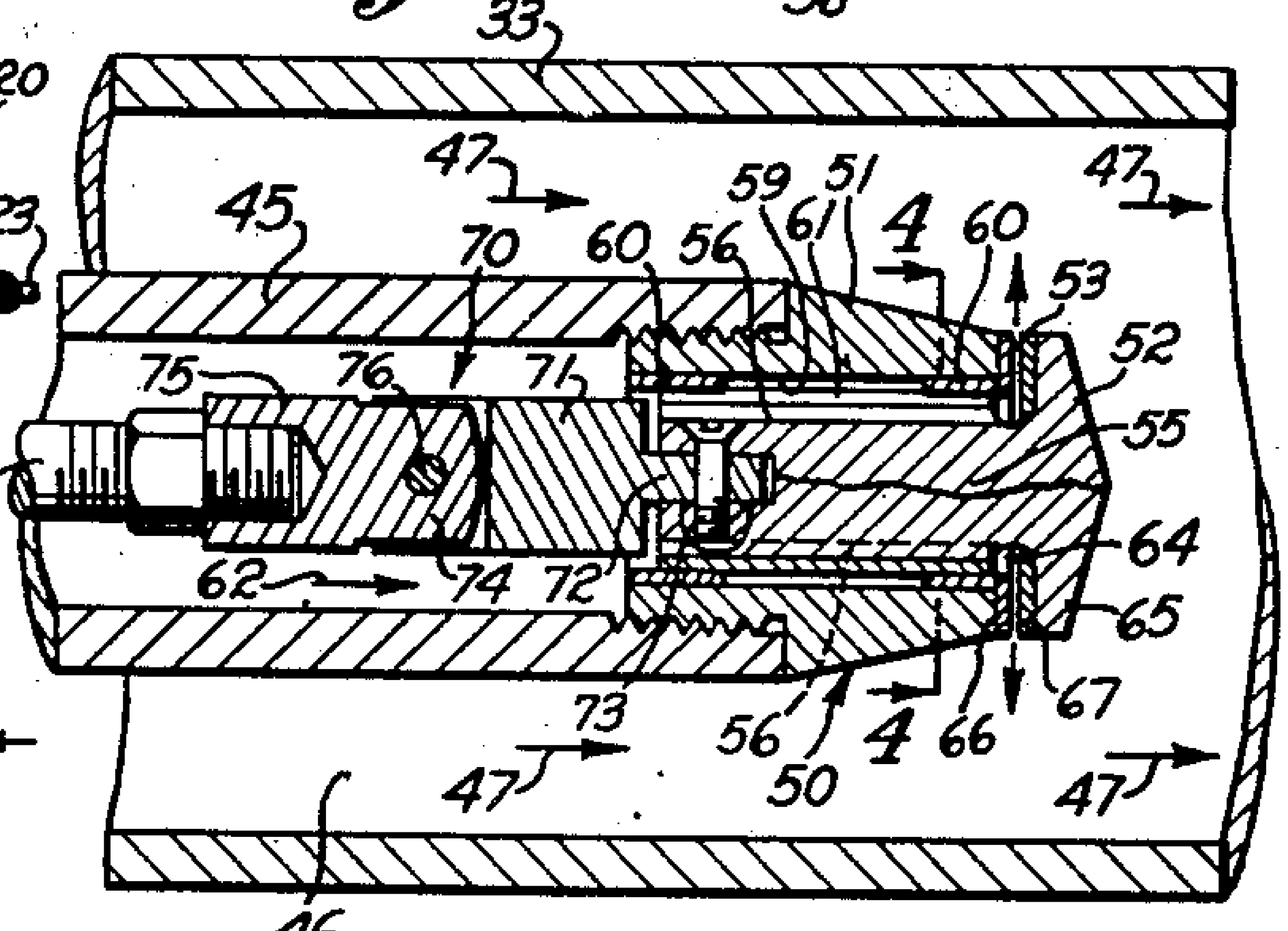


Fig. 2

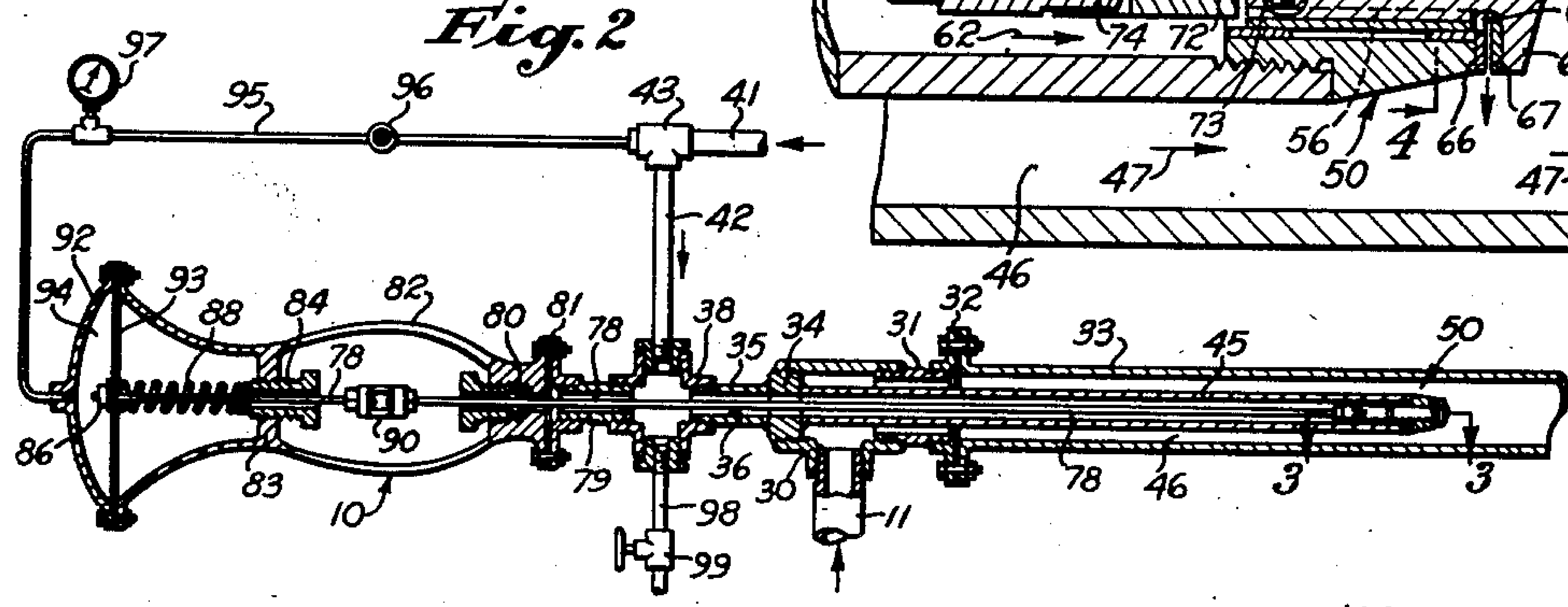


Fig. 5

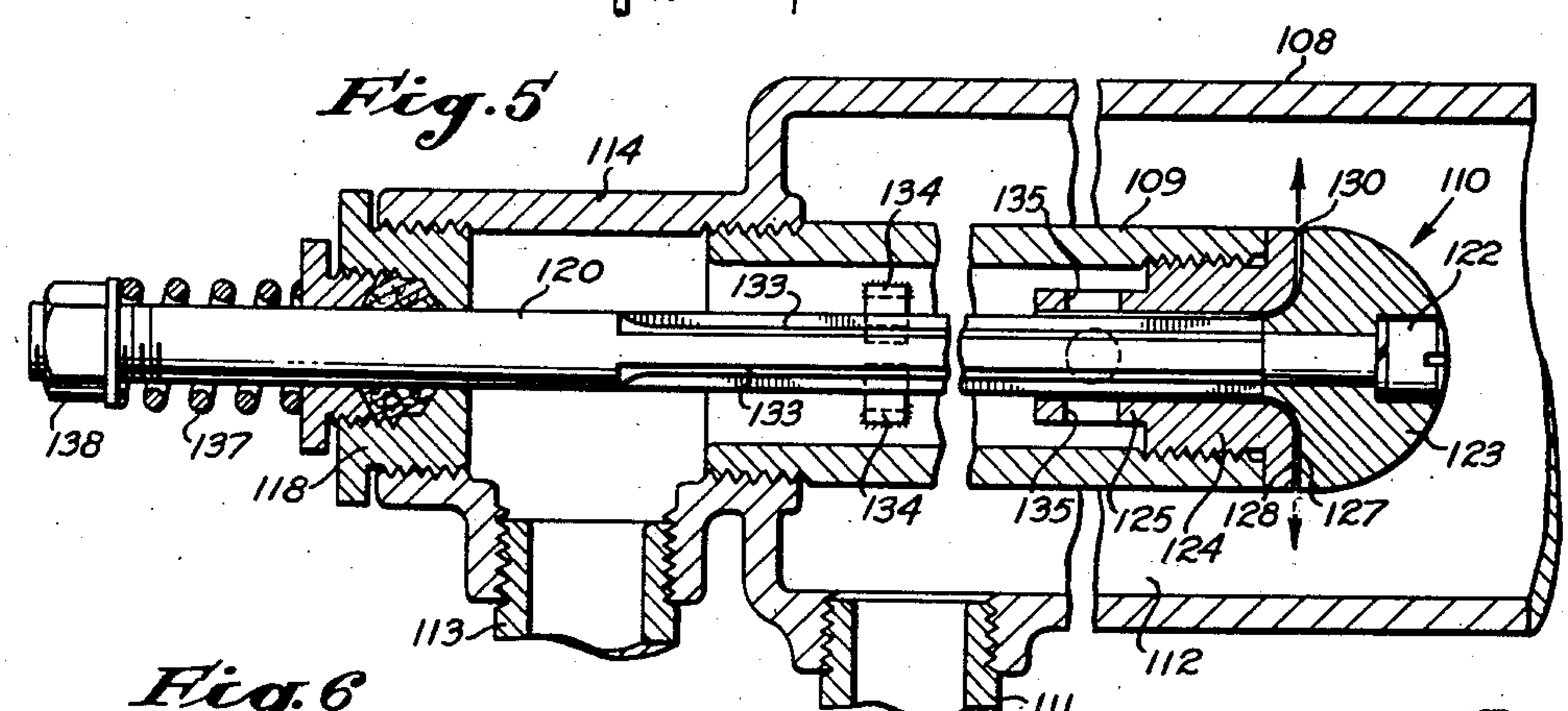


Fig. 6

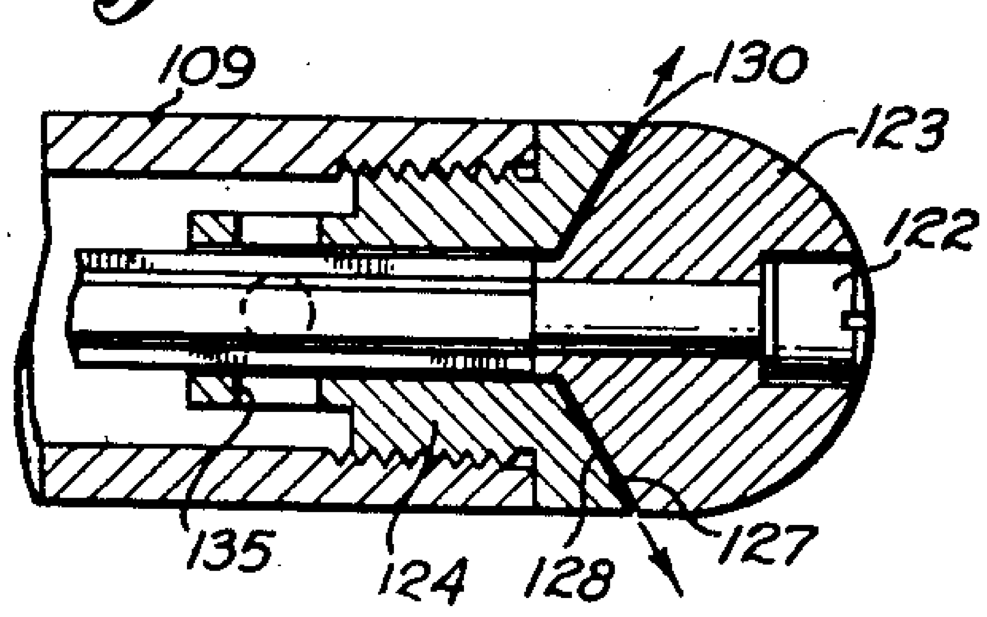
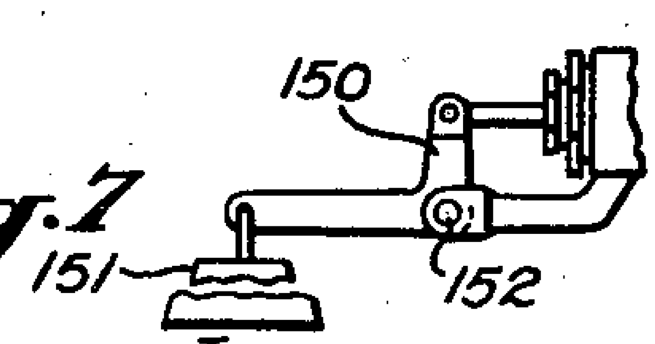


Fig. 7



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APPARATUS FOR MIXING

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12 Claims. (Cl. 259—4)

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Our invention relates to the mixing of dissimilar and substantially immiscible liquids to produce suspensions, e. g., dispersions or emulsions of more or less permanency. It will be particularly exemplified as applied to the synthesizing of water-in-oil type emulsions, the word "water" being herein used as including any aqueous medium or aqueous solution sufficiently immiscible with the oil to form a separate phase when mixed therewith.

If a mass of water and a mass of oil are intermixed, the resulting suspension or emulsion may be of the oil-in-water or water-in-oil type or a mixture of these two types, depending upon the relative volumes, the type of mixing and the emulsifying or dispersing agents present.

In the processing of oils, typically in their purification, it is often desirable to produce synthetic suspensions of the water-in-oil type. It has been proposed to do this in a continuous process by pumping streams of oil and water together to form a preliminary mixture which is then forced through a mixing valve. This requires high pressuring of both streams and involves relatively high pumping costs as the pressure drop across the mixing valve is usually relatively high to produce the desired mixing action.

It is an object of the invention to minimize the power required to mix two liquids. In the production of water-in-oil type suspensions or emulsions, the volume of water is usually substantially less than the volume of oil. According to the present invention only the smaller stream of water need be substantially pressured with resulting savings in power requirements.

It has been found that mixing systems, such as described above, or other conventional mixing apparatus are oftentimes deficient if a suspension or emulsion substantially exclusively of the water-in-oil type is desired. In conventional systems, a small amount of "inverse phase" is often formed, i. e., a quantity of oil-in-water type suspension or emulsion existing in the desired water-in-oil suspension or emulsion. For example, droplets of water may be dispersed in a continuous phase of oil but these droplets may themselves carry dispersed droplets of oil. Such dispersions of oil droplets in water are generally referred to as "inverse phase" emulsions in the petroleum dehydration and desalting arts.

The presence of such inverse phase, even in small quantities, is often troublesome in resolving suspensions or emulsions which are essentially of the water-in-oil type. Such resolution involves a coalescence and separation of the dis-

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persed water droplets. Any oil droplets dispersed in the water droplets will appear in the coalesced water masses and be carried downwardly thereby as they gravitate to and join with the body of separated water in the lower portion of the settling zone. This contaminates the body of separated water, prevents a clean separation of the oil and the water and raises a serious disposal problem due to the oil content of the water drawn from the settling zone.

Substantially the same difficulties arise in processes in which the emulsion is subjected to the action of a high voltage electric field to aid in the coalescence of the water droplets and in the resolution of the emulsion. In addition, the presence of any inverse phase presents additional difficulties in the electric treatment of emulsions. If present in large amounts, such inverse phase may short-circuit the treating electrodes or unduly increase the current therebetween. Even if present in minute quantities, such inverse phase is not directly resolved by the electric field because oil droplets dispersed in the water cannot be subjected to electrically induced coalescing forces because of the conducting nature of the water. It would be very desirable to eliminate or minimize the amount of inverse phase present in any water-in-oil emulsion or suspension.

It is an important object of the invention to provide a process and apparatus for the synthesizing of water-in-oil type suspensions or emulsions while minimizing or completely eliminating the forming of objectionable amounts of inverse phase therein.

A further object of the invention is to produce a suspension or emulsion particularly well suited to resolution and clean separation of the oil and water with a minimum amount of oil being suspended in the separated water.

The invention also contemplates the mixing of two immiscible liquids containing emulsion-stabilizing agents, these being present either initially or as a result of reaction between constituents of the two liquids upon contact, which agents tend to promote the oil-in-water type of emulsion but which tendency is repressed or nullified by the method of mixing employed in the invention.

In accordance with the preferred mode of operation of the present invention, one liquid, e. g., water, is discharged as a radial or conical spray or thin sheet into a confined stream of the other liquid, e. g., oil, as this other liquid moves along a space. Such a procedure produces a uniformity of distribution of the water in the oil, which is not possible with other mixing devices used in the art. Also, it permits control of the particle size of the aqueous dispersed phase by adjustment of the spray pressure and control of the force of the spray required to penetrate or cut through oils of different viscosity. The preferred apparatus also permits control of the thickness or velocity of the spray from a position removed from the spray and external to the space into which the spray discharges. It is an object of the invention to provide a process and apparatus for mixing which has this mode of operation and one or more of the above advantages.

Still other objects of the invention are to produce a mixing system which does not change its mixing action due to scaling of pipes, such as occurs with many conventional systems when mixing certain oils with water; which is readily adjustable to change the degree of dispersion; which can be made to produce a suspension or emulsion having a particle size distribution differing from suspensions or emulsions made by conventional apparatus; which substantially instantaneously produces the desired type of suspension or emulsion; or which avoids the presence of any large masses or bodies of water at the point of mixing.

One widely used method for desalting or otherwise purifying mineral oils of low water content involves emulsification of water with the oil and resolution of the resulting emulsion by use of chemical demulsifying agents, heat and pressure settling, or subjection to a high-voltage coalescing electric field in an electric treater. If the impure oil contains a small amount of dispersed water, e. g., residual brine droplets, best results are usually obtained by dispersing the added water into the oil to produce droplets of the added water coexisting with the originally present droplets. The present mixing apparatus is excellently suited to the production of emulsions of this type and emulsions which are unusually well adapted to such electrical purification processes. In the electrical desalting of oils, for example, use of the present invention produces better salt extractions, reduced amounts of sludge and decreased costs as compared with the use of conventional mixing valves for forming the emulsion. It is an object of the invention to provide an improved process for desalting or purifying oils.

Another process in which the invention is particularly useful is that in which an oil containing organic acids is mixed with an aqueous alkaline solution thereby producing a sodium soap when the two liquids come into intimate contact. Such soaps are in general very effective stabilizing agents and, if the mixing is by ordinary means, will definitely promote the formation of oil-in-water type emulsions. However, the method of the invention provides nc opportunity for the oil to become dispersed in the aqueous solution so that the formation of the oil-in-water type of emulsion is greatly repressed, if not entirely eliminated particularly if the volumetric ratio of the aqueous phase to the oil phase be kept reasonably low, usually below about 50%, depending to a considerable extent upon the amount and kind of acidic materials present in the oil, as well as somewhat upon the structure of the mixing device.

Further objects and advantages of the invention will be evident to those skilled in the art from the following description of exemplary embodiments.

Referring to the drawing:

Fig. 1 is a diagrammatic view showing one embodiment of the mixing apparatus of the invention as used in association with other purification equipment;

Fig. 2 is a longitudinal sectional view of the mixing apparatus of Fig. 1;

Fig. 3 is an enlarged sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is a longitudinal sectional view of an alternative form of spray unit;

Fig. 6 is a fragmentary sectional view of a further alternative spray unit head; and

Fig. 7 diagrammatically illustrates an alternative biasing means which can be used with any of the illustrated embodiments.

Referring particularly to Fig. 1, the mixing apparatus of the invention, indicated as a mixing unit 10, functions to mix oil supplied by pipe 11 and water supplied by pipe 12. The invention will be exemplified as used in a purification process to emulsify the water into the oil, the emulsion being resolved in a suitable treater 15 illustrated as equipped with upper and lower electrodes 16 and 17. These electrodes are insulated from each other and a high-voltage electric field is established therebetween by any suitable power source, not shown. This field coalesces the dispersed water droplets of the emulsion into masses of sufficient size to gravitate from the oil and form a body of separated water 20 in the lower end of the treater and a body of purified oil 21 in the upper end of the treater. In a continuous process, streams of oil and purified water are drawn respectively from the bodies through draw-off pipes 22 and 23 equipped with valves to build up a desired back pressure in the treater 15, typically 25–50 p. s. i. The emulsion enters the treater 15 through a pipe 25 and is discharged radially outward between the electrodes 16 and 17 through a distributor 26. Such treaters and their use in the electrical purification of oils are described in the patent to Harold C. Eddy No. 2,182,145.

In other instances, non-electric treating or resolution systems can be employed to treat or resolve the suspension or emulsion made by the mixing unit 10. For example, the treater 15 may be employed merely as a settling zone which permits gravitational sedimentation of the water from the oil with or without previous subjection of the emulsion to some coalescing action aided, for example, by the addition of known deemulsifying or chemical treating agents. Resolution in any of such processes is usually aided by superatmospheric temperature and pressure in the treater 15. With some oils gravitational sedimentation under controlled conditions of heat and pressure will produce a satisfactory resolution, particularly where an extremely high degree of purification is not required.

Heretofore it has been proposed, in such purification processes, to employ separate high-pressure pumps on the oil and water pipes 11 and 12 to pump the streams together at a pressure considerably in excess of that desired in the treater 15. The oil and water, usually preliminarily mixed at their point of contact, pass together through a mixing valve in the pipe 25. The pressure drop across the mixing valve is often about 20–60 p. s. i. and such conventional systems require pressuring of both the larger-volume oil stream and the smaller-volume water stream to a value equal to or somewhat above the pressure on the intake side of the mixing valve. The pressuring of large-volume oil streams is costly both in equipment and operation and the pumps employed often tend further to emulsify the oil with the water initially present therein, thus making subsequent removal of the water even more difficult.

Generally speaking, the present invention requires relatively high pressuring of the water stream only, the oil stream being pressured only to such extent as to cause it to flow to the treater 15 against any pressure existing therein. It contemplates the violent jetting of the water into a lower-pressure stream of oil to form the desired suspension or emulsion. The preferred mixing means jets or sprays the water into an annular stream of the oil as a high-velocity, thin, radially-flowing annular stream, the flow being inward or outward relative to the oil stream, the latter being preferred, and the flow being termed as radial irrespective of whether the water discharges in an exact radial plane or as a cone.

In the preferred mixing means, suggested in Figs. 1–4, the oil in oil pipe 11, flowing at relatively low pressure, is delivered to a pipe T 30. Connected to one side passage of this T 30 by a nipple 31 and a flange 32 is a tubular member 33 which may be merely a continuation of the pipe 25 or which may be of slightly larger diameter than this pipe. The other side passage of the pipe T 30 contains a removable plug 34 having a neck 35, this structure providing a water-conducting passage 36.

The neck 35 is threadedly received by one arm of a cross-type pipe fitting 38. The water or other liquid which is to form the dispersed phase, moves from the pipe 12 to the intake of a pump 40 where it is pressured and delivered through pipes 41 and 42 and T fitting 43 to the interior of the cross-type pipe fitting 38.

The plug 34 carries an inner tubular member or pipe 45 which is coaxial with the tubular member 33. The pipe 45 is smaller than the nipple 31 and the tubular member 33 and cooperates therewith in providing an annular space 46 through which the oil from pipe 11 moves as an annular stream in the direction of arrows 47 of Fig. 3.

To discharge the water radially outward into the annular oil stream, the inner end of the pipe 45 carries a spray-type distributor 50 including, generally speaking, a seat member 51 threaded into the end of the pipe 45 and a head member 52, these members cooperating in defining an outwardly-directed annular orifice 53.

It is desirable that the head member 52 be slidably journalled relative to the seat member 51 to change the width of the annular orifice 53. It is desirable also that there be substantially no side play between the head member and the seat member 51 so that there will be no chattering of the head member and so that the pressured water, flowing inside the pipe 45, will be jetted outwardly through the annular orifice 53 as a fan-like spray or annular stream which discharges substantially uniformly at all peripheral positions. It is desirable also that wear, produced by relative movement of the members 51, 52 or erosion or corrosion thereof by the water, be minimized. The spray-type distributor 50 of Figs. 2–4 is designed particularly to accomplish these results.

As there shown, the head member 52 provides a stem 55 in which peripherally-disposed longitudinal grooves 56 are cut. The peripheral zones between the grooves 56 are built up by coatings 57 of a hard, corrosion-resistant alloy such as stellite. The seat member 51 provides an opening 59 which is internally coated throughout a portion or all of its length with a similar hard, corrosion-resistant alloy. In the structure shown, two axially-spaced bands of such an internal coating are employed, such bands or coatings being indicated by the numeral 60. The outer peripheries of the coatings 57 and the inner peripheries of the coatings 60 are ground to a sliding fit. The grooves 56 thus form a plurality of longitudinal passages 61 and the pressured water in the pipe 45, flowing as indicated by the arrow 62 of Fig. 3, divides between the longitudinal passages 61. The resulting streams are delivered to and combined in an annular chamber 64, formed at the junction of the stem 55 and a flange or head 65 of the head member 52. The inner portion or entrance end of the annular orifice 53 opens on the annular chamber 64 and this chamber serves to equalize the distribution of water to the inner periphery of the orifice. The outer portion or exit end of the orifice 53 opens on the annular space 46.

To insure long life and equal peripheral discharge, the forward end of the seat member 51 and the rear face of the head 65 provide walls 66 and 67 formed of stellite or other hard, corrosion-resistant alloy. The faces of these walls 66, 67 are accurately ground or lapped together. The annular orifice 53 is bounded by such walls and will be of uniform width around its periphery and at all radial positions within the orifice. The orifice acts as a narrow slit which receives the pressured water and forms same into an annular stream or fan-like spray which discharges into the annular space 46, and into the annular oil stream moving therein, to form substantially instantaneously the desired suspension or emulsion. The water is projected from the orifice 53 with sufficient velocity and under sufficient force to penetrate the oil stream and be dispersed as small droplets therein.

It is often desirable that the oil should move with turbulent flow through the annular space 46 so as to be moving turbulently at the instant the water is projected thereinto. Such turbulent flow can be insured by correlation of the size of the annular space 46 relative to the relatively high velocity and the viscosity of the oil therein. Also, turbulence can be insured or increased by making the outer diameter of the orifice 53 smaller than the pipe 45, as suggested in Figs. 2 and 3. It should be clear, however, that the invention is not limited to this size relationship.

In the preferred arrangement, the head member 52 is resiliently urged toward closed-orifice position. We prefer to exert a pull on the stem 55 through a flexible connnector such as a universal joint, indicated generally by the numeral 70. As shown, this includes a forward universal joint element 71 having a tongue 72 extending into a groove at the rear of the stem and journalling therein about a pin 73. The rear end of the element 71 is bifurcated and receives a tongue 74 of a rear universal joint element 75, the tongue 74 being journalled on a pin 76 extending at right angles to the pin 73.

The rear universal joint element 75 threadedly receives and is locked to a rod 78 which extends centrally along the pipe 45, the plug 34 and its neck 35 and into and through the chamber of the cross-type pipe fitting 38. In this connection the rod 78 extends through a nipple 79 and through a stuffing box 80 detachably connected to the nipple by a flange 81. Arms 82 extend rearwardly from the stuffing box and support a plate 83 threaded to receive a gland or adjustment member 84 which is passaged to accommodate the rear end of the rod 78. The rear end of this rod carries a head 86. A compression spring 88 is compressed between this head and the adjustment member 84 to exert a resilient biasing force on the rod 78 which urges the head member 52 toward closed-orifice position. A coupling 90 may be disposed between the ends of the rod 78, preferably in the space bounded by the arms 82, to adjust the over-all length of the rod and the biasing action of the spring 88 if the coupling is of the turnbuckle type. Usually, however, the adjustment of the biasing force is accomplished by turning the adjustment mmeber 84 to change the spring tension without changing the over-all length of the rod 78.

The biasing means thus far described will produce satisfactory results without additional control. However, as a further refinement, it is sometimes desirable to keep the pressure drop across the annular orifice 53 substantially constant with change in the amount of water introduced or change in the pressure thereof. In this instance the rear end of the rod 78 may be pressure operated by the system suggested in Figs. 1 and 2. Here a stationary member or housing 92 cooperates with a movable member or diaphragm 93 in providing a chamber 94 communicating with the pipe T 43 through a small pipe 95. If a valve 96 in this small pipe is opened, the pressure of the incoming water will be indicated on a gage 97 and transmitted to the chamber 94. By connecting the diaphragm 93 to the head 86, any superatmospheric pressure in the chamber 94 will reduce the action of the spring 88 on the rod 78 and decrease the biasing force applied to the head member 52. Thus, if the pressure or volume of the water stream increases, the bias on the rod 78 will be decreased and the annular orifice 53 will open slightly, as compared with its previous width, with the result that the water pressure in the pipe 45 ahead of the spray-type distributor 50 will be reduced and the pressure drop across the orifice 53 will be maintained approximately constant. Correspondingly, if there are to be substantial variations in pressure or amount of the water mixed with the oil, use of such a pressure operated system will eliminate any manual adjustment of the biasing force such as would otherwise be necessary if it were desired to maintain the pressure drop across the orifice 53 substantially constant.

If desired, the cross-type pipe fitting 38 may be provided with a drain pipe 98 normally closed by a valve 99. This valve is opened only when it is desired to drain the water from the system.

In the alternative embodiment of Fig. 5 a tubular member 108 surrounds a pipe 109 providing a modified form of spray-type distributor 110. As before, oil from a pipe 111 flows along an annular space 112. Water is supplied from a pipe 113 to a T-like fitting 114 which threadedly receives the rear end of the pipe 109. A packing gland structure 118 guides and seals a rod 120. The forward end of this rod receives a screw 122 which fixes a head member 123 to the rod.

The head member 123 is a part of the spray-type distributor 110 which includes also a seat member 124 threaded into the forward end of the pipe 109 and providing a neck 125. The forward

end of the seat member 124 provides a radial wall 127 which cooperates with a radial wall 128 of the head member 123 to define the annular discharge orifice 130.

In this embodiment the rod 120 is splined to provide longitudinal passages 133. Radial guide members 134, secured to the pipe 109, extend into these longitudinal passages to prevent turning of the rod 120.

The forward end of the rod 120 slides relative to the seat member 124 and its neck 125 to center the head member 123 and prevent sidewise motion or chattering thereof. The longitudinal passages 133 permit free flow of the water. If desired the neck 125 may provide openings 135 respectively aligned with the longitudinal passages 133 to deliver water thereto.

The head member 123 is biased toward closed-orifice position by a spring 137 compressed between the gland structure 118 and a head or nut 138 of the rod 120. The biasing force can be adjusted by turning the nut 138.

In the embodiments of Figs. 1–5, the mid-plane of the orifice is perpendicular to the direction of oil flow, but this relationship is not essential to the invention. Any radial discharge of the water, whether the flow be in a flat plane or of a conical shape, can be used if the direction of discharge is transverse to the direction of flow of the recipient stream, e. g., the oil stream. In this connection, the word "transverse" is used in a broad sense as defining any motion in a direction extending across the recipient stream, whether or not at a right angle to the direction of flow of this recipient stream.

A conical-type stream is produced by the spray-type distributor of Fig. 6. This is similar to the embodiment of Fig. 5 except that the wall 127 of the seat member 124 is conical, as is also the wall 128 of the head member 123. As a result, the annular orifice 130 forms a conical stream flowing transversely of the oil stream moving along the annular space 112.

The rod, in any of the embodiments, can be biased by means other than a spring. For example, a weight-type bias is suggested in Fig. 7, a bell crank 150 providing one arm pivoted to the rod and another arm carrying a weight 151, the bell crank being pivoted to any stationary structure at 152.

The operation of any of the embodiments of the invention will be apparent from the following description of the operation of the structure shown in Figs. 1–4.

Assuming, for example, that the apparatus is to be used for the electrical desalting of a mineral oil of low water content, a stream of this oil, commonly available at a relatively low pressure, say, 25 p. s. i., or pressured to this value, is delivered to the pipe 11 for flow as a high velocity annular stream along the annular space 46. A substantially smaller-volume stream of relatively fresh water is pressured by the pump 40 to about 50–120 p. s. i. above the oil pressure. A relatively high pressure drop is desired across the annular orifice 53 when producing suspensions or emulsions of small particle size and which are relatively stable. Pressure drops on the water in the neighborhood of 50–120 p. s. i. will be found to give excellent results in the electrical desalting process.

The water discharges outwardly from the circular slit, formed by the annular orifice 53, at high velocity. In fact, the water is projected forcefully into the oil stream and breaks up into small particles. The discharge velocity should carry the water at least partially across the oil stream and any turbulent flow in the annular space 46 or therebeyond will mix the resulting suspension with any outer portion of the oil stream which may not have been penetrated by the water. In other instances we have used with success pressure sufficient to force the water completely across the annular space 46. Such a mode of operation can be observed in a transparent system, e. g., where the tubular member 33 is made of glass, or its presence can be verified by other tests. The desired type of suspension or emulsion is made practically instantaneously and at a position adjacent the point of injection.

For best results the annular orifice 53 should be very narrow as compared with its length, here its outer circumference. When this is the case, mixing of the oil and water never takes place in the presence of any large mass of water, thus eliminating or minimizing formation of inverse phase. Uusually the width of the orifice is desirably less than 5.0% of its length and sometimes as low as 0.8% of the peripheral length or lower.

In the electrical desalting process, there is no necessity for additional, water-subdividing mixing of such a suspension or emulsion before delivery to the electric treater. In fact, it is usually desirable to avoid any later mixing which would subdivide the dispersed water particles produced in the mixing apparatus of the invention. The pressure of the resulting suspension or emulsion need be only sufficient to force same into the electric treater and maintain the desired pressure therein. Thus, in the instant example, the 25 p. s. i. oil stream can be employed to maintain a pressure of 20 p. s. i. or somewhat more in the treater 15 if there is no large drop in pressure during flow through the distributor 26. The advantage of being able to highly pressure only the smaller water stream is of distinct value in reducing costs. In addition, the apparatus of the present invention has the advantage that the oil and water do not move together through a mixing orifice designed to produce the emulsion, thereby lessening inverse phase, producing a more easily treatable emulsion, reducing sludge accumulations in the treater, substantially eliminating oil contamination of the separated water withdrawn from the treater and producing the other desirable results previously mentioned.

Substantially the same advantages arise from non-electrical resolution systems employing the mixing device of the invention. This is true whether the invention is used to mix relatively fresh water with a salty oil in a desalting process or whether it is used to mix water with other oils to remove water-wettable and/or water soluble impurities which can be taken up by the water and which will appear, in large measure, in the body of separated water. It is also true if the water contains chemical agents reactive with the oil or some component thereof, i. e., in the alkali treatment of oils to remove naphthenic acids or the acid treatment of oils to remove those components which can be taken up by sulphuric acid, for example. In many instances the present invention makes less critical the amount of chemical agent employed, particularly when such amount is controlled in part on the basis of satisfactory separation of the reaction products. In such acid or alkali treating processes pressure drops across the orifice of 50–100 p. s. i. will usually be found sufficient and it will be found that the qantity of inverse phase will be substantially reduced as compared with the use of mixing valves for forming the suspension or emulsion.

Various changes and modifications may be made without departing from the spirit of the invention as defined in the appended claims.

We claim as our invention:

1. In an apparatus for mixing two dissimilar liquids to form a suspension, the combination of: a low-pressure pump for discharging a stream of one of said liquids; a tubular member connected to said low-pressure pump to receive and confine said stream; a discharge means comprising a narrow annular slit opening on the interior of said tubular member, the mid-plane of said slit being substantially transverse to the direction of flow of said stream; and a high-pressure pump for delivering a stream of the other of said liquids to said slit to produce a high-velocity annular stream of said other liquid discharging into said confined stream of said one liquid moving in said tubular member.

2. In an apparatus for producing water-in-oil type emulsions while substantially excluding the formation of small amounts of inverse phase, oil-in-water type emulsions, said apparatus including in combination: an outer tubular member providing a closure means at one end thereof; an inner tubular member extending through said closure means into said outer tubular member in coaxial relationship and cooperating therewith in defining an annular space; a spray-type distributor carried by said inner tubular member and comprising annular walls facing each other and cooperating to define an annular slit having an entrance end communicating with the interior of said inner tubular member and an exit end concentric with the axis of said outer tubular member and directed toward said outer tubular member; means for delivering a stream of oil under relatively low pressure to said outer tubular member to flow along said annular space past said exit end of said slit; and means for delivering to said inner tubular member under high pressure a stream of water to flow to said entrance end of said annular slit and thence through said slit at high velocity to be projected into said stream of oil as the oil passes said exit end of said annular slit.

3. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: a tubular member for confining a stream of said one liquid; means for jetting a stream of said other liquid into said tubular member at high velocity and into said one liquid flowing therein, said means including walls defining a narrow annular slit opening on the interior of said tubular member and concentric with the axis of said tubular member for forming said other liquid into an annular stream; means for mounting one of said walls to move relative to the other to change the width of said slit; pressure-responsive means responsive to changes in pressure of said other liquid delivered to said slit, said pressure-responsive means including stationary and movable members forming a chamber and including pressure-transferring means communicating between said chamber and said other liquid for varying the pressure in said chamber in response to changes

in the pressure of said other liquid to move said movable member in response to such changes in pressure; and means for operatively connecting said one of said walls to said movable member of said pressure-responsive means to vary the width of said slit in response to changes in pressure of said other liquid.

4. An apparatus as defined in claim 3 in which said means for operatively connecting said one of said walls to said movable member includes a rod, and including a spring and a means for operatively connecting said spring to said rod to exert a spring-induced pressure thereon in one direction to bias said one of said walls toward closed-slit position, said movable member of said pressure-responsive means exerting a pressure on said rod in an opposite direction upon increase in said pressure in said chamber.

5. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: outer and inner tubular members spaced to define a narrow annular space; means for turbulently flowing an annular stream of said one liquid along said annular space at high velocity; and means for jetting a stream of said other liquid from the interior of said inner tubular member outwardly at high velocity into said annular space and into the annular stream of said one liquid flowing therein, said means including walls defining a narrow annular slit having a periphery concentric with said tubular members and means for supplying said other liquid at high pressure to the interior of said inner tubular member to flow therealong to said annular slit.

6. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: outer and inner tubular members spaced to define a narrow annular space adapted to confine an annular stream of said one liquid to flow therein at high velocity; a spray-type distributor at one end of said inner tubular member and positioned within said outer tubular member, said distributor comprising a peripherally-continuous annular orifice communicating with the interior of said inner tubular member for conducting said other liquid therefrom while forming same into a high-velocity stream, said orifice being directed toward said outer tubular member and the periphery of said orifice being concentric with said inner tubular member; and means extending within said inner tubular member for controlling the width of said annular orifice.

7. A mixing apparatus as defined in claim 6 in which said distributor includes a movable head member in the path of flow of said other liquid and providing a wall, and a seat member providing another wall, said walls defining said orifice, and in which said controlling means includes a rod means extending from the other end of said inner tubular member and connected to said head member, a gland at the junction of said rod means and said other end of said inner tubular member, and means outside said inner tubular member for adjustably tensioning said rod means.

8. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the

liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: an outer tubular member for confining a stream of said one liquid; an inner tubular member concentric with said outer tubular member and providing a seat member having an annular wall, said outer tubular member being only little larger in internal diameter than the external diameter of said inner tubular member to form a relatively narrow annular space through which said stream of said one liquid flows at high velocity; a head member having an annular wall, said walls facing each other and cooperating to define an annular slit; means for mounting said head member to move toward and away from said seat member to vary the width of said annular slit; means for supplying to said inner tubular member a stream of said other liquid under high pressure, said slit discharging toward said outer tubular member to project a narrow annular stream of said other liquid into the stream of said one liquid flowing along said narrow annular space and past said slit to be broken into small droplets by such flow; and means within said inner tubular member adjacent said slit for slidably journalling said head member relative to said seat member to maintain the width of said annular slit equal at all peripheral positions during such relative movement.

9. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: an outer tubular member for confining a stream of said one liquid; an inner tubular member providing an inner end and an outer end; mounting means for mounting said inner tubular member with its outer end outside said outer tubular member and with its inner end concentric with and inside said outer tubular member to define a narrow annular space between said tubular members, said mounting means closing one end of said annular space; a seat member carried by said inner end of said inner tubular member and providing an annular wall; a head member providing an annular wall, said walls facing each other and cooperating to define an annular orifice communicating between the interior of said inner tubular member and said narrow annular space and directed transversely of said annular space; means for mounting said head member to move relative to said seat member to change the width of said annular orifice; biasing means outside both of said tubular members; means extending along the interior of said inner tubular member and from said outer end thereof for operatively interconnecting said head member and said biasing means for biasing said head member toward closed-orifice position; and supply means for supplying to said inner tubular member a stream of said other liquid under high pressure, said orifice discharging a narrow annular stream of said other liquid into the stream of said one liquid flowing along said narrow annular space to effect the mixing of said liquids.

10. An apparatus as defined in claim 9 in which said supply means communicates with said inner tubular member at a position between said mounting means and said biasing means.

11. An apparatus for mixing two dissimilar liquids to form a suspension in which one of the

liquids is substantially exclusively the continuous phase and the other of the liquids is substantially exclusively the dispersed phase, which apparatus includes: an outer tubular structure providing a sidewardly-directed opening; an inner tubular structure providing inner and outer ends; a mounting means for mounting said inner tubular structure with its outer end outside said outer tubular structure and extending beyond said mounting means and with its inner end within and concentric with said outer tubular structure to define an annular space therebetween, said sidewardly-directed opening communicating with said annular space at a position near said mounting means for conduction of a stream of said one liquid moving along said annular space; a seat member carried by said inner end of said inner tubular member and providing an annular wall; a head member providing an annular wall, said annular walls facing each other and cooperating to define an annular orifice communicating between the interior of said inner tubular structure and said annular space, said orifice being directed outwardly of said annular space; rod means operatively connected to said head member and extending along the interior of said inner tubular structure past said mounting means and from said outer end of said inner tubular structure; sealing means at the junction of said rod means and said outer end of said inner tubular structure; means for tensioning said rod means to bias said head member toward closed-orifice position; and supply means communicating with said inner tubular structure at a position between said mounting means and said sealing means for supplying a stream of said other liquid under pressure to the interior of said inner tubular structure and to said annular orifice to jet at high pressure therefrom into the stream of said one liquid moving along said annular space to effect the mixing of said liquids.

12. An emulsifying means for synthesizing resolvable emulsions which are substantially exclusive of the water-in-oil type and particularly suited to resolution by subjection to coalescing electric fields in being substantially devoid of inverse-phase emulsion of the oil-in-water type, said emulsifying means comprising: walls defining a long, narrow orifice having a width less than 5% of its length; pump means for delivering to said orifice an aqueous liquid which is to compose the internal phase of the emulsion to be formed, said orifice projecting a high-velocity stream of said aqueous liquid from said orifice in a given direction; a wall spaced equidistant from all portions of said orifice to define a narrow space; and a relatively low-pressure pump for delivering a relatively high-volume stream of oil to said space, the narrow width of said space causing said oil to flow at high velocity past said slit to shear droplets of the aqueous liquid from the stream thereof issuing from said orifice.

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