Oct. 11, 1955 C. E. SILK 2,720,358

CENTRIFUGE

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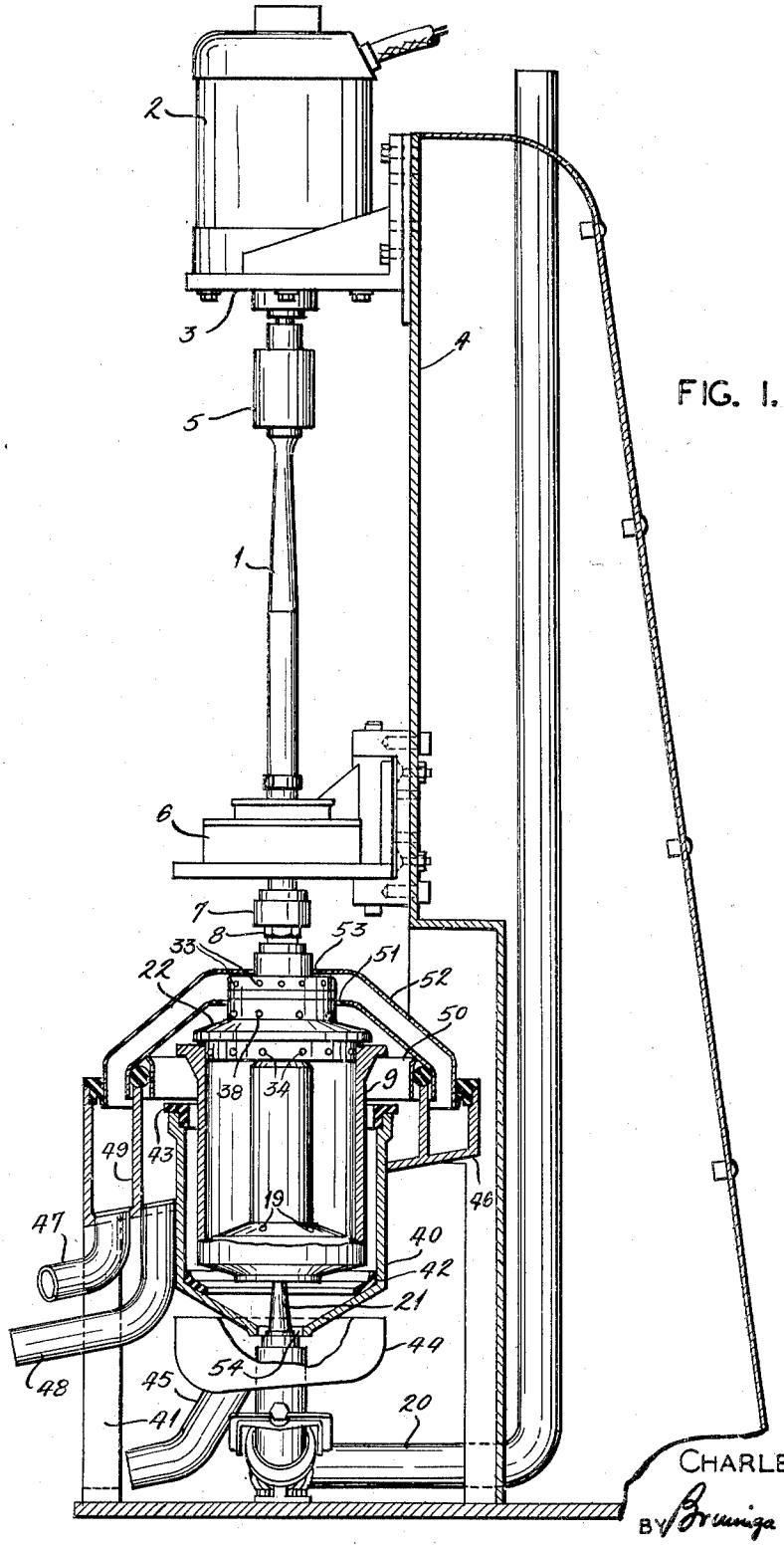


FIG. 1.

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FIG. 3.

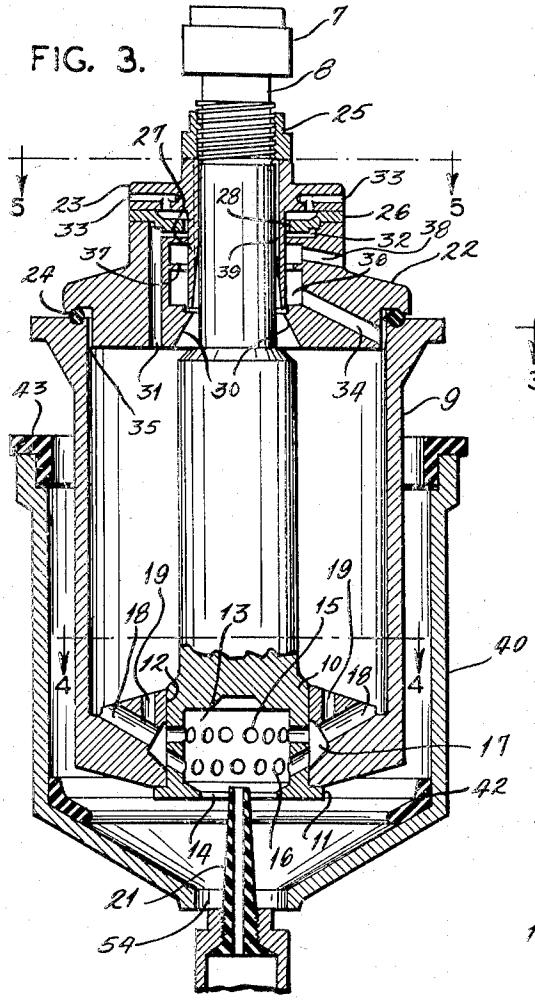


FIG. 2.

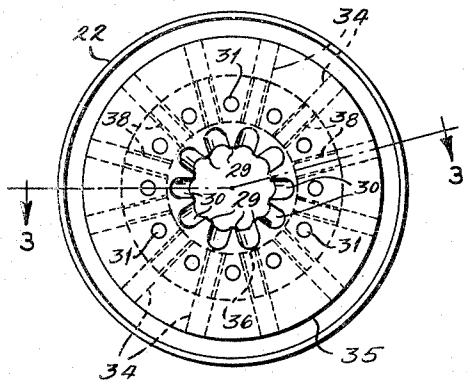


FIG. 4.

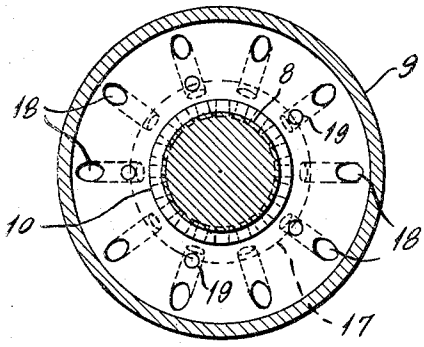
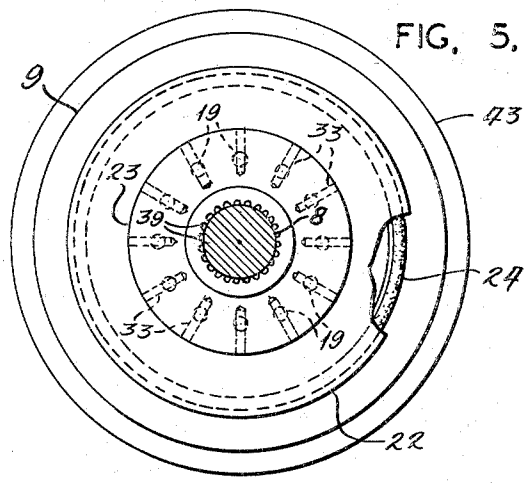


FIG. 5.



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2,720,358

CENTRIFUGE

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4 Claims. (Cl. 233—21)

This invention relates generally to centrifugal separators, and particularly to a centrifuge which may be safely used in the separation of nitroglycerine from spent acid used in the manufacture of nitroglycerine.

Although the centrifugal separation of nitroglycerine from spent acids has heretofore been suggested, such has been frowned upon by safety conscious operators in the explosive industry, because the centrifugal separators heretofore provided have been of a construction which permitted either the incoming liquid to be separated, or the separated components thereof, or both, to migrate into positions between moving and stationary parts. Obviously, in the separation of nitroglycerine from spent acid, the possibility that nitroglycerine might migrate to a position where it would be subject to friction or impact between relatively movable parts introduces a tremendous hazard.

The object of the present invention, generally stated, is to provide a centrifuge which may be safely used for the separation of nitroglycerine from spent acid, and in comparable situations where one component of the mixture undergoing treatment is liable to explode upon friction or impact.

Another object of the invention is to provide a centrifuge of the character aforesaid, which may be readily disassembled after use without likelihood of creating an explosion.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawings, in which:

Figure 1 is a view in side elevation of a centrifuge constructed in accordance with this invention, part being shown in section to reveal the relation of the parts;

Figure 2 is a bottom plan view of the cover element for the centrifuge bowl shown in Figure 1;

Figure 3 is a sectional view showing the bowl element and adjacent parts on an enlarged scale and in greater detail than is shown in Figure 1, the section through the cover being taken along line 3—3 of Figure 2;

Figure 4 is a sectional view taken along line 4—4 of Figure 3; and

Figure 5 is a sectional view taken along line 5—5 of Figure 3.

The present invention contemplates a centrifugal separator wherein the bowl or part in which the centrifugal separation occurs is mounted upon the lower end of a vertically extending shaft, and the bowl is free of stationary supports, guides or bearings below the level of the liquids undergoing treatment. In order to introduce the mixture of liquids to be separated into the rotating bowl, the invention contemplates the arrangement of a feeding device in physically spaced relation from the bottom of the bowl, and disposed to project a stream of liquid into position where it will, by centrifugal force, be drawn into the bowl.

In a cantilever-supported centrifugal bowl of the character aforesaid, there exists a possibility that, upon mechanical failure or upon disassembly after use, a moving part may make physical contact with a stationary part, and if there should happen to be a film of nitroglycerine between the parts as they make such physical contact, an explosion is likely to occur. Accordingly, the invention contemplates the provision of bumper blocks and gaskets, so disposed as to minimize the likelihood of physical contacts between relatively movable metallic parts. More especially, the invention contemplates that such gaskets and bumper blocks be made of polyethylene, a material which is insoluble in common solvents, resistant to the action of nitroglycerine and spent acids, sufficiently firm to maintain its shape under normal operation, but yet sufficiently soft that, when struck by a hard member, a film of nitroglycerine thereon does not explode.

The invention also contemplates that the centrifugal be so constructed and arranged that, when its operation is interrupted, the entire contents thereof (including any which may have migrated between parts which are separable in the process of disassembly) will drain to the exterior under the influence of gravity alone.

Referring now to the drawings for an illustrative embodiment of the invention, a vertically extending shaft 1 is connected to a motor 2, or other suitable source of power, and driven in rotation about a vertical axis. The motor 2 and shaft 1 are supported upon a bracket 3, carried by a structural frame 4, so that the entire load of the motor, the shaft, and the parts connected to the lower end of the shaft, is sustained by the bracket 3. Between the motor 2 and the shaft 1, any suitable separable coupling 5 may be provided, and, toward the lower end of the shaft 1, a centering bearing 6 may be provided about the shaft and carried by the structural frame 4. If desired, the bearing 6 may be of a type which will sustain some of the load of the shaft 1 and the parts connected to the bottom thereof. Below the bearing 6, the shaft 1 is connected, through a suitable detachable connection 7, to a shaft 8 which constitutes the shaft of the centrifuge.

The shaft 8 has a bowl 9 mounted on the lower extremity thereof, so as to rotate therewith. To accomplish the connection of the bowl 9 to the lower end of the shaft 8, the latter may have its lower extremity formed with an enlargement 10 and a shoulder 11. The bowl 9 has a central aperture 12 of a size and shape such as to make a press fit with the exterior of the enlargement 10, so that the parts are not only secured together against relative movement, but sealed against the admission of liquids undergoing treatment. The connection between the enlargement 10 and the opening 12 is a permanent one, and may be accomplished in any other suitable way, as by welding the parts 8 and 9 together, or casting them integrally.

The lower end of shaft 8 is provided with a recess 13 coaxial with the axis of rotation of said shaft and having its lower end open, as shown at 14. About the cylindrical wall of recess 13, two series of apertures 15 and 16 extend radially, and communicate with a circumferentially extending groove 17 about the hole 12 of bowl 9. From the groove 17 a series of passageways 18 extend upwardly and outwardly, while another series of passageways 19 extend upwardly, so that the mouths of the latter are radially inward from the mouths of the former.

The liquid to be separated is introduced through a tube 20, which extends from a source located at an elevation in order to provide some hydraulic head upon the liquid at the elevation of opening 14 into recess 13. It will be understood, of course, that the desired pressure on the incoming liquid may be provided by a suitable pump. In order to introduce the incoming liquid to be separated into the bowl 9 where the centrifugal separation takes place, the tube 20 terminates in a nozzle 21

which, as clearly shown in Figure 3, is located in coaxial relation with the bowl 9 and extends upwardly from the bottom, so that the mouth thereof terminates within the mouth 14 of recess 13. Accordingly, the incoming liquid is projected across the space between the stationary nozzle 21 and the moving parts of shaft 8 and bowl 9. In order to avoid the hazard of explosion upon possible mechanical contact between the nozzle 21 and the bounding parts of opening 14 or recess 13, the nozzle 21 is preferably formed of polyethylene.

The bowl 9 is provided with a cover 22 having a separable sleeve 23. Between the cover 22 and the upper rim of bowl 9, a gasket 24, also formed of polyethylene, is provided. The cover 22 is held down in sealing engagement with the gasket 24, and the latter with the upper rim of bowl 9, by a nut 25 threaded upon shaft 8 and applying its force to the upper end of sleeve 23. The sleeve 23 rests upon a dam ring 26, which in turn rests upon the upper end of cover 22, but the sleeve 23 has a skirt portion 27 extending within the central opening of the dam ring 26 and downwardly therebeyond about shaft 8. Where the skirt 27 passes the dam ring 26, a space 28 is left between them to permit the outflow of nitroglycerine over the inner periphery of ring 26.

The lower surface of cover 22 is formed as shown clearest in Figure 2, wherein it will be observed that the cover makes physical engagement with the shaft 8 only at narrow ledges 29. Between the ledges 29, a series of grooves 30 incline upwardly toward the lower end of sleeve 23. In radially outward spaced relation to the mouths of grooves 30, a series of holes 31 extend upwardly through the cover 22, terminating in a recess 32 immediately below dam ring 26. The holes 31 constitute the passageway through which the lighter component of the mixture being separated (i. e., the nitroglycerine in the case of separation of nitroglycerine from spent acid) is discharged from the bowl 9. The lighter component is delivered from recess 32 through space 28, and from above ring 26 to a series of radially extending holes 33 formed in sleeve 23.

The cover 22 is also provided with a series of holes 34, which incline upwardly and inwardly from shoulder 35, which is slightly spaced from the interior wall of bowl 9. The holes 34 terminate at their upper ends within a recess 36, which is provided with a ledge dam 37, and above the latter a series of holes 38 extend radially outward, inclined downwardly outward. The holes 34, recess 36, the space between ledge 37 and skirt 27, and holes 38 constitute the passageway through which the heavier component of the mixture being separated passes to the exterior of the bowl 9.

It will be understood that all of the parts 22, 23, and 26 are mounted on shaft 8 so as to prevent relative movement among them, and so that they rotate together but are nonetheless separable upon releasing nut 25.

The inner periphery of sleeve 23 makes discontinuous engagement with shaft 8, it being observed from Figure 5 that the inner periphery of sleeve 23 is provided with a series of axially extending grooves 39, which extend from the bottom to the top thereof and thus, upon release of nut 25, vent the interior of bowl 9. The sleeve 23, with its grooves 39, extends upwardly along shaft 8 to an elevation above any which may be reached by the liquid undergoing treatment, before the latter is discharged from the apparatus. Consequently, although nitroglycerine may migrate into the grooves 39 as high in the apparatus as the hole 33, there will be no tendency for the nitroglycerine to climb higher. Any nitroglycerine which has migrated into the space between sleeve 23 and shaft 8 will readily drain downwardly out of said space, particularly when nut 25 is released.

The arrangement of the light component passageway (including hole 33, space 28, recess 32 and hole 31) is such that any of that component which may repose in said passageway, upon interruption of the operation of the centrifuge, will readily drain downwardly and back into bowl 9. Likewise, the arrangement of the passageway for the heavier component (consisting of hole 34 and recess 36) will drain backwardly into the bowl 8, upon interruption of its operation. Upon such backward drainage, both components pass downwardly and outwardly from bowl 9 through the holes 18 and 14, into recess 13, from whence they continue to drop away from the moving parts of the apparatus.

A housing 40 embraces the lower portion of bowl 9 and is suitably supported in fixed relation, as by connection to the supporting structure 4 at one side, and by suitable supporting legs 41 at the other side. The housing 40 is substantially spaced in all directions from the bowl 9 in order to prevent the possibility that any whip in the shafts 1 or 8 might be sufficient to permit contact between the bowl (which is supported and guided only from above), and the housing 40. As a further precaution against such impact in the event of mechanical failure, or during assembly and disassembly, the housing 40 is provided about its interior with one or more annular bumper rings 42, formed of polyethylene, and disposed in positions where physical contact between the bowl 9 and the housing 40 is most likely to occur. Alternatively, the interior of housing 40 may be lined with a layer of polyethylene. About the upper rim of housing 40 a further bumper ring 43, likewise formed of polyethylene, is also provided, and disposed so as to extend inwardly between the interior wall of housing 40 and upwardly beyond the upper extremity thereof. The lower end of housing 40 is coned downwardly toward an opening 54, through which nozzle 21 projects. Accordingly, any dripping or outflow from recess 13 is caught by the sloping walls of housing 40 and directed downwardly through opening 54 into a stationary bowl 44, which discharges into drain 45.

About the exterior of housing 40 a launder 46 is mounted. The launder 46 has a floor which inclines toward outlets 47 and 48. The launder encircles housing 40, and is divided by an annular partition 49.

A hood member 50 extends upwardly and inwardly from partition 49, and terminates in spaced relation to cover 22 at an elevation between the mouths of holes 33 and 38. Since the hood member 50 is stationary, an annular space 51 is left between the upper edge of the hood member and the adjacent rotating parts, namely cover 22.

A second hood member 52 is arranged in spaced relation to the hood 50, and extends from the outer wall of launder 46 toward collar 23 above hole 33, and terminating so as to leave an annular space 53 between the upper edge of the hood and the adjacent moving parts. The hood members 50 and 52 are removably connected in any suitable manner so as to be sustained and positioned by launder 46.

In the operation of the device in the separation of nitroglycerine from spent acids, the mixture to be separated is introduced through nozzle 21 under sufficient pressure that it is projected across the space between the stationary nozzle 21 and the moving top of recess 13. When the mixture is thus deposited in the recess 13, the bounding walls of which are rotating at a relatively high speed, the tendency of the incoming mixture is to move radially outward under centrifugal force, and hence it passes through holes 15 and 16, reaching the interior of bowl 9 through either or both of holes 18 and 19. As the bowl becomes filled with liquid, the heavier component thereof moves toward the outer wall of bowl 9, while the lighter component (namely, nitroglycerine) forms in a layer on the inside of the heavier component. The heavier component is bled off through the space between shoulder 35 and the interior wall of the bowl 9, passing through holes 34, recess 36, and outwardly through hole 38, from which it is discharged centrifugally into the space below hood 50, and finally

into that part of the launder **46** which is defined within partition **49**. From the launder, the heavier component, namely the spent acid, is discharged through outlet **48**.

As the bowl **9** becomes sufficiently filled with liquid undergoing separation that the nitroglycerine layer therein extends inwardly to the mouth of hole **31**, it is discharged therethrough, passing upwardly through hole **31**, recess **32** and space **28**, and finally into hole **33**, from whence it is discharged radially outward onto the space between the hoods **50** and **52**, by which the nitroglycerine is guided into that portion of the launder which is outside partition **49**, and discharged therefrom through outlet **47**.

In order to control the rate of discharge of the lighter component, or nitroglycerine, through holes **31**, the size of the central aperture in the dam ring **26** may be varied in order to increase or decrease the space between it and skirt **27**, as desired.

As the bowl **9** may become completely filled, the nitroglycerine, being the lighter component, may under such circumstances tend to creep up through grooves **30** along shaft **8**, but as above indicated, such creepage will not exceed the elevation of hole **33**. Immediately as operation of the device is interrupted, the nitroglycerine which has crept along shaft **8** will drain backwardly into bowl **9**, so that by the time one is enabled to loosen the nut **25** as a condition precedent to relative movement between sleeve **23** and shaft **8**, the nitroglycerine will have drained from the interspace.

When it is desired to disassemble the apparatus, the couplings **5** and **7** are released, so that shaft **1** and bearing **6** may be moved aside. The hoods **50** and **52** may then be lifted off over the upper end of shaft **8**. Nut **25** is then unscrewed, so that collar **23** and cover **22** may be lifted from the top of bowl **9**. Shaft **8**, with its permanently connected bowl **9**, is then free to be lifted upwardly from within housing **40**. During the preliminary operations of releasing shaft **1** and removing the hoods **50** and **52**, all nitroglycerine will have had sufficient time to drain from the interior of bowl **9** and from between the several parts which are moved relatively during disassembly, so as to eliminate all hazard in the disassembling operation. In the removal of the bowl **9** from within housing **40**, the bumper block **43** is disposed to prevent engagement between the metallic surfaces of the bowl and the housing, which might, because of an adhered film of nitroglycerine, create an explosion.

Whenever rotation of the bowl **9** is interrupted, the entire contents thereof and of the housing **40** drain downwardly into stationary bowl **44**, and are discharged therefrom.

From the foregoing description those skilled in the art should readily understand that the invention accomplishes its objects, and provides a safe and efficient centrifugal for use in the separation of explosive mixtures. While a complete disclosure of one embodiment has been given in some detail, those skilled in the art will readily appreciate that many modifications and variations can be made in the device as disclosed without departing from the spirit of this invention, and consequently the same are contemplated by and within the scope of the appended claims.

Having thus described the indention, what is claimed and desired to be secured by Letters Patent is:

1. A centrifuge for separating an explosive liquid component from a mixture, comprising a vertically extending drive shaft, a bowl mounted on and concentrically around said drive shaft, said drive shaft extending through the bowl and being connected to the bottom of the bowl, said bowl being supported solely by said drive shaft, an open inverted cup in the center of the bottom of said bowl, said cup having radially outwardly and upwardly extending passages communicating with the interior of said bowl at its lowermost area, said passages thus being disposed to drain the bowl into the cup by gravity, and a stationary liquid inlet, spaced from contact with said bowl and said shaft, arranged to project a mixture to be separated upwardly into the cup.

2. A centrifuge of the character described in claim 1 wherein the bowl is provided with a cover having radially spaced discharge openings all disposed to drain under gravity toward the interior of the bowl, whereby liquid in said discharge openings drains to the interior of the bowl.

3. A centrifuge of the character described in claim 2 wherein the cover is provided with a sleeve embracing the shaft and extending vertically above the upper terminus of the discharge openings, said sleeve having discontinuous engagement with the shaft to provide a vertical vent therebetween, said vent communicating with the interior of said bowl.

4. A centrifuge of the character described in claim 1 wherein the liquid inlet takes the form of a nozzle formed of polyethylene, extending axially within the cup in the bowl but in spaced relationship thereto.

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