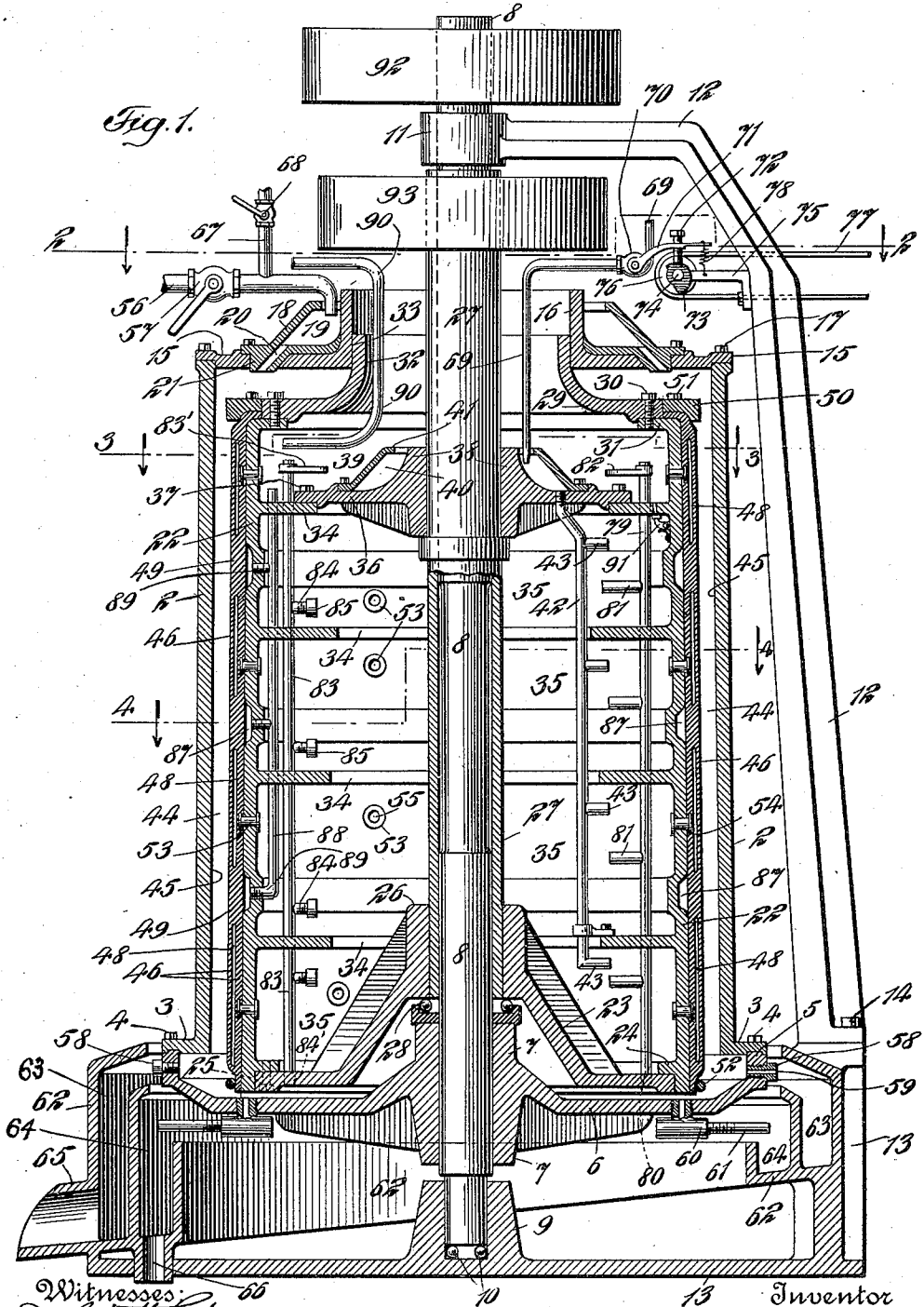


P. F. PECK.
CENTRIFUGAL ORE SEPARATOR.
APPLICATION FILED MAR. 17, 1911.

1,011,078.

Patented Dec. 5, 1911.

3 SHEETS-SHEET 1.



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Inventor
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3 SHEETS—SHEET 2.

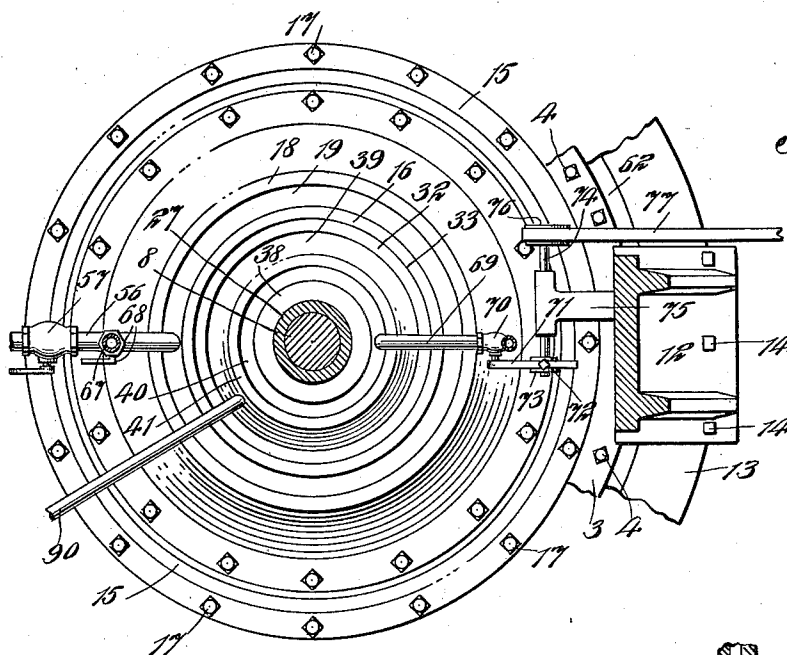


Fig. 2.

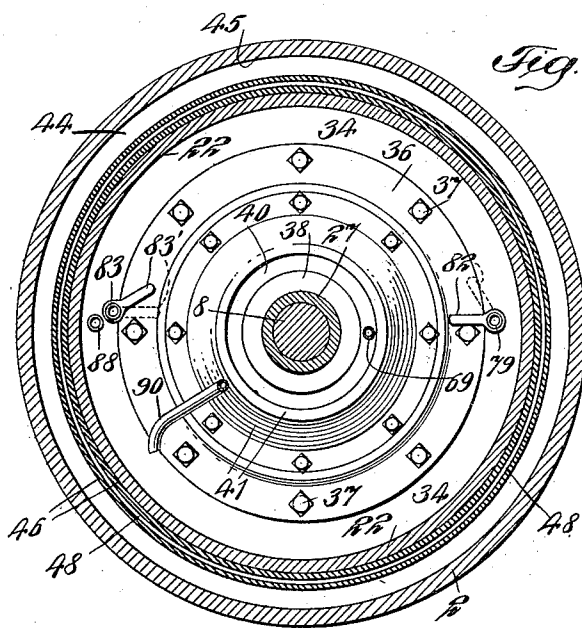


Fig. 3.

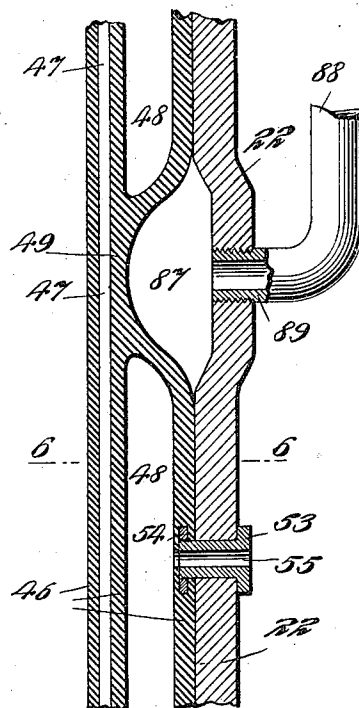


Fig. 5.

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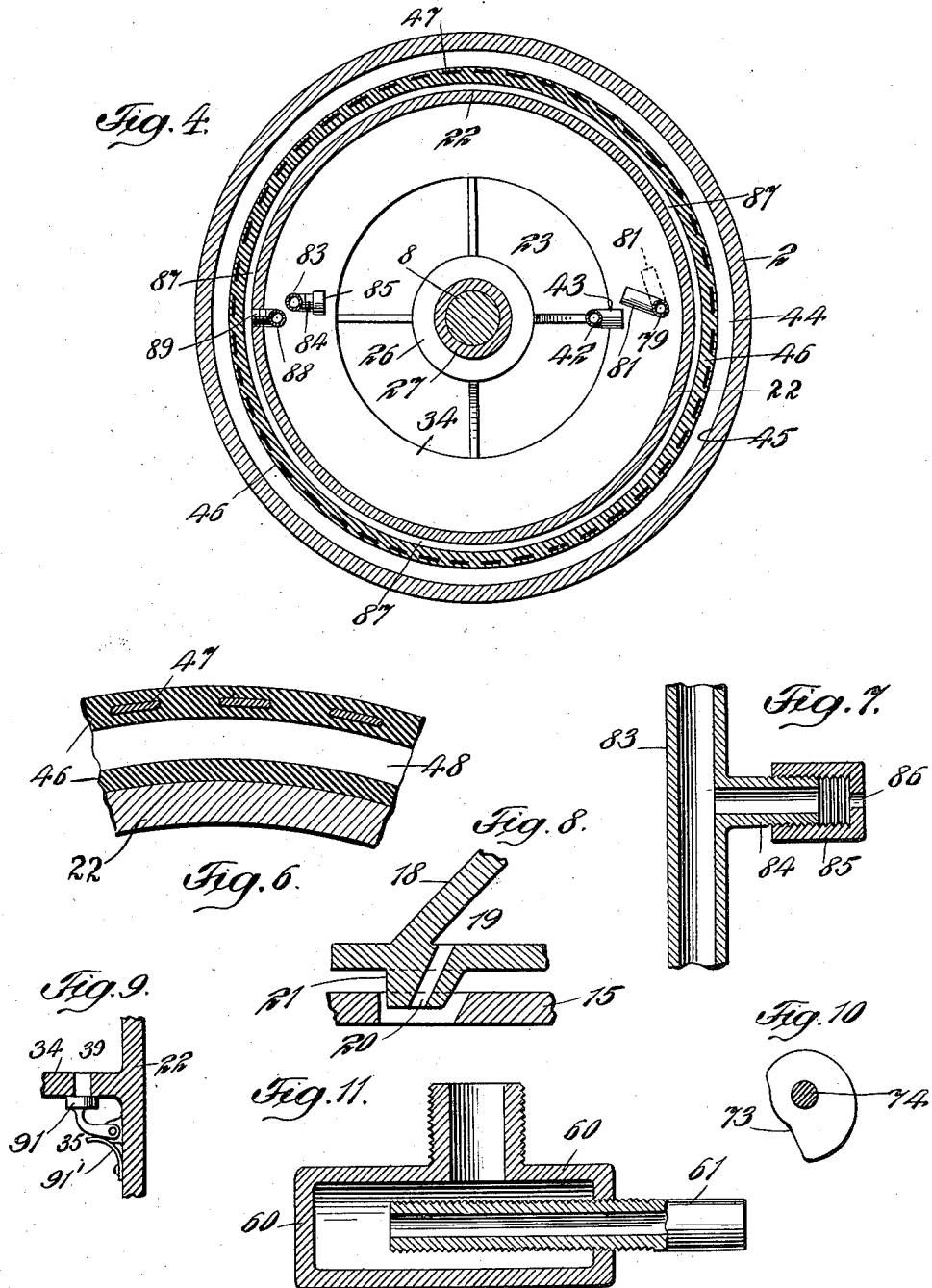
INVENTOR
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3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL ORE-SEPARATOR.

1,011,078.

Specification of Letters Patent.

Patented Dec. 5, 1911.

Application filed March 17, 1911. Serial No. 614,988.

To all whom it may concern:

Be it known that I, PHILIP F. PECK, a citizen of the United States, residing in the city of Chicago, State of Illinois, have invented certain new and useful Improvements in Centrifugal Ore-Separators, of which the following is a specification.

The object of my invention is to make a centrifugal ore separator for separation of heavier and lighter substances or solids, such as metalliferous ores and the like, while in a pulverized state and mixed with water, by employment of centrifugal force and washing friction, and my invention consists in the combination of coöperating parts, as well as features and details of construction hereinafter described and claimed.

In the drawings Figure 1, is a vertical central cross section of the main parts of my separating apparatus, except some parts which are shown in elevation. Fig. 2, is a plan and section of my separator, taken on line 2—2, of Fig. 1, looking in the direction of the arrows, it also shows some of the lower parts of my separator in broken plan. Fig. 3, is a cross section of my separator on line 3—3, of Fig. 1, looking in the direction of the arrows. Fig. 4, is a cross section of my separator, taken on line 4—4, of Fig. 1, looking in the direction of the arrows. This figure shows the metal strips in cross section in the friction jacket, which are omitted in Figs. 1 and 3, as they would appear small and confusing. Fig. 5, is an enlarged fragmentary longitudinal section of a portion of the circumferential wall of the deflector element and friction jacket of my separator, showing a place or zone where the outer and inner walls of the jacket are united, the jacket in a state of expansion and some other attached parts. Fig. 6, is a cross section of Fig. 5, on line 6—6, of Fig. 5. Fig. 7, is an enlarged longitudinal section of a fragmentary part of the primary discharge pipe, with one of its branches and caps, showing one of the comparatively small primary discharge openings. Fig. 8, is an enlarged fragmentary sectional detail of a portion of the upper head of the separating vessel and feed ring showing the two somewhat apart and the manner in which the lugs on the bottom of the latter enter openings in the former. Fig. 9, is an enlarged sectional detail of a portion of the

wall and one of the upper partitions of the deflector element showing check valve mechanism. Fig. 10, is an enlarged side elevation of the cam detached, illustrating the preferable form of its peripheral contour. Fig. 11, is an enlarged detached overflow means from the bottom of the separating element, shown mostly in longitudinal vertical section.

In making my improved centrifugal ore separator, I provide a rotatable separating member adapted to contain a body of water or other liquid while operating. It is of the nature of a vessel, and I will therefore term it as a separating vessel or separating element. This separating vessel preferably embodies a circumferential wall formed of a tube-shaped part 2, preferably somewhat larger at its lower end than at its top or upper end. It is provided at its large end with an outwardly extended flange 3, which engages, through screw bolts 4, with the upper edge of a flange 5, which is formed integral with the circumferential part of a bottom head 6, of the separating vessel. The head 6, is provided with a central hub 7, that rigidly engages a shaft 8, by which it, as well as the other parts of the separating vessel are supported. The shaft 8, is journaled at its lower portion in a box 9, and its lower end is stepped on a ball bearing 10, to carry its weight. The upper end of this shaft is journaled in a box 11, by which it is held in a vertical position, and the box 11, is secured to a frame column 12, of the separator. The column 12, is mounted on a bed plate 13, and secured thereto by bolts 14.

The upper end of the wall 2, of the separating vessel is provided with a head portion 15, which partly closes that end, but leaves an opening of considerable size at its central part. This head portion is provided with an upwardly extended flange 16, around the central opening, as illustrated, for purposes hereinafter described. The head 15, is secured to the upper end of the wall of the separating vessel by means of screw bolts 17, and mounted on the upper side of this head, surrounding the flange 16, there is provided a feed ring 18, for receiving feed material to be separated, mixed with water, which I will term pulp, and also for feed of water alone, when desired. The feed ring is

provided with a feed chamber 19, which has a series of passages 20, extending from around near its periphery, downward through depending lugs 21, on the bottom of the feed ring. These lugs register with and extend through openings in the upper head of the separating vessel, so that the passages 20, afford facility for delivery of material and water from the feed chamber into the upper end of the separating vessel. The position of one of the lugs and one of the openings that it enters, in the head 15, is illustrated in the fragmentary detail Fig. 8.

Within the separating vessel or element, and differentially rotatable to it, I provide a deflector vessel or element 22, with circumferential walls preferably conforming in general contour substantially to the form of the interior of the separating vessel. This deflector vessel is provided at its lower end with a head 23, secured to an inwardly turned flange 24, on its lower end, by screw bolts 25, substantially closing this end and is provided with a central hub 26, which rigidly engages a sleeve or central support 27, that is rotatably journaled around the shaft 8. The hub 26, rests at its lower end on an antifriction bearing 28, which is mounted on the upper end of the hub 7, thereby supporting the deflector in a manner to enable it to be rotated differentially to the separating element. The upper end of the deflector vessel is provided with a head portion 29, which partly closes that end, but leaves a comparatively large central opening around the sleeve 27. The outer diameter of this head portion is secured to the upper end of the deflector vessel by means of screw bolts 30, engaging the inturned flange 31, at this end of said vessel. The head 29, is provided with an upwardly turned-flange 32, around the central opening leaving a comparatively large annular space, as illustrated, between it and the sleeve 27, for purposes hereinafter explained. This flange is of size and form and is in position for its outer circumference to operate with the inner surface of a portion of the flange 16, as a journal bearing 33, between the two flanges, thereby serving as means for assisting to laterally hold the deflector element and the separating element in relative positions and alinement, yet permitting of their differential rotation.

Within the deflector element are provided a number of inwardly extended annular flanges or partial partitions 34, as is illustrated in the drawings, and especially in Fig. 1. These flanges serve to form annular troughs or compartments 35, around in the deflector vessel, suitable to hold or contain water or other liquid, while the separator is in a suitable state of operation. The uppermost of these flanges 34, also serves as means to which a head or plate 36, is secured, by screw bolts 37. This head or plate is pro-

vided with a central hub 38, that engages the sleeve or central support 27, serving to hold the upper portion of the deflector vessel in position relatively to such sleeve, and through agency of the journal 33, assists to support the upper end of the separating vessel. The uppermost of the flanges 34, is located down in the deflector a desired comparatively short distance from the upper head of said vessel, forming together with the plate 36, and such head a chamber 39, in the upper end of the deflector vessel, which chamber is substantially closed from the lower portion of said vessel and serves the purpose hereinafter explained. The plate 36, also closes the part of the deflector element located below it. Around the upper part of the hub 38, is provided a water chamber 40, which is formed by a suitably shaped part 41, carried by the plate 36, as illustrated in Fig. 1.

Located within the deflector vessel and communicating through the plate 36, with the chamber 40, is a water pipe 42, in position to extend over the inner edges of the several flanges or partitions 34. This pipe is provided with branch pipes 43, one of which branches is located in position to deliver water into each of the several troughs or compartments 35, so that in operation, water introduced into the chamber 40, will flow down through the pipes 42 and 43, and be discharged within the deflector vessel in the different compartments formed by said flanges 34, so the pipe 42, and its branches serve as means of distributing water into the deflector vessel. This deflector vessel is somewhat smaller than the inner diameter of the separating vessel, leaving a circumferential space or opening 44, between the outer wall of the deflector vessel and the inner wall of the separating vessel, which serves as a separating passage. On the inner wall of the separating vessel or element is formed a separating surface 45, so the separating passage at its outer side is adjacent to the separating surface. It is intended that the inner circumferential wall of the separating vessel will be made suitably to serve as the separating surface, the same preferably being smooth and even.

Around on the outer circumference of the deflector vessel is provided an expansible and contractible element 46, which I will term a friction jacket or friction element. This friction jacket is composed of rubber, canvas, and of metal strips 47, as best shown in Figs. 5 and 6. These strips are made up in the outer wall of the friction jacket in position lengthwise of the jacket, so as to assist in holding the jacket straight longitudinally, but yet to permit the jacket to be expanded diametrically. The friction jacket throughout most of its area is composed of an inner and outer wall, with ex-

pansion chambers 48, interposed between these walls. The divisions between these expansion chambers are made by circumferential zones of union of the inner and outer walls of the jacket as is illustrated at 49, most clearly in detail Figs. 1 and 5, so that the zones and the expansion chambers extend in a circumferential direction around the deflector vessel. Detail Fig. 5, especially illustrates a fragmentary part of the friction jacket in place on a portion of the deflector wall at the place or zone of union between the inner and outer walls of the friction jacket, and shows the jacket in a state of expansion.

There is provided at the top end of the deflector vessel, a ring 50, which clamps over the upper end of the friction jacket, as shown, to hold that end of the jacket securely in position on such vessel. This ring, is held in place by screw bolts 51, as shown. At the lower end of the deflector vessel, there are strands of wire 52, wrapped around the lower portion of the friction jacket to hold that end in place on said vessel.

Within the deflector vessel, extending through its walls are hollow studs 53, of suitable size and form to be screwed into openings in metal washers 54, which are made up at suitable places in the inner wall of the friction jacket. The openings in these studs and washers form water channels 55, from the compartments within the deflector vessel to the several expansion chambers in the friction jacket. In this way, such studs and washers not only form water channels communicating between the interior of the deflector vessel and the expansion chambers, but also assist in securely holding the friction jacket to its place over the deflector vessel. By means of these channels 55, water introduced in the different compartments of the deflector vessel, will be driven into the expansion chambers to a greater or less amount and will expand or inflate the friction jacket correspondingly, resulting in contracting the separating passage to a proportionate extent, as and when desired.

As means for introducing water and material, which is usually known as pulp, for separation, I provide a pulp feed pipe 56, having a suitable valve 57, adapted to govern the flow of such pulp. This feed pipe communicates with a suitable source of supply of pulp, not shown, such as an agitator tank in position for that purpose.

As means for discharging material and water from the separating vessel, I provide a circumferential row of plugs 58, removably screwed into holes through the flange 5, of the lower head of the separating vessel. These plugs are provided with comparatively small discharge holes 59, of size to

permit of a desired volume of discharge, but yet to retain a body of pulp or comparatively clean water in the separating vessel sufficient in amount to fill the separating passage.

Secured to the lower side of the bottom head of the separating vessel I provide a hollow T shaped portion 60, with one of its branches communicating through openings in such head as illustrated in the drawings. These T shaped portions are located a desired distance from the axis of the vessel and radiate transversely from said axis, and afford overflow passages for water and material introduced into the separating vessel in excess of the quantity that will be discharged through the smaller peripheral openings 59. These overflow passages therefore, substantially fix the extent to which a body of pulp or water can accumulate in the separating vessel.

As is especially illustrated in detail in Fig. 11, each of the T shaped portions is provided at one end with a pipe 61, of suitable size and length, and having for a considerable distance at one of its ends, screw threads thereon, and is screwed into one of the outer ends of the T shaped portions in position with the outer end of the pipes extending a distance outward for the purposes hereinafter explained. The inner ends of these pipes 61, serve as the intakes for the overflow of pulp and water from the vessel as the same passes into the T shaped portions, the position of the inner open ends of these pipes 61, regulating or determining the position of the inside surface of the accumulated body of such water or pulp in the separating vessel. The quantity of such accumulation can be regulated to a considerable extent by the distance the pipes 61, are screwed in or out of the T shaped portions, thereby moving the inner ends of such pipes near to, or farther from the axis of rotation.

Surrounding the lower portion of the separating vessel, and encircling the discharge plugs and the overflow pipes is provided a preferably cast metal launder 62, which is, in this instance made integral with a base plate of the separator.

The launder is provided with compartments 63 and 64. These compartments are each provided with circumferential openings at their upper portions, in annular alinement respectively, with the discharge plugs 58, and the outer ends of the overflow pipes 61, so that materials discharged from the separating vessel through the plugs or pipes will be caught in their respective compartment. The compartment 63, is provided with a delivery spout 65, and the compartment 64, is provided with a delivery spout 66, through which material discharged into the compartments may flow to be disposed of as may then be desired.

To effect separation in the separating passage, it is necessary that the separating surface, or the surface of the bedding concentrates and the outer surface of the friction jacket should be in comparatively close operating proximity, and to maintain this close operating condition throughout the accumulation or formation of the bed of concentrates, it is necessary to expand the friction jacket to its fullest extent, very largely filling the separating passage at the beginning of formation of such bed, and to gradually permit the same to become contracted as such bed is progressively formed, until there has accumulated a sufficient bed of concentrates to largely fill the separating passage, or until the friction jacket has become fully contracted. When the friction jacket has become fully contracted and the bed of concentrates sufficiently formed, the feed of pulp to the separating vessel is discontinued by closing the valve 57, and clean water is introduced through a branch pipe 67. This branch pipe is provided with a suitable valve 68, to control the flow of such water as desired. It will be understood that, at the time introduction of pulp for separation is discontinued and introduction of clean water is commenced, the speed of rotation of the separating vessel is temporarily reduced, which reduces the degree of centrifugal force being developed to hold the bedded concentrates in the separating passage, therefore enabling them to be carried out of such passage by the clean water then being introduced, whence the concentrates and water are discharged through the openings in plugs 58, in the same manner as the tailings were discharged during the period of separation. The concentrates, as discharged, are caught in the same compartment in the launder as the tailings were caught, but are diverted by any means desired to a suitable place of deposit, as they are flowed out of such launder.

To expand the friction jacket to the extent desired, water is introduced in the water feed chamber 40, by means of a suitable pipe 69, that connects with an appropriate source of supply of clean water. This pipe is provided with a valve 70, having a suitable handle 71, which is provided at its outer portion with a suitable screw bolt 72, passing through it and adopted to be adjusted through the handle, in position for one of its ends to contact with the periphery of a cam 73. This cam is mounted on and rotated by a suitable shaft 74, which is carried in a journal box in a bracket 75, that is secured to the column 12, of the separator frame. On the shaft 74, is mounted a pulley 76, by which the shaft is rotated by a belt 77. The contour of the cam is formed in a manner to open, and to permit closure of the valve 70, suitably to regulate the flow of

water as desired, through the pipe 69, and into the chamber 40, for the purposes hereinafter explained. The handle 71, has its end contracted and extended as illustrated, and engages a spring 78, which is secured at its other end to the frame of the separator. This spring serves to hold the handle downward and to keep the end of the screw bolt in contact with the periphery of the cam, so the valve will, at all times, be closed to the extent permitted by the screw bolt contacting with the periphery of the cam.

As has been explained hereinabove, the pipe 42, conducts water from the chamber 40, and deposits it into the several compartments inside of the deflector vessel, and this water serves to inflate or expand the expansion chambers and enlarge the diameter of the friction jacket thereby decreasing the size of the separating passage. The extent of inflation or expansion of the friction jacket will depend mostly on the amount of water, or of the hydrostatic body accumulated in the compartments in the deflector vessel, as such accumulation forms the hydrostatic head or column which, actuated by centrifugal force, results in such expansion pressure. As means for limiting the amount of such head and pressure, I have provided a pipe 79, passing lengthwise on the inside of the deflector vessel, and through the various partitions in it, so as to pass through the several compartments 35. This pipe is fitted closely at the places where it passes through the partition, so as not to permit of leakage from one compartment to another, and its lower end extends through the lower head of the deflector vessel at 80, as shown in Fig. 1, also in a closely fitted manner, but so the pipe is susceptible of being turned or rotated to the extent desired.

Within each of the compartments 35, in the deflector vessel, the pipe is provided with a short branch 81, extending toward the axis of rotation, and of suitable length to serve as a secondary overflow for water, to prevent such water from accumulating in a body and forming a hydrostatic pressure head nearer the axis than the inner ends of these pipes. These branch pipes are preferably made somewhat longer progressively toward the feed end of the vessel to permit of accumulation of a higher static head or column in the deflector vessel toward this end to balance or compensate for the greater resistance to expansion of the friction jacket toward this end caused by the greater pressure of pulp in the separating passage on account of the requirement in that respect to overcome friction of flow of such pulp through the separating passage, this frictional resistance progressively decreasing toward the discharge end.

The upper closed end of the pipe 79, extends through the partition into the cham-

ber 39, and is provided with a handle 82, by which it is adapted to be swung or moved around circumferentially, so as to carry the open ends of the several branch pipes 81, to a greater or less distance from the axis of the vessel, thereby moving the points of overflow a correspondingly greater or less distance from such axis, and limiting the accumulation of water within the compartments to a correspondingly decreased quantity. The changed position of the handle and overflow pipes is illustrated in dotted lines in Figs. 3 and 4, of the drawings.

To serve as means of primary overflows or discharges of water from the various compartments in the deflector vessel, I have provided a pipe 83, extending along longitudinally in said vessel, and through the partitions 34, in similar manner to the pipe 79, and have provided this pipe 83, in each of the compartments, with a branch pipe 84, of lesser length than the branch pipes 80. On the ends of the branch pipes 84, I have provided adjustable screw threaded covers or caps 85, so the caps may be adjusted toward or from the axis of rotation of the vessel. Through the caps 85, communicating with the openings in the branch pipes, I have provided comparatively small openings 86, as illustrated in enlarged detail Fig. 7, which are adapted to serve as discharge openings from the interior of the deflector vessel, and I will term them primary overflows, openings or discharges. The positions of these caps are intended to be adjusted, so the primary openings 86, will fix the minimum quantity of accumulation, or column of water in the compartments of the deflector vessel, for the purposes hereinafter explained, and they are intended to be a greater distance from the axis than are the intake ends of the secondary overflow pipes 81, so that the primary openings will, most, if not all of the time be submerged by the water in the deflector vessel thereby communicating with the hydrostatic body below its pressure head. This minimum hydrostatic head limited by action of the primary openings occurs at the time of greatest contraction of the friction jacket, which is at the time the bed or layer of concentrates has fully accumulated in the separating passage. The upper closed end of this pipe 83, passes up into the chamber 39, and is provided with a handle 83', by which the pipe may be somewhat revolved.

It will be understood, as illustrated in Fig. 1, that the pipe 83, has its lower end opening through the lower head of the deflector vessel, the pipe passing through this head at 84', so that the water passing through the small primary openings 86, will be delivered out through such head and be discharged from the deflector vessel.

The lengths of the branch pipes 84, or the

positions of their caps 85, are such as to fix the primary openings progressively nearer the axis of rotation of the vessel, in a direction toward the feed end, for the same reasons and purposes of compensating for the greater pressure in the separating passage toward that end, as is the case with the secondary openings in the pipes 81.

As above stated, it is desired to have the greatest degree of expansion of the friction jackets at the beginning of concentration, and to produce such expansion the relative positions of the cam 73, and the valve handle 71, and the peripheral surface of the cam are such as to open the valve 70, to supply the largest flow of water into the several compartments in the deflector vessel at that time. The preferable peripheral outline of the cam is illustrated in detail in Fig. 10.

As the separated concentrates lodge or bed in the separating passage, proportionately filling such passage, it is necessary for the friction jacket to become contracted to make room for the bedding of such concentrates; the body of water within compartments in the deflector vessel should be gradually decreased, thereby gradually lessening the expanding pressure on the friction jacket.

As hereinbefore stated the primary openings afford means for primary discharge of water from the deflector vessel, and their utility is for decreasing the body of accumulated static head of such water to permit of contraction of the friction jacket for purposes just above explained.

During the discharge or unloading period of the accumulated concentrates preparatory to the beginning of the concentrating period, the valve 70, is open through instrumentality of the cam, sufficiently wide to supply a considerably larger amount of water to the compartments of the deflector vessel than can be discharged by the small or primary openings 86. This results in accumulating during the unloading period and having at the beginning of the concentrating period, the largest body of water in the deflector vessel permitted by the secondary overflow pipes 81, being the amount requisite to produce the maximum hydrostatic expanding pressure on the friction jacket. The valve 70, is then with comparative quickness, closed sufficiently to reduce the water feed somewhat below the discharge capacity of the primary openings, and then as concentration proceeds and the accumulation of concentrates require that the friction element be contracted, the cam movement permits gradual further closing of the valve 70, as has been before explained, and automatically diminishes the flow of water to the interior of the deflector vessel to an extent desired or to full closure resulting in a desired gradual decrease of the accumulated

body of water in the deflector vessel; until the friction jacket has been fully contracted. Closing movement of the valve is effected by tension of the spring 78, as permitted by the cam. By this time a sufficient bed of concentrates having been accumulated, the flow of pulp for separation is discontinued and clean water is introduced into the separating vessel by the pipe 68. It is also intended that at this time the cam 73, will have revolved to a position for its peripheral surface to again widely open the valve 70, and supply a maximum quantity of water to the interior of the deflector vessel, which again increases the body of water and resultant hydrostatic pressure therein, and operates to again expand the friction jacket, thereby assisting in removal of concentrates and again adjusting the friction jacket so that its exterior surface is in close operating proximity to the concentrating surface suitable for commencement of concentration, when another cycle of operation is started. At the time clean water is introduced into the separating vessel, the speed of rotation of such vessel is, by any desired means, sufficiently reduced to enable the accumulated bed of concentrates to be easily removed by the clean water, assisted by washing friction between the friction jacket and the interior of the separating vessel. The reduced speed of rotation of the separating vessel continues for a sufficient short length of time to effect removal of the entire accumulation of concentrates, after which, the speed of rotation is restored suitably for effecting concentration; the flow of clean water to the vessel is discontinued, and the flow of pulp for separation again started. By this time the position of the cam 73, has become such that its periphery in rotation, forces the screw 72, backward and again gradually and automatically closes the valve 69, thereby again decreasing the flow of water to the interior of the deflector vessel as has been above explained, and the cycle of operation is repeated.

It will be seen that the flow or feed of water to the interior of the deflector vessel to serve in effecting expansion of the friction jacket, is automatically varied during the successive cycles of operation, preferably by first, with comparative quickness, increasing the quantity being introduced considerably in excess of the discharge capability of the primary discharge means, but not in excess of the capacity of its overflow or secondary discharge openings, and second, after the accumulation of water has become sufficient to overflow at the secondary openings, the feed is, with comparative quickness, decreased to a quantity somewhat less than, or below the discharge capacity of the primary openings, and third, by automatically gradually further reducing the feed of

such water, preferably until the friction jacket has become fully contracted.

As is illustrated in Fig. 3, and hereinabove stated, the pipe 83, may be somewhat revolved through its handle 83', swinging the branches with the caps 85, and the primary discharge openings, in position toward or from the axis of rotation, so as to limit, as desired, the minimum quantity of water that can remain within the several compartments throughout the cycles of operation, in the deflector vessel. This adjustment may also be obtained by screwing the caps in or out nearer or farther from the axis, as has been before explained. The pipe 79, and its branches 81, as well as the pipe 83, its branches 84, and its caps 85, revolve with such vessel, and deliver the water therefrom into the separating vessel.

During operation of my separator the friction jacket is subjected to a comparatively heavy external pressure from the pulp flowing through the separating passage, and is also subjected to a large hydrostatic pressure within the expansion chambers, caused by the accumulated body of water within the deflector vessel. During expansion of the friction jacket, the wall of the jacket is drawn and stretched away from the outer surface of the deflector vessel, around throughout the zones of juncture 49, of the inner and outer walls of such jacket, thereby forming the spaces 87, as especially illustrated in detail Fig. 5. These spaces 87, are bridged crosswise by the outer wall of the friction jacket and the metal strips 47, that are made up in such wall, and as a result the effect of the said pressure on the outside of the friction jacket over this space is to deflect or bend the metal strips and the outer wall of jacket inwardly, resulting in an uneven surface longitudinally of the jacket, which condition tends to disturb the best results in separation. To compensate this condition and to lessen the load or burden sustained by the wall of the jacket and the metal strips therein over these zones, and yet maintain sufficient excess pressure on the inner wall of the jacket to hold it securely against the outer wall of the deflector vessel, I have provided a pipe 88, on the inside of the deflector vessel, extending longitudinally of such vessel, in suitable position to communicate by branches 89, through the wall of the deflector vessel, with the spaces 87. One of these connections is especially illustrated in detail Fig. 5, such connection being at the lower end of the pipe 88. This pipe 88, has its open end extended into the chamber 39, at the upper end of the deflector vessel, so that water contained in such chamber will pass into the several spaces 87, subjecting the friction jacket at these places or zones to a water pressure resultant to the body of water contained in the chamber 39,

while being acted upon by centrifugal force during operation of the separator.

The pressure within the spaces 87, is intended to be a desired amount less than the pressure within the separating passage and the expansion chambers, so the pressure in the latter places will be sufficiently in excess to insure that the friction jacket be held well to place on the outside circumference of the deflector vessel; yet so that the pressure within the spaces 87, will largely relieve the external burden of pressure which the wall of the friction jacket with its metal strips will be required to carry where they bridge or cross these spaces; therefore largely or wholly remedying the deflection of those parts at such places, and insure a substantially uniform plane longitudinally of the outer circumference of the friction jacket.

As means for regulating the quantity of water maintained in the chamber 39, and the resultant hydrostatic pressure in the spaces 87, there is provided a pipe 90, of suitable size and form and extending down into the chamber 39, as illustrated in Fig. 1, in position so that its lower open end will operate against the surface of the rotating body of water within the chamber, as shown in Fig. 3, and remove or scoop out such water to that extent, limiting the accumulation of such body in quantity to the end of the scooping pipe. This pipe may be moved in or out from the axis of rotation of the vessel, and thereby govern the amount of such water and the resultant degree of pressure exerted by it within the spaces 39. The pipe 90 extends up through the opening in the head portion 29, with its upper end outside of the deflector vessel for delivery of the removed water as may be desired.

To insure that the hydrostatic pressure within the spaces 87, under the friction jacket, will not, by accident or otherwise, become greater than that within expansion chambers 48, I have provided check valve mechanism or means 91, communicating through the wall between the chamber 39, and the chambers or compartments 35, adjacent to it, so if the hydrostatic head or column becomes greatest in the chamber 39, such valve means will be opened by the said excess pressure and permit of balance or establishment of the pressure equilibrium between these two chambers, by permitting water to flow from the chamber 39, into the chamber 35, resulting in substantially equalizing the pressure within the spaces 87, and the expansion chambers 48. The valve 91 is normally held to place by a spring 91'.

It will be understood that separation, within the separating passage, is produced through combined action of centrifugal force and washing friction on the pulp while within the separating passage, and that the washing friction is mostly generated as a

result of differential rotation between the separating vessel and the deflector vessel. In order to rotate these respective vessels at desired speed, I have provided a pulley 92, secured to the shaft 8, of the separating vessel by which such vessel is revolved, and have provided a pulley 93, secured to the sleeve 27, to which the deflector vessel is attached, and thereby rotation is imparted to the deflector vessel.

While the application of liquid forces and pressures within the deflector element and the friction element are principally hydrostatic, or of a hydrostatic nature, they are also of a hydraulic character, from the fact that much movement circulation and removal of liquid occurs, and I therefore wish it understood that in the use of the term "hydrostatic," I also mean "hydraulic," to the extent such condition prevails.

What I regard as new and desire to secure by Letters Patent is:

1. In a centrifugal ore separator, the combination of a rotatable separating vessel adapted to contain a body of water while in operation, a differentially rotatable deflector within the separating vessel, substantially closed with respect to the separating vessel, provided with multiple compartments on its interior adapted to contain water therein, means adapted to introduce water into the deflector vessel, an expansible and contractible friction element around said deflector vessel attached thereto and adapted to be expanded by hydrostatic pressure of water within said deflector vessel, overflow means of comparatively large capacity for water in said deflector vessel, and discharge means of comparatively small capacity submerged below the surface of the water in said deflector vessel for removal of water therefrom, substantially as described.

2. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector element within said separating element provided with an expansible and contractible friction element secured thereto, said deflector element adapted to contain a body of water serving to effect expanding pressure on the friction element, means adapted to limit the maximum accumulation of such water during the cycle of operation and means adapted to gradually decrease the amount of such water during such cycle as such cycle proceeds, embodying respectively comparatively large and comparatively small discharge openings, and automatic variable means adapted to supply water to the deflector element, substantially as described.

3. In a centrifugal ore separator, the combination of a rotatable separating element

adapted to contain a body of water while in operation, a differentially rotatable deflector element within said separating element adapted to contain a body of water during operation, an expansible and contractible friction element surrounding the deflector element adapted to be expanded by hydrostatic pressure from within the deflector element, means adapted to introduce water into the deflector element, means adapted to limit the maximum accumulation of water in the deflector element, means for limiting the minimum amount of water therein, both of said limiting means rotatable and contained within the separating element, substantially as described.

4. In a centrifugal ore separator, the combination of a rotatable separating element, adapted to contain a body of water while in operation, a differentially rotatable deflector element within the separating element adapted to contain a body of water while operating, an expansible and contractible friction element around the deflector element adapted to be expanded by pressure of water from within the deflector element, the deflector element provided with overflow means adapted to limit the maximum amount of water therein and with discharge openings farther from its axis adapted to limit the minimum amount of water in the deflector element, said overflow means and discharge means rotatable with the deflector element and adapted to deliver water therefrom into the separating element, substantially as described.

5. In a centrifugal ore separator, the combination of a rotatable separating element, adapted to contain a body of water while in operation, a differentially rotatable deflector element within the separating element, adapted to contain a body of water while operating, a friction element surrounding the deflector element and secured thereto, adapted to be expanded by hydrostatic pressure from within the deflector element, overflow means of comparatively large capacity adapted to limit the maximum hydrostatic head within the deflector element, and discharge means of comparatively small capacity in position farther from the axis of the deflector element than the overflow means adapted to limit the minimum hydrostatic head within the deflector means, both said overflow and discharge means rotatable with the deflector element and adapted to deliver water therefrom into the separating element and automatically variable means adapted to introduce water into the deflector element substantially as described.

6. In a centrifugal ore separator, the combination of a rotatable separating element, adapted to contain a body of water while in operation, a differentially rotatable deflector element within the separating element,

adapted to contain a body of water while operating, a friction element surrounding the deflector element and secured thereto, adapted to be expanded by hydrostatic pressure from within the deflector element, overflow means of comparatively large capacity adapted to limit the maximum hydrostatic head within the deflector element and discharge means of comparatively small capacity in position farther from the axis of the deflector element than the overflow means adapted to limit the minimum hydrostatic head within the deflector means, both said overflow means and discharge means variable with respect to the axis of the deflector element and rotatable with said deflector element, and adapted to discharge water therefrom into the separating element, and automatically variable means adapted to introduce water into the deflector element, substantially as described.

7. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while operating, a friction element adapted to be expanded by water pressure from within the deflector element, overflow means of comparatively large capacity opening in position substantially above the surface of the water in the deflector element and adapted to limit the maximum accumulation of such water, comparatively small discharge means from said deflector element in position substantially below the surface of the accumulation of water therein adapted to gradually decrease the hydrostatic head in the deflector element during the cycle of operation, both said overflow means and discharge means rotatable with the deflector element and adapted to deliver water therefrom into the separating element, means for feeding water into the deflector element variable alternately in quantities greater and less than the discharge capacity of the discharge means located in position farthest from the axis, substantially as described.

8. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector element within the separating element adapted to contain a body of water while operating, an expansible and contractible friction element surrounding the deflector element adapted to be expanded by water from within said deflector element, said deflector element provided with primary discharge means of comparatively small discharge capacity and secondary discharge means of comparatively large discharge capacity, the former located in position farther from the axis of the vessel than the latter, said discharge means variable in distance from said axis, and with respect to each other, and automatic means adapted to

introduce water into the deflector element in varying quantities, substantially as described.

9. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while operating, a differentially rotatable deflector element within the separating element adapted to contain a body of water while operating, an expansible and contractible friction element surrounding the deflector element adapted to be expanded by water from within said deflector element, said deflector element provided with multiple compartments separately adapted to contain bodies of water, primary water discharge means in said multiple compartments, each being located farther from the axis of the vessel, progressively as they approach the discharge end of the separating vessel, and overflow means from said compartments successively located farther from the said axis in a direction toward the discharge end of the separating vessel, and means for introducing water into said compartments, substantially as described.

10. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector element within said separating element provided with an expansible and contractible friction element secured thereto, having double walls with multiple expansion chambers between them, and having zones of union of said double walls dividing the expansion chambers, means adapted to subject the under side of the friction element at such zones and adjacent to the wall of the deflector element to hydrostatic pressure, and means adapted to regulate such pressure, substantially as described.

11. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector element within said separating element provided with an expansible and contractible friction element secured thereto, said friction element having double walls with multiple expansion chambers between them and having zones of union of said double walls dividing the expansion chambers, means adapted to subject the under side of the friction element at such zones and adjacent to the wall of the deflector element to hydrostatic pressure, means adapted to regulate such pressure and automatic means adapted to prevent pressure under the friction jacket from materially exceeding the pressure within the expansion chambers, substantially as described.

12. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water

while in operation, a differentially rotatable deflector element within said separating element, provided with an expansible and contractible friction element attached thereto having double walls with multiple expansion chambers between them, said wall having zones of union forming divisions between said expansion chambers, means for subjecting the under side of the friction element at such zone and adjacent to the wall of the deflector element to hydrostatic pressure, said deflector element adapted to contain a body of water serving to effect expanding pressure on the friction element, means adapted to limit the accumulation of such water during the cycle of operation, and means adapted to gradually decrease the amount of such water during such cycle of operation as said cycle proceeds, embodying discharge openings of comparatively large and of comparatively small discharge capacity, and automatically variable means adapted to supply water to the deflector vessel, substantially as described.

13. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector within said separating element, provided with an expansible and contractible friction element secured thereto, said deflector element adapted to contain a body of liquid forming a hydrostatic pressure head for effecting expansion of the friction element, means adapted to limit the maximum amount of such pressure head during the cycle of operation and means adapted to gradually decrease the amount of said hydrostatic head during such cycle as the cycle proceeds, said latter means communicating with the hydrostatic body below the surface of the pressure head, and the maximum limiting means communicating with said hydrostatic body at a point nearer the axis of the vessel than the communication of said decreasing means, substantially as described.

14. In a centrifugal ore separator, the combination of a rotatable separating element substantially closed at its lower end and adapted to hold a body of water while in operation and provided with a head portion at its upper end having a comparatively large central opening, a differentially rotatable deflector element within said separating element substantially closed at its lower end, and provided with a head portion at its upper end having a comparatively large central opening, a journal bearing between the head portion of the separating element and the head portion of the deflector element, means within the deflector element in position between its lower end and its upper head portion engaging its axial support, said means effecting substantial closure of the lower end of the deflector

element and forming a chamber within the upper end of said deflector element, means adapted to distribute water therefrom into the deflector element, means adapted to deliver water into said chamber and means for removing water therefrom, passing from said chamber in a course nearer the axis of the vessel than the journal bearing between the upper head of the separating element and the deflector element, substantially as described.

15 15. In a centrifugal ore separator, the combination of a rotatable separating element adapted to contain a body of water while in operation, a differentially rotatable deflector element located within said separating element and adapted to contain a body of water while operating, said deflector element provided with an expansible and contractible friction element secured thereto adapted to be expanded by pressure of water

within the deflector element, means adapted to limit the maximum accumulation of such water during the cycle of operation, means adapted to limit the minimum accumulation of such water during operation, and automatic means for supplying water into said deflector element adapted during the unloading period to feed the requisite amount of water to effectuate the greatest hydrostatic pressure desired and at the beginning of the concentrating period to reduce such feed with comparative quickness somewhat below the discharge capacity of the primary openings and then gradually further reduce such feed during the concentrating period, substantially as described.

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Witnesses:

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