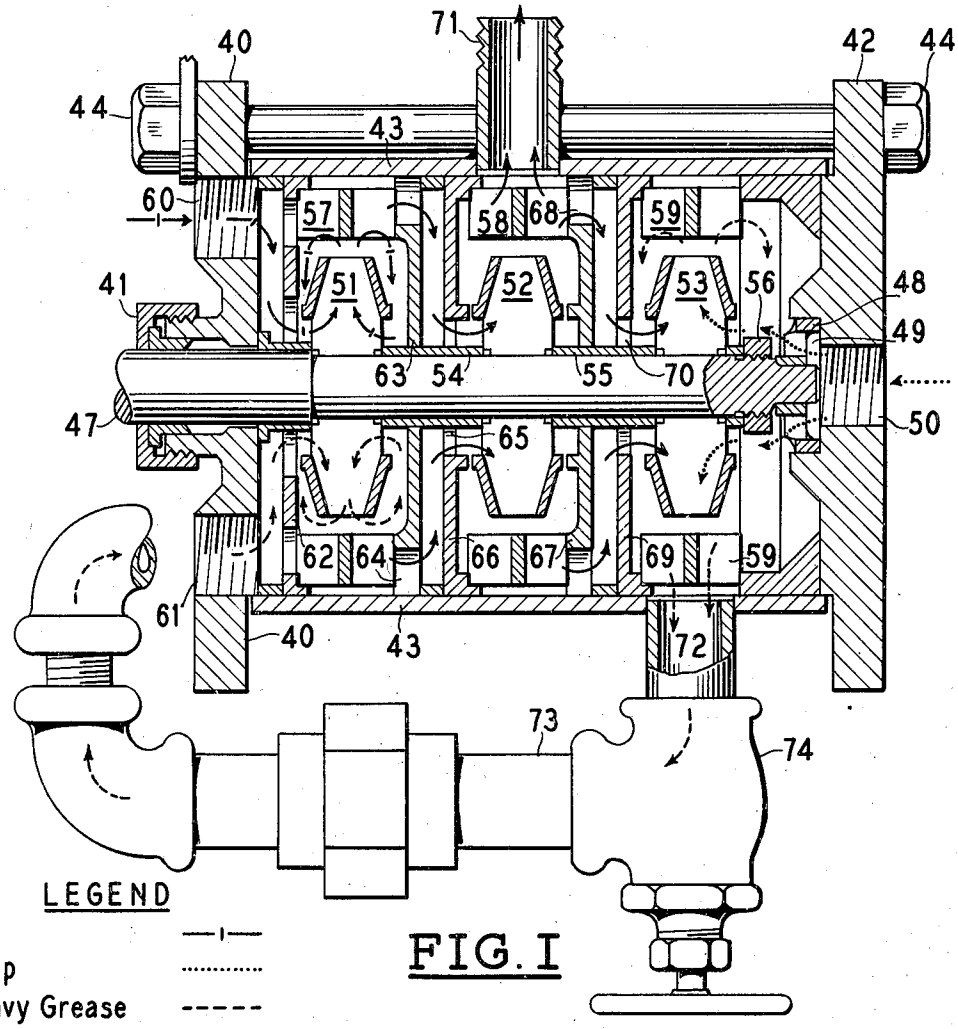
Aug. 2, 1949. C. R. HETHERINGTON ET AL 2,477,929

FLUID MIXING DEVICE

Filed Nov. 12, 1946



LEGEND

Oil —I—

Soap .....

Heavy Grease - - - - -

Finished Grease ——

FIG. I

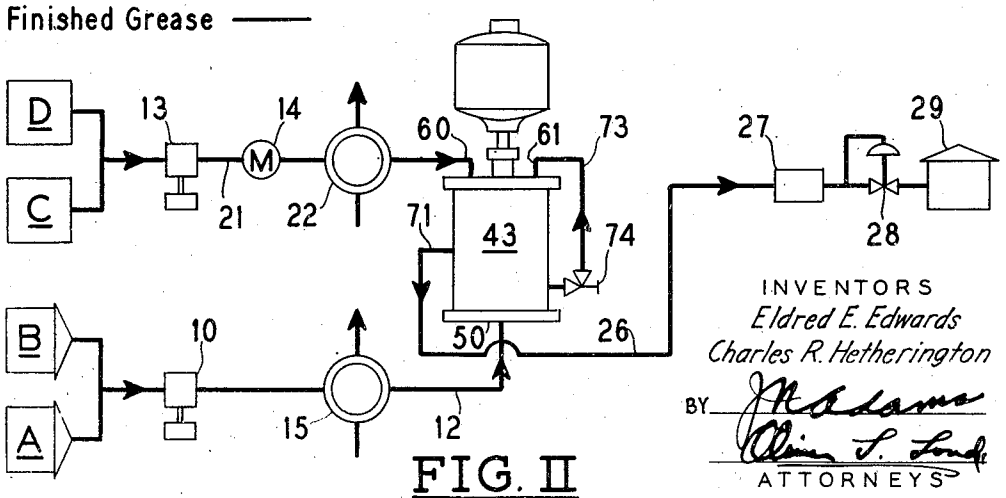


FIG. II

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FLUID MIXING DEVICE

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Application November 12, 1946, Serial No. 709,290

8 Claims. (Cl. 259—9)

1

This invention relates to a fluid mixing device and particularly refers to one adapted to receive fluids of different physical characteristics, for example viscosity, consistency, shear strength, etc., to mix them continuously to form a finished product, for example, grease.

Heretofore, in the manufacture of certain mixtures from fluid or semi-fluid components having widely varying physical characteristics of viscosity and the like it was difficult to obtain the required intimate degree of contact in continuously operating mixers. This invention comprehends broadly the provision of a multi-stage mixer having separate inlets for the fluids of different characteristics, the mixing being carried out in sequence and including the provision for circulating an intermediate component from one stage in the sequence to a different stage in the sequence, thereby producing continuous mixtures or blends of materials at a more rapid and economical rate than was possible heretofore. The example of the invention shown and described herein is particularly applicable to the manufacture of soap-thickened compositions which form the subject matter of the copending sole application of Charles Ray Hetherington, one of the inventors herein, filed November 12, 1946, as Serial No. 709,319. Although it is particularly applicable to this process, it is obvious that the invention is similarly usable in sulfonation, hydrocarbon reacting or other contacting operations where components of widely varying physical characteristics are to be intimately and continuously contacted.

In the drawing, Figure I is a longitudinal sectional view of a preferred form of this invention. Figure II is a flow diagram showing the application of this invention to a continuous process for the manufacture of grease, referred to in the sole application of Charles Ray Hetherington mentioned above.

In Figure I of the drawing, reference numeral **40** designates generally a plate or other suitable type of end member, provided with a central shaft aperture and stuffing box **41**. An opposite end member **42** is spaced from member **40** by means of a cylindrical housing or shell **43**, the whole assembly being fastened together with through bolts **44**, equally spaced around the periphery of shell **43**.

A shaft **47** adapted to be driven by a prime mover (not shown) extends through stuffing box **41** and is received in a central bearing **48** in end member **42**. Bearing **48** is provided with a plurality of openings **49** adapted to communicate

2

with a central port **50** in housing **42** for the purpose of admitting the first component, represented by dotted arrows, substantially uniformly around that end of shaft **47** which is received in bearing **48**. Mounted on shaft **47**, in this example, are three shrouded impellers, respectively designated **51**, **52** and **53**, of the type generally used in centrifugal pumps. These are spaced along shaft **47** by sleeves **54** and **55** and are secured to the shaft by the customary keys (not shown) and a threaded nut **56**, adjacent the outboard or bearing end of shaft **47**.

Within the housing shell **43** diffusion vane assemblies **57**, **58** and **59** may be provided, of a type similar to those utilized in turbine type centrifugal pumps. Two inlets **60** and **61** are provided in the end member **40** to communicate with an inlet eye of mixing impeller **51**. Inlet **60** is the inlet for the second component and inlet **61** is the recirculation inlet for the intermediate component. To facilitate this communication, a first diaphragm **62** having a central aperture is positioned within the housing shell **43** adjacent to but spaced from the inner face of end member **40** and the inlet eye of impeller **51**. A second diaphragm **63** is positioned on the opposite side of mixing impeller **51** from diaphragm **62** and is provided with apertures **64** near its periphery so that a portion of the finished component effluent passing outwardly from impeller **51** into diffusion vanes **57** will be redirected inwardly toward shaft **47** to pass through a central aperture **65** in third diaphragm **66**, from which the finished component will be admitted to the inlet or eye of a pumping impeller **52**, which is the center impeller of the three in this example. The material passing into the eye of pumping impeller **52**, designated as the finished component, is represented by the solid arrows.

Desirably, a portion of the fluids or semi-fluids passing through impeller **51** into diffusion vanes **57** recirculate in the spaces between impeller **51** and diaphragms **62** and **63**, as shown by the arrows, to reenter the inlets of that impeller and insure maximum turbulence and mixing.

A fourth diaphragm **67** is positioned on the opposite side of pumping impeller **52** from diaphragm **66** and, similar to diaphragm **63**, is provided around its periphery with aperture **68** to cooperate with a fifth diaphragm **69** to redirect at least a portion of the finished component effluent passing outwardly from impeller **52** through the space between diaphragms **67** and **69** to a central aperture **70** in the latter diaphragm which acts finally to direct the finished component into

an inlet or eye of the third or mixing impeller **53**. The clearance or spacing between diaphragms **66** and **67** and impeller **52** is as close as practicable, to form a seal so that reasonably efficient pumping action will be obtained from this impeller. A portion of the finished component passes continously out of the mixer through outlet **71**.

As pointed out above, the first component, represented by dotted arrows, admitted through port **50**, enters the eye of mixing impeller **53** opposite from that just described so that mixing of the first component and the portion of the finished component which has passed to mixing impeller **53** will take place within the last-named impeller and its corresponding diffuser **59**. It will be noted from the arrows on the drawing that recirculation from the periphery of impeller **53** inwardly to the eyes thereof is facilitated by the spacing between diaphragm **69**, end member **42**, and the adjacent faces of the impeller shroud.

Two outlets are provided from the cylindrical shell **43**. The first, designated by numeral **71**, communicates with diffusion vanes **58** for pumping impeller **52**, and is the outlet for the finished component. The second, designated by numeral **72**, communicates with the outlet of mixing impeller **53** and is the outlet for the recirculated intermediate component. Desirably, outlet **72** is provided with a conduit **73** in which is mounted valve means **74**, so that the intermediate component, represented by dashed arrows, passing outwardly from the space surrounding mixing impeller **53** may be controllably circulated to inlet **61**, whereby this intermediate component will be introduced and mingled with the second component entering inlet **60** to pass to the inlet eye of mixing impeller **51**. In the example of Figure I, the second component, entering through inlet **60**, is represented by dash-dot arrows; the first component, entering through inlet **50**, by dotted arrows; the intermediate product by dashed arrows; and the finished component, both that which flows to product storage through outlet **71** and that which is admixed with the first component, by solid line arrows, as shown in the legend of the drawing.

Above we have described one exemplification of our fluid mixing device. Described below is the operation of such device in grease manufacture. The mixing device is first filled with finished grease. Proportioned amounts of heated preformed soap stock (first component) are continuously pumped in through inlet **50**. Proportioned and heated amounts of mineral oil (second component) are continuously pumped in through inlet **60**. A portion of the finished grease (finished component) flows out through outlet **71**. Another portion of the finished grease (finished component) passes to mixing impeller **53** where it is continuously admixed with soap stock (first component) entering the system through inlet **50**. The intermediate component, formed by the intimate mixing of the finished grease and the soap stock, passes continuously through outlet **72**, through line **73** into inlet **61**. After entering mixing impeller **51**, this heavy intermediate component is intimately mixed and dispersed with mineral oil (second component) which continuously enters the system through inlet **60**. The product resulting from the intimate dispersion of the mineral oil (second component) and the heavy intermediate component is finished grease (finished component) to complete the cycle.

The speed at which shaft **47** is operated varies, naturally, with the physical characteristics of the first, second, intermediate and finished components and with the design of the impellers employed. When using the mixing device to manufacture lubricating greases containing 10% soap, we prefer to rotate the shaft at about 1200 R. P. M. Good dispersions are obtainable with speeds as high as 3600 R. P. M. and as low as 200 R. P. M.

Referring now to Figure II, wherein the mixer of this example is illustrated diagrammatically by a flow sheet as being applied to the continuous manufacture of grease, preformed soap stock from tanks A and B is forced by metering pump **10** through heater **15** and line **12** into inlet **50** of mixer **43**. Mineral oil is continuously drawn into the system from tanks C and D by a variable drive metering pump **13** through meter **14** and heater **22**, passing into high-speed motor-driven mixer **43** through inlet **60**. Intermediate product formed, as described above, in one stage of mixer **43** is controllably passed through conduit **73** and valve **74** to reenter a different stage of the mixer through inlet **61**. Finished grease passes out of the mixer through outlet **71** and line **26** through strainer **27** and pressure control valve **28** to the finished product storage tank **29**. The process or method involved is claimed in the copending sole application of Hetherington cited above.

From the foregoing it will be apparent that the example illustrated and described constitutes one form of a continuous multistage grease mixing apparatus adapted separately to receive and mix several components in successive stages to form a plurality of grease structures having different physical characteristics, means being provided whereby certain of said grease structures are recirculated or returned to different mixing stages, ultimately to produce continuously a finished grease having the desired properties. The number of mixing impellers and the number of pumping impellers may be varied at will and the point at which a given grease structure is taken from a mixing impeller for circulation, as through line **73** of Figure I, back to the impeller with the soap stock inlet may be also varied as desired. By the term "grease structure" as used in this specification and appended claims we mean a grease, such as a calcium or soda base grease, and the like, as they are known to those skilled in the art, which said grease may contain more or less soap stock or oil than is desired in the finished grease.

Although a single embodiment of this invention as well as a single application of that embodiment to a specific purpose, namely, the manufacture of grease from mineral oil and soap stock, have been illustrated and described it is obvious that other applications of this invention as well as modifications of the specific structure disclosed can be made without departing therefrom. Accordingly, all such modifications and changes that come within the scope of the appended claims are understood to be embraced thereby.

We claim:

1. A continuous multistage multiple-fluid mixing device comprising a housing having separate inlets for fluids of different characteristics, a rotatable shaft extending into said housing, a plurality of shrouded impellers on said shaft, means in said housing for directing effluent sequentially from the discharge of one impeller to the inlet of the next adjacent impeller, an out-

let from said housing communicating with an intermediate impeller discharge, and a second outlet from said housing communicating with the final impeller discharge and adapted to conduct effluent therefrom to the inlet of the first impeller of said sequence.

2. A continuous multistage multiple-fluid mixing device according to claim 1, in which said housing is provided with two inlets for separate introductions of two of the fluids to be mixed therein, one inlet communicating with the inlet of the first impeller and the second inlet communicating with the inlet of the last impeller of said sequence.

3. A continuous multistage multiple-fluid mixing device comprising a cylindrical housing, an axial shaft mounted for rotation therein, a plurality of shrouded impellers on said shaft, means in said housing for directing effluent sequentially from the discharge of one impeller to the inlet of the next adjacent impeller, a fluid outlet for said housing communicating with an intermediate impeller of said sequence, separate inlets for at least two of the fluids to be mixed therein, said inlets leading to separate impellers of said sequence, and conduit means associated with said housing for controllably circulating fluid from an intermediate mixing stage to the inlet of a separate impeller for mixing with a component of the finished product.

4. A continuous multistage multiple-fluid mixing device according to claim 3, with the addition of means in said housing spaced from certain of said impellers to permit fluid recirculation between the discharge and inlet of said impellers.

5. In a continuous multistage grease mixing device having a plurality of mixing stages and adapted to receive soap stock and mineral oil through separate inlets whereby an intermediate component is formed in one stage, outlet and passage means from said stage for continuously and controllably circulating said intermediate component to an inlet adjacent said mineral oil inlet in another stage to be mixed with the mineral oil to form the desired finished grease, passage means for continuously removing a portion of said finished grease from said mixing device, and passage means to circulate the remainder of said finished grease to said first named stage for mixing with incoming soap stock to form the above-named intermediate component.

6. In a continuous multistage grease mixing apparatus having a plurality of mixing stages adapted to receive through separate inlets and disperse soap stock and oil whereby in addition to a finished grease a plurality of intermediate grease structures are formed, passage and pressure differential means for continuously and controllably circulating at least a portion of one of said intermediate grease structures from one stage to an inlet of another stage adjacent to the soap stock inlet to be controllably and continuously dispersed with such soap stock to form another of said intermediate grease structures and passage and pressure differential means for controllably and continuously passing at least a portion of said last named intermediate grease structure to an inlet adjacent to oil inlet to be continuously and controllably dispersed with said oil and means for controllably and continuously removing said finished grease from said apparatus.

7. In a continuous multistage mixing apparatus having a plurality of mixing stages adapted to receive through separate inlets and disperse two substances of diverse consistencies, one of which, relative to the other, is of high consistency, whereby there are formed a finished product and a plurality of intermediate products of a consistency intermediate between the substance of higher consistency and that of lower consistency, passage and pressure differential means for continuously and controllably circulating one of said intermediate products from one stage to an inlet of another stage adjacent to the said substance of higher consistency to be continuously mixed with such substance of higher consistency to form an intermediate product and passage and pressure differential means for controllably and continuously passing at least a portion of said last named intermediate products from said stage of formation to an inlet adjacent to the said substance of lighter consistency in another mixing stage to be continuously and controllably mixed with said substance of lighter consistency and means for continuously removing from said apparatus the finished product of desired consistency.

8. A continuous multi-stage multiple-fluid mixing device comprising a housing having separate inlets for fluids of different characteristics, a rotatable shaft extending into said housing, three shrouded impellers on said shaft, ported diaphragms in said housing separating said impellers whereby the outermost impellers act as mixers and the center impeller has pump characteristics, said diaphragms and ports therein being arranged to provide means whereby effluent from the first mixer impeller is discharged into the inlet of said pump impeller, which in turn discharges at least a part of its effluent into the inlet of said second impeller, a finished product outlet for said housing communicating with the discharge of said pump impeller, and conduit means for controllably circulating the effluent from said last-named mixer impeller to the inlet of said first mixer impeller.

CHARLES RAY HETHERINGTON.
ELDRED E. EDWARDS.

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