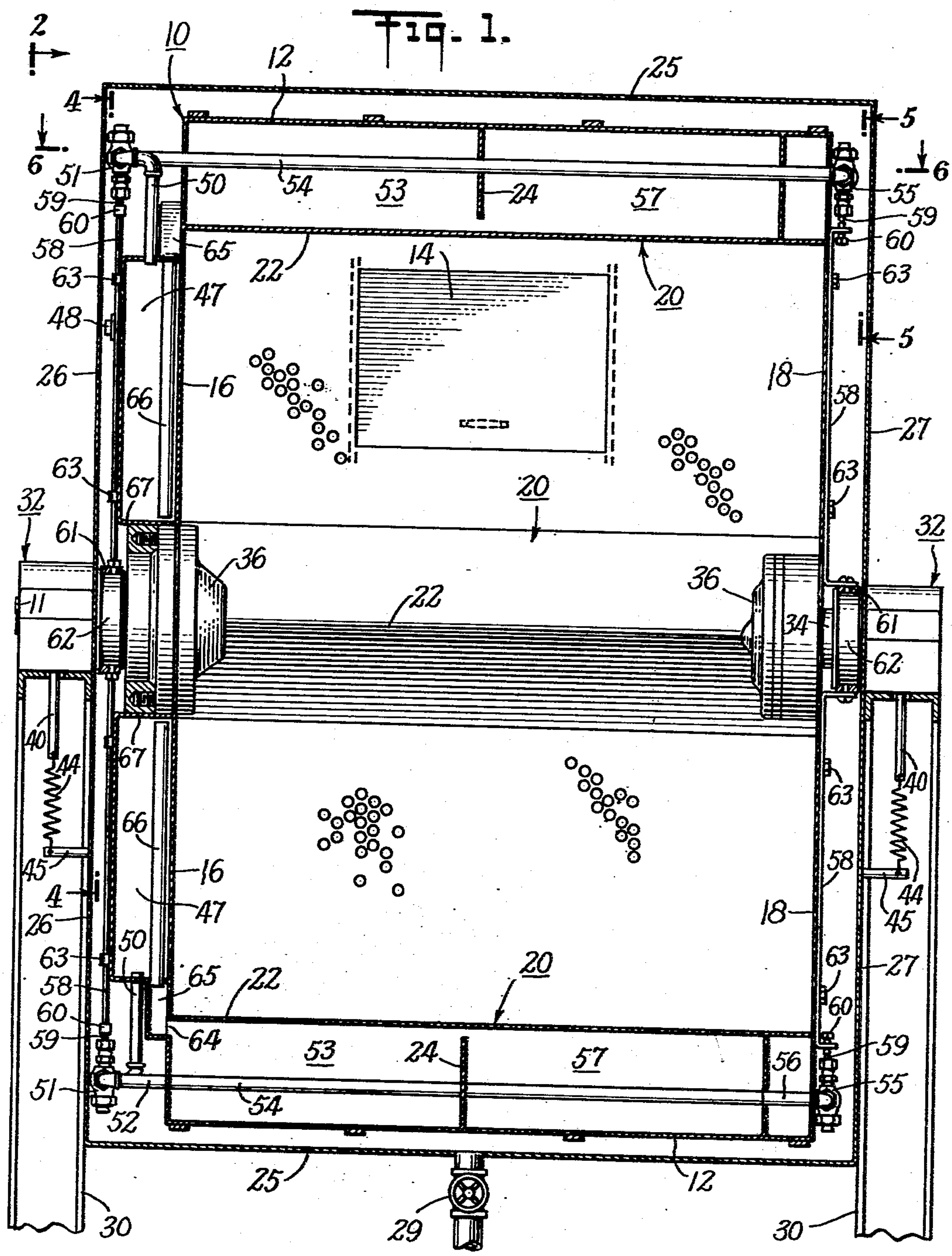
Aug. 24, 1954 F. J. ARMSTRONG 2,687,215

AUTOMATIC BALANCING OF HORIZONTAL EXTRACTORS

Filed Dec. 29, 1951 6 Sheets-Sheet 1

Fig. 1.

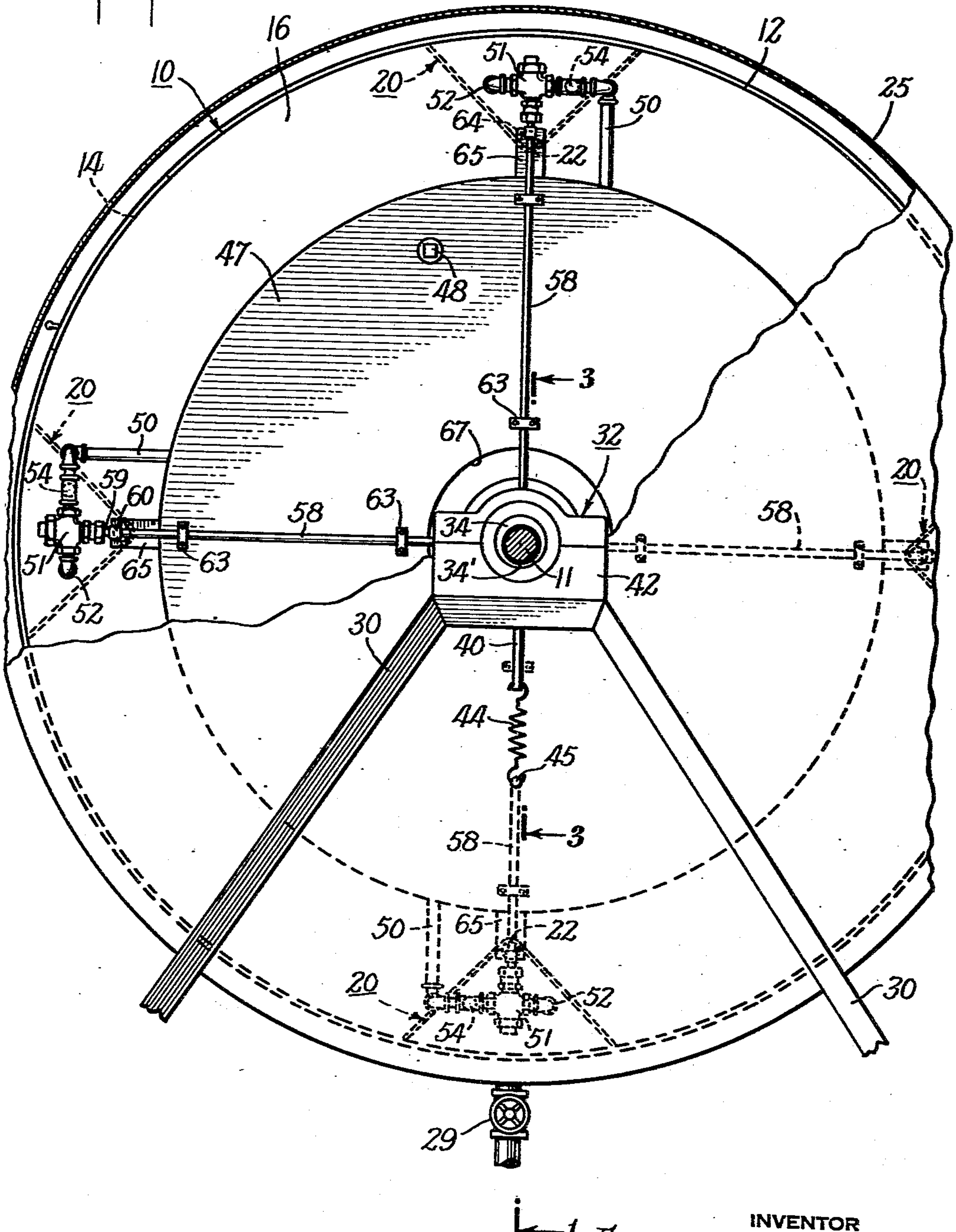


INVENTOR
Francis J. Armstrong
BY
Curtis, Morris + Safford
ATTORNEYS

AUTOMATIC BALANCING OF HORIZONTAL EXTRACTORS

Filed Dec. 29, 1951 6 Sheets-Sheet 2

FIG. 2.



INVENTOR
Francis J. Armstrong
BY
Curtis, Morris + Safford
ATTORNEYS

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Filed Dec. 29, 1951 6 Sheets-Sheet 3

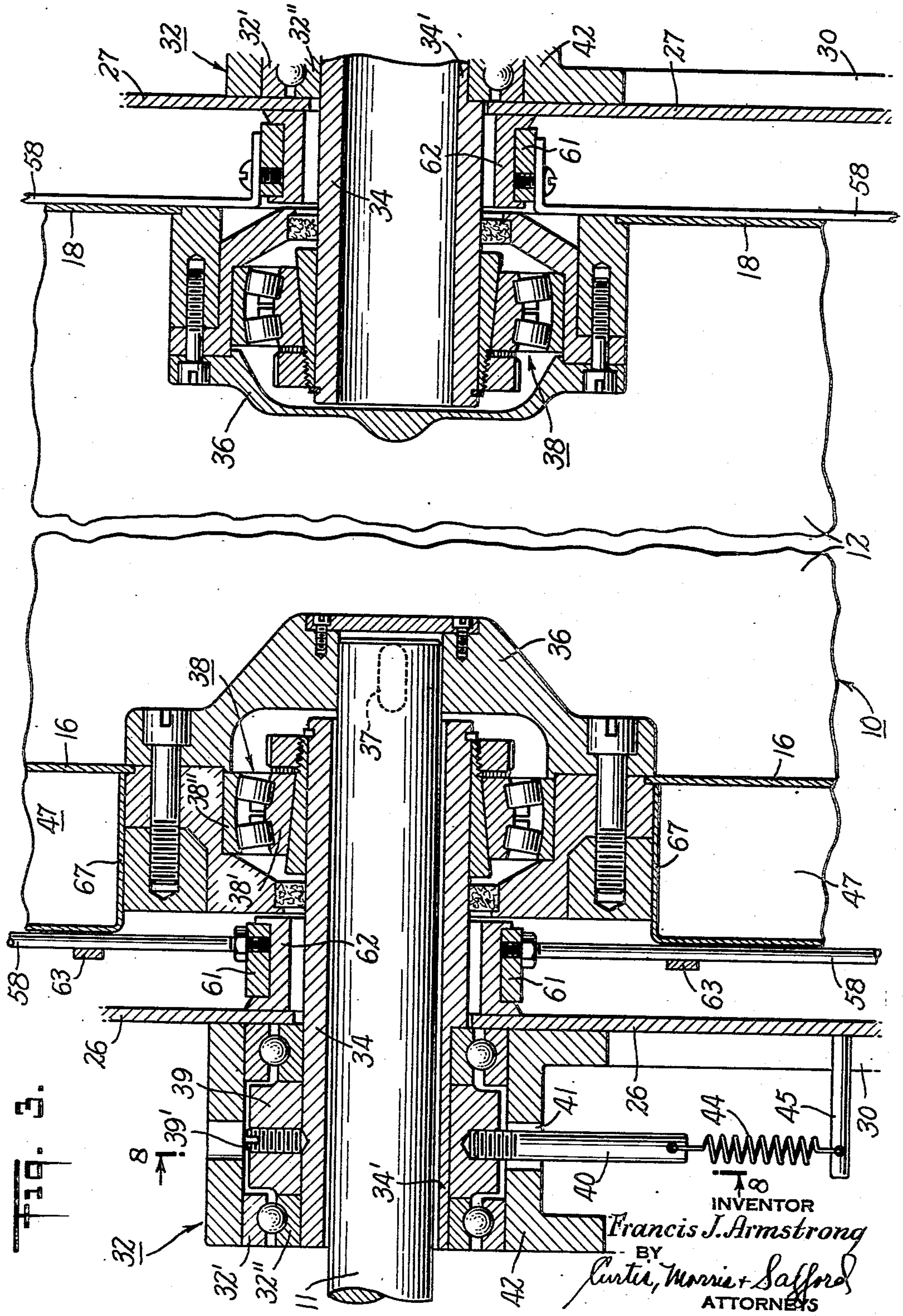

FIG. 3.

INVENTOR
Francis J. Armstrong
BY
Curtis, Morris + Safford
ATTORNEYS

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6 Sheets-Sheet 4

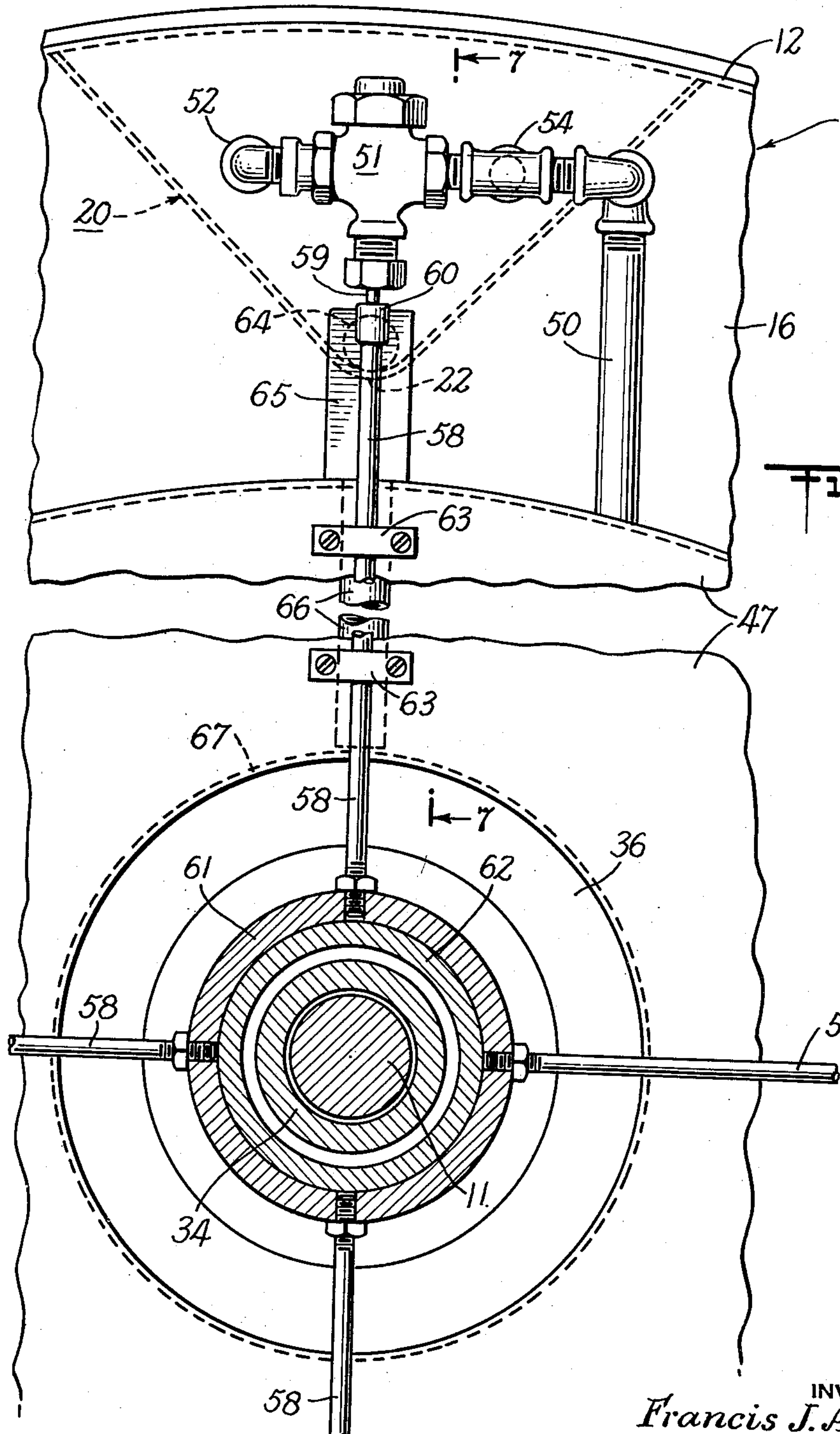

FIG. 4.

INVENTOR
Francis J. Armstrong
BY
Curtis, Morris & Safford
ATTORNEYS

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6 Sheets-Sheet 5

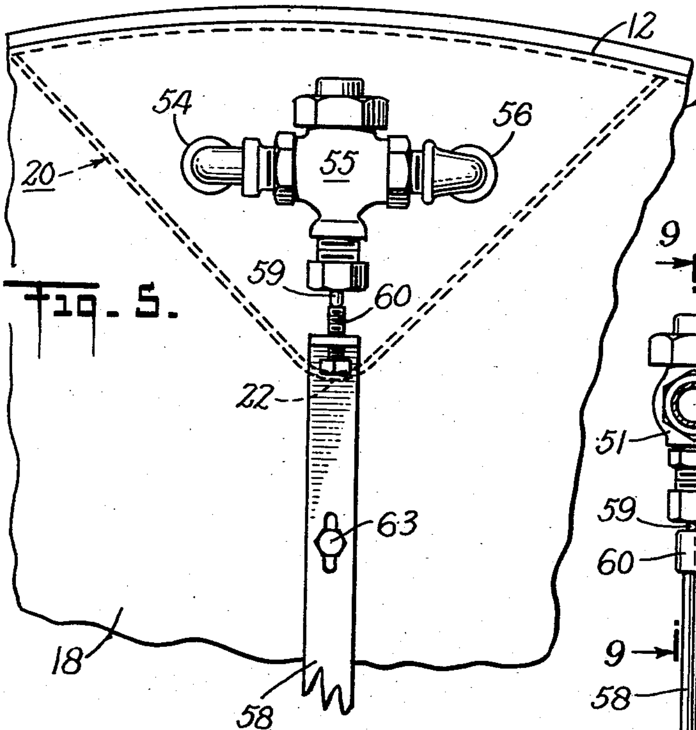


FIG. 5.

FIG. 7.

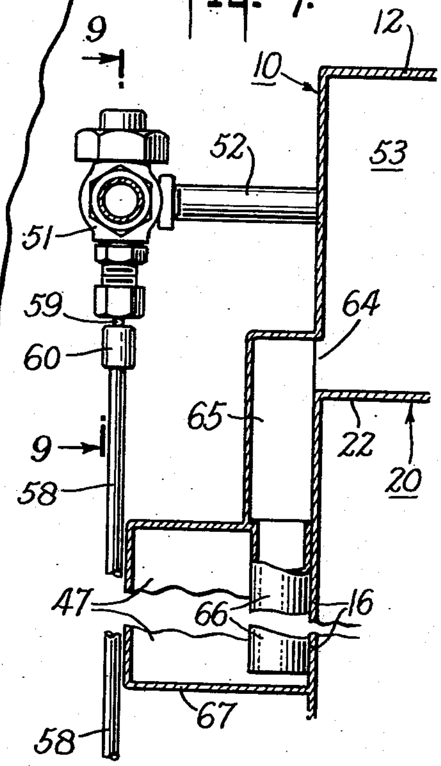
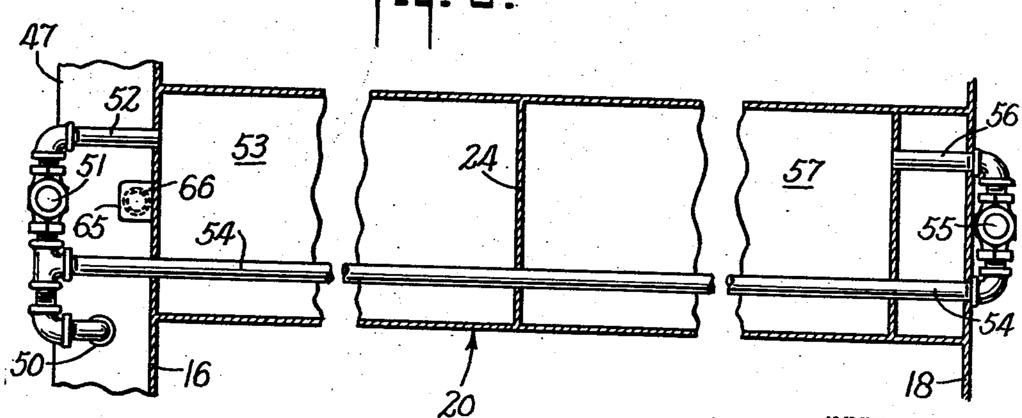


FIG. 6.



INVENTOR
Francis J. Armstrong
BY
Curtis, Morris + Safford
ATTORNEYS

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6 Sheets-Sheet 6

FIG. 8.

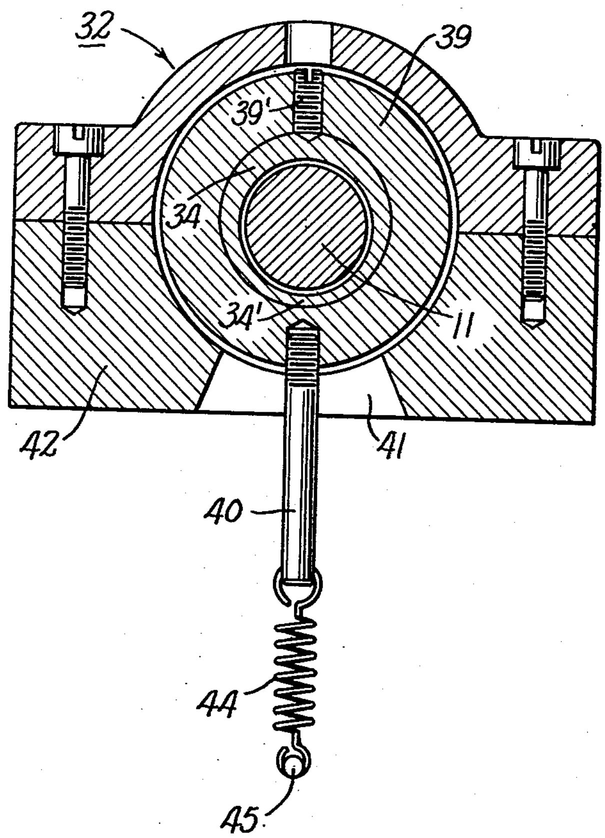
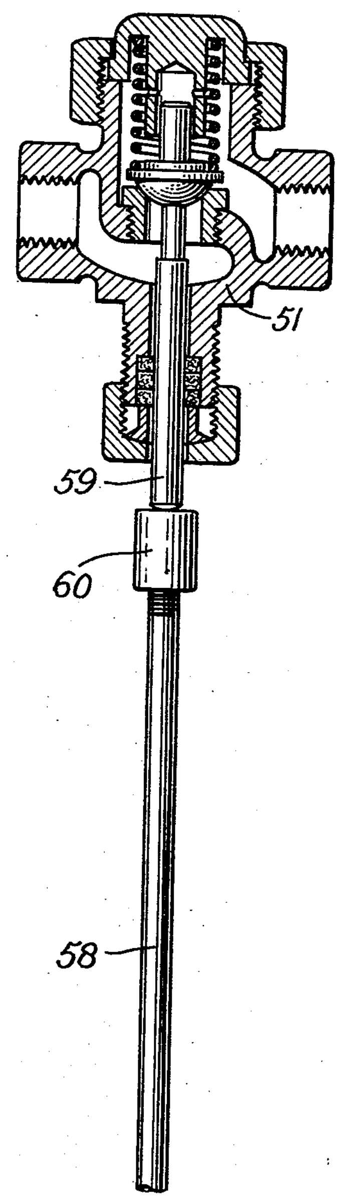


FIG. 9.



INVENTOR
Francis J. Armstrong
BY
Curtis, Morris & Safford
ATTORNEYS

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2,687,215

UNITED STATES PATENT OFFICE

2,687,215

AUTOMATIC BALANCING OF HORIZONTAL EXTRACTORS

Francis J. Armstrong, Fayetteville, N. Y., assignor to United States Hoffman Machinery Corporation, New York, N. Y., a corporation of Delaware

Application December 29, 1951, Serial No. 264,127

16 Claims. (Cl. 210—71)

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This invention relates to improvements in automatic balancing devices, where a liquid is used to balance a rotating tumbler, and particularly to compensate or correct unbalance of horizontally rotative washing and/or drying cylinders, such as are empoyed in laundries and dry cleaning establishments. These usually comprise a perforate cylindrical wall supporting a plurality of peripheral tumbling ribs, extending lengthwise between the ends of said cylinder.

In the use of a rotary tumbler of this type for drying clothes it is difficult equally to distribute the weight of the load placed therein for treatment, as a result of which, because of the action of unbalanced centrifugal forces, the cylinder will have a tendency to vibrate dangerously at the higher extracting speeds of rotation.

It is therefore an object of this invention to provide a machine of this type with novel, simple and effective means which will automatically compensate for unequal loading of the machine or for dynamic unbalance due to other causes.

Other objects of the invention are in part obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the features of construction, combination of elements, and arrangement of parts, described herein, and the scope of the application of which will be indicated in the following claims.

In the drawings which embodies one suitable embodiment of the invention.

Fig. 1 is a vertical section taken on center line 1—1 of Fig. 2, as indicated, the supporting structure being broken away;

Fig. 2 is a partial left end view on line 2—2 of Fig. 1, with some parts indicated by broken lines;

Fig. 3 is a larger scaled longitudinal section, taken on line 3—3 of Fig. 2, showing the cylinder bearings in greater detail, other parts being broken away;

Fig. 4 is a partial enlarged detail in end elevation and vertical section, taken on line 4—4 of Fig. 1; the housing being shown partly broken away;

Fig. 5 is an enlarged detail on line 5—5 of Fig. 1;

Fig. 6 is a broken cross section on line 6—6 of Fig. 1;

Fig. 7 is a vertical section on line 7—7 of Fig. 4;

Fig. 8 is a vertical section thru the supporting frame structure and bearings for the cylinder drive shaft and eccentric shaft associated therewith, taken on line 8—8 of Fig. 3 and

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Fig. 9 is a vertical valve detail on line 9—9 of Fig. 7.

Similar reference characters refer to similar parts throughout the drawings.

Before taking up the description of the present apparatus it may be well to refer briefly to the many efforts which have heretofore been made by engineers and others concerned with the operation of rotating washing cylinders, and/or drying tumblers or extractors, to find a satisfactory way to promote the object above set forth. Much has been done along this line in the case of vertical centrifugal extractors and, to some extent, attention has been paid to the balancing of horizontal extracting cylinders.

In the former category, among the various means employed, has been the automatic addition of balancing liquid to the light side or removal thereof from the heavy side of unbalanced baskets rotating about vertical axes. Such devices may be understood by reference to such patents as Stillman 305,026 or Verdier et al. 2,224,241. In each of these devices the automatic control of liquid flow for balancing purposes has depended upon the degree of wobble or gyration of the basket, with reference to its normal running axis, caused principally by unbalanced loading of the basket. Such devices, suitable for vertical extractors, may not easily be adapted for use with cylinders rotating about horizontal axes, especially where, as in the present case, centrifugal forces, due to unbalance, are to be directly applied to effect the operation of balancing fluid controlling devices.

Some attempts have been made to attain the desired end in the case of horizontal washing and/or extracting machines, the cylinder shafts of which have been rotated, as usual, in rigid bearings, the vibrations due to unbalance of the rotating drum or of its housing or even of the extended drum shaft being detected by delicate electrical instrumentalities which by commutation and electronic amplification have passed on sufficient electric potential to effect the operation of solenoid valves, which in turn have controlled admission of fluid to balancing tanks disposed within the rotating cylinder. Vibration controlled systems of this kind are extremely delicate and unnecessarily costly. They require a great deal of expensive servicing and are generally objectionable because of the necessity of firmly securing the machines to the floor of the establishment, or by the employment of resilient mountings.

In the development of the present invention, the aim was to discover a means which would be sensitive to off balance in the load and which could apply centrifugal forces of unbalance directly to operate compensating mechanism. Many indirect means for accomplishing this purpose were considered but found inadequate. Moreover, none of them seemed satisfactorily to solve the problem. What was wanted was a means actuated by the cylinder itself and its relation under unbalanced condition to a fixed reference point, as, for example, the support axis of the rotating mass of the tumbler.

The use of resilient spokes supporting the cylinder seemed a natural approach to the problem. This would permit the basket to move to an eccentric position with respect to its own drive shaft when the load was eccentric. Such movement could then actuate mechanism directly without outside power, and without commutation. Several embodiments of the resilient spoke idea were tried but all had the common fault that the basket was to an extent always eccentric, due to the gravity component of the forces involved.

Many structures were considered which would permit the basket to move horizontally, but be constrained as to vertical motion. The best idea seemed to be a form of pendulum suspension of the basket and its shaft. In such suspension, gravity would not affect the relation of cylinder and shell under static conditions, nor under normal running conditions. Horizontally acting forces could, however, cause the cylinder to shift from side to side. It was found necessary, however, to consider the problem of resonance to the extent that it was desirable to avoid a condition wherein the natural frequency of the pendulum would coincide with the impressed frequency of the rotation speed and create dangerous or critical vibration.

For example, should a pendulum length for period slower than extraction speed be arbitrarily established, oscillation at top speed would be resisted and a critical speed would result, through which it would be necessary to pass as acceleration of the rotation speed occurred. On the other hand, a length chosen for frequency above rotation speed would have to be very short, measuring only a small fraction of an inch. This would place the fulcrum point of the pendulum within the shaft diameter and present a difficult construction problem.

The natural period for a free pendulum is:

$$F=\sqrt{\frac{G}{L}}\times\frac{60}{2\pi} \text{ or } F=9.55\sqrt{\frac{386}{L}}$$

where

F=frequency of pendulum.
G is acceleration due to gravity.
L is length of pendulum in inches.

Assuming a desired extraction speed of 500 to 700 R. P. M., then an arbitrary selection of 800 for frequency F—to be substantially higher than extraction speed—would make L (length of pendulum) equal to .055'', or thereabout.

In the present case the pendulum comprises the cylinder with its shaft and bearings acting at center of gravity located at center of rotation. The suspension of this pendulum "bob" on a fulcrum only .055'' above the shaft center, with a shaft required to be some 3'' in diameter, presented a problem. This was solved by the provision of a secondary bearing arrangement for support of the mass, having its center located .055'' above that of the main rotation bearings. This allowed the main shaft to rotate on its own bearings but also to oscillate on the support bearings.

A model made according to the above calculation disclosed that the .055'' eccentricity, while correct for frequency, produced a self-locking tendency and would not reliably respond to horizontal forces. To overcome this difficulty the pendulum length was increased and, to avoid resonance, the free pendulum idea was somewhat departed from by introducing a restoring spring to stiffen the oscillating system and to increase the frequency. This spring accomplished two desirable results:

(1) Ability to increase the pendulum length to .125'' without decreasing its natural frequency. This increase in length eliminated the self-locking effect and allowed horizontal forces to "swing" the cylinder.

(2) The spring, as can be seen by reference to the drawings which will presently be fully explained, acts in line with the support and rotation bearing centers, at either or both ends of the cylinder, through arms attached to oscillatory eccentric stub shafts which carry and oscillate with the cylinder. When the cylinder swings on its approximate ⅛'' off center radius, the arm, or arms, oscillate and, in doing so, stretches the spring (or springs in the case of a cylinder supported at both ends). A slight motion of the cylinder is multiplied many times at the point of spring attachment. In a case where the arm is 7 inches long the cylinder's oscillatory motion is thus multiplied by 56 (putting inches in terms of eighths of an inch).

Spring tension increases greatly with the amplitude of swing of the cylinder but offers slight resistance to oscillation at small magnitude. This restriction proved valuable as it was found that at large amplitude, say 30°, reliable balance could not be achieved (because of lag between cause and effect), but at amplitude of 3 or 4 degrees balance was excellent.

By using a stop action stroboscope and operating with a fixed off center test weight in the cylinder, it was found with large amplitude (swing restricted only by free pendulum action) the off-balance load was seen to be at the top vertical or zenith position when maximum horizontal swing had taken place. This indicated that cause and effect were 90° out of phase, rendering good balance impossible. With restricted amplitude and increased frequency of oscillation, because of strong spring action, it was found that the fixed weight was in horizontal position at approximately the same time that maximum horizontal swing occurred, showing that for small amplitudes the disturbing cause and its effect on the pendulum were in step with each other.

The above discussion of the aims and objects of the invention will be more clearly understood by reference to the following description of this present embodiment of the invention, with specific reference to the drawings which disclose a tumbler drum or cylinder **10** (see Figs. 1 and 2).

The present apparatus comprises a tumbler suitable for washing, extracting and/or drying laundry materials or other articles of a similar nature. The tumbler **10** comprises a perforated cylindrical sheet or wall **12** and is mounted on a rotatable shaft **11** which may be driven by any conventional means, as motor or belt, (not shown) and may be reversible, or rotatable at different speeds. A conventional type of sliding door 14 is provided for loading and unloading the cylinder, which latter is provided with left and right hand integral heads 16 and 18 and tumbling ribs 20, in the present construction, four in number, integrally disposed equidistant about the interior of said cylinder. Each rib extends from head to head as shown. Each rib serves as, or may contain, a tank adapted selectively to receive balancing liquid to compensate for any unbalanced condition of the loaded cylinder. These tanks or ribs 20 are angular in shape with the vertex of the angle disposed radially a suitable depth within the cylinder sheet, as indicated at 22. Each tank has an axially central transverse partition 24 which extends from the cylindrical wall 12 down to a point short of said vertex 22, thus dividing the tank into right and left portions connected solely by the space beneath the partition 24.

Surrounding the tumbler is a housing 25 having end walls 26 and 27, and which may be supported by standards 30, Figs. 1, 2 and 3. The housing serves as a tub to hold washing or dry cleaning solution, which may be supplied in any usual manner, and be drained off by means of a suitable dump valve, as 29.

The housing structure is rigidly supported by the said standards 30 which carry support bearings 32 at either end of the housing. Each of these bearings comprises an outer ball race 32′ (see Fig. 3), which is supported by the support bearing, and an inner ball race 32″ which supports stub shafts 34, one at each end of the cylinder. These stub shafts have eccentric portions 34′ which may oscillate in the support bearings 32. They are, however, restrained from complete rotation. Each head of the cylinder carries a rigid hub structure 36, which is mounted to rotate about a self-aligning bearing 38 having an inner ball race 38′ rigid with the inner ends of the two stub shafts, and an outer ball race 38″ rotatable with the cylinder. In the drawings the hub members are shown as of separable sectional construction. This is for ease of assembly, and is not a necessary feature of the invention.

As stated in the earlier discussion herein, the support axis for oscillation is normally located ⅛″ higher than the axis for rotation. Hence the support bearings 32 are centered ⅛″ higher than the rotation bearings 38. The cylinder thus depends from the support bearings as the bob of a pendulum of short length, which condition normally tends to hold the stub shafts in the position best shown in Fig. 3.

As will be seen, the drive shaft centers with the hubs, to one of which it is coupled to cause rotation of the cylinder. It is here shown connected to the left hand hub by means of a sliding key 37 which serves as a universal joint to permit slight relative motion between shaft and cylinder when the latter is oscillated about the support bearings. The universal might be of the "Oldham" type. In many cases there is sufficient resilience in the drive shaft itself to take care of the very slight eccentric condition which takes place during cylinder operation. It will be noted that each of the support bearings 32 comprises two separate bearing structures, spaced apart to give better support to the cylinder. However, there is no intention to limit the cylinder support to this specific construction, as a single support bearing for each stub shaft may be used.

Advantage is taken of the present arrangement, to mount between the separate parts of the support bearing of each stud shaft a collar or

sleeve 39, held rigid with the stub shaft by means of a set screw 39′. Each collar 39 has depending therefrom an arm 40, threaded or otherwise attached to the bottom part of the collar, which extends downwardly through a slot 41 formed in the base of the bearing block 42. Each arm 40 is attached by means of a tension spring 44 to an end wall of the housing 26, as by means of a pin 45.

The left hand cylinder head 16, as seen in Fig. 2, has a concentric annular closed chamber or reservoir 47 secured thereto in a liquid tight manner, as by welding. This reservoir may be filled to a desired level with balancing liquid, through an opening provided for that purpose, as indicated by the plug 48 in Fig. 2. Any suitable balancing liquid may be used. Perchloroethylene—weighing about 13 lbs. to the gallon—has been found satisfactory. The tanks or ribs 20 have sufficient volume to hold adequate masses of such liquid, that the desired balanced condition of the tumbler may be attained. The annular reservoir 47 is made of a size to hold more liquid than will need be supplied to the ribs to balance any ordinary unbalanced condition occurring in normal operation, as the present mode of operation requires extra free space within the reservoir, as will be explained later.

Feed of balancing liquid from the reservoir tank 47 to the ribs 22 is effected by centrifugal force supplied by an annulus of liquid which will form against the cylindrical wall of said reservoir after the cylinder has begun to rotate at a sufficient speed. The fluid is thus flung outwardly through conduits 50 extending between the periphery of the reservoir 47 and the end of each tank 20 which abuts the left end of the cylinder. Conduit 50 leads to a control valve 51 from which liquid flows through one branch pipe 52 into a tank compartment 53, disposed to the left of the partition 24. The conduit 50 is also connected by means of a branch pipe 54, which passes through each rib 20 to a similar control valve 55 carried by the right hand head 18 of the cylinder. Valve 55 connects by means of a pipe 56 with tank compartment 57 occupying the space within the rib to to the right of the partition 24.

Valves 51 and 55 are of the poppet valve type, the construction of which is clearly shown in Fig. 9 of the drawings. Each valve, left and right, is under the control of a push rod 58, which, when the cylinder oscillates, as will be explained, is engaged by the valve stem 59. A push rod length adjustment is indicated at 60. It will be understood then that each tank compartment may be supplied by a poppet valve located adjacent the respective end of the tank, in fixed relation to the approximate cylinder heads.

The inner ends of the push rods 58 are threaded and locked, as shown in Fig. 1, into a sleeve 61, which is rotatable upon a concentric bearing member 62, mounted in fixed relation to the supporting frame or housing of the machine, which sleeve is coaxial with the true rotation center of the structure. Thus whenever the cylinder is caused to oscillate, the push rods, rotating with the cylinder, serve to actuate the valve stems to open certain of the valves. Guides 63 attached to the cylinder cause the push rods 58 to rotate with the cylinder but permit the rods to move radially with respect to the cylinder to actuate the valve stems. The reason that the rib tanks comprise a section of tank at each end of the cylinder, which connect as above described, is so that balancing liquid may be admitted to both portions simultaneously if the cylinder unbalance is evenly distributed throughout the length of the cylinder, or more readily flow into one end section of a tank or tanks than into the other, should the condition of unbalance exist more at one end of the cylinder. Thus it will be seen that the flow of liquid from the reservoir 47 is controlled by a valve leading to its respective compartment, one valve at one end and one at the opposite end for each of the four ribs.

Reference to Fig. 1 will disclose that the push rods 58, disposed at the reservoir end of the cylinder, extend directly to their respective valves 51 without offsets; while the push rods 58 at the other end of the cylinder lie close to the surface of the head at that end and are offset somewhat at their two ends to provide engagement with the cooperating collar 61 and stems of valves 55. The difference is purely a matter of design and does not affect operation.

The mode of operation of the device in accomplishing compensation for an unbalance, which may be the result of an uneven disposal of the wash-load in the cylinder, will be readily understood from the following description, it being remembered that the center of oscillation coincides with the center of support and is normally directly above the center of rotation, which is the normal center of mass of the cylinder structure. Under normal balanced conditions it will be seen that no oscillation takes place. It follows then that the weight of the cylinder acts on each of the centers of support through a vertical line. When, however, there is unbalance, the center of mass no longer acts through vertical lines at all times or positions of the cylinder. During rotation of the cylinder the center of rotation will be caused to oscillate about the center of support until balance is restored and the center of mass coincides once more with the center of rotation.

When the speed of rotation is sufficient to cause oscillation of the cylinder it will be seen that an unbalanced load at one side of center will cause a swinging movement of the cylinder to that side, or in the direction of an unbalanced centrifugal force. A very small movement in this direction will cause a valve stem on the light side to come into contact with its push rod, opening the valve and permitting liquid to flow into the rib on the said light side.

As the cylinder continues to rotate the valves on the light side will be opened and closed in succession so long as their stems continue to engage their push rods. Usually the one or two tanks which are more or less symmetrically opposite the unbalanced load will take fluid, but this action will, in fact, be quickly discontinued, as balance is attained almost immediately. When this occurs the valves will cease passing liquid and the balanced condition will be maintained until the cylinder is slowed down to a stop. During this latter period of operation the liquid will drain by gravity back to the reservoir by means of openings 64 formed adjacent the tank vertex 22 at the left end wall of the tanks. From the openings conduits 65 pass through the peripheral wall of reservoir 47 when they connect with pipes 66, leading down to within short distance of the inner wall 67 of the liquid reservoir.

While the balancing liquid admission valves are described above in their relation to the two end bearing embodiment it should be understood that the eccentric means of operation may apply with equal facility to the single support bearing

of a cantilever, or open end type of extracting cylinder.

As many possible embodiments may be made of the mechanical features of the above invention, without departing from the scope of invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In apparatus of the character described, in combination, an extractor cylinder adapted to be rotated about a normal horizontal axis, eccentric bearing means supporting said cylinder to permit and compel said cylinder to oscillate as a pendulum, due to unequal distribution of weight, to carry its axis of rotation to horizontally lateral positions with respect to said normal rotation axis, means for supplying balancing liquid, a plurality of tanks distributed evenly about the periphery of said cylinder, and means carried by said cylinder and cooperative with said eccentric supporting means to effect a flow of balancing liquid to a tank or tanks mounted diagonally opposite that side of the cylinder which may be heavier by reason of unequal weight distribution.

2. Apparatus as in claim 1 in which said means for supplying balancing liquid comprises a closed annular chamber mounted upon a head of and rotatable coaxially with said cylinder and connected peripherally by means of conduits with each of said tanks, whereby liquid will tend to flow into said tanks by centrifugal force, and means associated with said conduits and with said eccentric means supporting said cylinder for oscillation, normally adapted to intercept the said flow to said tanks, and movable to positions for admitting liquid to said tanks selectively, upon oscillation of said cylinder because of unequal weight distribution.

3. Apparatus as in claim 1 in which said means for supplying liquid is positioned and normally adapted to tend to pass liquid to said tanks, means normally positioned to prevent the passage of balancing liquid to said tanks, and means cooperative with said last means and with the eccentric supporting means for said cylinder and movable in response to out-of-balance oscillations of said cylinder for selectively admitting liquid to said tanks to compensate for said unequal weight distribution.

4. In apparatus of the character described, in combination, an extractor cylinder, a hollow shaft mounted horizontally in rigidly disposed support bearings and having a journal whose normal axis is offset below the axis of said support bearings and is adapted to swing laterally about the axis of said support bearings, bearings for rotatably mounting said cylinder on said journal, a rotary drive shaft extending loosely within said hollow shaft and universally connected in substantial alignment with the normal axis of said journal bearings, a plurality of receptacles distributed evenly about the periphery of said cylinder, a source of balancing liquid normally tending by centrifugal force to enter said receptacles during rotation of said cylinder, means normally preventing such entrance, and means controlled by lateral oscillation of said hollow shaft journal with respect to its support bearings, because of an out-of-balance condition of said cylinder, for enabling said preventing means to admit balancing liquid selectively to said receptacles to compensate for such condition.

5. In apparatus of the character described, in

combination, a cylinder, a hollow shaft mounted for support in rigidly disposed bearings and having a journal whose normal axis is offset below the axis of said support bearings, a bearing for rotatively mounting said cylinder on said journal, a drive shaft extending loosely within said hollow shaft and universally connected in normal alignment with the geometric axis of said cylinder, means for supplying balancing liquid, receptacles distributed about the circumference of said cylinder to receive successive masses of said liquid in order to correct an out-of-balance condition of said cylinder, and means active during rotation of said cylinder selectively to control the admission of said masses of liquid to said receptacles, due to lateral movements of said journal axis to one side or the other with respect to its normal axis.

6. In apparatus of the character described, in combination, a cylinder, a hollow shaft mounted for support in rigidly disposed bearings and having a journal whose normal axis is offset below the axis of said support bearings by a distance substantially less than the radius of said hollow shaft, a bearing for rotatively mounting said cylinder on said journal, a drive shaft extending loosely within said hollow shaft and universally connected in normal alignment with the geometric axis of said cylinder, means for supplying balancing liquid, receptacles distributed about the circumference of said cylinder to receive successive masses of said liquid in order to correct an out-of-balance condition of said cylinder, and means active during rotation of said cylinder selectively to control the admission of said masses of liquid to said receptacles, due to lateral movements of said journal axis to one side or the other with respect to its normal axis.

7. In apparatus of the character described, in combination, a cylinder movable about horizontal rotation bearings, and means for effecting lateral movement of said cylinder with respect to a normal horizontal position when the cylinder is out of dynamic balance, comprising oscillatable supporting members for suspending said rotation bearings from fixed support bearings to permit lateral oscillation of said cylinder as a pendulum with the support bearings as the center of oscillation, the pendulum length being selectively short to effect a predetermined rapid vibration, the period of which will not be in resonance with the natural period of vibration of the cylinder due to its rotation at normal extraction speeds.

8. In apparatus of the character described, in combination, a cylinder movable about horizontal rotation bearings, means for effecting lateral movement of said cylinder with respect to a normal horizontal position when the cylinder is out of dynamic balance, comprising oscillatable supporting members for suspending said rotation bearings from fixed support bearings to permit lateral oscillation of said cylinder as a pendulum with the support bearings as the center of oscillation, the pendulum length being selectively short to effect a predetermined rapid vibration, the period of which will not be in resonance with the natural period of vibration of the cylinder due to its rotation at normal extraction speeds, and resilient means cooperatively associated with said supporting members and the fixed support bearings to increase the natural period of cylinder oscillation as a pendulum and aid in restoring the cylinder to said normal horizontal position, whereat the axis of said rotation bearings takes its normal position, substantially directly beneath the support axis of the rotating mass, after compensation for said out-of-balance condition has taken place.

9. In apparatus of the character described, a non-rotatably supported housing, an extractor cylinder having a horizontal axis, a rotatable drive shaft connected to rotate said cylinder, a hollow shaft member surrounding said drive shaft having a portion eccentric to the axis of said cylinder and a portion concentric with said axis, a fixed bearing on said housing for supporting the eccentric portion of said shaft member for oscillation about an axis disposed vertically above said cylinder rotation axis, a rotation bearing on said shaft member about which said cylinder is adapted to rotate, the combined bearing structure being adapted to permit a dynamically unbalanced cylinder to oscillate laterally about the fixed support bearing as a pendulum of a length less than the radius of the support bearing of said hollow shaft, and means operable by cylinder oscillation to effect counterbalance of said cylinder.

10. Balancing apparatus for horizontally rotatable extractor cylinders, comprising in combination, a plurality of balancing tanks arranged to receive balancing liquid from a source of supply, the tanks being positioned at equally spaced intervals peripherally within the cylinder, means for selectively supplying such liquid to said tanks, support bearings for said cylinder mounted in fixed relation to a rigid supporting structure, hollow eccentric members mounted to oscillate in said support bearings, a drive shaft disposed within one of said hollow members and connected to rotate said cylinder, rotation bearings mounted upon said eccentric members to support the said cylinder for rotation, at the same time permitting oscillation of said cylinder laterally with respect to the axis of said support bearings, whereby unbalanced centrifugal forces caused by an out-of-balance condition of the cylinder act to swing said eccentric members about the axis of support, and means mounted in rotative relation to the support bearings and engageable by said liquid supplying means selectively to admit balancing liquid to said tanks in response to such cylinder oscillation.

11. In apparatus of the character described, in combination, an extractor cylinder mounted for normal rotative movement and for pendulous oscillation about an axis of support located directly above its normal axis of rotation, an annular balancing liquid reservoir concentrically located on a head of said cylinder, a plurality of balancing tanks arranged symmetrically and peripherally within said cylinder, valve means connecting each said tank with the interior of said reservoir at a point in radial alignment with an admission opening in said tank, and means for selectively opening said valves to admit balancing liquid to a tank or tanks substantially diametrically opposite the heavy side of an unbalanced cylinder, comprising a member movable with said cylinder about a fixed axis coincident with the normal running axis of the cylinder and having push rods extending in radial alignment with the respective operational stems of said valves and engageable by the valve stems located on the light side of said cylinder to admit balancing liquid to their respective balancing tanks and thus effect weight compensation and the return of the rotation axis of said cylinder to its normal position in parallelism with its axis of support,

after an unbalanced condition has caused lateral movement of said cylinder with respect to its normal axis of rotation.

12. In apparatus of the character described, in combination, an extractor cylinder having a plurality of balancing tanks spaced about its periphery and adapted to receive masses of a balancing liquid to compensate for a condition of drynamic unbalance, an annular balancing liquid reservoir adapted to hold a supply of liquid for said tanks, valved conduit means connecting said reservoir with each tank, a rigidly mounted support bearing, a hollow stub shaft having a support portion adapted to oscillate about the axis of said support bearing, a rotation bearing member carried by said cylinder and cooperating with a bearing member rigidly mounted on a portion of said stub shaft concentric with the center of gravity of said cylinder and eccentric to the axis of said support bearing, means tending to hold the rotation axis, at a predetermined distance directly below said support axis, in a vertical plane passing through said support axis, and means operable to admit masses of said balancing liquid to said tanks in response to cylinder oscillation about the said support portion of the hollow stub shaft.

13. In apparatus of the character described, in combination, an extractor cylinder, means for rotating said cylinder, and supporting means for said cylinder having cooperative bearing parts permitting rotation of said cylinder about one horizontal axis and lateral oscillation as a fixedly supported pendulum about a second axis disposed above said one axis, the distance between said axes being of a dimension to prevent resonance between the period of oscillation of the pendulum and the natural period of vibration of the cylinder while rotating at extracting speeds, and the operational relation of said cooperative parts being such as to compel said lateral oscillation, under conditions of dynamic unbalance during rotation of said cylinder.

14. Apparatus as in claim 13, in which said cooperative parts comprise a suspension member supported to oscillate about said second axis and to provide support for rotation about said one axis, a plurality of balancing tanks evenly distributed about the periphery of said cylinder, means for supplying balancing liquid cooperatively associated with said cylinder and said tanks, and control valves operable by lateral oscillation of said cylinder and adapted to admit liquid to the appropriate tanks to counterbalance said dynamic unbalance.

15. In an extractor of the character described, in combination, a cylinder mounted to rotate about a normal horizontal axis, means supporting said cylinder to permit said cylinder to oscillate laterally and tend under the force of gravity to return its center of gravity to a position in vertical alignment with said normal axis in the event that said center has moved laterally with respect to said axis, because of uneven weight distribution in said cylinder, a drive shaft mounted to rotate coaxially with said normal axis and means universally connecting said shaft to drive said cylinder, means for supplying liquid for effecting balance of said cylinder, a plurality of receptacles distributed evenly about the periphery of said cylinder, means having a fixed position with reference to said normal axis mounted cooperatively with respect to said supporting means and said cylinder to permit or prevent flow of balancing liquid selectively to said receptacles according as the momentary position of the axis of rotation of said cylinder is to one side or the other of said normal axis.

16. In an extractor as in claim 15, resilient means tending at all times to aid the force of gravity to bias the rotation axis of said cylinder toward coincidence with said normal axis, thus providing a means for determining the period of oscillation of the cylinder.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,190,455	McCollum et al.	Feb. 13, 1940
2,461,643	Hemmeter	Feb. 15, 1949
2,463,801	Page	Mar. 8, 1949
2,534,268	Kahn	Dec. 19, 1950