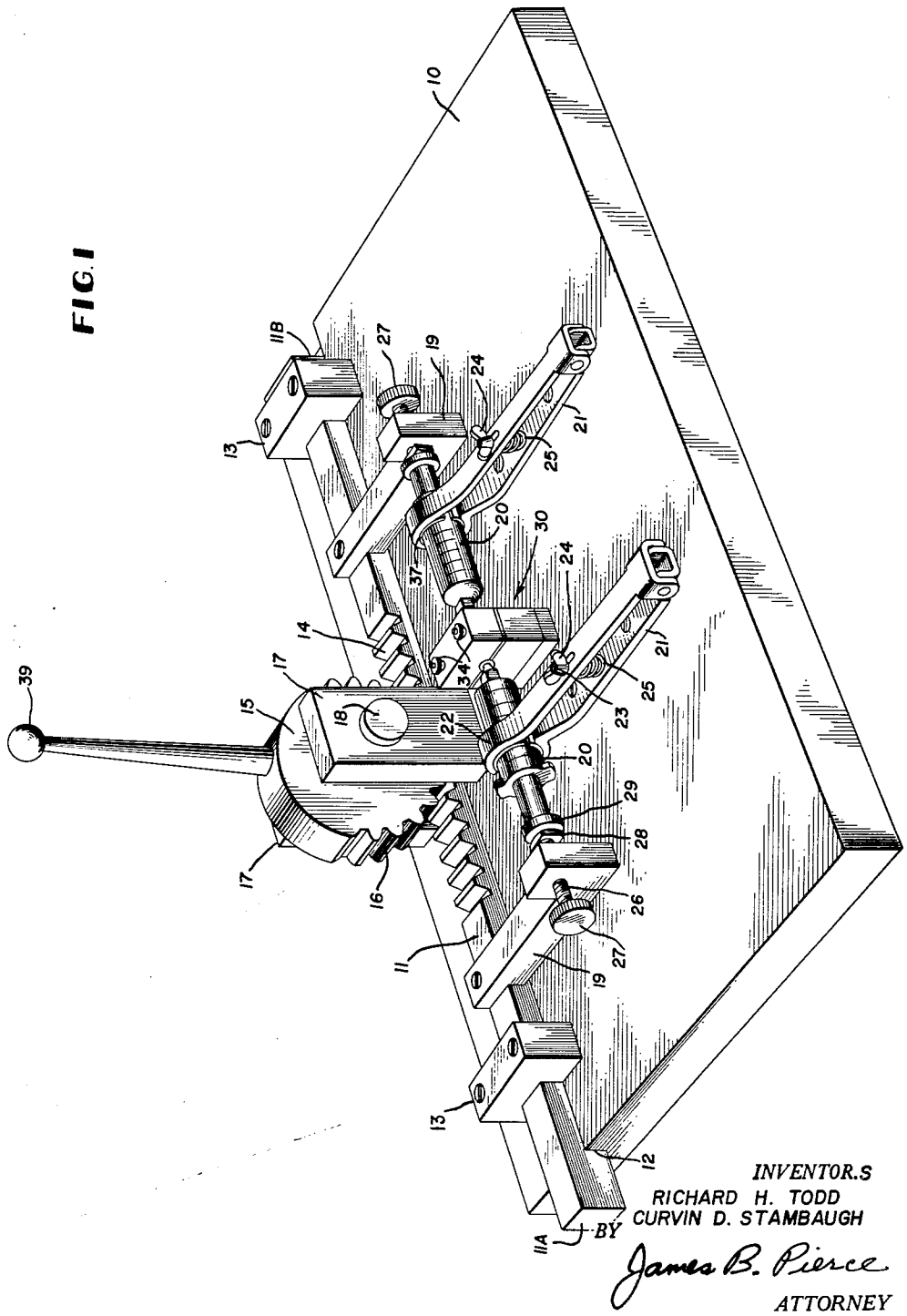
May 22, 1962 R. H. TODD ETAL 3,035,820

EMULSIFICATION APPARATUS

Filed March 23, 1960 2 Sheets-Sheet 1

FIG. 1



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EMULSIFICATION APPARATUS

Filed March 23, 1960 2 Sheets-Sheet 2

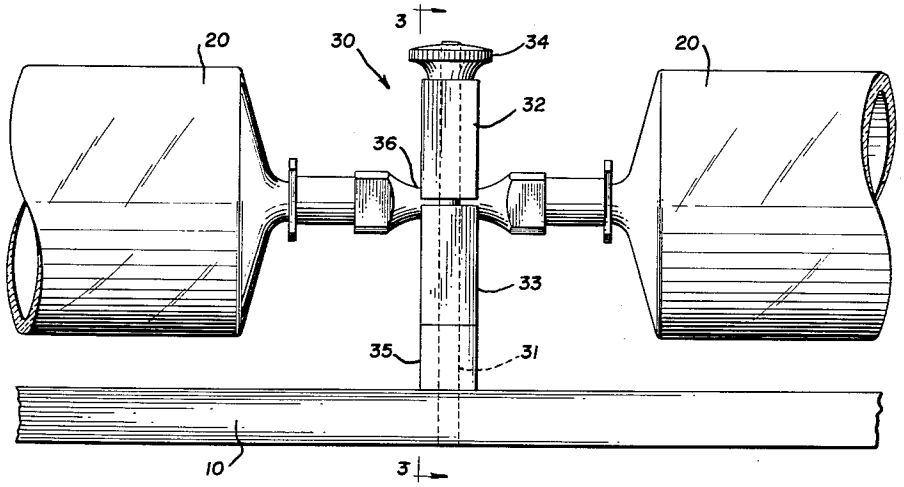


FIG. 2

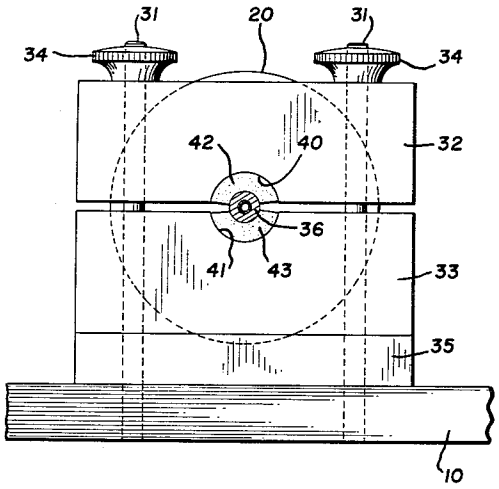


FIG. 3

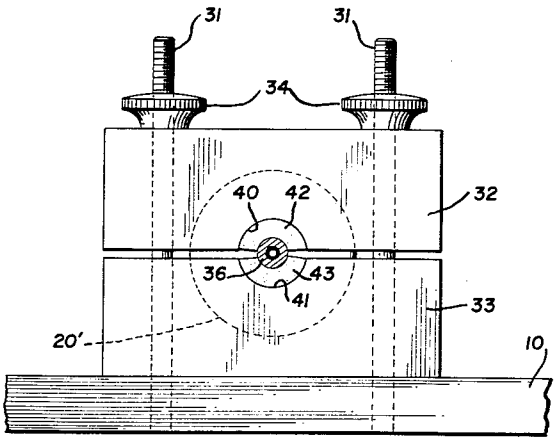


FIG. 4

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EMULSIFICATION APPARATUS

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4 Claims. (Cl. 259—98)

The present invention relates to mechanically actuated pressure emulsification apparatus for emulsifying or homogenizing the suspension of solids or semi-solids in a liquid, such apparatus being of the type wherein the suspension or mixture is forced through a constricted passage at high velocity and/or high pressures.

The apparatus of the present invention is particularly suitable for making small quantities of emulsion and for being operated by manual power, although its application is neither limited to small capacities nor to hand operation. A known form of pressure emulsor for producing emulsions such as those of oil and water consists of a pair of opposed syringes or hypodermic members of the type including a syringe barrel or cylinder containing the mixture to be emulsified and having a plunger or piston operable in each barrel or cylinder for repetitively transferring the fluid from one syringe to the other through a constriction which couples the opposed cylinders to one another.

The high pressure secured in this apparatus forces the mixture or imperfect emulsion, which may, for example, be oil and water, through a narrow passage at high pressure in order to perform the emulsification. As such mixture is transferred from one syringe to the other and the emulsification process proceeds, the viscosity of the resultant fluid increases so as to require increasing pressure to be applied to the alternately actuated syringe plungers or pistons. It has been found that such increasing pressures are difficult to apply manually to the exposed end of the syringe piston, and in certain instances, the viscosity of the emulsion builds up to such a point that direct application of increased pressure as secured by a mechanical advantage is necessary.

Accordingly, it is a general oject of the present invention to provide an apparatus for applying mechanical pressure to alternately actuate the syringe pistons of an emulsification device of the type aforesaid.

A further object of the present invention is to provide apparatus for actuating an emulsor of the opposed syringe type so as to accommodate paired syringes of different size or capacity.

Another oject of the present invention is to provide a device which is readily and economically constructed and which permits a simple and efficient use and operation thereof.

A still further object of the present invention is to provide emulsification apparatus of the type utilizing a pair of opposed hypodermic syringes wherein the syringes and the restricted transfer passage therebetween are protected against mechanical breakage due to distortion or misalignment during the application thereto of mechanical forces which effect the emulsification process.

A more specific object of the present invention is to provide such an apparatus for applying mechanical forces to the aforesaid syringe type emulsor, the parts of which are of simple construction, readily produced economically on a mass basis, and capable of adjustment after assembly in order to accommodate syringe barrel structures and associated components of varying size, and permitting in a simple manner the introduction and removal of the syringe apparatus.

The above and further objects, features, advantages,

and applications of the present apparatus will be understood and appreciated by reference to the following detailed description of a preferred embodiment of this invention, taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of the embodiment of the invention showing the mechanical actuating apparatus operatively associated with the syringe type emulsor;

FIG. 2 is a front elevational view of a portion of the emulsor apparatus to an enlarged scale;

FIG. 3 is a sectional view of the emulsor device illustrated in FIG. 2, taken substantially along the line 3—3 of FIG. 2; and

FIG. 4 is another sectional view of a second emulsor apparatus, taken along a line such as that indicated as line 3—3 in FIG. 2; and represents a second application of the apparatus of the present invention.

Referring now specifically to the drawings, and in particular to FIG. 1 thereof, there is shown a main base plate **10** upon which the apparatus of the present invention is mounted. An elongated mechanical rack bar member **11** of generally rectangular cross section is slidably received in a groove **12** of corresponding dimensions which is provided in the base plate **10**. Two or more bridging members **13** are provided in order to secure the rack member in an operative relationship within the groove or track **12**. The upper surface of bar **11** is provided with rack teeth **14**, which may be formed directly therein as by a cutting or milling operation, or may be affixed thereto as a separate element which then becomes an integral part with the rack bar. Operatively associated with the rack teeth **14** is the gear member **15** of basically circular configuration. Gear teeth **16** are provided in at least a portion of the outer periphery of member **15** and such teeth are of a size, spacing and configuration so as to mesh with teeth **14** of member **11**. A central axle **18** extends from either side of gear **15** and supports the same in a fixed elevational relation with respect to the rack bar for rotational movement with respect thereto by means of the journal blocks **17**. Blocks **17** are affixed to the base plate **10** on either side of the groove **12** by any convenient method, for example, as by welding in the case of metallic elements, or by a suitable adhesive and/or mechanical fixing means in the case of non-metallic elements.

A pair of actuating arms **19** extend outwardly from the rack bar **11** in a plane parallel to and spaced from that of the base member **10** at substantially right angles to the member **11**. Arms **19** are fixed to the member **11** by any convenient means, such as that indicated by the screw members in FIG. 1, for unitary movement together with the rack bar in a direction parallel to the face of base member **10** and longitudinal of the major axis of element **11**.

A pair of adjustable clamping members **21** are fixed to the base plate **10** in spaced parallel relationship by any convenient means such as that indicated by the screw elements as shown in the drawings. The clamping members **21** may include opposed hinged jaws **22** which are movable toward one another by means of the threaded screw member **23** and wing nut **24** so as to securely clamp the syringe barrels **20** in fixed relationship with the emulsification apparatus. At least the inner faces of jaws **22** are preferably covered with a cushioning and facing means having a relatively high coefficient of friction as is indicated by the portion **37** in the drawing so as to securely clamp the syringe barrel **20**. A coaxial spring **25** is mounted upon the screw **23** so that when the pressure of the jaws is released by rotation of the wing nut **24** the jaws may open so as to permit removal of the emulsor apparatus.

The emulsor apparatus consists of a pair of hypodermic

syringes, each of which are indicated by the reference numeral 20, as applied to the barrel portion thereof, and they further include a piston member 29 which may be reciprocated within the barrel in order force the fluid contents thereof through a constricted communicating passage 36 between the paired syringe barrels. Pressure is applied alternately to the head of one and then to the other of the opposed syringe pistons by means of arms 19 which are reciprocated by the rack bar 11. Pressure is transmitted from each arm 19 to the head of the piston 29 by means of the adjustable screw element 26, the position of which may be regulated by means of the knurled head element at 27, and is directly applied to the head of the piston by means of the bearing member 28 which is attached to the end of screw member 26. Cushioning facing means may be provided on member 28. During the operation of the emulsification apparatus of this invention, as described in detail hereinafter, the gear 15 is rotated on its axle 18 by alternate reciprocation of the operating handle 39 so as to reciprocate the rack element and the attached arms 19. During the repetitive passage of the fluid through the restriction 36 the pressures are such as to cause an increase in viscosity of the mixture as it approaches the final emulsified condition.

The combination of the paired opposed syringes 20 is thus subjected to increased pressures and the reciprocation of the pistons 29 of the syringes becomes increasingly difficult, due to the large pressure transmission and reaction forces which build up. The magnitude of these forces are such as to cause the possibility of undesired movements of the paired syringes either in a direction longitudinal of their common axis or transverse thereto, or both. Either direction of movement should be avoided as it results in a loss of efficiency, but of the two the transverse movement is to be particularly avoided. The transverse movement may be such as to cause the common connection between the syringes to buckle or deflect away from its normal axial position with possible distortion or fracture of the constricted passage 36, or the couplings which attach the same to syringes 20, or of the syringe barrel at such coupling point. According to an important feature of the present invention, one or more pillow block clamping fixtures or centering assemblies designated generally by the reference character 30 are provided in order to obviate the above mentioned possibilities.

As indicated in FIGS. 2 through 4 of the drawings the constriction which connects the paired syringes of the emulsor system is of minimum diameter and thus such interconnection is subjected to the maximum forces developed in the system. The constriction 36 in its simplest form may consist merely of a portion of a conventional hypodermic needle which is secured between two standard couplings, which couplings are releasably attached to the base of each syringe barrel. The centering assembly 30 is shown in particular detail in FIGURES 3 and 4. Referring now to FIG. 3, a portion of base plate 10 is shown in the area adjacent to the mounting of such clamping fixture. Assembly 30 consists of a pair of spaced posts 31 which are fixed into the base member 10 as by threading therein on either side of the axis of the emulsor; more specifically the axis of the constricted portion 36 thereof. Two complementary blocks 32 and 33 are provided to engage the outer surface of the restriction element 36, and such blocks are counterbored in order to be releasably secured upon the posts 31. A spacer block 35 may be utilized in combination with blocks 32 and 33 as indicated in FIG. 3 in order to bring the semi-circular jaw openings 40 and 41 into axial alignment with the longitudinal axis of the hypodermic barrel 20 and the constriction member 36. Clamp nuts 34 are threadedly received upon the posts 31 in order to rigidly hold member 36 between the blocks 32, 33 and thereby maintain the same in fixed relationship to the base member 10. Cushioned lining means 42 and 43 are advantageously incorporated in jaws 40 and 41 to assist in the clamping action.

It will be apparent to those skilled in the art that hypodermic syringes are available in various volumetric sizes and that, as such, the diameter of the cylinders thereof vary accordingly. It is one of the advantages of the present invention that paired hypodermic syringe emulsors of varying capacities and therefore of varying sizes may be accommodated by the apparatus. For example, the syringe 20 as shown in FIGS. 1 through 3 may be of a capacity of 20 cc. In the event that emulsor syringes of a smaller quantity are to be utilized with the apparatus, for example, of a 10 cc. capacity, as indicated at 20' in FIG. 4, then it will be apparent that the transverse diameter and radius of such smaller syringes will be less than that shown for the 20 cc. syringe of the embodiment depicted in FIG. 3. When paired syringes of such lesser quantity are utilized with the present invention, the spacer blocks 35 shown in FIG. 3 is removed from posts 31 and the assembly 30 appears as shown in FIG. 4. By means of a series of spacer blocks 35 it is possible, according to the concept of the invention, to accommodate paired syringe emulsors of variable capacity, and particularly to utilize the apparatus to prepare very small quantities of emulsion.

The operation of the emulsification apparatus of the present invention will now be apparent. The paired syringe emulsor is first prepared by placing the piston of one syringe at the end of the barrel adjacent to the constriction 36 and removing the piston of the opposite syringe. The mixture which is to be emulsified is then introduced into the open syringe barrel and its piston 29 is then replaced. The emulsor assembly is then placed within the emulsification apparatus by opening each clamping member 21 and also removing the nuts 34 and upper clamping block 32 from the assembly 30. Rack bar 11 is next moved by means of the handle 39 so as to place the arms 19 in such a position as to accommodate the piston faces of the emulsor apparatus. The emulsor apparatus is then introduced within the clamps 21 which are securely fastened down to the syringe barrels 20, and the block 32 of the clamping fixture 30 is replaced and nuts 34 are tightened to hold the constriction member 36 in fixed relationship to the base plate 10. Screw elements 26 are then adjusted so as to place the bearing members 28 against the outer operating faces of the two pistons 29. The operator then manipulates the handle 39 back and forth to reciprocate rack bar 11 and thus to alternately apply an actuating force to the pistons 29 so as to force the mixture within the syringe barrels through the constricted passage 36 at high velocities and pressures to properly emulsify the liquid mixture.

When the emulsification has progressed to a statisfactory state, which will be apparent to the operator based upon one or more of the following factors, such as the experience of the operator, the number of transfers of the solution from one syringe to the other, the physical appearance of the emulsion when transparent syringe barrels are utilized, or the observable increase in pressure necessary to be applied at the handle 39, the movement of such handle is stopped. Clamp nuts 24 and 34 are then released, as are the screw elements 26, and the emulsor assembly is removed from the apparatus. At this time the emulsion product will preferably all rest within one syringe, and the constricted coupling 36 between the paired syringes may be released, thus permitting the operator to readily handle the resulting emulsion which is now contained within one hypodermic syringe. It will be apparent that such an emulsion-filled syirnge may now be conveniently handled for subsequent use thereof. For example, a sterile closure may be applied to the base of the syringe barrel in order that the emulsion may be stored for later use, or a hypodermic needle may be attached to the syringe barrel in the event that immediate infusion of the emulsification product is to be effected. With the emulsification of the mixture completed, the empty hypodermic syringe and constriction assembly 36 may be

readily cleansed and sterilized in the usual manner with conventional equipment. The emulsification apparatus by which the mechanical application of pressures to the emulsor is effected need not be cleaned or sterilized since no part thereof has come into contact with the liquid which has been emulsified.

Numerous modifications may be made to the preferred embodiment of the apparatus as described above, for example the reciprocation of the rack bar **11** may be effected by means other than the gear **15** and manual operating handle **39**. The end face **11A** of the bar **11** may be utilized as a cam follower and be alternately driven or displaced in a reciprocal manner by means of a rotary motor and cam arrangement of any known type. If such motor-driven cam actuation is not of the type which produces a power stroke for each reciprocal direction, then it would be obvious to modify the apparatus further by the provision of a return biasing spring which would be attached to the opposite end face **11B** of the rack bar and to the base plate **10**. Further possible modifications of the emulsification apparatus will also be apparent, for example, the clamping members **21** could be replaced by a substitute equivalent structure of the type shown in the pillow block clamping fixture or centering assembly **30**.

It should further be noted that while the preferred embodiment of the emulsification apparatus of this invention has been described as suitable for particular application with an emulsor of the opposed hypodermic syringe type, such apparatus is also capable of application and utilization with similar opposed piston assemblies to which mechanical reciprocal forces are to be applied. For example, the apparatus of the present invention could be utilized with the opposed syringe viscosity testing assembly shown in the U.S. patent to Hain No. 2,447,598.

Further, while the opposed syringe assembly to which mechanical reciprocal forces are applied by the apparatus of the present invention has been designated as an emulsor for emulsifying or homogenizing a suspension of solids or semi-solids in a liquid, the term emulsor may also equally apply to assemblies utilized for emulsifying or homogenizing a mixture or suspension of solids or semi-solids in a solid or semi-solid vehicle as in the preparation of ointments. A recognized definition of an ointment being a vehicle such as lard, lard and wax, or petrolatum in which some addition substance has been incorporated and thoroughly intermixed and dispersed.

It is therefore intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not in a limiting sense.

What is claimed is:

1. A mechanically actuated emulsification apparatus including, in combination, a hydraulic pressure emulsification device comprising a pair of spaced opposed cylindrical syringe barrels interconnected mechanically and hydraulically by a coaxial emulsor member, each barrel having a piston mounted therein for reciprocal movement of a given stroke length, a base plate, means to clamp said emulsification device to said base plate with the pistons extending outwardly at opposite ends of the device disposed along an axial line of action spaced from and parallel to said base plate, a force transmitting member mounted on said base plate for reciprocal motion parallel to said axial line of action, a pair of spaced arms extending outwardly from said force transmitting member, the free end of each arm bearing upon one of said pistons and the spacing between such arms being such that when a first piston is reciprocated a complete stroke length inwardly toward the interconnecting emulsor member the second piston may be reciprocated a complete stroke length outwardly away from such member, and means to apply a reciprocating force to said force transmitting member to alternately drive said first piston and said second piston inwardly.

2. Apparatus according to claim 1 wherein said means to clamp said emulsification device includes first clamping means to secure each syringe barrel in fixed relation above said base plate, and second clamping means to secure said interconnecting coaxial emulsor member in fixed relation above said base plate and spaced therefrom a distance determined by the diameter of the cylindrical syringe barrels.

3. Apparatus as set forth in claim 2 wherein said second clamping means including a plurality of spacer elements for selective use as determined by the diameter of the cylindrical syringe barrels.

4. Apparatus as set forth in claim 3 wherein each such spacer element has a different relative distance dimension which is directly proportional to the diameter of the cylindrical syringe barrel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,288,966	Nielsen	Dec. 24, 1918
2,071,879	Jolma	Feb. 23, 1937
2,477,598	Hain	Aug. 2, 1949
2,948,920	Hausmann	Aug. 16, 1960

FOREIGN PATENTS

683,567	Germany	Nov. 9, 1939
414,957	Great Britain	Aug. 16, 1934

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,035,820 May 22, 1962

Richard H. Todd et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 44 and 52, for "oject", each occurrence, read -- object --; column 4, line 17, for "blocks" read -- block --; column 6, line 34, for "including" read -- include --.

Signed and sealed this 16th day of October 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents