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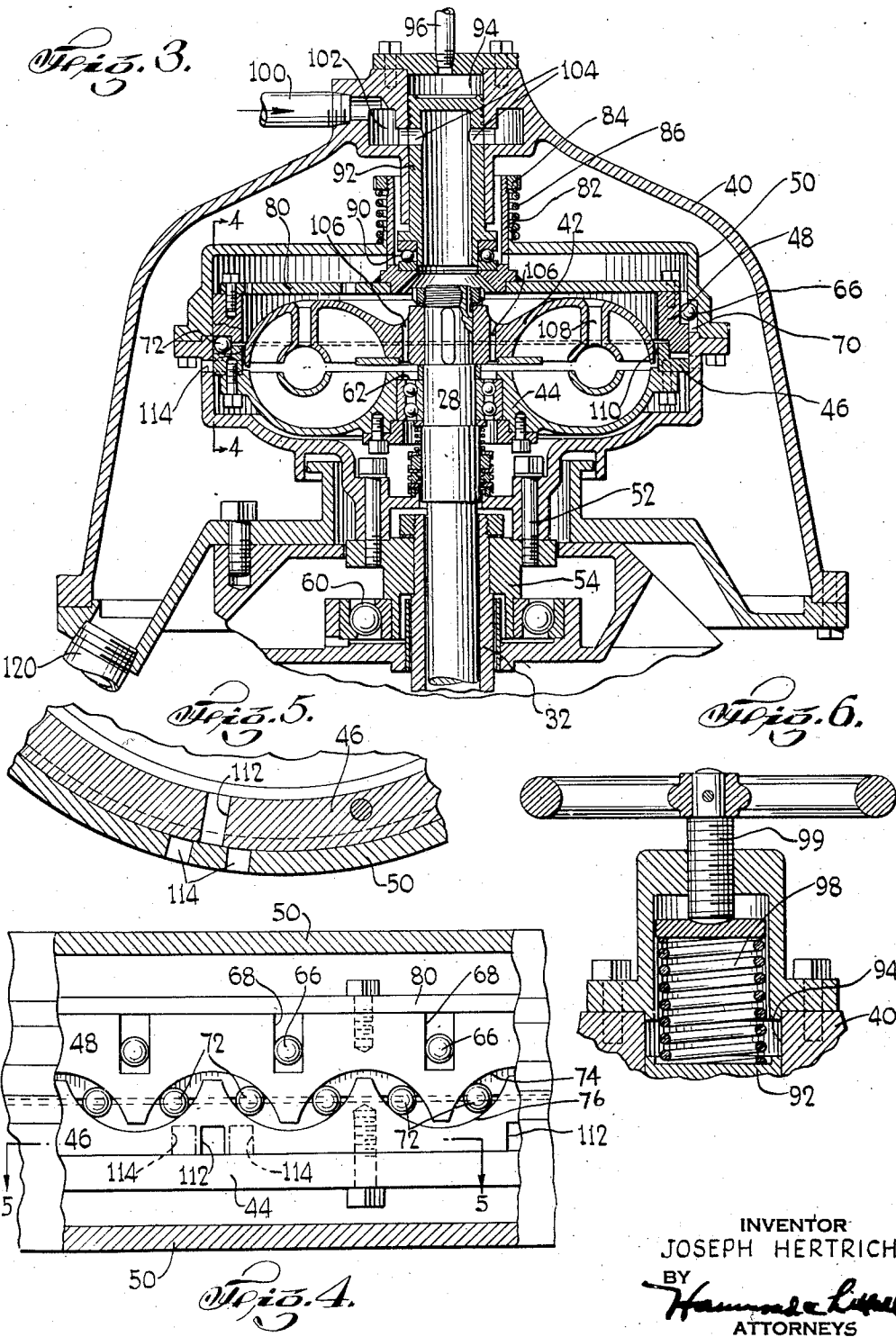
J. HERTRICH

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CENTRIFUGAL MACHINE AND DRIVING SYSTEM THEREFOR

Filed Jan. 16, 1941

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CENTRIFUGAL MACHINE AND DRIVING SYSTEM THEREFOR

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Fig. 7.

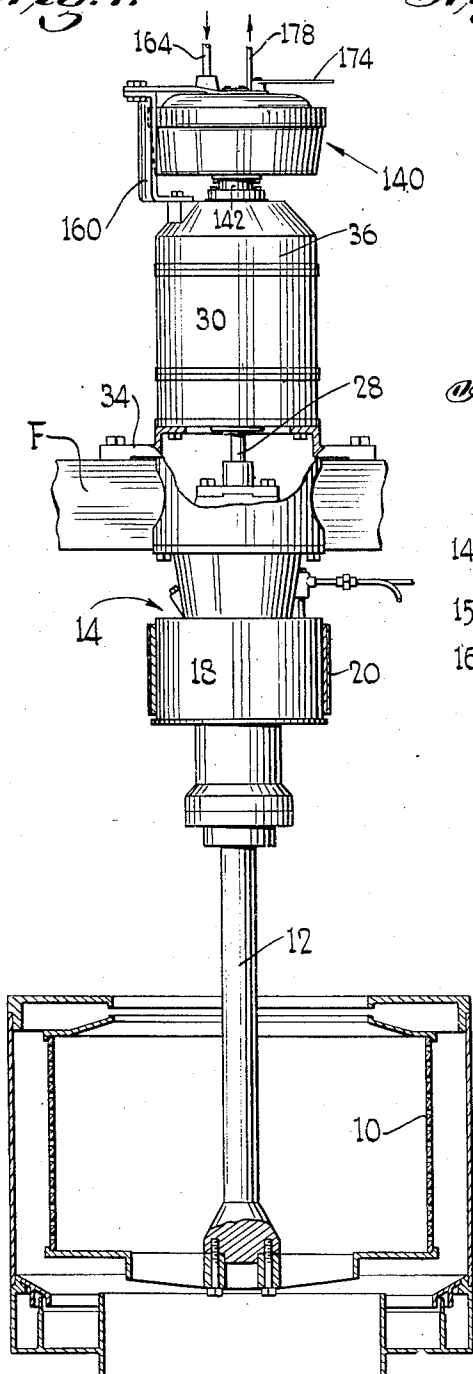


Fig. 9.

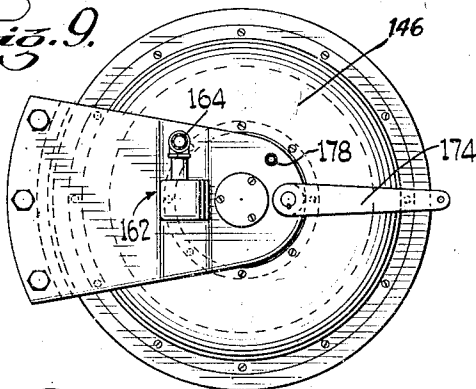
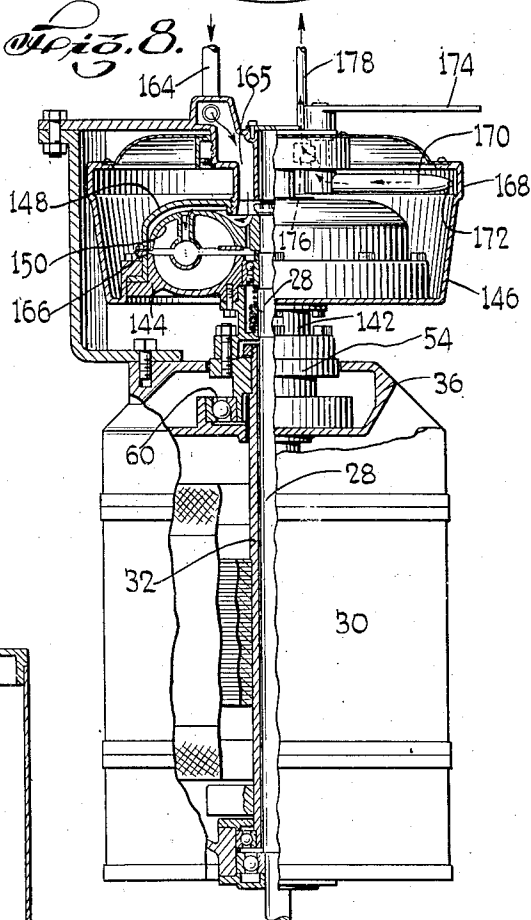


Fig. 8.



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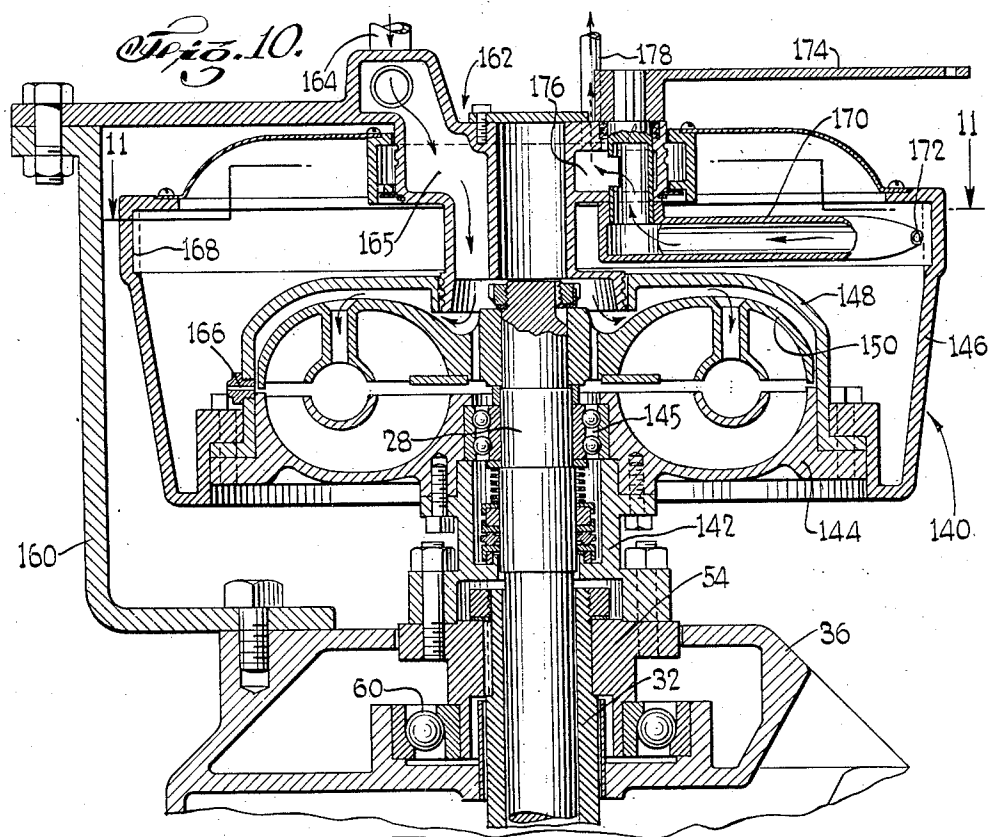
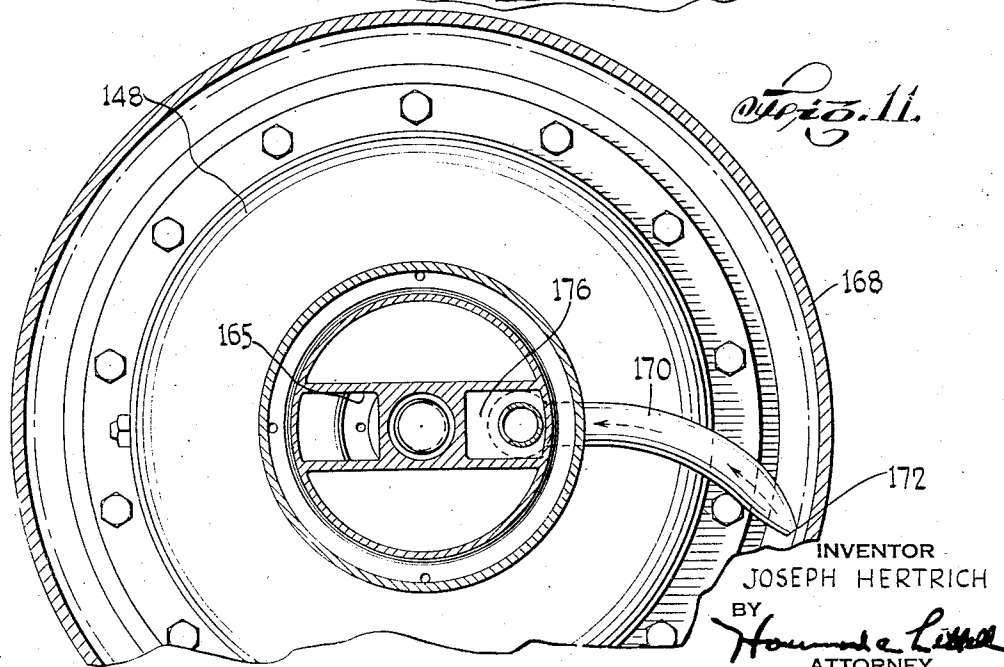
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CENTRIFUGAL MACHINE AND DRIVING SYSTEM THEREFOR

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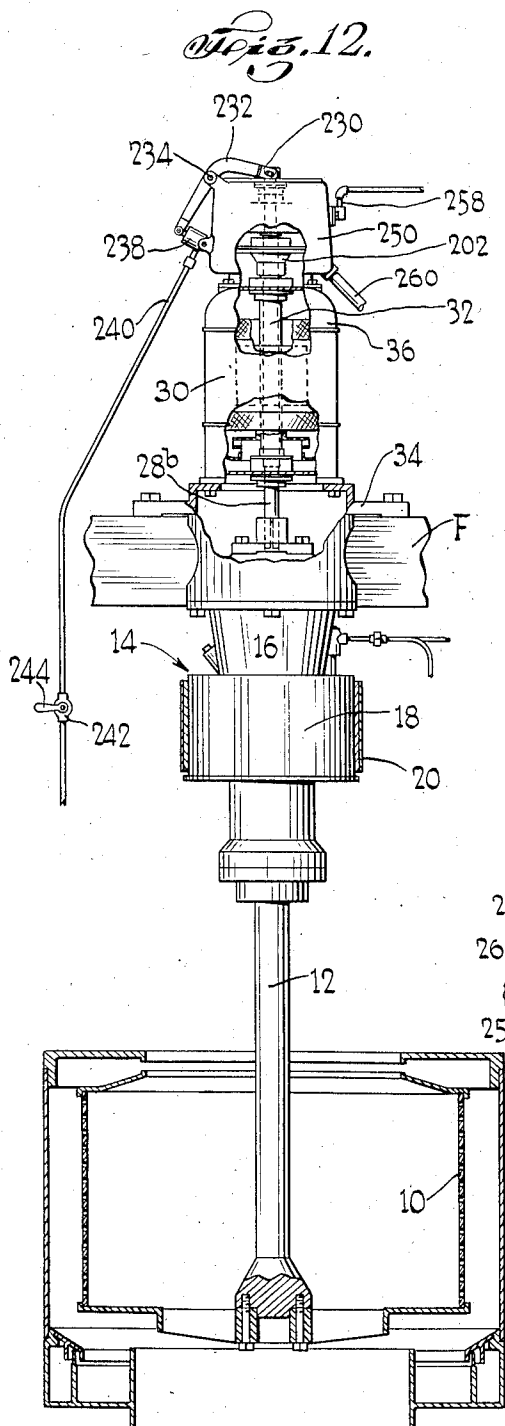
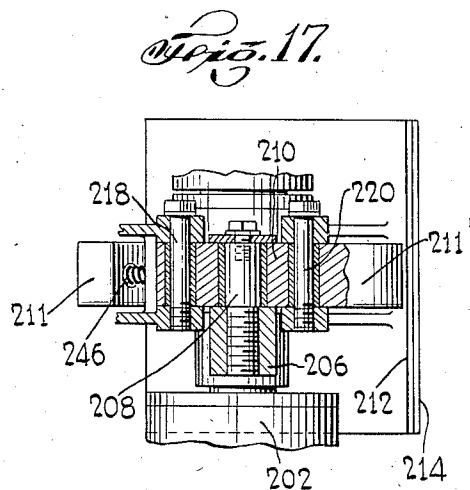
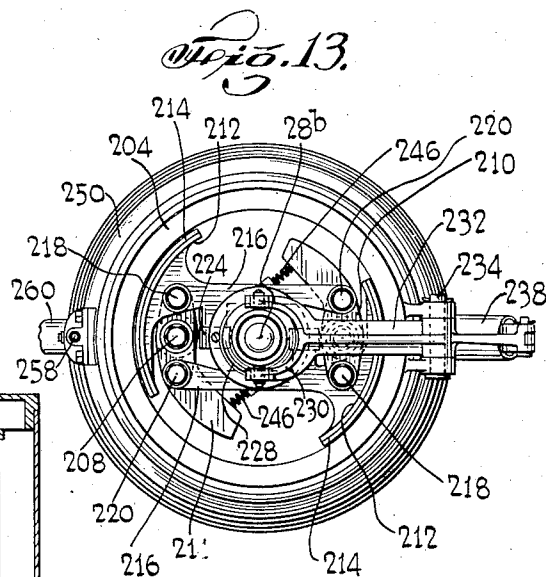
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CENTRIFUGAL MACHINE AND DRIVING SYSTEM THEREFOR

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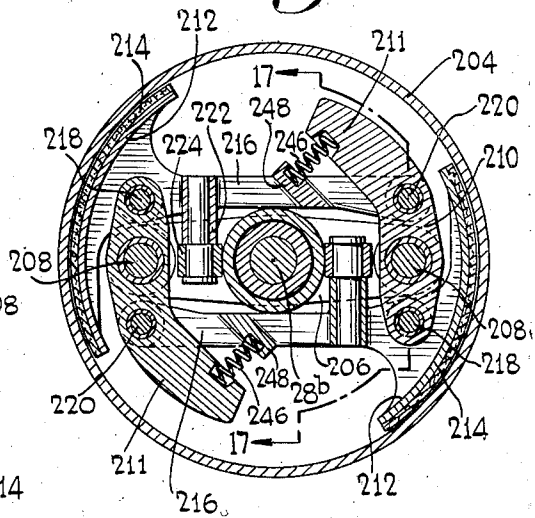


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13 Claims. (Cl. 210—71)

This invention relates to new and useful improvements in centrifugal machines and particularly to driving systems for heavy-duty suspended centrifugals of the type used for the manufacture of sugar.

Recent developments in the processing of sugar massecuites and similar mixtures have shown the importance of using high centrifugal forces, and hence high centrifugal speeds, in all types of purging operations, and also of effecting rapid acceleration to high centrifugal speeds when treating so-called "free-purging" mixtures, such as white massecuites, affination magmas and the like. These factors have tended to reduce the cycle time in centrifugal operations and to impose on the centrifugal driving system severe operating requirements for which conventional machines were not suited. It has also been found important to provide a uniform, prolonged centrifugal acceleration to high speeds in the processing of low grade massecuites, and to determine and use for each type of massecuite an acceleration rate that is especially adapted to the qualities of the particular material undergoing treatment.

The foregoing requirements have been served best by the use of improved belt-driven centrifugals, and especially of Roberts gear driven centrifugals; but belt-driven machines are limited as to the top speeds that may be reached satisfactorily, and gear driven machines are comparatively expensive to install; and in the cases of both belt-driven and gear-driven machines it has been difficult heretofore to secure the kind of controlled slow acceleration desired for certain types of centrifugal work. In addition, the mechanical arrangements characteristic of such machines sometimes make it difficult or impractical to install them where improved operations are needed.

As an alternative to belt-driven or gear-driven machines, centrifugal machines driven by directly connected motors have been improved recently for use in high speed centrifugal operations, on both short and long cycles. Where rapid acceleration is required, however, special motors have had to be constructed to withstand the high overloads and the excessive heat generated during acceleration, and such motors are necessarily quite expensive. Excessive power peaks are encountered in operation, not only during the acceleration stage of each cycle but also during the discharging of solids from the centrifugal basket at the end of each cycle, for the use of mechanical dischargers requires the basket to be revolved at low speed, and this is effected by momentary en-

ergization, or "jogging," of the motor. Moreover, in the case of known motor driven machines, the accelerating characteristics of the centrifugal are restricted to the accelerating characteristics of the motor itself, which is an objectionable feature because the motor accelerates rapidly at times but only slowly as it approaches its maximum speed of rotation, and also because there is no way to control or vary the acceleration so as to obtain the best processing results.

It has been proposed to avoid some of these characteristics of direct motor drives by installing a centrifugally actuated clutch between the driving motor and the centrifugal spindle, but such an expedient is of little or no advantage. The clutch reduces the machine's efficiency, and when used with a two-speed driving motor the motor still must be built to withstand high overloads and to absorb most of the heat generated during acceleration, for if the clutch is efficient at the lower motor speed it will no longer slip after the motor has been changed to its higher speed. Also, the clutch blocks and friction straps wear out after a short period of continual service, causing objectionable expense and delays in sugar factory operations, and during the use of such clutches they change in effectiveness so that wide variations occur in the acceleration rate of the centrifugal.

An object of the present invention is to provide new and useful improvements in centrifugal apparatus, and particularly in driving systems for centrifugal machines, by which the acceleration characteristics of the centrifugal may be freed from limitations inherent in known motor-driven machines and may be controlled so as to obtain selected acceleration rates and substantially uniform acceleration at any selected rate, thereby enabling centrifugal operations to be carried out in a manner best suited to the requirements of the material undergoing treatment.

Another object of my invention is to provide new motor driven centrifugal combinations which give desirable accelerating and operating characteristics for certain types of sugar processing work and yet prevent the centrifugal driving motor from becoming overloaded or overheated during either the acceleration of the machine at the start of each cycle or the discharging operation at the end of each cycle. Thereby I propose to provide much greater freedom in the selection of centrifugal driving motors than now prevails where special operating requirements must be met, thus making it unnecessary to use expensive driving motors of special construction for

such centrifugal operations, and also to increase the efficiency and reduce the power peaks in such centrifugal operations.

Another object of my invention is to provide new motor driven centrifugal combinations as hereinbefore mentioned which can be installed readily in various plant arrangements and which may utilize the same supporting framework as is used for conventional motor driven centrifugals or the gear units of Roberts gear-driven centrifugals.

Other objects of my invention are to provide new motor driven centrifugal combinations which permit the driving motor for each machine to be kept in constant operation while the centrifugal basket is being unloaded and reloaded, thereby making it unnecessary to start and stop the motor in each operating cycle; to provide such centrifugal combinations in which a two speed electric motor may be used as the driving source, with resulting power savings during the acceleration stage of each cycle; and to provide such combinations in which regenerative braking may be employed to advantage during the braking stage of each cycle so as to regenerate electrical power but without causing troublesome generation of heat in the driving motor.

In the new motor driven centrifugals of my invention, each centrifugal is provided with a driving motor having suitable speed and horsepower characteristics, which may be any of a wide variety of standard electric motors without requiring special constructions or windings to handle excessive overloads or overheating; the basket-carrying spindle and driving head of the centrifugal are suspended from supporting frame-work and, if desired, the driving motor is mounted on the same frame-work in the usual manner for direct-connected motor driven centrifugals; and torque is transmitted from the motor to the head, spindle and basket of the centrifugal through a special slip clutch mechanism connected with the motor shaft and the centrifugal spindle and provided, in preferred embodiments hereof, with means by which to vary and limit the torque transmission between the motor and the spindle.

The driving motor is preferably a hollow shaft motor having a speed of rotation adapted to the desired top speed of the centrifugal and a power rating ample for all centrifugal acceleration rates likely to be required. This motor is mounted on the centrifugal frame-work with its hollow shaft extending upwardly, and to the upper end of the hollow driving shaft is connected the driving element of the variable torque slip clutch. The driven element of the clutch is connected with a driven shaft which extends vertically through the hollow motor shaft and is connected with the centrifugal spindle through a flexible coupling in the centrifugal head. The variable torque clutch so mounted above the driving motor is connected to the motor housing in such manner as to be substantially a part of the motor itself, and it is provided with means under the control of the centrifugal attendant by which its torque transmission may be varied from zero to the maximum torque capable of being developed by the clutch. In this way, it becomes possible to disconnect the motor entirely from the centrifugal through the clutch control and to maintain during the acceleration stage of the centrifugal cycle and at other times a torque control which will give controlled acceleration characteristics and at the same time eliminate excessive overloads on and overheating of the motor. In addition, it becomes possible

and practical to keep the driving motor in constant rotation, during the braking, unloading and reloading of the machine, and thereby to reduce starting loads and power peaks and keep a high motor torque available at all times.

The slip clutch employed in the new combination may be a mechanical clutch provided with means by which to vary and control the torque transmission thereof, or it may be a standard hydraulic clutch, or hydraulic coupling, provided with a scoop control for varying and controlling the torque transmission. In the preferred embodiments, however, the clutch is a hydraulic clutch of special construction combined with adjustable means automatically responsive to the torque of the clutch for controlling the quantity of liquid in the clutch so as to maintain its accelerating torque substantially constant. In any case, the heat generated during acceleration of the centrifugal is developed in the slip clutch instead of in the driving motor, and in the embodiments using hydraulic clutches this heat may be carried away by continuous circulation of the clutch fluid. In embodiments using a mechanical torque control clutch the heat developed during acceleration of the machine is dissipated by a suitable clutch cooling system.

As another feature of preferred embodiments hereof, I use as the driving motor for the centrifugal a two speed hollow-shaft electric motor having high and low speed windings, and for the slip clutch connected with this motor I use either a hydraulic or a mechanical clutch which transmits torque in either direction of power transmission. With such a combination a power saving is effected during acceleration of the centrifugal by reason of the two-speed windings of the motor, and regenerative braking may be employed for part of the braking stage of each cycle by transmitting torque from the running centrifugal through the clutch to the motor. Thus the heat developed during the regenerative braking period is absorbed in the clutch instead of in the motor. When the machine has been braked to the lower motor speed, the slip clutch may be rendered inactive, and a mechanical brake may then be applied to stop the machine, the driving motor being allowed to continue running at its lower speed.

The foregoing and other objects, features and advantages of my invention will become more apparent from the following description of specific embodiments thereof when considered in connection with the accompanying drawings, wherein

Figure 1 is an elevation, partly in section, of a centrifugal machine constructed according to the preferred embodiment of my invention;

Figure 2 is an enlarged view, partly in elevation and partly in vertical section, showing details of the driving motor and clutch assembly of Figure 1;

Figure 3 is an enlarged vertical section of the clutch assembly;

Figure 4 is a developed fragmentary view showing the periphery of some of the clutch parts as seen substantially along line 4—4 of Figure 3;

Figure 5 is a horizontal cross-section, substantially along line 5—5 of Figure 4, showing a detail of the construction; and

Figure 6 is a fragmentary vertical section illustrating an alternative construction for controlling the setting of the clutch mechanism of Figures 1 to 5, inclusive.

Figure 7 is an elevation showing the assembly of another embodiment of this invention;

Figure 8 is an enlarged view, partly in elevation and partly in vertical section, showing details of construction of the driving motor and the clutch mechanism of Figure 7;

Figure 9 is a plan view of the structure of Figure 8;

Figure 10 is an enlarged vertical section through the clutch mechanism of Figure 8; and

Figure 11 is a horizontal section, substantially along the line 11—11 of Figure 10.

Figure 12 is an elevation showing an assembly of a third embodiment of my invention;

Figure 13 is a plan view of the clutch mechanism of Figure 12.

Figure 14 is an enlarged vertical section through the same;

Figure 15 is a horizontal section, substantially along line 15—15 of Figure 14;

Figure 16 is a section similar to Figure 15, but showing the parts in a different condition of actuation; and

Figure 17 is an elevation, partly in section, substantially along the line 17—17 of Figure 15.

Referring first to the embodiment of Figures 1 to 6, inclusive: The usual perforate centrifugal basket 10 is carried by a spindle 12 which extends upwardly into a driving head 14 and is suspended from a stationary hanger 16 depending from supporting frame-work F. A brake drum 18 is secured for rotation with the spindle and arranged to be engaged by friction brake bands 20 in any known manner. In the hanger 16 and the head 14 is a ball and socket joint 22 which provides for the requisite gyration or swinging movement of the basket and spindle during operation of the machine.

The upper end 24 of the spindle is connected through a flexible coupling 26 with the lower end of a driven shaft 28 which extends vertically through the hollow shaft 32 of a driving motor 30. The motor 30 is mounted on a base plate 34 secured to the frame-work F, base plate 34 being of a type commonly used for mounting the motor of a direct-connected motor driven centrifugal or the gear unit of a gear driven centrifugal. The motor preferably is a hollow-shaft, two-speed induction motor of standard construction, having high speed and low speed windings.

Attached to the top of the motor casing 36 is a casing 40 enclosing a special torque control hydraulic clutch which cooperates with the motor in driving the centrifugal. The driven shaft 28 extends above the hollow motor shaft 32 and is connected at its upper end to the runner 42 of the fluid clutch. Facing opposite to the runner 42 is an impeller 44 which acts in a well known manner, in the presence of liquid between the clutch members, to transmit torque to the runner and thence through shaft 28 and coupling 26 to the centrifugal spindle. The torque produced by the clutch varies with the quantity of liquid in the clutch and the amount of slip between the runner and the impeller, according to well known hydraulic principles.

The impeller 44 has connected thereto a ring member 46, which in turn is connected with another ring member 48 in such manner as to rotate therewith, but also in such manner as to permit a certain relative movement therebetween. The ring member 48 is connected for rotation with a housing 50 which encloses the clutch members. Housing 50 extends downwardly and inwardly to a point of connection,

by means of bolts 52, with a collar 54 that is keyed to the hollow driving shaft 32 of the motor 30. It will therefore be evident that when the motor shaft 32 is in rotation there is a corresponding rotation of housing 50, ring 48, ring 46 and impeller 44, and through a liquid medium within the clutch torque may be transmitted to the runner 42 and the centrifugal shaft.

A thrust bearing 60 in the upper end of the motor sustains the axial thrust of the collar 54 and housing 50 assembly. The impeller 44 runs freely on a bearing 62 surrounding the driven shaft 28. The axial thrust of shaft 28 and runner 42 is sustained by a thrust bearing 64 carried in the base of motor 30.

As already mentioned, the arrangement of the impeller 44 with the ring members 46 and 48 and the housing 50 permits of a slight relative movement between the two ring members, and therefore between the impeller and the housing. Provision is made for this relative movement, for example, by connecting member 48 with housing 50 through a series of balls 66, which are confined within registering axial slots 68 and 70 formed in the ring member 48 and the housing 50, respectively, thereby allowing the ring member to have a certain axial movement relative to the housing; and by connecting ring member 48 with ring member 46 through a series of balls 72, which are confined between oppositely facing, overlapping arcuate surfaces 74 and 76, respectively, on the two ring members, thereby allowing ring member 46 to have a certain extent of angular movement relative to member 48. It will be evident (see the developed view of this construction in Figure 4) that a change in the relative horizontal positions of members 46 and 48 necessitates a certain change in the axial position of member 48 relative to the housing 50, which is allowed by the axial elongation of the slots 68 and 70 in which the balls 66 are confined.

As shown in Figure 3, the ring member 48 has attached thereto a thrust plate 80, which is connected to a sleeve 82 that extends above the housing 50 and has a flange 84 thereon which forms a seat for a compression spring 86 compressed between the same and housing 50. Spring 86 tends to hold the thrust plate 80 and the ring member 48 in their extreme upper position, thus holding the two ring members apart to the maximum extent and allowing ring member 46 to reach the limit of its angular movement relative to ring member 48. Bearing against the thrust plate 80, through a ball bearing 90, is a plunger 92 which works in a cylinder 94 at the top of the casing 40. An inlet pipe 96 admits a fluid pressure medium, either hydraulic or pneumatic, into the cylinder 94 whereby to force plunger 92 downward and apply a pressure on the thrust plate 80, thus overcoming the resistance of spring 86 and tending to hold the ring members 48 and 46 in a relative position as shown in Figure 4, all for the purpose and with results hereinafter described.

The circulation of oil or other clutch fluid into and through the fluid clutch takes place as follows: Oil from an inlet pipe 100 is introduced into a bore 102 in the casing 40 and thence into the clutch through siftable valve means comprising the hollow plunger 92 having openings 104 in the side wall thereof. Oil passes from the plunger 92 over the runner 42 and inside of the clutch members through bores 106 and 108 in the runner. To effectuate the discharge of oil from the clutch, one or more bleeder holes 112 are

provided in the ring member 46 in such position as to be either partly or wholly in registry or entirely out of registry with openings 114 in the peripheral walls of casing 50. See Figures 4 and 5. The holes 112 and 114 are made large enough to allow a substantial flow of oil and cause substantially instantaneous emptying of the clutch whenever they are brought into registry with the clutch in operation, the centrifugal force on the clutch fluid being sufficient to effect a rapid discharge of the fluid. The oil so discharged from the clutch is collected by the casing 40 and drawn off through a pipe 120, whence it passes into a collecting tank 122. The oil may then be drawn from tank 122 by a pump 124, passed through a cooler 126, and returned from the cooler to the inlet 100. A valve 128 is provided in the clutch fluid supply line for regulating the rate of circulation. Since the rate of supplying oil to the clutch does not depend upon the rate of discharge from the clutch, a single oil tank and cooler can be used for a group of centrifugals.

The inlet pipe 96 leading into cylinder 94 may extend from a location convenient to a centrifugal attendant, where it is equipped with a pressure regulating valve 130 having a control lever 131 by which to vary the pressure of fluid on the plunger 92 and thus to vary the amount of force tending to move the ring member 48 into its lowermost position relative to ring member 46. It is to be noted that in one limiting position, the lowermost, of member 48 relative to member 46 the latter is necessarily disposed in such relation to the former and to casing 50 that the bleeder holes 112 are substantially entirely out of registry with the holes 114, so that little or no oil is discharged from the clutch under such conditions. Also, openings 104 in the plunger 92 register with the oil inlet bore 102, so that oil enters the clutch and keeps the same full or nearly full of liquid. In other words, this is the condition of maximum torque transmission with minimum slip for any given speed conditions. It is further to be noted, however, that the torque of the clutch itself, acting on the impeller 44, always tends to move the impeller and member 46 to the limit of their possible angular movement relative to member 48 and casing 50, which is also to say that the torque of the clutch itself tends to overcome the effective pressure of the fluid medium in cylinder 94, and, in proportion to the extent that it does so, to cause movement of the bleeder holes 112 into registry with holes 114.

There is consequently a definite relationship between the torque of the clutch and the pressure on the thrust plate that tends to keep the bleeder holes closed and hold oil in the clutch. When this pressure is insufficient to overcome the force of spring 86, any torque produced by the clutch will move impeller 44 and ring 46 to a position in which the bleeder holes are open, and the clutch therefore empties itself and becomes inactive. When the pressure on the thrust plate exceeds the force of spring 86, there is a corresponding torque value which will be produced and automatically maintained by the clutch; for if the torque becomes greater than such value it will displace the ring members and open the bleeder holes so as to reduce the quantity of oil in the clutch, and if the torque becomes less than such value the pressure opposing it will displace the ring members and restrict the bleeder holes so as to increase the quantity of oil in the clutch. Consequently, the torque transmission of the clutch can be varied and controlled by varying

the pressure on the thrust plate 80, as by adjustment of control lever 131 of the regulating valve 130; and for any given pressure on the thrust plate there will be a definite torque transmission which automatically will be held substantially uniform throughout the acceleration stage of each centrifugal cycle.

When an equilibrium condition exists between the torque of the clutch and the opposing pressure of the thrust plate, the thrust is divided over the total number of balls 72, and for each ball there is a definite resulting tangential force which balances a torque component and which determines the torque value of the clutch. The torque value of the clutch is equal to this unit tangential force times the number of balls 72 times the radius of rotation of the balls. As soon as the torque of the clutch exceeds this value a relative angular movement of member 46 takes place in response thereto, and a relative axial movement of member 48 takes place in a direction away from member 46; and as soon as the torque of the clutch becomes lower than this value relative movements of the ring members take place in the opposite directions.

In the position of maximum thrust or maximum torque transmission the holes 112 are out of registry with the holes 114 and there is a hole 114 on either side of the holes 112. By reason of this arrangement, the clutch and torque control system function in either direction of torque transmission; that is to say, not only when the drive is from the motor 30 to the centrifugal, but also when the drive is from the centrifugal to the motor, as during a regenerative braking period.

An alternative arrangement for applying pressure to the thrust plate 80 is illustrated in Figure 6, wherein the plunger 92 in the top of housing 40 is held under the pressure of a compression spring 98, means such as indicated at 99 being provided for varying the compression of the spring.

It is to be noted that the arrangement of openings 104 relative to bore 102 forms a fluid inlet valve that is open only when the plunger is pressed to a position causing the clutch to be active. Upon the release of pressure from the plunger, the clutch empties itself automatically by the opening of the bleeder holes 112, and at the same time the inlet openings 104 are closed so as to cut off further flow of oil into the clutch, i. e. to render the liquid supply system inactive. In other words, the clutch not only becomes automatically disengaged, but also a condition is established which prevents oil from flowing there-through and producing a slight drag on the clutch. The exceedingly rapid discharge of liquid from the clutch under centrifugal force and the simultaneous stoppage of liquid inflow result in a substantially instantaneous inactivation of the clutch that permits the brake 20 to be applied immediately and with maximum effect whenever desired.

A further feature of importance, in addition to the variable and controlled torque transmission obtained from this embodiment, is that the drive from the motor 30 to the centrifugal is quite efficient at all times. The clutch is always provided with a torque capacity larger than the normal requirement for acceleration of the machine, so that during acceleration the torque control system will keep the clutch only partly full of oil, say half full. As soon as this stage has been reached, there will be a continuous oil flow

from the bleeder holes 112, which may be at a substantial rate with the result that the clutch is kept cool and operates efficiently when the high torque transmission takes place and the major amount of heat is produced. As soon, however, 5 as the centrifugal has been brought to top speed, the torque transmission drops off, and the flow of oil through holes 112 is automatically restricted. The clutch thereupon becomes completely full of oil and produces its maximum coupling effect with a minimum of slip between the runner and the impeller. This results in maximum driving efficiency when the machine is running at top speed and minimizes the heat generated in the clutch during that period.

Furthermore, when the machine is running at top speed there need be no discharge of oil from the clutch, or at most a small amount of oil circulation for cooling purposes, so that little or no energy is lost on that account, and whatever oil may enter the clutch under these conditions is held near the axis of rotation thereof and consequently does not result in any substantial loss of energy.

In the operation of the embodiment of Figures 1 to 6, inclusive, the two-speed motor 30 is started in rotation at its lower speed, and the centrifugal basket 10 is loaded either at rest or while rotating at a low speed as a result of having opened the pressure regulating valve 130 to activate the clutch. The centrifugal is started in its acceleration simply by moving the control lever 131 to a predetermined position giving a pressure on the thrust plate 80 sufficient to establish a predetermined accelerating torque for the machine. The clutch itself then establishes this torque value and holds the same value until the centrifugal has reached its top speed, unless, of course, it is desired to stop the machine or change the acceleration rate by changing the setting of the control lever 131 during the acceleration period. The motor 30 is switched from its lower to its higher speed, preferably by automatic control means of any suitable construction, when the speed of the centrifugal approaches the lower motor speed, so that a constant and uniform acceleration of the centrifugal is obtained. After the centrifugal has reached its top speed and rotated for the desired period of time at top speed, the motor is switched back to its lower speed winding, and the clutch is kept active so that the momentum of the centrifugal causes a transmission of torque through the clutch into the motor, against the resistance of the motor, with the result that the speed of the centrifugal is retarded and power is regenerated and introduced into the power supply line. When the centrifugal has been braked to approximately the lower motor speed, the pressure valve 130 is closed and the mechanical brake 20 is applied to bring the machine to a full stop. This preferably is done by automatic control means of any suitable type. The motor is continued in rotation at its lower speed and need not be stopped, although it is obvious that the motor may be stopped and restarted from cycle to cycle if desired.

The heat generated during acceleration and regenerative braking is developed in the clutch instead of in the motor, and is dissipated by circulation of the clutch fluid.

The discharging of solids from the basket 10, at the end of each cycle, may be carried out with a mechanical discharger while manipulating the control lever 131 so as to cause rotation of the

basket under the desired torque conditions. Thus jogging of the motor may be eliminated.

It will therefore be evident that the motor itself need never be placed under an excessive overload and that overheating of the motor may be completely avoided. Not only that, but the machine operates with controlled and variable acceleration characteristics that render it suitable for almost all types of centrifugal processing operations; and the machine itself is so constructed and arranged, and permits the use of motors of such nature, that great advantages and economies are realized over known centrifugal driving systems.

The embodiment of Figures 7 to 11, inclusive, involves an arrangement and combination similar to that of the embodiment first described, but it differs in that a standard type scoop-controlled hydraulic clutch is employed for the torque transmission instead of the special torque control hydraulic clutch of the first embodiment. The hollow shaft 32 of the motor 30 is keyed to a collar 54 which, in this embodiment, is connected through a ring 142 with the impeller 144 of a standard scoop controlled fluid clutch 140. The thrust of this assembly is sustained by the thrust bearing 60 in the top part of the motor casing 36. The impeller runs on a bearing 145 surrounding the shaft 28. To the impeller 144 is secured a rotary housing 146, and also a rotary oil shield 148 which extends upwardly and inwardly to enclose the runner 150. The runner is keyed to the upper end of the driven shaft 28, which extends through the hollow motor shaft, and is connected at its lower end in any suitable manner to a flexible coupling in the centrifugal head 14, and through such coupling with the gyratory spindle 12 upon which the centrifugal basket 10 is carried.

A bracket 160 secured to the top of the motor casing 36 extends upwardly along a side of the clutch housing 146 and supports a stationary oil inlet and outlet structure 162. This structure projects downwardly into the rotary housing 146, with which it is associated in such manner as to prevent escape of oil from the housing. An oil inlet pipe 164 opens into a passage 165 which leads to the top of the runner 150, whence the oil passes beneath the shield 148 and into the space between the impeller and the runner to drive the clutch.

A small bleeder hole 166 is provided in the shield 148 to maintain a constant discharge of oil from the clutch. The liquid discharged from this bleeder hole collects inside the housing 146 and forms a peripheral wall of liquid against the housing wall in a region 168 where the housing is of maximum diameter. A scoop tube 170 is swivelled in the structure 162 so as to be turnable about a vertical axis and to hold its open end 172 within the wall of liquid at 168. A control handle 174 is provided for changing the position of the scoop 170. Liquid entering the scoop passes through an outlet passage 176 and thence through an outlet pipe 178, from which it goes to an oil cooler (not shown) and returns directly to the clutch through the inlet pipe 164. The amount of oil in the clutch therefore depends upon the position of the scoop 170, for the oil discharge at 166 is substantially constant and the amount of oil in the clutch depends upon the amount allowed by the scoop to remain at 168.

The new combination, as illustrated by this embodiment, enables the use of a standard type

scoop-controlled hydraulic clutch, designed for horizontal mounting, in a vertical motor centrifugal drive, which formerly could not be done in such driving arrangements because it was necessary to mount the coupling in an upside down position.

In the operation of this embodiment, the motor 30 is preferably maintained under constant rotation as heretofore mentioned, and torque is transmitted to the centrifugal through the scoop controlled fluid clutch, which slips and absorbs the heat generated during acceleration, thereby freeing the motor from overloads and overheating. The torque of the clutch 140 is varied by changing the position of the scoop 170. Adjustments of the scoop and of the torque produced by the clutch may be made either by manual control of the lever 174, or by automatic control of the lever 174 through mechanism of any suitable construction.

It will be understood that, in the use of this particular embodiment, as the centrifugal increases in speed there will be a reduction in the slip of the clutch and a reduction in torque transmission unless the amount of oil in the clutch is increased. Such increase may be effected through control of the scoop 170 when it is desired to maintain the accelerating torque of the clutch substantially constant.

The embodiment of Figures 7 to 11, inclusive, therefore will be understood to possess some but not all of the features and advantages of the embodiment of Figure 1 to 6, inclusive. This second embodiment may be employed to advantage, for example, in the processing of low grade massecuites where prolonged purging is desired at the maximum speed of the centrifugals and where quick control over the centrifugal drive is not essential. Inasmuch as the scoop controlled clutch as shown requires a substantial period of time, usually from six to ten seconds, to become emptied, and also a substantial period of time to become active and to react to changes in the scoop position, it will be evident that this particular form is not as satisfactory as the first embodiment.

In Figures 12 to 17, inclusive, I have illustrated a third embodiment of my invention, wherein the arrangement and combination of the centrifugal with its driving system, and the driving motor 30, may be substantially the same as in the previously described embodiments, but wherein the variable torque slip clutch is a friction clutch instead of a fluid clutch. The motor 30 is a hollow shaft motor mounted on a base plate 34 secured to the centrifugal frame-work F, as previously described, and a driven shaft 28b extends through the hollow motor shaft 32 and is connected with the basket-carrying spindle 12 through a flexible coupling inside of the centrifugal head 14 in any desired manner. To the upper end of the hollow motor shaft 32 is keyed a spider 202 which supports an annular friction rim 204 constituting one element of a mechanical clutch 200. Thus the friction rim 204 is kept in constant rotation with the motor.

The driven shaft 28b extends above the spider 202 and has keyed thereto a clutch arm 206 which extends to both sides of the shaft and carries oppositely disposed stub shafts 208 thereon. These stub shafts serve as fulcrums for clutch levers 210. The arcuate clutch shoes 212, having friction linings 214 thereon, are provided with backward extensions 216, each of which carries a forward stub shaft 218 and a backward

stub shaft 220. The stub shafts 218 and 220 of the respective extensions are arranged in parallel relation and swivelled in the clutch arms 210 on opposite sides of the stub shafts 208. See Figures 13, 15 and 16. It will therefore be evident that the clutch shoes and their extensions, the clutch levers 210 and the clutch arm 206 all rotate in unison on the shaft 28b, and also that the clutch levers 210 are free to turn in unison on their respective stub shafts 208 so as to cause the clutch shoes to be moved together either into or out of engagement with the inner surface of the friction rim 204.

Integral with each of the extensions 216 is a support 222 for a roller 224 that is disposed adjacent to the hub of the clutch arm 206. A clutch wedge 226 is mounted on the upper end of shaft 28b for sliding movement into engagement with the rollers 224. The wedge 226 is equipped with a non-rotary collar 228 which is movable in axial direction by a clevis 230 on one end of an actuating lever 232. The lever 232 is fulcrumed on a stationary pivot 234, and its other end is connected with the plunger 236 of a pressure cylinder 238. An inlet pipe 240 admits a fluid pressure medium into the cylinder from a suitable source of hydraulic or pneumatic pressure, the pipe preferably having a pressure operating valve 242 therein under the control of a lever 244.

The clutch levers 210 have weighted extensions 211 at one end thereof. Compression springs 246 are provided between these extensions and spring seats 248 integral with the shoe extensions 216. These springs keep the clutch shoes retracted from the rim when the machine is at rest.

The clutch lever extensions 211 are so weighted that they will counter-balance the weight of the clutch shoes 212, keeping the shoes from being pressed against the rim 204 by centrifugal force, and preventing the pressure of the shoes against the rim from being influenced by their speed of rotation. Pressure of the shoes against the rim is obtained, instead, by downward pressure on the clutch wedge 226, which applies a certain pressure to the rollers 224 and thence to the clutch shoes. The torque produced by the clutch is proportionate to the pressure applied to the clutch wedge. By means of the illustrated fluid-pressure control system, or any other suitable system, this torque is made subject to variation within wide limits.

At the start of a cycle of operation, the motor 30 may be running at half speed, or at full speed in the case of a single speed motor, and the friction rim 204 rotates at the motor speed. The centrifugal is started for loading by turning the control lever 244 to apply a certain fluid pressure in the cylinder 238 and thus obtain the desired torque for the loading operation. For the acceleration stage of the cycle the pressure regulating valve 242 is adjusted to provide the maximum pressure on the clutch shoes, or such other pressure as may be desired to obtain the desired accelerating torque. The clutch continues to develop a substantially uniform torque until the centrifugal has nearly reached the top speed of the motor, at which time the clutch stops slipping. At the end of the running stage of the cycle, particularly in the case of a two speed driving motor, the motor may be switched back to its lower or half speed, whereupon regenerative braking takes place while the clutch has a relative slip in a direction opposite to the direction of slip during the acceleration stage. When the centrifugal has been decelerated to approximately the lower motor speed, the pressure valve

242 is closed, causing the clutch to be automatically disengaged, and the mechanical brake 20 is applied to stop the machine. Again, the discharging operation may be carried out by slipping the clutch instead of jogging the motor.

The heat developed during acceleration and regenerative braking is developed in the clutch and is dissipated by suitable cooling means such as the water cooling system illustrated in Figure 14. As shown in that figure, a water housing 250 is mounted on the top of the motor casing 36 to surround the friction rim 204, seals 252 and 254 being provided between the rim and the housing to avoid the escape of liquid. A spray nozzle 256 is mounted in the housing 250 and arranged to deliver a water spray against the outer face of the friction rim 204. Water is delivered to the spray nozzle through an inlet pipe 258. A discharge pipe 260 communicates with the bottom of the housing 250 to draw off water collected therein.

From the foregoing descriptions it will be understood that each of the several illustrated embodiments of my invention possesses distinct features and advantages which are not available from known motor driven centrifugals. In each instance, the driving motor can be wound for a higher average horse power, because the heat developed during acceleration and during regenerative braking is absorbed by the slip clutch. The power drain on the motor is much more even than in the case of known motor driven machines, and extra high power peaks are eliminated. The motor can have an excess of power, and still the acceleration can be held to almost any desired period of time by reason of the variable torque transmission of the installation.

The loading and discharging of the centrifugal may be carried out more easily than in the case of known motor driven machines, and the excessive power peaks obtained when discharging such machines by jogging the motor are eliminated. The provision for constant rotation of the driving motor, either at full speed, or at half speed in the case of a two-speed motor, makes it unnecessary to accelerate the motor parts from standstill every cycle, and also enables the motor to cool itself efficiently while the basket and spindle assembly are decelerating or at rest.

The new combinations herein disclosed also have distinct advantages in respect of their mechanical arrangement and installation features. The centrifugal spindle and head may be suspended from the usual centrifugal framework, and the driving motor may be mounted on this framework in a conventional manner. This keeps the motor close to the head and contributes to efficient operation. The variable torque slip clutch becomes a part of the motor itself and is installed with the motor without requiring additional space or special supports. Nevertheless, the clutch is readily accessible and can be repaired or dismantled without disturbing the rest of the machine.

Although I have referred specifically to machines which would be operated at top speeds corresponding to the top speeds of the driving motors, I wish to point out that the new combinations herein disclosed may be employed for operations at speeds different from the motor speeds, for example, by the provision of frequency changers for the motors, or as disclosed in my copending application, Serial No. 394,423, filed May 21, 1941.

I have illustrated and described several specific embodiments of my invention in sufficient detail to permit the ready adaptation and use thereof

by those skilled in the art, but it will be understood that the various new features herein disclosed may be utilized in other ways and embodied in numerous forms and types of construction without restriction to the specific arrangements and details herein disclosed. I therefore desire that my invention be accorded a scope fully commensurate with its novel contributions to the art, as intended to be set forth in the appended claims.

I claim:

1. In a centrifugal machine comprising a suspended basket-carrying spindle and a driving shaft therefor, a variable torque hydraulic clutch having impeller and runner elements connected respectively with said shaft and said spindle to transmit torque therebetween, a clutch liquid supply system extending into the clutch, the clutch having means for discharging liquid therefrom, torque control means including shiftable valve means in said supply system to regulate the liquid supply to the clutch, an angularly movable member connected with said valve means and responsive to the torque of the machine to urge said valve means toward closed position, and means connected with said valve means for applying thereto a yieldable force to urge the same toward open position in opposition to such torque, whereby a maximum torque proportionate to such force may be maintained, and manually operable means accessible to an operator of the machine for regulating the force of said force-applying means so as to vary the maximum torque of the machine.

2. In a centrifugal machine comprising a suspended basket-carrying spindle and a driving motor having a driving shaft, means including a variable torque hydraulic clutch to transmit torque between said shaft and said spindle, and control means operative when said clutch is operative to limit the torque of the machine and hold the acceleration thereof substantially constant, said control means comprising means shiftable in response to said torque in a direction to reduce the quantity of liquid in said clutch, means to apply to said shiftable means a predetermined force opposing the action of said torque thereupon and tending to increase the quantity of liquid in said clutch, and manually operable means for rendering said force-applying means active and inactive.

3. A machine as described in claim 2 wherein the force-applying means comprise means for supplying fluid under pressure to said shiftable means, and wherein the manually operable means comprise a variable pressure-regulating valve for turning off and on the fluid pressure and selecting desired values thereof.

4. In a centrifugal machine comprising a suspended basket-carrying spindle, a motor thereabove having a driving shaft, and a hydraulic coupling for delivering torque from said shaft to said spindle, means for supplying liquid into and for discharging liquid from said coupling, control means operative when said coupling is operative to vary the action of the aforesaid means, said control comprising means shiftable in reaction to said torque in a direction to decrease the filling of the coupling, means to apply to said shiftable means a predetermined force opposing the action of said torque thereupon and tending to increase the filling of the coupling, and manually operable means for rendering said force-applying means active and inactive whereby to start and stop the transmission of power to the spindle.

5. In a centrifugal machine for cyclical opera-

tion including a suspended basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, a flexible connection between the lower end of said driven shaft and said spindle, and slip clutch means above said motor including cooperating clutch elements secured to said driven shaft and said hollow shaft, respectively, and operative to slip and generate heat therein whenever the torque thereon exceeds a predetermined value.

6. In a centrifugal machine for cyclical operation including a suspended basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, a flexible connection between the lower end of said driven shaft and said spindle, variable torque slip clutch means above said motor for transmitting torque from said hollow shaft to said driven shaft, and control means operable during operation of the centrifugal for varying and controlling the torque developed by said clutch means.

7. In a centrifugal machine for cyclical operation including a suspended basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, means connecting said driven shaft for rotation with said spindle and hydraulic clutch means mounted on the upper end of said motor and having cooperating clutch elements connected respectively with said hollow shaft and said driven shaft.

8. In a centrifugal machine for cyclical operation including a suspended basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, means connecting said driven shaft for rotation with said spindle, and a scoop-controlled hydraulic clutch mounted above said motor having an impeller and a runner connected respectively with said driving shaft and said driven shaft for transmitting torque from said motor to said spindle, said clutch having a housing connected to rotate therewith and to receive and hold liquid expelled from between the clutch members during operation, control means including an adjustable scoop to withdraw liquid from said housing and recirculate the liquid between the clutch members, and means to vary the setting of said scoop to vary the volume of liquid between the clutch members and thus select the torque to be delivered from the motor to the machine.

9. In a centrifugal machine for cyclical operation including a suspended basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, means connecting the lower end of said driven shaft for rotation with said spindle, a variable torque friction clutch mounted at the upper end of said motor and having clutch members connected respectively with said hollow shaft and the upper end of said driven shaft for transmitting torque from said motor to said machine, fluid pressure responsive means associated with said clutch to determine the friction and thereby the maximum torque transmission thereof, and means operable at will in the use of the machine for supplying fluid under pressure to

said pressure responsive means, fluid pressure-responsive means for pressing said clutch members together to set the friction and thereby the maximum torque transmission thereof, and means operable at will in the use of the machine for supplying fluid under pressure and for discontinuing the fluid pressure to said pressure-responsive means.

10. In a centrifugal machine for cyclical operation including a suspended, gyratory, basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, a positive but flexible connection between the lower end of said driven shaft and said spindle, a variable torque hydraulic clutch mounted at the upper end of said motor, said clutch including an impeller connected for rotation with said hollow shaft and a runner connected for rotation with said driven shaft, and means responsive to the torque being delivered to said spindle for controlling the volume of liquid in the clutch so as to hold substantially constant the accelerating torque of the machine.

11. In a centrifugal machine for cyclical operation including a suspended, gyratory, basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, a positive but flexible connection between the lower end of said driven shaft and said spindle, a variable torque hydraulic clutch mounted at the upper end of said motor including an impeller connected for rotation with said hollow shaft and a runner connected for rotation with said driven shaft, said hydraulic clutch including means responsive to the torque developed thereby for automatically controlling the volume of fluid therein so as to maintain the accelerating torque thereof substantially constant.

12. In a centrifugal machine for cyclical operation including a suspended, gyratory, basket-carrying spindle, an electric motor having a hollow driving shaft mounted in vertical position above said spindle, a driven shaft extending vertically through said hollow shaft, a positive but flexible connection between the lower end of said driven shaft and said spindle, a variable torque hydraulic clutch above said motor including an impeller connected for rotation with said hollow shaft and a runner connected for rotation with said driven shaft, said hydraulic clutch including means rotatable with said impeller but movable relative thereto in response to variations in the torque thereof for controlling the amount of fluid in, and thereby maintaining uniform the torque transmission of, said clutch.

13. In a motor driven centrifugal machine comprising a suspended basket-carrying spindle, an electric driving motor mounted in vertical position on framework above said spindle, said motor having a hollow driving shaft, a driven shaft positively but flexibly connected with said spindle and extending vertically through said hollow shaft, a variable torque hydraulic clutch mounted on top of said motor and having cooperating impeller and runner members connected respectively for rotation with said hollow shaft and said driven shaft to transmit torque therebetween, a clutch liquid supply system extending into the clutch, the clutch having means for discharging liquid therefrom, torque control means including shiftable valve means in said supply system to regu-

late the liquid supply to the clutch, an angularly movable member connected with said valve means and responsive to the torque of the machine to urge said valve means toward closed position, and means connected with said valve means for urging the same toward open position with a predetermined force opposing such torque, whereby a maximum torque proportionate to such force

5 may be maintained, manually operable means for rendering said liquid supply system active or inactive, and brake means including a brake drum mounted for rotation with said spindle, whereby the machine may be stopped by the brake with the motor running when the supply system is rendered inactive.

JOSEPH HERTRICH.

CERTIFICATE OF CORRECTION.

Patent No. 2,380,595.

July 31, 1945.

JOSEPH HERTRICH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, first column, line 71, claim 9, beginning with the word "fluid" strike out all to and including "means," in line 1, second column, same claim; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of December, A. D. 1945.

Leslie Frazer

First Assistant Commissioner of Patents.

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