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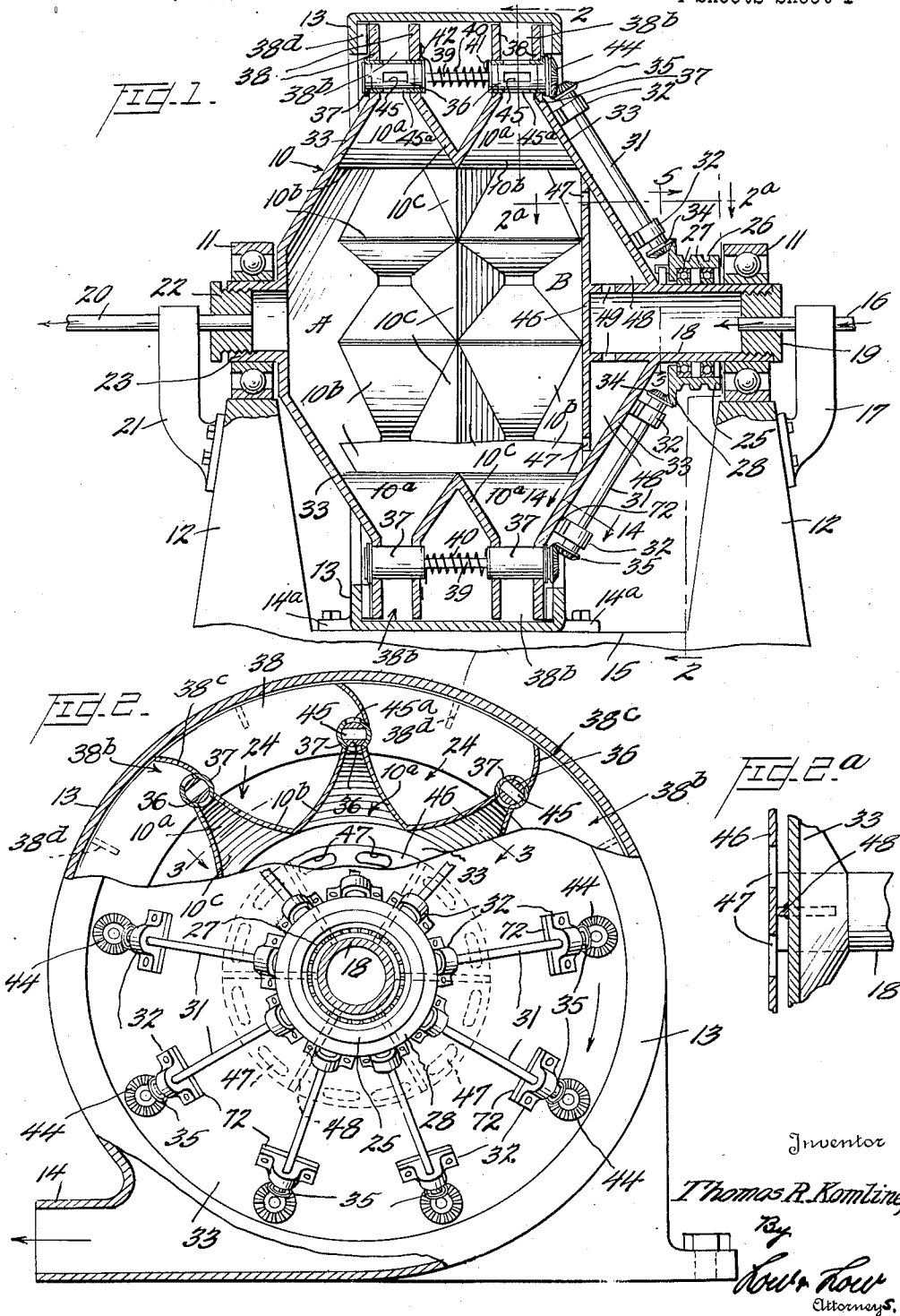
T. R. KOMLINE

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CENTRIFUGE

Filed Dec. 13, 1945

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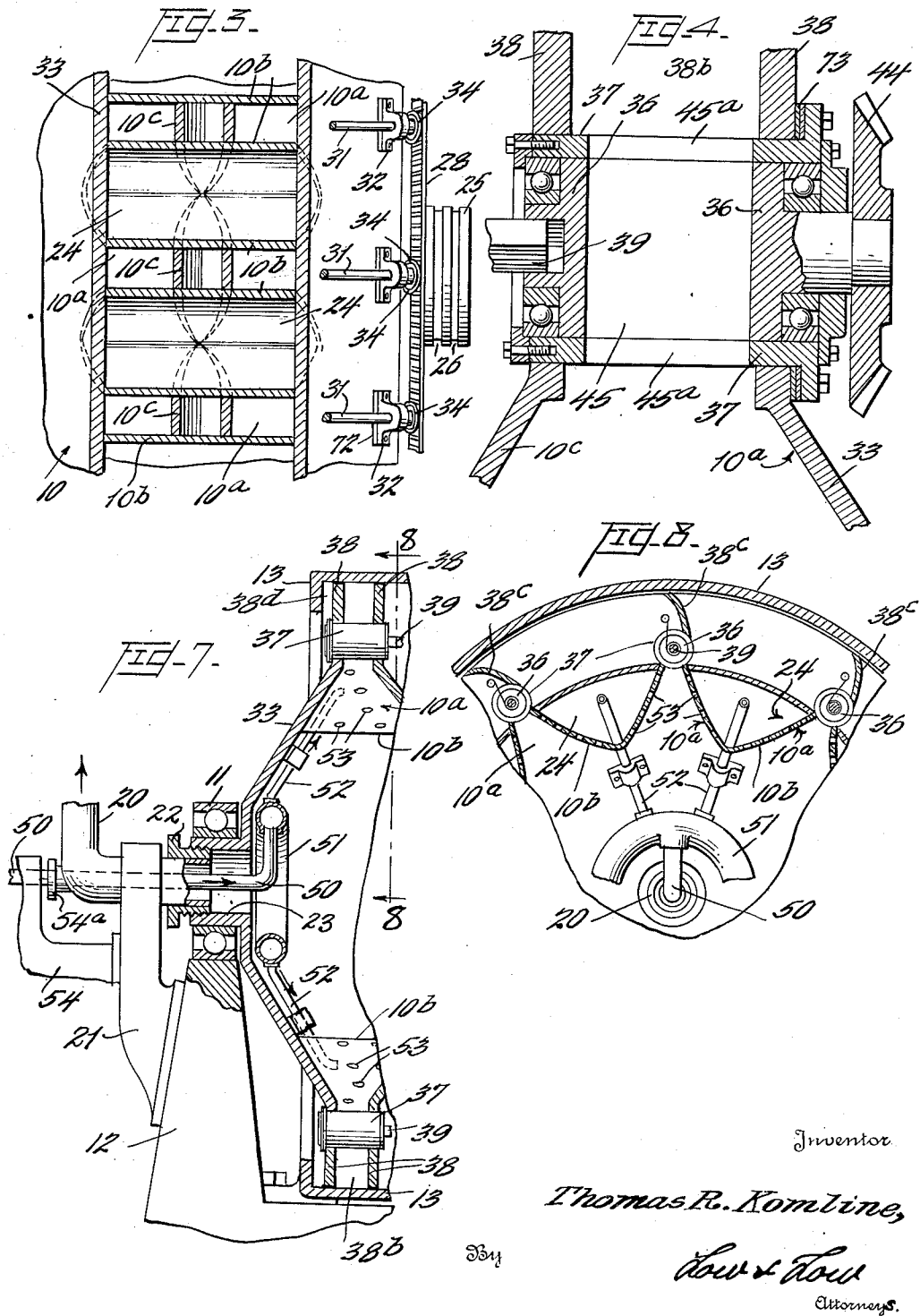
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T. R. KOMLINE
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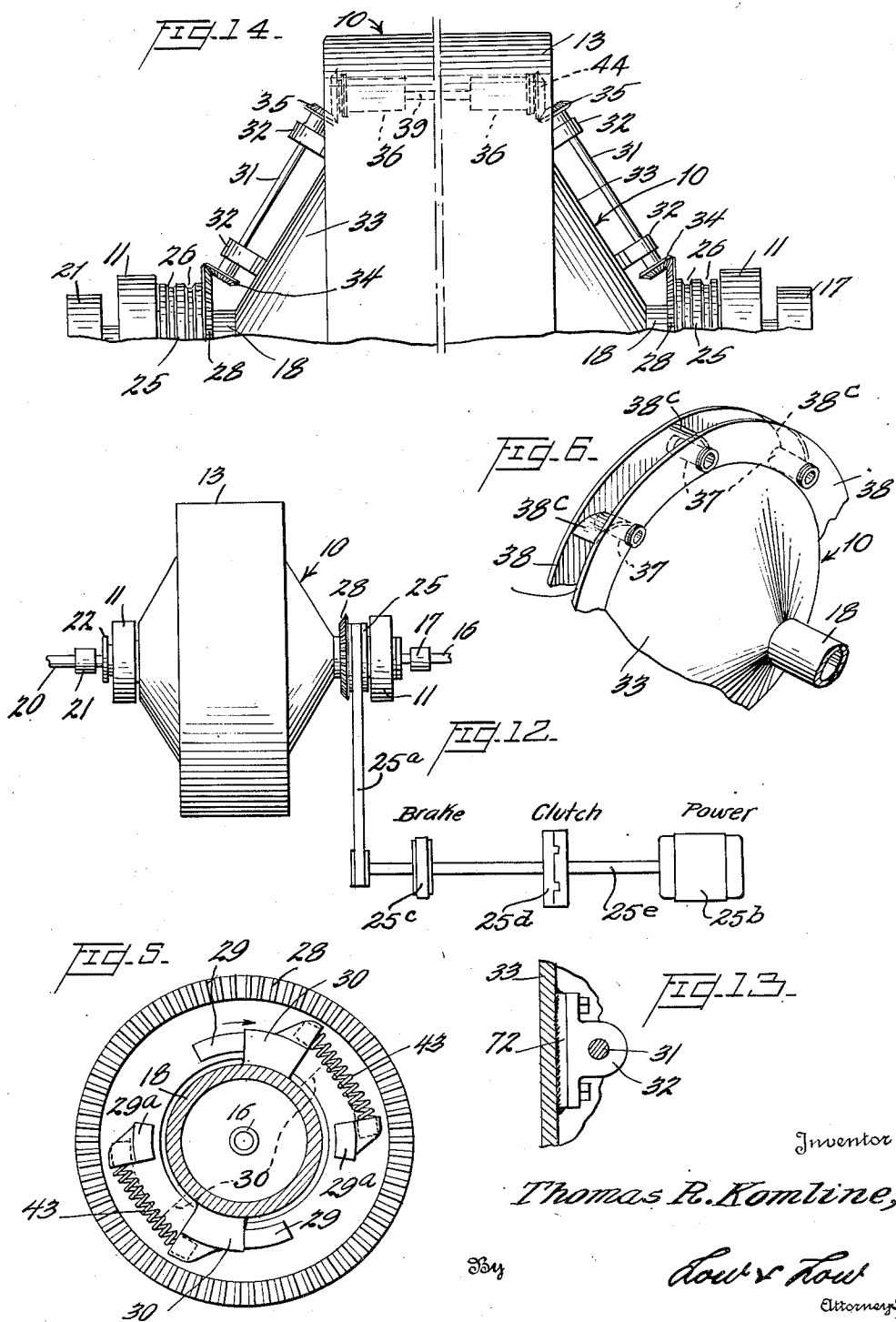
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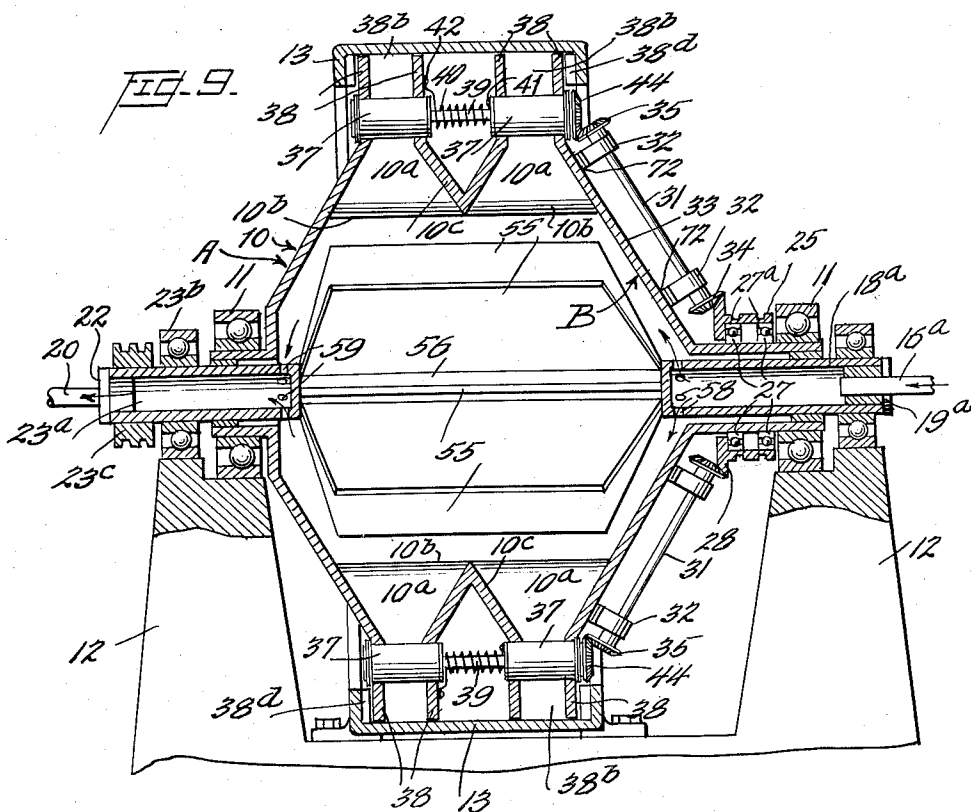
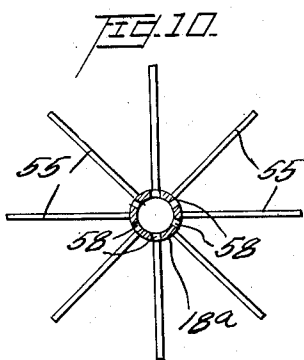
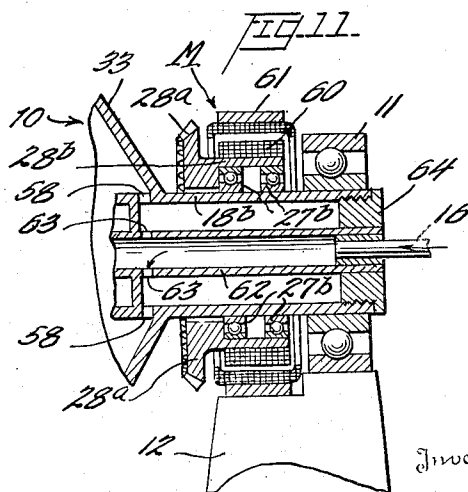
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CENTRIFUGE

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,538,529

CENTRIFUGE

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6 Claims. (Cl. 233—20)

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The invention relates to centrifuge machines and has for its objects to provide certain new and useful improvements in centrifuges of the self-unloading type.

An important object of the invention is to provide a centrifuge machine wherein the peripheral contents of the rotating drum may be periodically unloaded and discharged from the machine when desired without necessitating stoppage of the machine or in other respects curtailing the continuous operation thereof.

A further object is to provide an improved centrifuge machine of increased capacity wherein the output of the machine is substantially doubled or multiplied within approximately the same amount of floor space ordinarily occupied by present machines of materially less capacity and output.

The machine is particularly designed for separating the heavier and lighter constituents of sewage sludge, paper pulp, pulp resulting from juicing citrus fruits, and clarification of sugar beet or sugar cane juice after crushing. The machine however is equally adaptable for separating, classifying or clarifying other variable types of chemical sludges and slurries, and for similar equivalent usage.

The present known types of machines for accomplishing the above desired results usually consist of vacuum filters or presses which are comparatively cumbersome, slow of operation, as well as expensive both as to initial capital outlay and in maintenance, or in centrifugal separators which may be generally characterized as "batch" machines, which must be slowed down or stopped for periodic discharge of the heavier constituents, with incident objectionable and expensive delay.

The instant invention comprises a centrifuge machine capable of normal operation at a drum speed of approximately 1,000 R. P. M. for continuous operation with attendant automatic valve control mechanism for periodic discharge of the heavier material thrown off to the periphery of the drum whenever desired and without interference with the feed of the original materials to the machine, contamination of the clarified effluent, or for selective classifying discharge of the separated materials therefrom.

A further important object of the invention is to control and operate the discharge valves by the utilization of energy stored up within the rotating drum during normal operation of the machine for any of the intended purposes for which the same is designed.

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Another object is to provide a simplified drive for the centrifuge, in which the rotor and stator elements of an electric motor are made integral with other parts of the machine.

A still further object is to provide a machine in which a countercurrent liquid or water wash is or may be employed to recover valuable constituents of the liquid which may be entrained in the heavier portions of the materials being treated and which have accumulated in the drum hoppers, and aid in the discharge of the thickened slurries when their consistency is such as to warrant the use of such liquid wash.

Another object is to effectively seal the machine by means of fluid pressure against undesired leakage or escape of the materials.

The improved machine further contemplates a centrifuge consisting of a vaned rotor within a housing, which latter may be stationary or rotatable, or, if desired, relatively rotatable to the rotor. With the vaned rotor multiplying the centrifugal forces evolved, the drum may be rotated at a considerably lower and safer speed.

Regardless of whether the machine is operated at high or low speeds, depending on the character of the materials being treated, the instant centrifuge is designed for more perfect balance with consequent absence of vibration and attendant objectionable wear and loosening of the parts, combined with considerations for ease of fabrication.

In the operation of the machine, the materials to be treated or separated into their heavier and lighter components are continuously introduced into the revolving drum in an axial direction with respect thereto, and the lighter or thinner liquids, or effluent, from which the heavier constituents have been separated by centrifugal force, are continuously discharged axially of the machine to a suitable place of deposit. The heavier separated components are flung radially into tapered collecting hoppers peripherally arranged in the drum, and removed therefrom with a minimum of effluent contamination by actuation of valves set in annular discharge flanges which are a vertical continuation of the conical portions of the drum, and thence discharged from the machine with the aid of impellers set in the discharge flanges. The hopper plates, discharge flanges and impellers are designed to provide an especially rigid assembly which is capable of withstanding high stresses and strains during rotation of the drum, as well as effectively resulting in efficient performance of the machine for its intended purpose. When the character of materials oper-

ated upon requires a longer time for separation, or when there is a large amount of solids to be separated, the present machine is capable of storing and discharging a relatively large volume of such solids within a minimum of drum space. This is particularly true when a plurality of adjacent rows of peripherally spaced hoppers are present in the drum or drum sections. When a plurality of hoppers are employed the machine is capable of further separating or classifying the heavier constituents into their own heavier and lighter components, the heavier particles being deposited in the row of hoppers nearest to the inlet side of the machine.

In many operations it is desirable to introduce a countercurrent liquid or water wash through the thickened material accumulating in the hoppers. For example in the sugar industry when clarifying cane juice, it is highly desirable to recover all of the syrup, and therefore the solids collecting in the hoppers should be elutriated. This countercurrent wash may consist of water or a suitable solvent, and appropriately arranged pipes are provided leading to each of the circumferentially arranged drum hoppers, or the cellular space between each hopper from which it is introduced to the hopper. This results in the water or solvent passing out of the machine together with clarified effluent through a suitable axially disposed pipe or discharge means.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Fig. 1 is a longitudinal vertical sectional view through a centrifuge machine constituting a preferred embodiment of the invention.

Fig. 2 is a transverse vertical section taken on line 2—2 of Fig. 1.

Fig. 2a is a detail sectional view on line 2a—2a of Fig. 1.

Fig. 3 is a detail horizontal sectional view taken on line 3—3 of Fig. 2 and showing what may be termed a plan development of this portion of the drum.

Fig. 4 is an enlarged vertical section through a portion of the drum at the upper right hand portion of the latter as viewed in Fig. 1, showing one of the valves in open position.

Fig. 5 is a detail vertical section on line 5—5 of Fig. 1, illustrating a part of the mechanism for driving the drum and actuating the valves, and upon an enlarged scale.

Fig. 6 is a perspective view of a portion of the drum proper.

Fig. 7 is a vertical sectional view similar to Fig. 1 but illustrating a slightly modified drum structure wherein a liquid wash or solvent is employed as an incident to separation or clarification of the materials.

Fig. 8 is a transverse vertical section through a portion of the drum as viewed on line 8—8 of Fig. 7.

Fig. 9 is a vertical sectional view similar to Fig. 1 and illustrating a modified construction of the machine wherein a vaned rotor is employed within the drum.

Fig. 10 is a transverse section through the rotor member illustrated in Fig. 9.

Fig. 11 is a detail view in vertical section illustrating an alternate manner for driving the drum and controlling the discharge valves thereof,

wherein a built-in electric driving motor is featured.

Fig. 12 is a diagrammatic view of a driving arrangement between the centrifuge drum and a suitable power source.

Fig. 13 is a detail sectional view on line 14—14 of Fig. 1, drawn on an enlarged scale.

Fig. 14 is a view similar to the upper portion of Fig. 1, and illustrating a centrifuge drum composed of a plurality of sections with means for driving the drum and controlling the series of valves for each drum section from both or opposite ends of the drum, in order to insure against undue torsional stresses and strains under operating conditions, particularly at high speed.

Referring to the drawings, the centrifuge drum is indicated generally at 10 and in the embodiments illustrated consists of two adjacent conical drum sections or chambers A and B. However the invention may be utilized to advantage in a single drum section or wherein more than two sections are embodied in the drum, depending on operation conditions and the character of the material being treated. The drum assembly is mounted for rotation within bearings 11 in turn secured to oppositely disposed bracket elements 12 constituting the main frame of the machine. An inlet conduit or trunnion 13 of the drum extends through to an annular baffle 46 fixed to the interior of the drum wall, and a plurality of radially extending triangular stiffening plates 48 are fastened to the inner extension of the conduit, the baffle and the conical sides of the drum. These stiffening plates perform further to give a spinning or rotative motion to the material being worked on as it enters the drum through the apertures 47 and 49 through the baffle and trunnion 13 respectively, and also strengthen and rigidify the drum and inlet conduit 13 against torsional strains and any tendency to whip or vibrate during operation at relatively high speeds.

Each drum section includes a series of radially and circumferentially disposed tapered hoppers or collecting chambers 19a, and at the apex of each hopper a rotating or oscillating valve 36 is mounted between longitudinally spaced peripherally disposed discharge flanges 38 of each drum section. A substantially circular discharge trough 13 encircles the base portion 15 of the frame. Said discharge trough as best seen in Fig. 2 includes a discharge opening 14 for the heavier materials thrown off as a result of the rotation of the drum and after unloading of these materials from the discharge hoppers of the latter. The discharge opening 14 may connect with a pipe or other convenient means for directing the heavier discharged constituents to any suitable place of collection. The sludge or slurry to be separated or classified is introduced into the drum through an axially disposed stationary pipe or conduit 16 suitably supported by a bracket member 17 on the machine frame 12, said pipe communicating with the axially disposed conduit 18 of the rotary drum. A stuffing box 19 or other appropriate sealing means may be provided at this locality to effectively seal this relatively rotatable pipe and conduit. The material flows through the circumferentially spaced apertures 49 and 47 in the conduit 18 and baffle 46 respectively into the drum, in which the material is subjected to centrifugal force. The lighter material or liquid effluent resulting from the centrifugal separating or classifying action is discharged from the drum as by means of a fixed pipe or conduit 20 supported by a bracket element

21 at the opposite end of the machine, a stuffing box or other sealing means 22 being interposed between said discharge pipe and a hub portion 23 of the drum. The bearing 11 at one end of the machine surrounds said drum hub portion 23, while the companion bearing 11 at the opposite end of the machine surrounds the corresponding central hub portion or conduit 18 of the drum.

The heavier material that has been flung radially into the hoppers by centrifugal action is allowed to accumulate in the hoppers, and then flows out into the discharge space 38b when the valves are opened. The heavy components are here subject to the action of the discharge vanes 38c and wiping vanes 38d of the drum which impel this material out of the discharge trough 13 and thence through the discharge opening 14 of the casing.

With regard to the actuation of these valves, in the embodiment illustrated in Fig. 1 a pulley member 25 having a belt groove 26 is mounted upon the hub portion 18 of the drum 10, and to permit relative rotation within limits of the drum and pulley, one or more bearing elements 27 are or may be disposed between said drum hub portion and the interior hub wall of the pulley. Said pulley further includes a ring gear portion or member 28 preferably of integral construction and which partially encloses the said bearing or bearings 27 to insure a compact construction.

The pulley member 25 is rotated by means of a belt or belts 25a (Fig. 12) engaging the pulley grooves and which may lead from a motor or other desired power source 25b in which is incorporated a braking element 25c and clutch 25d on a line or other shaft 25e (see Fig. 12).

As best seen in Fig. 5 the inner wall face of the ring gear element 28 is preferably provided with a pair of diametrically opposed driving lugs 29 which may be integrally formed with the gear and which are adapted to respectively engage a corresponding pair of diametrically opposed driven lugs 30 which may be formed integrally with or projecting from the hub portion 18 of the drum. In the position shown in full lines in Fig. 5, a driving connection is present between the combined pulley and ring gear and the drum 10 for rotation in a clockwise direction. A similar pair of diametrically oppositely disposed projecting lugs 29a is further provided on the gear element 28 between the aforesaid pair of lugs 29 and which may also be integrally formed as a part of the gear. Relative rotation between the drum hub and gear is limited in one direction by engagement of the drum lugs 30 with gear lugs 29, and in the opposite direction by engagement of the opposite ends of the drum lugs 30 with the gear lugs 29a, as will be apparent from Fig. 5 wherein the relative position of the drum and gear lugs in the alternate position is indicated in dotted lines.

A plurality of independent corresponding rotatable shafts 31 are mounted at their opposite ends in bearings 32 in turn secured as illustrated to one of the conical end walls 33 of the drum 10, said shafts being disposed in spaced circumferential radial relation to the drum axis as best seen in Fig. 2. The inner end of each of said shafts carries a fixed bevel pinion 34 for intermeshing engagement with the circumferential teeth of the ring gear 28 for rotation by the latter under desired and periodic conditions to be hereinafter described. The opposite or outer ends of said shafts are each provided with a similar gear or pinion 35 fixed thereto.

Fig. 13 shows a preferred drum construction to insure accurate positioning of the valve shaft bearings 32 on the outer drum wall, to obtain a maximum of drum balance and valve control efficiency. To this end the outer drum wall at one end thereof is provided with a series of aligned pairs of pads 72 preferably welded to the wall in permanent position. These pads are designed to support the bearings 32 for the radially disposed valve shafts 31. In the event of slight warpage of the drum wall during or after its manufacture, these pads may be accurately machined to compensate for such warpage and to accurately locate the bearings thereon in proper shaft alignment relative to the driven valve pinions 44 and driving gear 28 with a precision adjustment with a minimum of friction and attendant maximum balance. For this reason the said valve shaft bearing pads fixed in pairs radially around the end wall of the drum 10 constitute an important feature of the invention.

In the double drum section design of the machine as illustrated herein each drum section A, B, adjacent its outer periphery is provided with the series of radially disposed spaced tapered hoppers 10a, the series of hoppers for both drum sections being formed by means of a single series of circumferentially disposed partition members 10b extending from end to end of the drum. The said partition members are in turn divided into multiple rows of hoppers with a single row or series for each drum section, by means of a series of circumferentially disposed filler plates or insert members 10c. Each space between adjacent hoppers constitutes an intermediate cell 24 (Figs. 2 and 8) and the described parts may be welded or otherwise secured in assembled relation on the drum 10.

Each drum hopper is provided with the rotary valve member 36 of identical construction, said valves being mounted for rotary movement within bearing elements or sleeves 37 in turn secured within suitable apertures or bores within the opposed pairs of spaced wall portions or discharge flanges 38 of the corresponding adjoining drum sections A and B. The valve members 36 are connected for simultaneous rotary or oscillatory actuation by means of interposed shaft or rod elements 39, each at least partially of non-circular cross-section (Fig. 4) for a purpose to be described. In the embodiment illustrated in Fig. 1 a torsion spring 40 surrounds each rod member 39. One end of the spring is secured as at 41 to the valve member 36, the opposite end of said spring being secured as at 42 to the adjacent drum casing or discharge flange 38.

In the form shown in Fig. 5 a pair of diametrically opposed compression springs 43 are disposed between the drum hub portion 18 and the ring gear 28, one end of each spring being secured to a drum lug 30 and the opposite end of the spring in turn being secured to the gear lug 29a. The described arrangement of the springs tends to maintain a driving relation between the drum and gear as illustrated in full lines. Obviously the same result would be obtained by interposing a pair of tension springs between the gear lugs 29 and drum lugs 30 as an aid in maintaining the parts in driving relation illustrated in full lines in said Figure.

Each circumferentially disposed rotary valve member 36 of a drum section is provided at its outer end with a gear or pinion 44 having meshing engagement with its corresponding shaft pin-

ion 35 for rotative control of the valves under desired operating conditions to be described. Each valve member 36 is further provided with a transverse port or aperture 45 as best seen in Fig. 2 and which controls communication, through diametrically aligned apertures 45a in the sleeve 37, between each circumferentially disposed drum hopper 10a and the space 38b between the discharge flanges 38 of the drum, and thence to the discharge trough 13.

Provision for accurate location of the valves 36 and associated sleeves 37 on the valve axes is illustrated on an enlarged scale in Figs. 4 and 13. As illustrated an annular shim 73 is positioned in the drum walls between the discharge flanges 38 of the drum and the outer flanges of the sleeves 37, said shim elements being one or more in number respectively provided for each valve sleeve 37 around the drum adjacent the periphery thereof. These shims are designed to engage the valve sleeves 37 therein so as to variably position the valves 36, sleeves 37 and valve pinions 44 axially of the drum section adjacent the valve actuating mechanism to compensate for possible warpage therein, and so as to also accurately position said pinions for effective meshing engagement with the valve operated shaft pinions 35. This feature helps to provide for ease of fabrication, in that discharge flanges 38 do not require machining to a perfect plane. Since the corresponding valves 36 of the drum section or sections disposed inwardly of the outermost drum section just described, need not be adjusted for a driving connection with gear element 28, these remote valves are not adjusted simultaneously with the outer valves through the medium of the shim or shims 73. Therefore the above described squared or non-circular portion of connecting rod 39 engaging a bore of similar cross-sectional configuration in valve 36 of the adjacent drum section (to the left as viewed in Figs. 1 and 9), provides for rotation of the valve under operating conditions, as well as for relative sliding movement between the valves and adjacent drum sections when the valves of one outer drum section are axially adjusted relative to the remaining valves of an adjacent section.

The aforedescribed valve construction is an extremely desirable feature of the invention; these parts are subject to considerable wear and it is necessary that some demountable means be provided for their easy replacement or repair.

In the event that four or more rows of hoppers are employed, it may be desirable to utilize a dual pulley or motor drive, in which a pulley or rotor shafts as herein described would be mounted on each end of the machine, and half of the valves operated by each pulley or motor.

While the above described embodiment of pulley or pulleys and shafts is a preferred method of construction, other mechanical linkages may be employed with the objective of actuating the valves through the inertia of the rotating drum.

Operation

When it is desired to open the valves and discharge the heavier centrifugally separated constituents of the material into the trough, and assuming the drum to be revolving at a normal speed of 1000 R. P. M., the driving means or motor is braked or snubbed to retard the speed of the pulley 25 and drive gear 28. In the case of a reversible motor driving means, the latter may be subjected to a reversing current to obtain the

same result, thus setting up a slight speed differential between the drum and gear with the drum rotating at the greater speed. This moves the driving and driven gear and drum lugs from the position shown in full lines in Fig. 5 to that shown in dotted lines. This limited relative movement between the drum and gear serves to partially rotate the shafts 31 in the desired direction, by reason of the geared connection therebetween, all of the valves 36 being rotated approximately 90° to align the valve ports 45 with the valve sleeve ports 45a. The heavier materials accumulating in the hoppers are thus discharged by centrifugal action into the trough 13 from whence they are discharged through the opening 14 to any desired point of collection. This valve actuation of course occurs without shutting down the drum rotation and during continuous operation of the machine.

After discharge of the collected materials into the troughs, the valves are partially rotated in the opposite direction to close the same, and if desired, with the aid of the torsion springs 40 (Fig. 1) or by virtue of the expansion of compression springs 43 (Fig. 5).

This closing action is effected by speeding up the driving gear 28 as by engaging a clutch or motor switch (Fig. 12) in the clockwise driving connection as illustrated in Fig. 5, said driving speed then being slightly in excess of the driven or coasting speed of the drum. This reverse differential speed as contrasted with that to open the valves, serves to rotate the latter as will be apparent, in the opposite direction until the parts resume the position shown in full lines in Figs. 1 and 5. The valves are thus returned to their normal closed position by reverse partial rotation of substantially 90°, also without materially affecting or retarding the speed of rotation of the drum and attendant separating or classifying action.

In the slightly modified embodiment illustrated in Figs. 7 and 8 of the drawings, a counter liquid current back wash is employed to prevent escape of valuable constituents of the material which may be collected in the hoppers 10a. For this purpose the discharge pipe 20 at one end of the drum axis may be made of larger diameter so as to accommodate therethrough a rotating inlet pipe 50 communicating at its inner end with an annular rotatable manifold 51 disposed within and suitably mounted on the drum. Said manifold communicates with a plurality of radially extending fixed branch pipes 52 mounted in suitable bearings on the drum wall and communicating at their outer ends respectively with the drum cells 24 intermediate the hoppers 10a. Said drum cells are apertured on their inner wall surfaces as at 53 for the passage therethrough to the drum interior of the wash water or other liquid introduced through pipe 50 and branch pipes 52, with the result of carrying back into the interior of the drum, valuable constituents which may be mixed with the heavier discharge materials in the hoppers 10a. Said returned lighter materials are thence carried with the effluent through discharge pipe 20 to any appropriate place of collection. A supplemental bracket element 54 may be provided for supporting the outer end of the rotating intake pipe 50, and a stuffing box 54a provided in fixed pipe 20.

In the embodiment of Figs. 9 and 10 the drum assembly may include a radially vaned rotor or agitator element 55 having a hub portion 56 disposed coincidently with the longitudinal drum

axis. Said rotor is or may be fixed to the hollow sleeve element 23a having a bearing 23b and drive pulley 23c keyed thereon for imparting rotation to the rotor independently of the drum. The heavier material constituents within the drum are aided in their flow or progress toward the radially and circumferentially disposed hoppers 10a by the independent rotation of the rotor which may have a faster or slower speed than the drum depending upon operating conditions and the character of material being treated. The drum as in the instance of Fig. 1 is continuously rotated through combined pulley and ring gear 25, 28 at the opposite end of the drum. The corresponding end of the rotor 55 is secured for driving movement to a hollow rotary sleeve 18a corresponding to the sleeve 23a, and into the outer end of which sleeve the intake end of the material supply pipe 16a is projected. A stuffing box or other sealing medium 19a is interposed between the stationary intake pipe 16a and rotating sleeve 18a to seal the parts against escape of material while permitting relative or coincident rotation of the described parts.

The incoming materials to be treated flow into one end of the drum through spaced radially disposed apertures 58 at the inner end of the hollow rotor sleeve, and the lighter material or effluent discharged axially of the drum through the hollow sleeve member 23a, is admitted thereto through circumferentially and radially disposed ports or apertures 59 thereof.

As illustrated in Fig. 11 a built-in motor drive may be alternately employed for the drum, particularly in the instance of high speed separation or classification of semi-fluid materials. In such instance the hollow sleeve or trunnion 18b at one end of the drum is provided with one or more armature bearing elements 27b for the rotor 60 of a reversible motor M. Said bearings are fixed on their inner surface to the drum sleeve or trunnion 18b and at their outer ends to the motor rotor 60. Said motor includes a fixed stator element 61 surrounding the rotor, and electric current is supplied to said motor from any suitable source with appropriate switch controls therefor.

In the motor driven embodiment of Fig. 11 a single interposed driving ring gear 28a having a hub 28b is carried by the motor rotor 60 for common engagement with the plurality of bevel pinions 34 of valve controlling shafts 31 (Figs. 1 and 9). An inner hollow sleeve 62 constituting an integral part of the drum 10 and having spaced apertures 63 therein may be provided in this embodiment to introduce effluent through said apertures and the outer sleeve apertures 58 into the drum interior. A stuffing box or other sealing element 64 may be provided to insure against escape of incoming materials from between the inner and outer sleeve elements 62 and 18b.

Control of the rotary valve units 36 alternately to open and closed positions as determined by operating conditions, may be obtained by applying a reversing current to rotor 60 of the reversible motor M, through motor driven ring gear 28a and associated pinions and shafts 34, 31, 35 and 44 (Figs. 1 and 9).

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advan-

tages, the forms hereinbefore described being merely preferred embodiments thereof.

I claim:

1. In a centrifuge, the combination of a plurality of peripheral hoppers, a stationary discharge trough surrounding the periphery of said drum adjacent the outer ends of said hoppers for communication therewith, a plurality of rotatable valves mounted on said drum and respectively disposed between said hoppers and said discharge trough, each of said valves being rotatable upon horizontal axes disposed substantially parallel to the axis of said drum, a ring gear for continuously driving the drum and bodily rotating said valves as a unit on the drum axis, a plurality of rotatable shafts carried by said drum, said shafts being respectively geared to the drum rotating means and to said valves for simultaneously rotating the valves in opposite directions to open and closed positions, cooperating relatively movable abutting lugs respectively carried by said drum and said ring gear to provide limited relative movement between said drum and said gear to oscillate said valves in opposite directions by means of a rotative speed differential between said gear and drum, whereby to control discharge of material from said hoppers to said discharge trough without discontinuing the rotation of the drum, and spring means for normally holding said valves in closed position and for augmenting the closing of the valves when the speed of said driving gear is increased.

2. In a centrifuge, the combination of a rotatable drum having a peripheral hopper, a discharge outlet disposed adjacent said drum and said hopper, a valve on said drum between said hopper and discharge outlet, driving means for revolving the drum and valve as a unit, a transmission shaft carried by said drum and operatively connected to the drum rotating drive and to said valve for actuating the valve, a coupling carried by said drum and driving means respectively to provide limited relative rotary movement between said drum and said driving means to operate said valve actuating transmission shaft by means of a speed differential between said drum and driving means during rotation of said drum and driving means, and a compression spring normally holding said valve in closed position during unitary rotation of the drum and driving means at coincident speeds, said valve actuating shaft being operative to open the valve when the speed of said driving means is decreased and to close the valve when the driving means speed is increased relative to the drum speed, and said spring augmenting the closing of the valve under the latter mentioned condition.

3. In a centrifuge, the combination of a frame, a drum having a peripheral hopper therein rotatably mounted on said frame, a discharge outlet disposed adjacent the periphery of said drum and said hopper, a valve on said drum between said hopper and discharge outlet, an electric motor built into said frame for rotating the drum and valve as a unit, a transmission shaft carried by said drum and operatively connected to said motor for actuating the valve, and a coupling providing relative movement between said drum and the rotor of said motor for operating said valve actuating transmission shaft means by the inertia stored within the rotating drum, to control discharge of material from the hopper to said discharge outlet during rotation of the drum.

4. In a centrifuge, the combination of a frame, a drum having a peripheral hopper therein ro-

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tatably mounted on said frame, a discharge outlet disposed adjacent the periphery of said drum and said hopper, a rotatable valve on said drum between said hopper and discharge outlet, an electric motor built into said frame for rotating the drum and valve as a unit, said motor including a stator element secured to the frame and a rotor element, a transmission shaft carried by said drum and operatively connected to said motor for rotating said valve on its axis, and a coupling providing relative movement between said drum and the rotor of said motor for operating said valve rotating transmission shaft by the inertia stored within the rotating drum, whereby to discharge material from said hopper to said discharge outlet during rotation of the drum.

5. In a centrifuge, the combination of a stationary frame, a drum having a plurality of peripheral hoppers therein rotatably mounted on said frame, a discharge trough mounted adjacent the periphery of said drum and said hoppers, a plurality of rotatable valves peripherally spaced about said drum and located between said hoppers and discharge trough, an electric motor built into said frame for rotating the drum and valves as a unit, a plurality of radially disposed shafts carried by said drum and operatively connected to the rotor of said motor for respectively rotating the valves on their individual axes, and a coupling providing relative movement between said drum and the rotor of said motor for operating said rotating shafts on their axes by means of the rotative inertia stored within the rotating drum, whereby to discharge the heavier constituents of the material from said hoppers into said discharge trough without substantially altering the speed of rotation of the drum.

6. In a centrifuge, the combination of a stationary frame, a drum having a plurality of peripheral hoppers therein rotatably mounted on said frame, a discharge trough mounted adjacent

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the periphery of said drum and said hoppers, a plurality of valves rotatable on their own longitudinal axes peripherally spaced about said drum respectively disposed between said hoppers and said discharge trough, an electric motor built into said frame, said motor including a stator element secured to the frame and a rotor element for rotating the drum and valves as a unit, a plurality of radially disposed shafts mounted on said drum and respectively having a gear connection with said drum rotating motor for individually rotating said valves on their longitudinal axes, and a coupling between said motor rotor element and said drum for effecting relative rotary movement between the drum and said rotor to operate said valve rotating shafts by means of the rotative inertia stored within the rotating drum, whereby said shafts and valves may be rotated alternately in opposite directions to control the discharge of material from said hoppers to said discharge trough without substantially affecting the speed of rotation of the drum.

THOMAS R. KOMLINE.

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