April 16, 1935. R. COWAN 1,998,359

METHOD AND MEANS FOR CENTRIFUGAL SEPARATION

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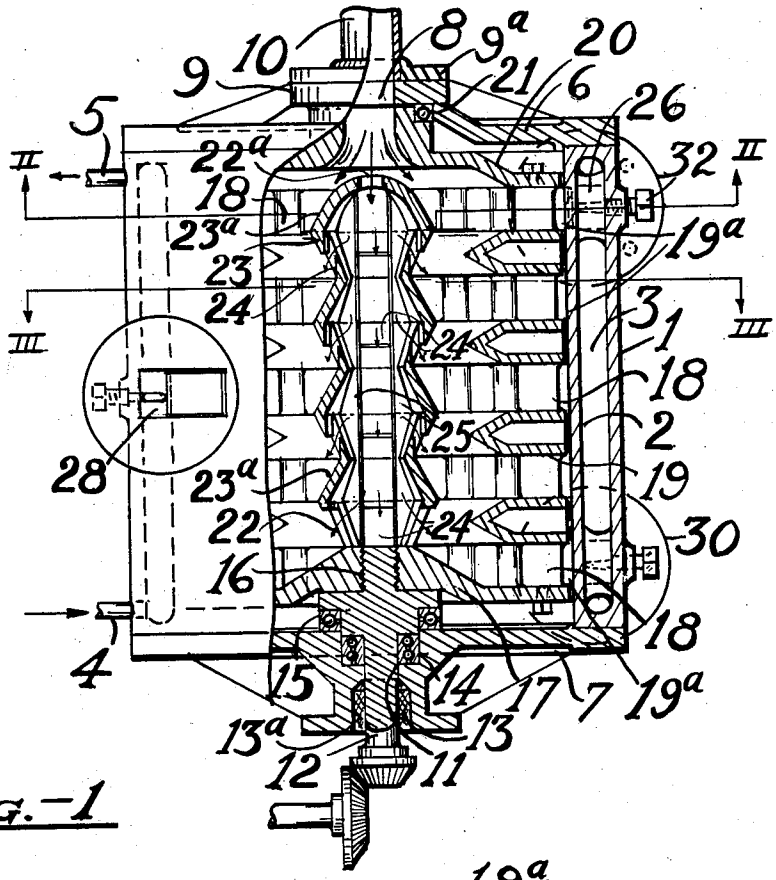

FIG.—1

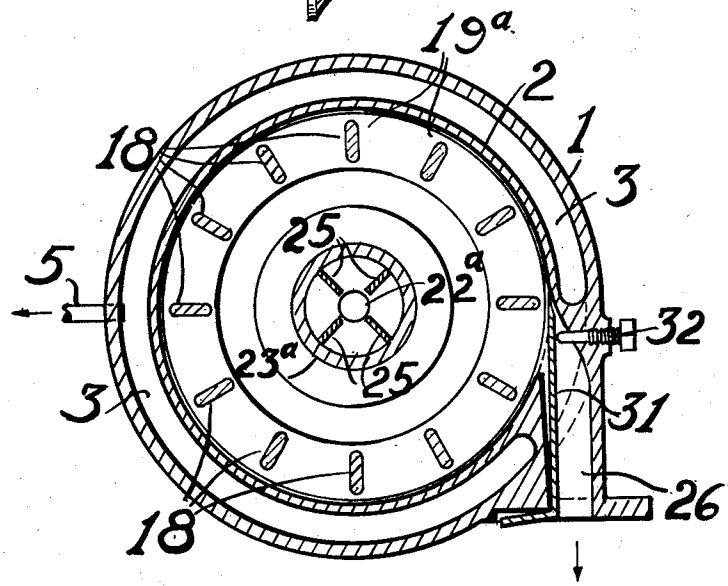

FIG.—2

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METHOD AND MEANS FOR CENTRIFUGAL SEPARATION

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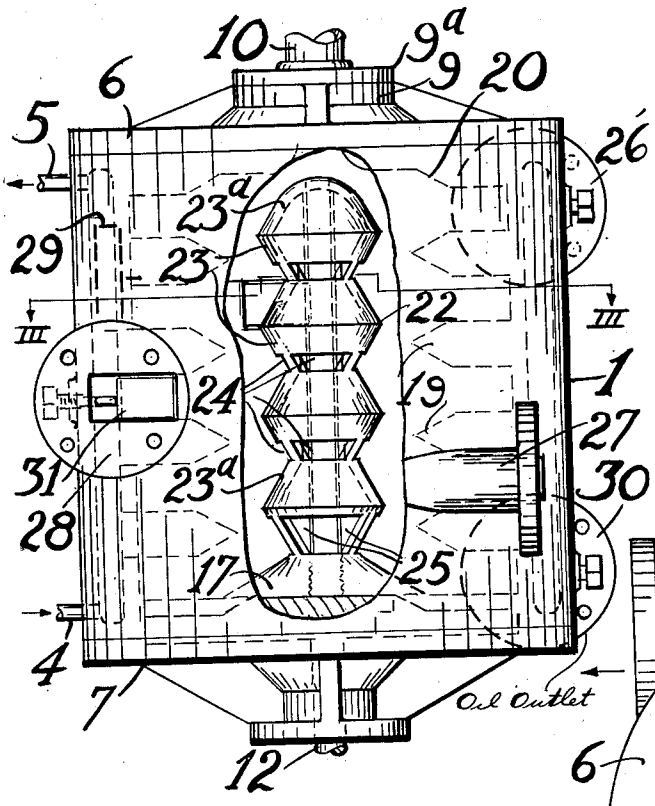

FIG.—4

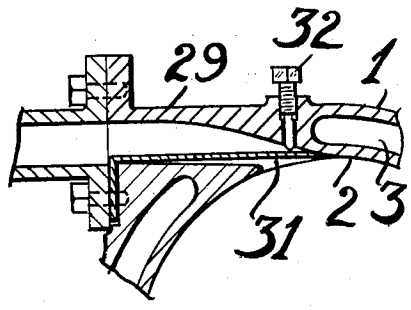

FIG.—6

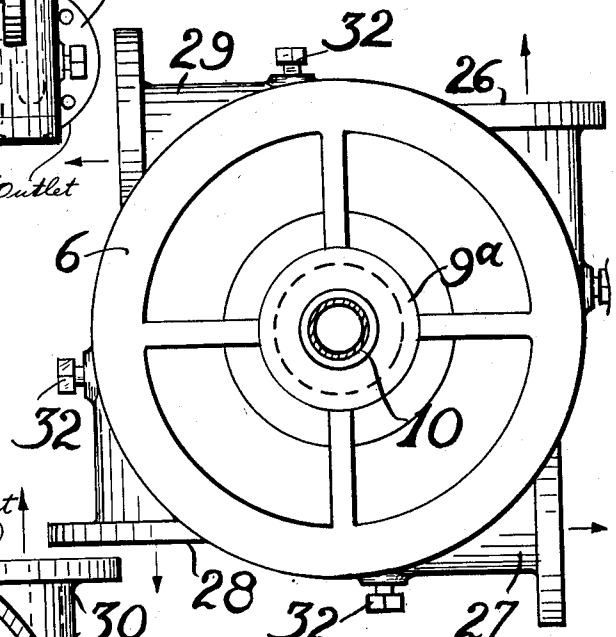

FIG.—5

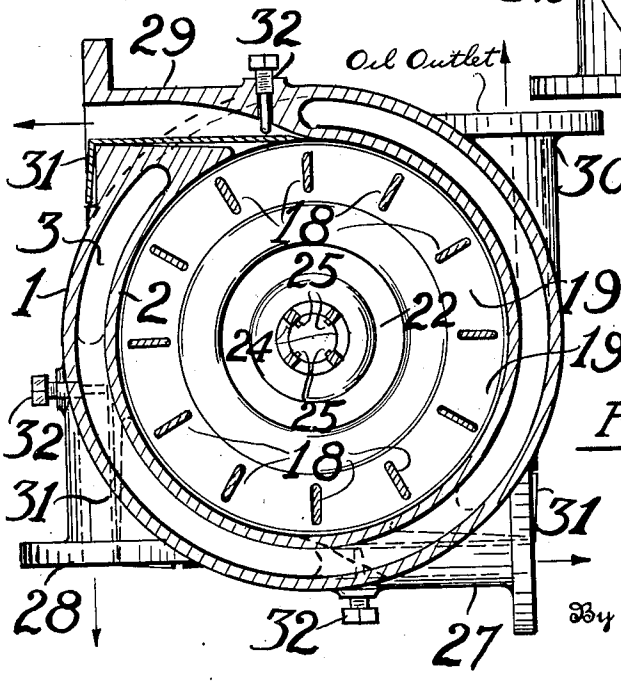

FIG.—3

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METHOD AND MEANS FOR CENTRIFUGAL SEPARATION

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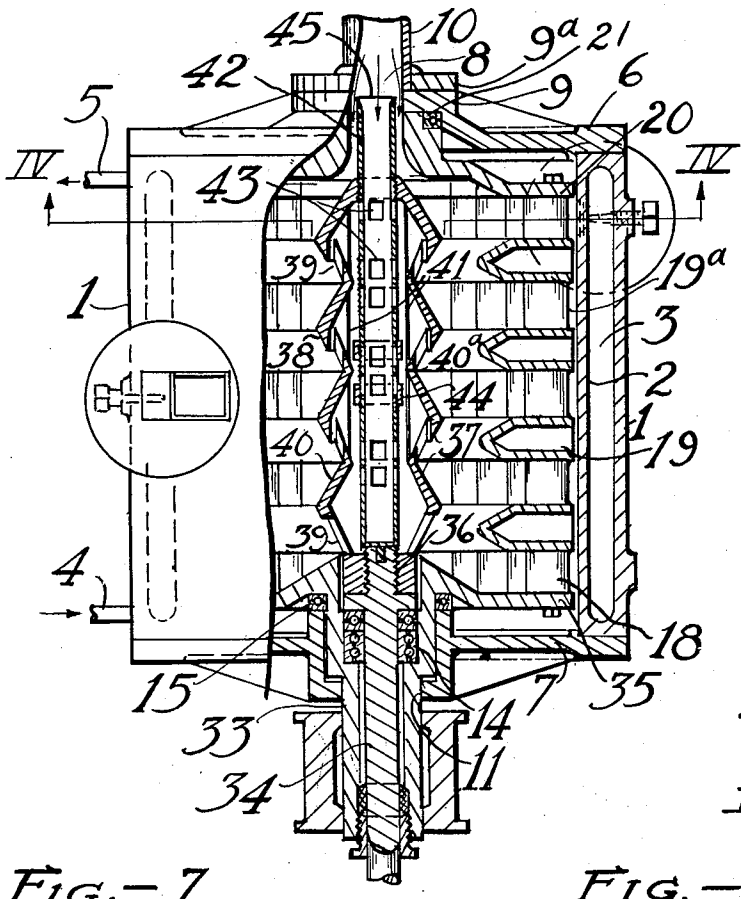

FIG.—7

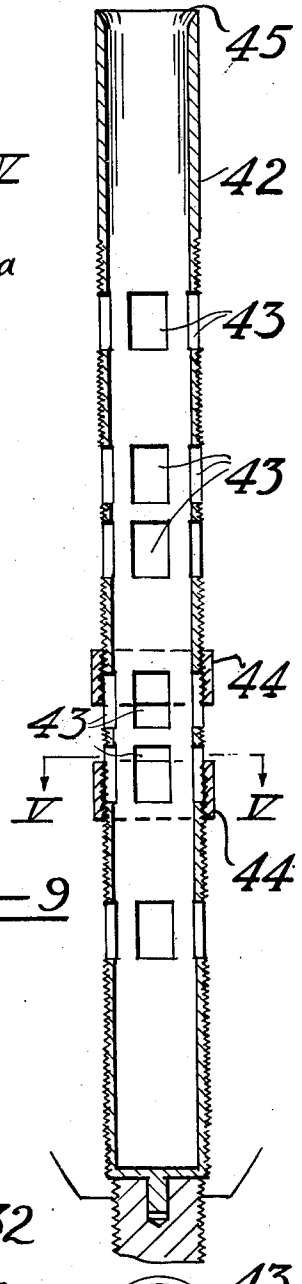

FIG.—9

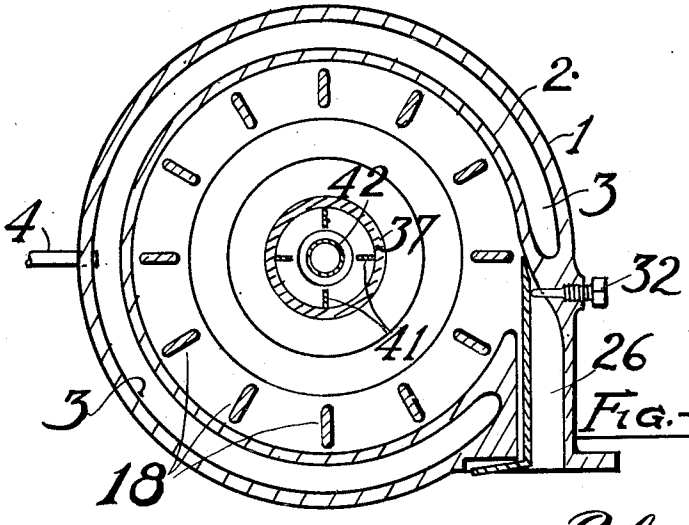

FIG.—8

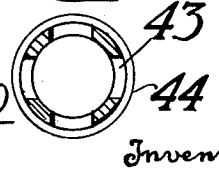

FIG.—10

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Patented Apr. 16, 1935

1,998,359

UNITED STATES PATENT OFFICE

1,998,359

METHOD AND MEANS FOR CENTRIFUGAL SEPARATION

Robert Cowan, Sarnia, Ontario, Canada, assignor to Standard Oil Development Company

Application December 26, 1931, Serial No. 583,331

8 Claims. (Cl. 210—51)

The present invention relates to the art of removing solids from liquids by centrifugation, for example wax from hydrocarbon oils, and more particularly to removing wax from wax-containing viscous fractions derived by distillation of petroleum oil under non-cracking conditions, particularly with fire and steam or with vacuum. A particular object of the invention is to provide a pressure-feed multi-stage centrifugal mechanism which will separate from oil not only its crystalline wax content but a portion at least of its amorphous wax. It will be understood, however, that the description of the use of the machine in connection with petroleum oil is illustrative only, and that various other uses are desirable.

The invention will be fully understood from the following description, illustrated by the accompanying drawings in which:

Fig. 1 is a side elevation and sectional view of a centrifuge suitable for carrying out the invention;

Fig. 2 is a transverse sectional view on the line II—II, Fig. 1;

Fig. 3 is a transverse sectional view on the line III—III, Fig. 1;

Fig. 4 is another side elevation and sectional view of the centrifuge;

Fig. 5 is a top view of the centrifuge;

Fig. 6 is a sectional view of an outlet of the centrifuge;

Fig. 7 is a side elevation and sectional view of a modified form of the centrifuge;

Fig. 8 is a transverse sectional view on the line IV—IV, Fig. 7;

Fig. 9 is a side elevation and sectional view of a distributing tube in the centrifuge of Fig. 7; and

Fig. 10 is a transverse sectional view on the line V—V, Fig. 9.

Referring to the drawings, the numeral 1 indicates the outer shell of a cylindrical centrifuge made according to this invention. Secured to the outer shell and preferably cast integrally with it, is an inner shell 2. An annular space 3, closed at both ends, is thus provided between the walls 1 and 2 and the assembly forms the stator of the machine. An inlet 4 and outlet 5 are provided for passing a cooling medium, such as cold brine, through the annular space 3. The centrifuge is provided with a top cover 6 and a bottom cover 7, which are securely bolted to the cylindrical walls 1 and 2. The top cover 6 has a central opening 8 with flange connections 9 for matching with the flange 9a of the pipe 10 through which the liquid to be centrifuged is introduced. The bottom cover 7 has a central opening 11 through which a shaft 12 passes. Opening 11 is provided with a recess 13 to receive packing 13a for the shaft 12 where it passes through the bottom cover 7. This bottom cover 7 is provided with a heavy radial ball bearing 14 and the inside of the bottom cover 7 is faced to take ball thrust bearing 15.

The shaft 12 has a threaded projection 16. A disc 17 which extends to the inner wall 2 is threaded on shaft 12 on the threaded projection 16 and is so arranged that the pressure from the rotation of the disc 17 will prevent the shaft from unthreading. Disc 17 is bolted to space supports 18, of which there is a series as shown in Fig. 2. Circular hollow ring 19, fitted adjacent to the inner lining of inner shell 2, of uniform thickness for a short distance from the inner lining and tapered to a point toward the inner diameter of the centrifuge, is joined to the space supports 18. Alternate series of similar space supports and hollow rings are joined together extending to a disc 20 which is in the upper part of the centrifuge.

The disc 20 is open in the center and at the point of contact of disc 20 and the top 6 is a recess to take a radial ball bearing 21. Attached to the bottom disc 17 in the center of the centrifuge is a conduit or pipe 22 of irregular or serrated contour extending upwards to a point adjacent to the entrance of inlet pipe 10 in the upper part of the centrifuge. Pipe 22 preferably consists as shown of an alternate series of hollow upright and inverted frustums of cones. The inverted frustums of cones 23 have openings 24 on the sides and the upright hollow frustums of cones 23a are closed on the sides. The hollow frustums of cones are so arranged that the narrow ends of an upright and of an inverted frustum are joined together and the next joint consists of the enlarged ends of an upright and inverted frustum. In other words, the pipe 22 is so shaped that the diameter of the walls alternately increases and decreases. Pipe 22 has an opening 22a at the top.

It will be seen that the rotor of the machine is formed of two parts, what may be called an inner rotor formed of the serrated pipe 22, and what may be called an outer rotor formed of the hollow rings 19 and their connections. The inner and outer rotors are joined by disc 17.

Four bars 25 are inside pipe 22, equally spaced around the narrowest part of the pipe and extend the length of the pipe. Pipes 26 to 30 pass through the outer and inner shells 1 and 2 and also through the annular space 3. These pipes 26 to 30 open into the inner part of the centrifuge at the space formed by space supports 18 between

the hollow circular rings 19 and between the hollow circular rings 19 and disc 17 and 20. The openings to the pipes 26 to 29 from the spaces formed by the space supports in the centrifuge are fitted with knife valves 31 controlled by screws 32. The opening to pipe 30 from the part of the centrifuge most remote from the inlet, at the space between the disc 17 and the adjacent hollow ring, is controlled by a spring relief valve set to operate at a predetermined pressure. The spring relief valve may be regulated by a screw similar to screws 32.

The knife valves 31 are made of spring steel. The cutting edge is tensioned against the inner face of wall 2 by having the angle formed by the back of the knife made at a greater angle than 90°, so that when a flanged connection is bolted to the outlet port, the flange will press on the part of the knife that projects at the flange of outlet pipes 26 to 29 and will press the knife edge hard up against the valve face at the opening through wall 2, thereby stiffening the knife against the possibility of opening out through the pressure of wax driven through the valve opening. (See Fig. 6.)

Referring to Fig. 7, a modified centrifuge is shown. The bottom cover 7 has a central opening 11 through which two shafts 33 and 34 pass, shaft 33 being hollow and shaft 34 passing through the central hollow space. The shafts 33 and 34 are adapted to revolve at different speeds by suitable power means, (not shown). This bottom cover 7 is provided with a heavy radial ball bearing 14 and the inside of the bottom cover 7 is faced to take ball thrust bearing 15.

The hollow shaft 33 extending through opening 11 in bottom cover 7 is secured to disc 35 which extends to the inner wall 2. Disc 35 is bolted to space supports 18, of which there is a series as shown in Fig. 8. Circular hollow ring 19, fitted adjacent to the inner lining of the inner shell 2, of uniform thickness for a short distance from the inner lining and tapered toward the inner diameter of the centrifuge, is joined to the space supports 18. Alternate series of similar space supports and hollow rings are joined together extending to a disc 20 which is in the upper part of the centrifuge.

The disc 20 is open in the center and at the point of contact of disc 20 and the top 6 is a recess to take a radial ball bearing 21. An inner shaft 34, extending through the hollow shaft 33, has a threaded projection 36. Attached to the threaded projection 36 is a conduit or pipe 37 of irregular or serrated contour extending upwards to a point adjacent to the entrance of inlet pipe 10 in the upper part of the centrifuge. Pipe 37 preferably consists as shown of an alternate series of hollow upright and inverted frustums of cones. The inverted frustums of cones 38 have openings 39 on the sides and the upright hollow frustums of cones 40 are closed on the sides. The hollow frustums of cones are so arranged that the narrow ends of an upright and of an inverted frustum are joined together forming joint 40a and the next joint consists of the enlarged ends of an upright and inverted frustum. In other words, the pipe 37 is so shaped that the diameter of the walls alternately increases and decreases.

Four bars 41 are inside pipe 37, equally spaced around the narrowest part of the pipe and extend from the first narrowing portion of the pipe above the bottom to the upper portion of pipe 37. A pipe 42 attached to inner shaft 34 extends through pipe 37 to the opening 8 in the top of the centrifuge. Pipe 42 is attached to the top of pipe 37 closing the top opening of pipe 37. Pipe 42 is fitted with an opening 45 at the top and ports or openings 43 on the sides at the narrowest points of pipe 37 and the openings 43 are fitted with couplings 44 adapted to regulate the size of the openings.

Outlet pipes 26 to 30 passing through the outer and inner shells 1 and 2 and also through the annular space 3 as shown by Figs. 3 and 5 are provided in this modified centrifuge. The openings of the spaces 19a formed by the space supports into the outlet pipes 26 to 30 are controlled by suitable valves as described in relation to Figs. 1 and 4.

The following is an illustration of the manner in which my invention may be applied to the dewaxing of paraffin distillate, without in any way limiting the scope of such invention to specific details.

According to the centrifuge shown in Fig. 1; the chilled paraffin distillate, either as such or diluted with naphtha, is delivered under pressure through pipe 10 to the opening 8 into the centrifuge, where shaft 12 rotates the discs 17 and 20, circular hollow rings 19 and pipe 22 at about 3000 to 15,000 revolutions per minute. The chilled paraffin distillate entering the centrifuge, which is maintained at a low temperature by circulating brine through opening 3 by means of inlet 4 and outlet 5, is divided into two streams, one stream passing to the outside of pipe 22 and the other stream passing through the opening 22a in the top of pipe 22. The heavier wax particles in the stream passing to the outside of pipe 22, which is revolving rapidly, are driven due to centrifugal force into the spaces between the first disc 20 and the first circular hollow ring 19, where the wax builds up and forms into a solid mass extending from the tapered end of the hollow ring to the inner wall 2.

The wax of lower specific gravity than the distillate is also forced into this mass, as the fresh feed containing the heavier wax particles will be driven through the liquid mass at higher velocity than the lighter wax particles and in so doing these heavier velocity particles of wax pick up the lighter particles of wax and carry them at an increased velocity owing to the additional weight, into the spaced openings, with the result that there is found in this mass a higher percentage of low specific gravity wax than of oil.

The fraction of distillate passing into pipe 22 is subjected to centrifugal force and the wax particles are thrown against the walls of the pipe. The bars 25 inside of pipe 22 tend to break up any independent circular motion of separated wax in pipe 22. The particles of wax thrown on the walls pass along the wall due to the shape of the pipe and through the openings 24 in the wall of the pipe. The wax particles passing through the openings 24 are thrown through the distillate being constantly fed into the centrifuge and the partly dewaxed distillate on the outside of pipe 22, where due to the high velocity of heavy wax particles the lighter gravity wax particles are forced in the spaced openings between the hollow circular rings 19. The paraffin distillate passing both on the outside and inside of pipe 22 is progressively dewaxed in a number of stages so that by the time the oil reaches the bottom of pipe 22 it is substantially free of wax and is removed from the centrifuge through pipe 30 controlled by the spring relief valve. The stages

are represented by the alternate increase and decrease of diameter in pipe 22. This configuration may be made to give any number of stages desired.

The oil flowing past the peak of each cone 23a reaches a zone of lower pressure, namely, the down slope of cone 23. There it encounters the high velocity stream of oil leaving openings 24 which sweeps it up the rising slope of the next cone 23a for a further subjection to the maximum centrifugal effect. The heavy particles in the stream from openings 24 tend to collect the lighter amorphous wax from the oil and project such wax into the collecting areas 19a.

The wax separated from the oil by centrifugal force and pressed against the inner wall 2 of the centrifuge is continuously removed by opening the knife valves 31 by regulating screws 32. The knife valves 31 are forced towards the revolving masses of wax in the spaced openings and the knife blade of the valve cuts into the revolving wax and continuously removes sections of the wax which is passed through pipes 26 to 29 to a wax sweater or other suitable treater.

In the use of the modified centrifuge shown in Fig. 7, the chilled paraffin distillate, either as such or diluted with naphtha, is delivered under pressure through pipe 10 to the opening 8 into the centrifuge, where shaft 33 rotates the discs 35 and 20 and circular hollow rings 19 at about 3000 to 5000 revolutions per minute and the shaft 34 rotates pipes 37 and 42 at about 10,000 to 15,000 revolutions per minute. The chilled paraffin distillate entering the centrifuge, which is maintained at a low temperature by circulating brine through opening 3 by means of inlet 4 and outlet 5, is divided into two streams, one stream passing to the outside of pipe 42 and the other stream passing through the opening 45 in the top of pipe 42. The heavier wax particles in the stream passing to the outside of pipe 42, which is revolved rapidly, are driven due to centrifugal force into the spaces between the first disc 20 and the first circular hollow ring 19, where the wax builds up and forms into a solid mass extending from the tapered end of the hollow ring to the inner wall 2.

The fraction of distillate passing into the pipe 42 is subjected to a greater centrifugal force than the fraction passing to the outside of pipe 42 due to the higher speed at which pipes 37 and 42 are operated. The distillate passing through the inner rotating pipe 42 is further divided into fractions. As the distillate passes through pipe 42, fractions are gradually passed from the pipe through adjustable openings 43 into the pipe 37 and the wax particles are thrown against the walls of pipe 37. The bars 41 inside of pipe 37 tend to break up any independent circular motion of separated wax in pipe 37. The particles of wax thrown on the walls pass along the wall due to the shape of the pipe and through the openings 39 in the walls of the pipe. The wax particles passing through the opening 39 are thrown through the distillate, being constantly fed into the outer part of the centrifuge and the partly dewaxed distillate on the outside of pipe 37, where due to the high velocity of heavy wax particles the lighter gravity wax particles are forced into the spaced openings 19a between the hollow rings 19. The paraffin oil passing both on the outside and inside of pipe 37 is progressively dewaxed in a number of stages so that by the time the oil reaches the bottom of pipe 37 it is substantially free of wax and is removed from the centrifuge through pipe 30 regulated by a spring relief valve. The stages are represented by the alternate increase and decrease of diameter in pipe 37. This configuration may be made to give any number of stages desired.

The oil flowing past the peak of each cone 40a reaches a zone of lower pressure, namely, the down slope of cone 40. There it encounters the high velocity stream of oil leaving openings 39 which sweeps it up the rising slope of the next cone 38 for a further subjection to the maximum centrifugal effect with further addition of distillate from pipe 42 through the openings 43. The heavy particles in the stream from openings 39 tend to collect the lighter amorphous wax from the oil and project such wax into the collecting areas 19a.

The wax separated from the oil by centrifugal force and pressed against the inner wall 2 of the centrifuge is continuously removed by means of outlet 26 to 29. The oil substantially free of wax is removed by means of outlet 30.

The centrifuge operates in an enclosed circuit under pressure and is vapor tight. Therefore, it is free from fire and explosion hazards and also cannot overflow.

The foregoing description is merely illustrative and various changes and alternative arrangements may be made within the scope of the appended claims in which it is my intention to claim all novelty inherent in the invention as broadly as the prior art permits.

I claim:

1. The method of centrifuging a liquid containing suspended solids, which comprises dividing a flowing liquid into a main body and a minor body of liquid, subjecting the main body of flowing liquid to a centrifugal force, flowing the minor body of liquid forward over a series of serrations while subjecting it likewise to centrifugal force, continuously injecting in an outward direction separate portions thereof into the main body of flowing liquid through a series of openings at points spaced in relation to the innermost and outermost portions of the series of serrations and collecting the solids separated by the combined action of centrifugal force and the injected liquid.

2. The method of separating wax from lubricating oil, comprising the continuous separation of the oil into two parts, continuously subjecting both parts separately to centrifugal force, continuously concentrating the wax resulting from the centrifuging of one part of the oil, continuously passing the wax resulting from the centrifuging of the other part of the oil through the separated oil to the said concentrated wax and continuously removing the separated wax and oil.

3. The method of separating wax from lubricating oil, comprising chilling the oil, separating the oil into two parts, centrifuging the separate parts of the oil, concentrating by centrifugal force the wax resulting from the separation of wax from one part of the oil, passing by centrifugal force the wax separated from the other part of the oil through the separated oil to the said concentrated wax and separately removing the wax and the oil.

4. The method of separating wax from lubricating oil, comprising the dilution of the oil, chilling of the diluted oil, separating the oil into two parts, centrifuging the separated parts of the oil, collecting the wax separated from one part, passing the wax separated from the other part through the separated oil of the first part to the said

collected wax, and separately removing the wax and oil.

5. The method of separating wax from lubricating oil, comprising the continuous separation of the oil into two parts, continuously subjecting both parts separately to centrifugal force, the centrifugal force exerted on one part being greater than the force exerted on the other part, continuously concentrating the wax resulting from the centrifuging of one part of the oil with the lesser centrifugal force, continuously passing the wax resulting from the centrifuging with greater centrifugal force of the other part of the oil through the separated oil to the said concentrated wax and continuously removing the separated wax and oil.

6. The method of separating wax from lubricating oil, comprising chilling the oil, separating the oil into two parts, centrifuging the separated parts of the oil with centrifugal forces of different degrees, concentrating by centrifugal force of lesser degree the wax resulting from the separation from one part of the oil, passing by centrifugal force of greater degree the wax separated from the other part of the oil through the separated oil to the said concentrated wax and separately removing the wax and the oil.

7. Apparatus for separating wax from lubricating oil, comprising a centrifuge, means for separating the oil into two parts, means for subjecting both parts to centrifugal force of different degrees in a centrifuge, means for collecting the wax separated first from one part of the oil with the centrifugal force of lesser degree, and then from the other part of the oil after the oil has passed through the separated oil of the first part, and means for separately removing the wax and oil.

8. Apparatus for separating wax from petroleum oil, comprising a casing, a two-part centrifugal mechanism therein, one of said parts comprising a serrated central conduit having perforations therein, the other of said parts comprising a shell surrounding said conduit and having wax-collecting chambers therein, means for simultaneously rotating the two parts of the centrifugal mechanism, means for supplying oil containing wax and for distributing the same into both parts of the centrifugal mechanism, and means for rotating the same at high speed whereby the liquid in the serrated conduit is projected through the openings therein and the wax content of such liquid passes with that of the liquid surrounding the conduit into the wax-collecting chambers.

ROBERT COWAN.