July 8, 1930. A. W. EMPSON 1,770,302

MIXING AND EMULSIFYING APPARATUS

Filed June 25, 1927 2 Sheets-Sheet 1

Fig. 1.

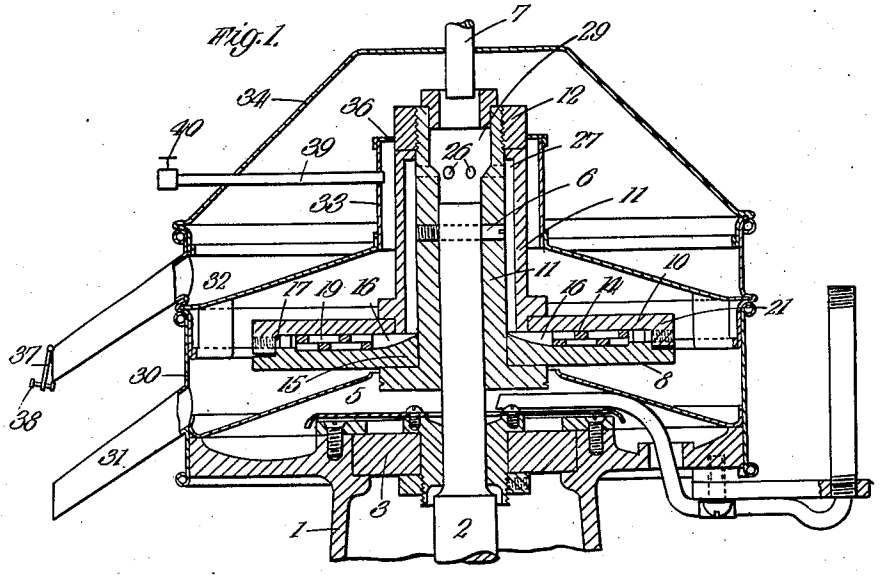
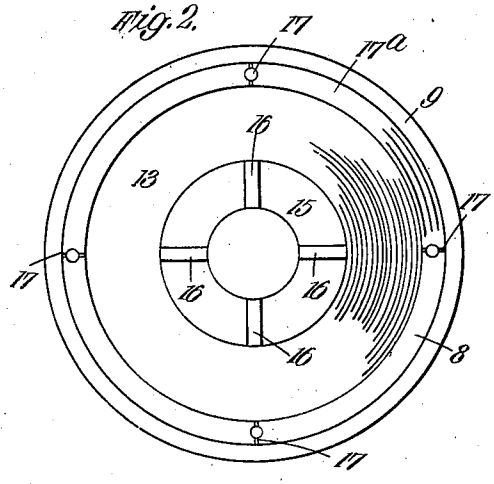


Fig. 2.



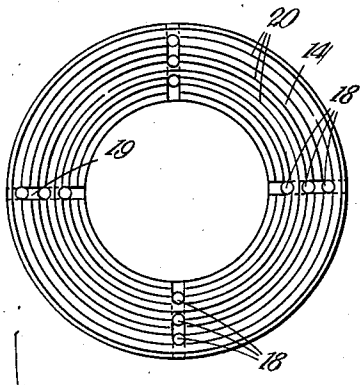


Fig. 4.

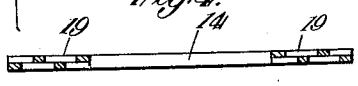
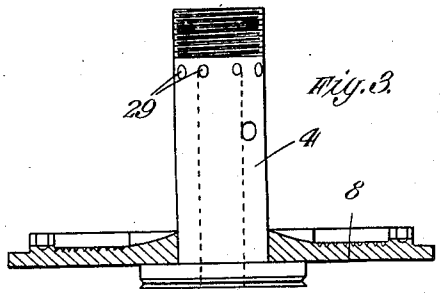


Fig. 3.



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July 8, 1930. A. W. EMPSON 1,770,302

MIXING AND EMULSIFYING APPARATUS

Filed June 25, 1927 2 Sheets-Sheet 2

Fig. 5.

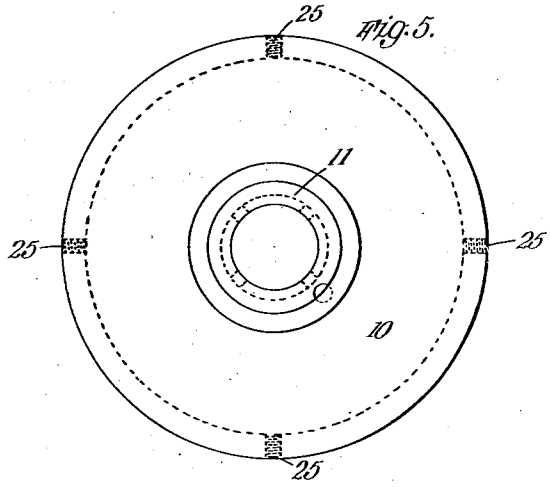


Fig. 6.

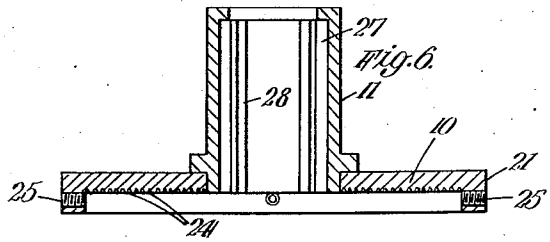


Fig. 7.

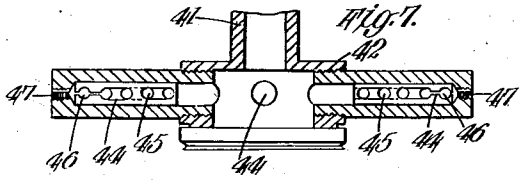


Fig. 8.

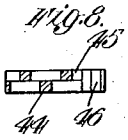
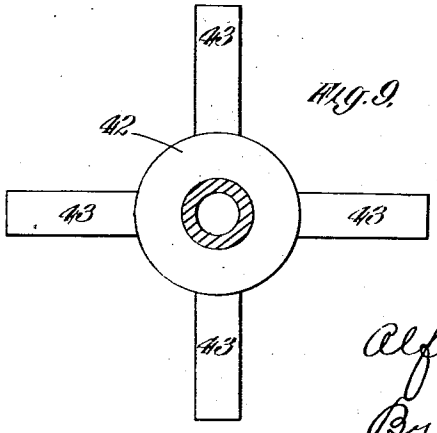


Fig. 9.



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Patented July 8, 1930 1,770,302

UNITED STATES PATENT OFFICE

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MIXING AND EMULSIFYING APPARATUS

Application filed June 25, 1927, Serial No. 201,514, and in Great Britain June 26, 1926.

This invention relates to an improved method of apparatus for the manufacture of compositions of matter such as emulsions or the reconstitution of milk and cream from their separated contents. The invention is also applicable for the manufacture of margarine, ice cream and so forth.

Generally, the method employed to produce emulsions and the like is to pass the mixture previously prepared through tortuous passages formed by juxtaposed perforated or grooved cylinders or discs which may be fixed or movable relatively to each other, the arrangement being such as to bring the constituents of the mixture into intimate contact. So far as the methods which are known to me are concerned, the degree of emulsification hitherto attained has not been such as to meet all the requirements of commercial practice. For example, although a relatively stable emulsion could be produced by reconstituting the separated contents of milk, there was lacking the quality of true flavour. I have found as the result of experiment that flavour, amongst other qualities of an emulsion is to a great extent dependent upon the extent to which the constituents of the mixture are split up or divided and brought into intimate contact.

The method therefore according to the present invention is to pass the mixture through a labyrinthine duct with a sequence of abrupt changes of direction and velocity to bring the constituents into a fine state of subdivision and intimate contact and then to intensify the subdivision and the turbulence at or near the outlet of the duct to produce a higher degree of emulsification. This is accomplished by throttling the outlet of the duct to the requisite extent, such throttling being preferably adjustable or variable to suit the requirement of different circumstances.

The apparatus employed for carrying out the method may be of the centrifugal or static type but in any case comprises broadly a casing, an inlet in the casing for the mixture to be emulsified, a labyrinthine duct or ducts in the casing confined on all sides, means for forcing the mixture through said duct or ducts, a throttle in the discharge outlet of each duct and a receptacle provided with a delivery spout for collecting and delivering the emulsion.

It should be noted that the ducts employed according to this invention are of such character as to prevent any lateral spreading of the stream between the inlet and discharge orifices, that is to say, they are confined on all sides as will hereinafter transpire.

Further features of the invention will be hereinafter described with reference to the accompanying drawings, in which:—

Figure 1 is a vertical fragmentary section of a centrifugal type of machine.

Figure 2 is a detail of the drum base,

Figure 3 shows the drum base and spindle assembled,

Figure 4 shows the drum ring in plan and in cross-section,

Figures 5 and 6 show details of the drum cover or casing,

Figure 7 is a fragmentary section of a static type of machine,

Figure 8 is a detail of duct formation, and

Figure 9 is a diagrammatic plan of Figure 7.

Referring to Figures 1 to 6 of the accompanying drawings, 1 is the pedestal of a centrifugal type of emulsifier, 2 the driving spindle and 3 the usual type of resilient buffer. The lower part of the machine which is of the usual construction has for the sake of clearness not been shown. Mounted on the spindle 2 is a casing consisting of a hollow sleeve 4 flanged at 5 and pinned to the spindle at 6. Above this hollow sleeve is located an inlet pipe 7 for the mixture to be emulsified. The casing supplies a drum base 8, shown in detail in Figures 2 and 3, and consisting of a ring supported by the flange 5. This ring is rebated at 9 to accommodate the drum cover 10 which is held in position by a sleeve 11 and nut 12. An annular channel 13 is formed in the drum base 8 to receive the drum ring 14 shown in detail in Figure 4. The boss 15 of the drum base is provided with channels 16, for example four, communicating with the annular channel 13. A similar number of escape outlets or orifices

17 are formed in the upstanding flange or rim 17ª of the base 8. These escape orifices are preferably formed by drilling holes on the median circumference of the upstanding flange and making a radial slit through the flange on the diameter of each hole.

The drum ring 14 is drilled on four radii with a series of holes 18, for example three holes on each radius, which holes are in alignment with the channels 16 formed in the boss 15. As shown in Figure 1, the drum ring 14 fits snugly into the annular channel 13 and is recessed on both sides, between alternate pairs of adjacent holes, to form labyrinthine ducts 19 leading from the inner to the outer periphery of the ring. The inlet ends of these ducts communicate with the channels 16 and the outlet ends with the escape orifices or ducts 17. Flutings 20 may with advantage be formed on each face of the drum disc 14 as shown in Figure 4. The drum cover 10 fits over the drum base 8 and makes contact with the drum ring 14 located in the channel 13. The flange 21 of the drum cover fits snugly in the rebate in, the drum base 8 and is held down through the intermediary of the flanged sleeve 11 and nut 12. Flutings 24 may be formed on the interior faces of the drum cover and drum base and the flange 21 is drilled and tapped at four points 25, in the same radii as the channels 16 and ducts 19 and escape orifices 17. These holes are fitted with grub screws, shown in dotted lines in Figure 1, upon which a flat is formed thus leaving a small discharge orifice for the escaping emulsion as will hereinafter transpire.

Just above the upper end of the spindle 2 a series of ports 26 are formed in the sleeve 4, see Figures 1 and 3, and these ports allow the incoming mixture to pass into the annular space 27 formed between the sleeves 4 and 11 whence it finds its way to the channels 16. To accelerate the mixture, a series of radial vanes or ribs is preferably provided either on the inner periphery of the sleeve 11 or the outer periphery of the sleeve 4. These are indicated at 28 in Figure 6.

The operation of the device thus far described is as follows. The mixture, for example milk powder, hot water and butter in predetermined proportions is admitted at 7 and fills the chamber 29 and passes through ports 26 into the annular chamber 27 thence into the channels 16 and labyrinthine ducts 19 to the escape orifices 17 and finally through the discharge orifices formed by the flats on the grub screws at 25 in the flange of the drum cover 10. During its passage the fluid is subjected to great turbulence and frequent changes of direction and when passing through the orifices in the flange 17ª of the drum base the fluid is subjected to vortex motion in the holes on the median circumference of flange 17ª. The throttling effect at the outlets of the ducts with the changes of direction and the vortex motion adjacent the discharge orifices greatly enhances the emulsifying effect.

The discharged emulsion is collected in a receptacle 30 formed of sheet metal and attached to the pedestal 1 in the customary manner. The receptacle is provided with a discharge spout 31. Another receptacle 32 formed of sheet metal is fitted into the receptacle 30 and this upper receptacle 32 is provided with a centre tube 33 and a cover 34. This receptacle conducts away any surplus of mixture with which the machine cannot cope and such mixture is discharged through a spout 35. The centre tube 33 is provided with a cap 36 which provides a very fine clearance between it and the rotating portion of the machine.

Baffles not shown are fitted in the receptacle 30 for the purpose of arresting the orbital motion of the discharged emulsion.

It is important in many cases to aerate the emulsion before it leaves spout 31 such for instance when cream is being manufactured from its constituents or ice cream is being produced. Aeration of the emulsion may be accomplished in several ways, for instance, the baffles within receptacle 30 induce a flow of air down the centre tube 33 which air passes out through spout 31. This flow of air can be controlled in various ways for regulating the aeration of the emulsion, for instance, the amount of clearance between cap 36 and the rotating parts of the machine may be varied to control the flow of air. Alternatively, the spout 35 of the overflow receptacle 32 may be fitted with a hinge flap 37 which does not fit too tightly and while permitting of overflow mixture to be discharged, limits the amount of air which can gain access to the interior of the overflow vessel and therefore to the centre tube 33. The amount of air thus admitted to the overflow receptacle may be regulated by the screw 38 which regulates the amount of closing of the flap 37.

As an alternative arrangement, the spout 35 may discharge into a container which forms a fluid seal so that air cannot find its way into the overflow receptacle by way of spout 35. In this case an air tube 39 may be introduced through the cover 34 and extended through the centre tubes 33 and provided at its outer extremity with a regulating valve or cock 40. In this way the amount of air admitted to the centre tube 33 and to the receptacle 30 can be regulated.

For the purpose of adjusting the rate of flow or discharge of the emulsion the grub screws in the flange 21 may be changed that is to say, sets of grub screws with different sizes of flats formed thereon may be used to vary the size of the discharge orifices in flange 21.

Although the machine shown in Figures 1 to 6 and hereinbefore described is of the centrifugal type it will be clear that it will operate equally well under a static head of pressure, it only being necessary to make a suitable connection between the pipe 7 and the hollow sleeve 4. The head of pressure in such cases may be by gravity or provided by a force pump.

Figures 7, 8 and 9 show a modification suitable for use in the centrifugal or static forms of constructions. In this modification, the casing 41 may be mounted on the spindle 2 in a convenient manner and this casing has a lower drum portion 42 into which are screwed a series of radial tubes 43, for example four as shown in Figure 9. These tubes contain cylindrical plugs 44 which are drilled with a series of holes 45 and recessed between adjacent pairs of holes on opposite sides to form labyrinthine ducts as described above in connection with the drum ring 14. Near the discharge ends of each of these ducts a hole 46 is drilled and this hole communicates with the adjacent holes by means of a slit and with the extremity of the plug by means of another slit, these slits constituting the discharge orifices. It is in the space formed by the holes 46 that vortex motion of the fluid takes place. The ends of the tubes are drilled and fitted with grub screws 47 having flats thereon as hereinbefore described whereby the emulsion discharged from the labyrinthine ducts in the plugs 44 escapes. A detail of the plug in cross-section is shown in Figure 8.

The arrangement of Figures 7, 8 and 9 may be used as a static form by simply connecting the sleeve of the casing 41 to a supply valve in a manner which it will be clear to those acquainted with the art.

The air entering the emulsifier may be induced to pass through a suitable filter to exclude dust particles and also through a sterilizing agent. Ozone or some other gaseous or vapourized agent may be injected into the air stream and passed out through the emulsion discharge spout into the cooler casing and then discharged to atmosphere. Alternatively the air in the emulsion and overflow receptacles may be sterilized and caused to circulate in a closed circuit. As stated above suitable gas or vapour with or without air may be mixed with the emulsion.

I claim:—

1. A device for emulsifying a mixture comprising a casing, an inlet in the casing, a labyrinthine duct in said casing confined on all sides, means for forcing the mixture through said duct, there being a discharge orifice at the end of the duct, said orifice having a smaller cross-sectional area than the duct.

2. A device for emulsifying a mixture comprising a casing having an inlet, a labyrinthine duct in said casing confined on all sides, means for forcing the mixture through said duct, there being a constricted discharge opening at the end of the duct, and a receptacle adapted to receive the emulsified mixture from said discharge opening.

3. A device for emulsifying a mixture comprising a spindle, means for rotating said spindle, a drum mounted on said spindle, a radial labyrinthine duct in said drum, said duct being confined on all sides, a constricted discharge orifice at the outlet end of the duct, and a receptacle to receive the mixture discharged through said orifice.

4. A centrifugal apparatus for emulsifying a mixture comprising a spindle, means for rotating said spindle, a radial labyrinthine duct in said drum said duct being confined on all sides, a constricted discharge opening at the outlet end of the duct, a receptacle to receive the mixture discharged through said discharge opening, and vanes in said receptacle adapted to arrest the orbital motion of the discharged emulsion.

5. A centrifugal apparatus for emulsifying a mixture comprising a spindle, means for rotating said spindle, a radial labyrinthine duct in said drum said duct being confined on all sides, a constricted discharge opening at the outlet end of the duct, a receptacle to receive the mixture discharged through said discharge opening, vanes in said receptacle adapted to arrest the orbital motion of the discharged emulsion, and a receptacle arranged to receive liquid overflowing from the intake of said duct.

6. A centrifugal apparatus for emulsifying a mixture comprising a spindle, means for rotating said spindle, a radial labyrinthine duct in said drum said duct being confined on all sides, a constricted discharge opening at the outlet end of the duct, a receptacle to receive the mixture discharged through said discharge opening, vanes in said receptacle adapted to arrest the orbital motion of the discharged emulsion, and means to control the amount of air admitted to said receptacle.

7. A device for emulsifying a mixture comprising a spindle, means for rotating said spindle, a drum mounted on said spindle, a radial labyrinthine duct in said drum, said duct being confined on all sides, a constricted discharge orifice at the outlet end of the duct, a receptacle to receive the mixture discharged through said orifice and vanes arranged on said drum adapted to induce a flow of air during rotation of the drum.

8. A device for emulsifying a mixture comprising a casing, an inlet in the casing, a labyrinthine duct in said casing confined on all sides, means for forcing the mixture through said duct, there being a discharge orifice at the end of the duct, said orifice having a smaller cross-sectional area than the

duct, and means whereby the size of the discharge orifice may be regulated.

9. A device for emulsifying a mixture comprising a casing, an inlet in the casing, a labyrinthine duct in said casing confined on all sides, means for forcing the mixture through said duct, there being a discharge orifice at the end of the duct, said discharge orifice comprising two slits of smaller cross-sectional area than the duct and opening into an enlarged space.

10. A device for emulsifying a mixture comprising a casing, an inlet in the casing, a labyrinthine duct in said casing confined on all sides, means for forcing the mixture through said duct, there being a discharge orifice at the end of the duct, said orifice having a smaller cross-sectional area than the duct, and means arranged adjacent said discharge orifice for producing a vortex in the mixture as it is forced through the duct.

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