Sept. 12, 1939. W. K. KRAUSS 2,172,661

HOMOGENIZER

Filed Dec. 14, 1938 3 Sheets-Sheet 1

FIG. 1

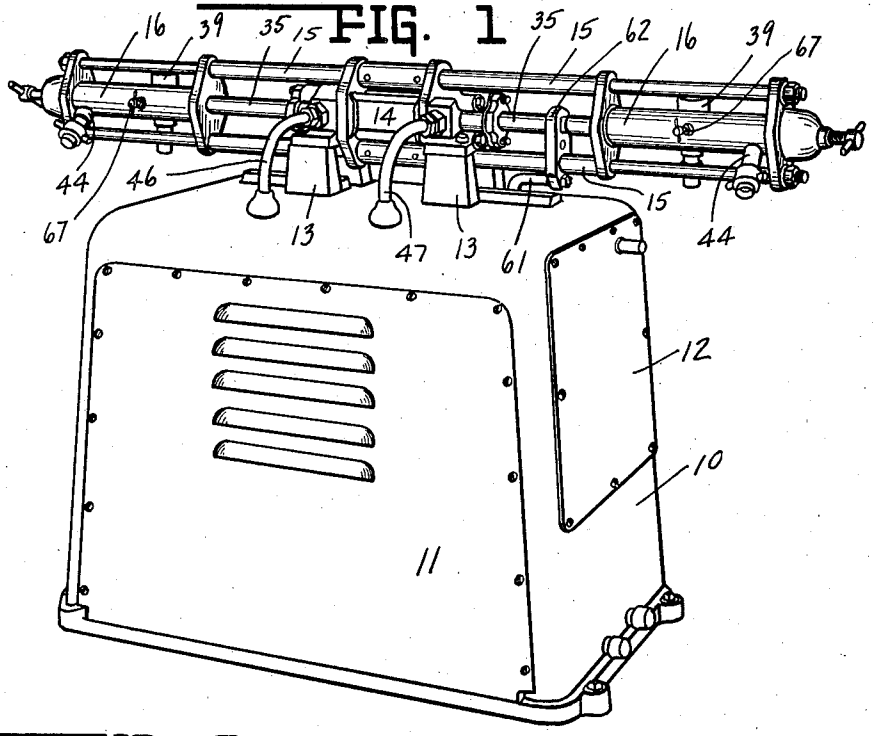


FIG. 6

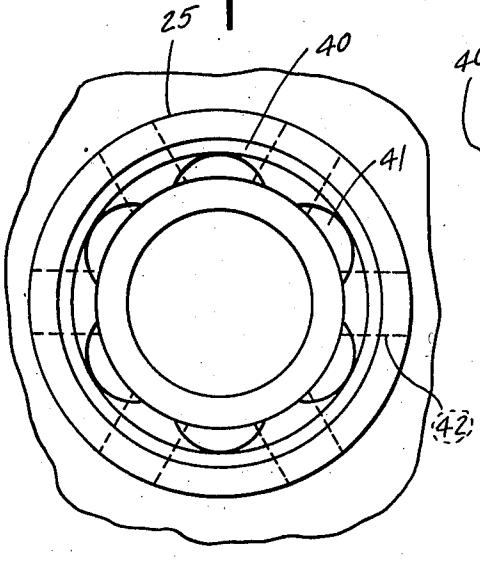
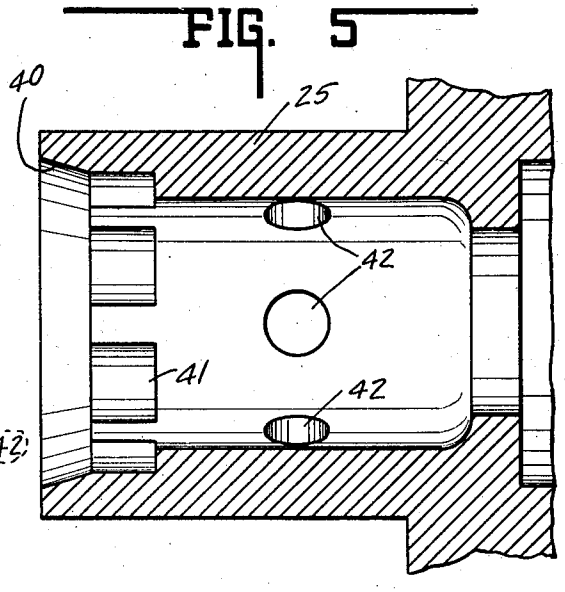


FIG. 5



INVENTOR.
WILFRED K. KRAUSS.

BY Lockwood, Goldsmith & Galt,
ATTORNEYS.

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Filed Dec. 14, 1938 3 Sheets-Sheet 2

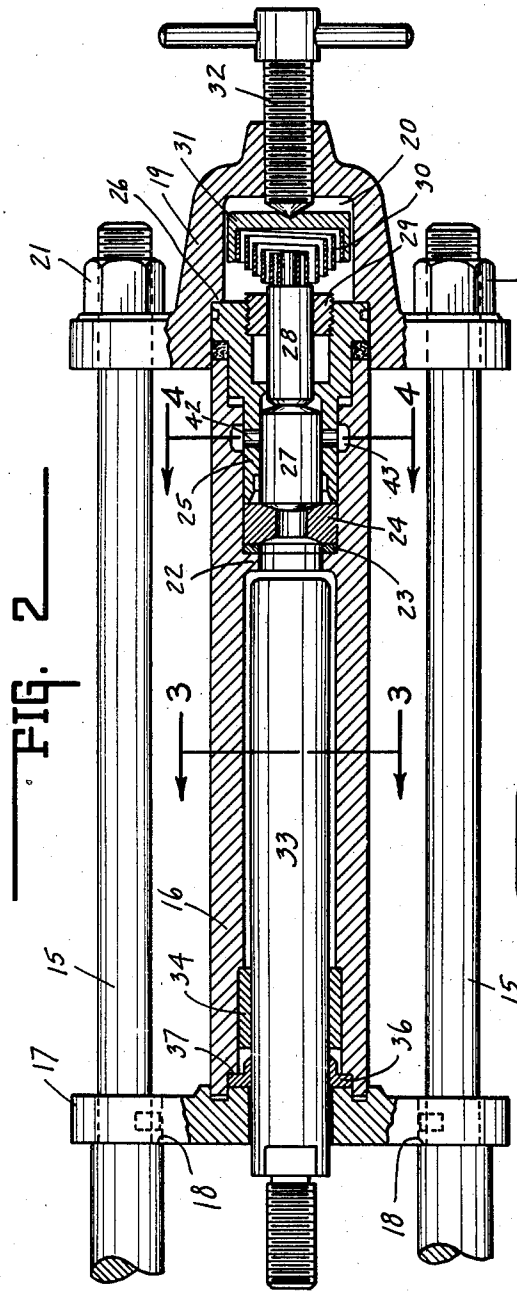


FIG. 2

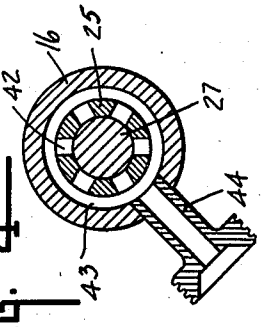


FIG. 4

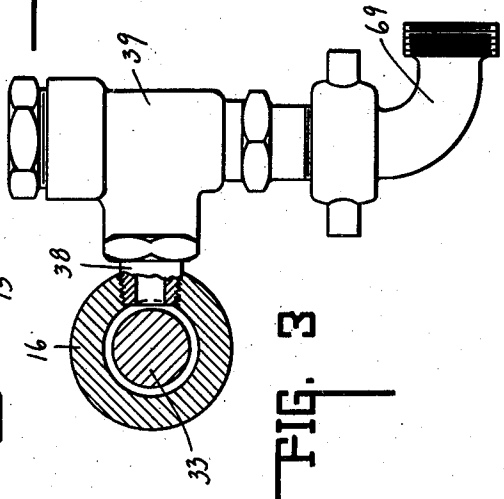


FIG. 3

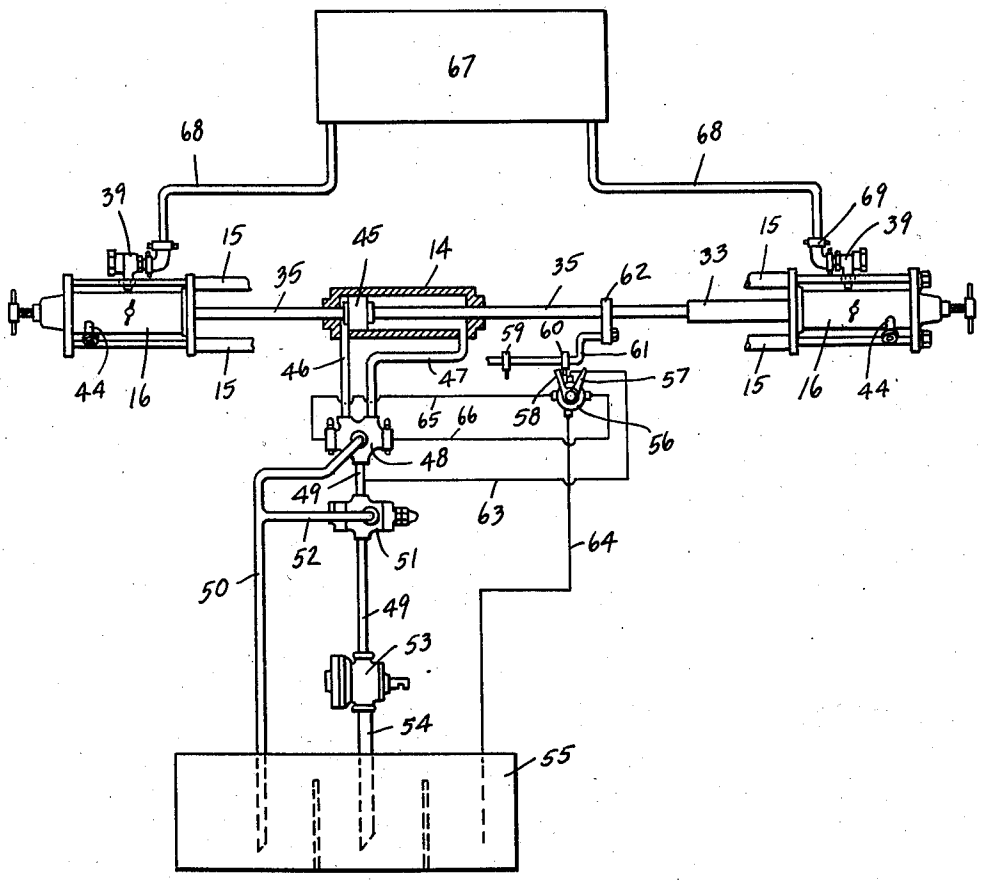
INVENTOR.
WILFRED K. KRAUSS,
BY Lockwood, Goldsmith & Galt.
ATTORNEYS.

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Filed Dec. 14, 1938 3 Sheets-Sheet 3

FIG. 7



INVENTOR.
WILFRED K. KRAUSS.
BY Lockwood, Goldsmith & Galt,
ATTORNEYS.

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UNITED STATES PATENT OFFICE

2,172,661

HOMOGENIZER

Wilfred K. Krauss, Grand Rapids, Mich.

Application December 14, 1938, Serial No. 245,603

9 Claims. (Cl. 99—267)

This invention relates to a homogenizer especially adapted for processing milk and milk products but equally useful for emulsifying other fatty materials.

In the homogenizing process, the product is discharged under high pressure through a valve having a relatively small opening. The process results in breaking down the globules of fat and thereby produces a product in which the fatty and non-fatty constituents do not have the same tendency to separate as in the original material.

In this process the degree of homogenization is controlled principally by the pressure exerted upon the material and by the dimensions of the valve opening through which the material is forced. Uniform processing therefore requires both uniform pressure and uniform valve opening. The pressures used for homogenizing often run as high as 3500 pounds per square inch. Obviously, a pump of some sort is required to initially place the material under such pressures. When a centrifugal pump is used, only the lower range of the homogenizing pressures can be reached because of the inherent characteristics of such pumps. When the usual type of plunger pump is used in which the plunger is driven by a crank or eccentric, the velocity of the plunger varies throughout the stroke. This variation results in pressure surges which produce non-uniform homogenization in the several parts of the plunger cycle. These surges not only vary the pressure but also vary the valve opening when the usual spring loaded type of valve is employed. Where a valve having its opening mechanically stopped is employed, the valve opening may be constant but the variations in pressure are much greater since there is no relief of the excess pressure by a wider opening of the valve. In large size units, the variations in pressure may be somewhat mitigated by the use of multiple cylinders but the undesirable effects cannot be entirely eliminated by this means.

One object of the present invention is to provide a homogenizer in which both the pressure and the valve opening are uniformly maintained and in which this result may be accomplished in the higher pressure ranges beyond the capacity of a centrifugal pump. This result is accomplished by the particular arrangement of elements hereinafter described.

Another object of the invention is to provide a structure which may be dismantled for cleaning and sterilization with a minimum of lost time and effort and in which the sterilization may be readily accomplished with complete thoroughness.

Another object of the invention is to reduce the manufacturing cost of the homogenizer.

Another object of the invention is generally to improve the construction and operattion of homogenizers of this type.

Other objects and features of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a perspective view of a complete homogenizer constructed in accordance with the invention. Fig. 2 is a longitudinal sectional view of one of the homogenizer cylinders and associated valve mechanism. Figs. 3 and 4 are sectional views taken on the lines 3—3 and 4—4, respectively, of Fig. 2. Fig. 5 is a longitudinal sectional view of a portion of one of the valve members shown in Fig. 2. Fig. 6 is an end view of the same. Fig. 7 is a diagrammatical layout of the complete homogenizer.

In the form of the invention shown in the drawings by way of illustration, there are provided a base housing 10 having removable closures 11 and 12 and housing certain parts of the apparatus. Pedestals 13 formed on the top of the housing 10 support a power cylinder 14 to which there is secured a pair of stationary horizontal bars 15 forming a rigid framework on which there is mounted a pair of homogenizing cylinders 16.

Each of the cylinders 16 is constructed as shown in Fig. 2 and is provided with a cylinder head 17 supported on the bars 15 and resting against shoulders 18 formed on said bars. At the opposite end a cylinder head 19 having a central chamber 20 therein is also supported on the bars 15 and is held in place by nuts 21 threadedly engaging the ends of said bars. Within the cylinder 16 there is formed a shoulder 22 having a washer 23 in engagement therewith. A valve seat 24 having a central opening therein engages the washer 23 and is held in place by a valve bushing 25, the opposite end of which is held in place by a shoulder 26 formed in the cylinder head 19. A valve member 27 is longitudinally slidable within the bushing 25 and has one end engaging and closely fitting the valve seat member 24. A pressure pin 28 is slidably mounted in the bushing 25 and in a collar 29 threadedly engaging the bushing. Said pressure pin engages the opposite end of the valve member 27 and is in turn engaged by a spiral spring 30 seated in a spring seat 31 within the chamber 20. An adjusting screw 32 threadedly engages the cylinder head 19 and has its inner end engaging the spring seat 31. By suitably adjusting the screw 32 the pressure exerted by the spring 30 may be varied.

The pressure of the spring 30 normally maintains the valve member 27 against the valve seat 24. A plunger 33 is slidably mounted in a bushing 34 mounted in the cylinder 16 and extends outwardly through the cylinder head 17 and is connected by any suitable means to a piston rod 35. A packing member 36 preferably formed of leather is retained between the cylinder head 17 and an internal shoulder 37 formed in the cylinder 16. Said packing member seals the cylinder 16 against escape of material along the surface of the plunger 33.

In the operation of the homogenizing cylinders the plunger 33 is reciprocated by means to be hereinafter described. On the outgoing stroke of the plunger, the material to be processed is drawn into the cylinder through an inlet connection 38 to which there is connected a check valve 39 of a well known commercial form. On the incoming stroke of the plunger 33 the valve 39 is closed. The pressure exerted by the plunger on the material forces the valve member 27 to the right in Fig. 2 against the action of the spring 30 and thus opens the valve a very small distance. The material is forced at high velocity between the valve 27 and the seat 24 and this high velocity jet of material impinges upon a frusto-conical surface 40 formed in the end of the bushing 25 (Fig. 5). The effect of this high velocity action on the material is to break down the globules of fat into much smaller sizes and thus to make a more perfect emulsion. The discharged material is collected in recesses 41 formed in the bushing 25 and while still under considerable pressure is forced between the valve member 27 and the inner surface of the bushing 25, thus receiving further homogenizing action. For this purpose, a diametrical clearance of approximately ten one-thousandths of an inch is provided between the valve 27 and bushing 25. The processed material then passes through openings 42 provided in the bushing 25 and into a circular recess 43 formed in the cylinder 16. An outlet fitting 44 communicates with the recess 43 and may be connected to any suitable outlet line.

The piston rod 35 passes through the power cylinder 14 and has secured thereto within said cylinder a piston 45 (Fig. 7). The effective area of the piston 45 is considerably greater than the effective areas of the plungers 33, preferably about three times as great. Pipe connections 46 and 47 lead to the opposite ends of the cylinder 14 and are connected to a common form of piston operated reversing valve 48. Said reversing valve is also provided with an inlet pipe 49 and an outlet pipe 50. A pressure relief valve 51 is connected in the pipe 49 and is provided with an outlet 52 communicating with the pipe 50. A pump 53 which may be of the centrifugal type or a positive action rotary pump discharges into the line 49 and is provided with a suction pipe 54 connected to a tank 55 in which there is maintained a supply of oil or other operating fluid for the cylinder 14. The tank 55, pump 53 and valves 48 and 51 are preferably housed within the casing 10. A reversing pilot valve 56 is also provided within the casing and has a pair of operating arms 57 and 58 arranged to be operated respectively by strikers 59 and 60. Said strikers are carried upon a rod 61 in turn mounted upon a fitting 62 secured to the piston rod 35. The valve 56 has an inlet connection 63 connected to the line 49 and an outlet connection 64 discharging into the tank 55. Connections 65 and 66 connect the valve 56 with the opposite ends of the valve 48.

Air vents 67 are provided for each of the homogenizing cylinders for the removal of air which may accumulate in the cylinders and hinder the intake operation thereof. These vents are of a well known form which need not be described in detail.

In the operation of the apparatus the material to be processed is supplied to the check valves 39 from a tank or reservoir 67 by means of pipes 68 which may be connected to said valves by means of sanitary fittings 69. The pump 53 constantly supplies oil under pressure from the tank to the pipe 49. The pressure may be considerably below the homogenizing pressures and therefore a centrifugal pump or a positive rotary pump may be employed and gives a substantially constant fluid pressure in the pipe 49. This pressure is controlled by the setting of the overflow relief valve 51 which permits any excess of fluid to be returned to the tank 55. With the parts in the position shown in Fig. 7, the striker 60 has engaged the operating arm 58 and moved the valve 56 to admit fluid under pressure from the pipe 49 to the pipe connection 65 and to connect the pipe connection 66 to the outlet line 64. The fluid under pressure is then admitted to the lefthand side of the valve 48 and moves the said valve to connect the pressure line 49 with the pipe connection 46 and to connect the pipe connection 47 with the outlet line 50. The operating fluid under pressure is thus admitted to the lefthand end of the cylinder 14 and forces the piston 45 to the right. The pressure of the piston is transmitted through the piston rod 35 to the plunger 33 of the righthand homogenizing cylinder. Said plunger is thus forced through its operating stroke.

At the same time, the plunger 33 of the lefthand homogenizing cylinder is drawn outwardly for its suction stroke. At the end of the working stroke of the right hand cylinder and the suction stroke of the lefthand cylinder, the striker 59 engages the operating arm 57 and reverses the valve 56. In the reverse position, the pipe connection 66 is connected to the pressure line 63 and the pipe connection 65 is connected to the drain line 64. The valve 48 is thus reversed and in the same manner reverses the connections to the pipes 46 and 47 to cause the return movement of the piston 45.

By this means the piston 45 may be driven with a substantially uniform pressure throughout its stroke in either direction. The pressure exerted by the plungers 33 is a multiple of the pressure in the cylinder 14 and is itself substantially constant throughout each stroke of the plunger. Since the pressure in the homogenizing cylinders is constant, the valve openings for a given setting of the springs 30 is also constant. Thus all parts of the material receive their homogenization under uniform conditions of pressure and valve opening. The resulting product therefore is truly homogenous.

Aside from the provision of uniform pressure and valve opening, the construction of the valve apparatus is of importance. It will be apparent that the cylinder heads 19 may be readily removed by first removing the nuts 21 and that all of the working parts may then be easily extracted from the cylinder for sterilization. The reassembly of the apparatus may be accomplished with equal facility. The transmission of the pressure of the nuts 21 through the bushing 25 to the valve seat member 24 insures that the working parts are securely locked in place when

in use. The fact that the material flows about the valve **27** insures free movement of said valve and prevents undesirable sticking of the valve.

The invention has been described in one of its preferred forms but I do not desire to be limited to the exact details of construction shown and described, since obvious modifications will occur to a person skilled in the art. For example, it is not necessary in securing a large part of the benefit of the invention that the cylinder **14** have a larger effective piston area than the plungers **33**. It may have a longer stroke instead and be connected to the plungers by any suitable well known mechanical connection which may operate the plungers **33** with a shorter stroke and a higher pressure. When designed to operate on low homogenizing pressures, the power cylinder may have the same displacement and pressure as the homogenizing cylinders and still give notable advantages in smoothness of operation and uniformity of results.

It is not necessary that the working fluid in the power cylinder be a liquid. Steam may be used as well, for example. In that case, it is only necessary to replace the pump **53** with a suitable steam generator. The valve gear illustrated herein will operate in the same manner to supply steam at a uniform pressure throughout the stroke of the power cylinder.

The invention claimed is:

1. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, and an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston.

2. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston, and means for supplying a working fluid under a substantially uniform pressure to said power cylinder.

3. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, and an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston, said piston having a greater effective area than said plunger, whereby said power cylinder may be operated under a smaller pressure than that desired in said homogenizing cylinder.

4. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston, said piston having a greater effective area than said plunger, whereby said power cylinder may be operated under a smaller presure than that desired in said homogenizing cylinder, and means for supplying a working fluid under a substantially uniform pressure to said power cylinder.

5. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, and an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston, said piston having a greater displacement per stroke than said plunger, whereby said power cylinder may be operated under a smaller presure than that desired in said homogenizing cylinder.

6. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a hydraulically operated piston operating in said power cylinder, an operating connection between said piston and said plunger adapted to give to said plunger a movement proportional to that of said piston, said piston having a greater displacement per stroke than said plunger, whereby said power cylinder may be operated under a smaller pressure than that desired in said homogenizing cylinder, and means for supplying a working fluid under a substantially uniform pressure to said power cylinder.

7. In a homogenizer, a central double acting power cylinder, a pair of homogenizer cylinders arranged coaxially therewith, a homogenizer valve associated with each of said homogenizer cylinders, a piston operating in said power cylinder, plungers operating in said homogenizer cylinders to force material to be processed through said valves, a piston rod connecting said piston and said plungers, and means automatically operable to supply a working fluid under pressure alternately to the two ends of the power cylinder.

8. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material to be processed through said valve, a power cylinder, a piston operating in said power cylinder, means directly connecting said piston and said plunger, and means for supplying a working fluid under a substantially uniform pressure to said power cylinder.

9. In a homogenizer, a homogenizing cylinder and valve, a plunger in said cylinder adapted to force material under pressure through said valve, and hydraulic means for moving said plunger at a substantially uniform velocity throughout its pressure stroke.

WILFRED K. KRAUSS.