Aug. 3, 1926.

1,594,501

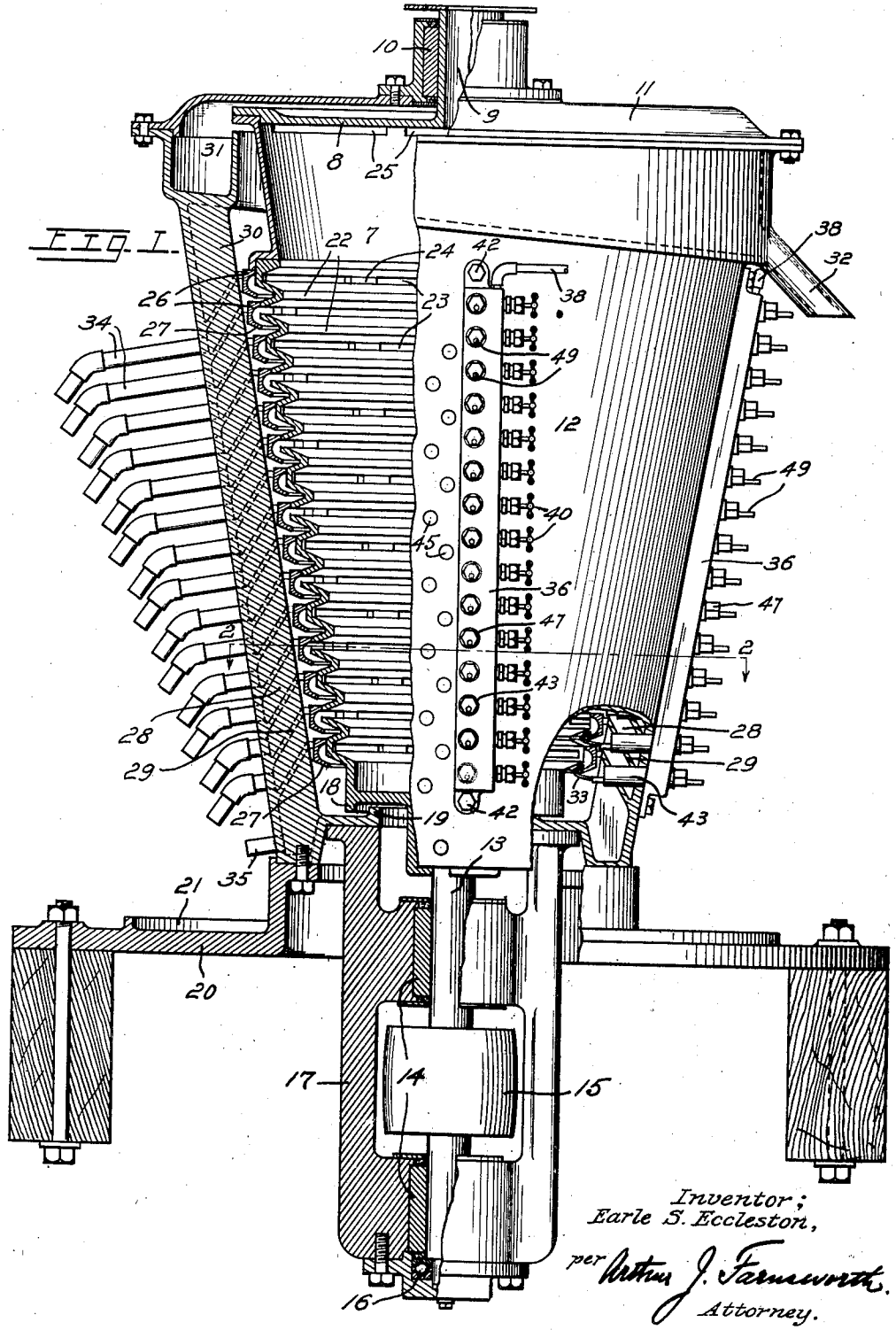
E. S. ECCLESTON

CENTRIFUGAL SEPARATOR

Filed April 2, 1925

2 Sheets-Sheet 1

FIG. 1.



Inventor;
Earle S. Eccleston,
per Arthur J. Farnsworth.
Attorney.

Aug. 3, 1926.

1,594,501

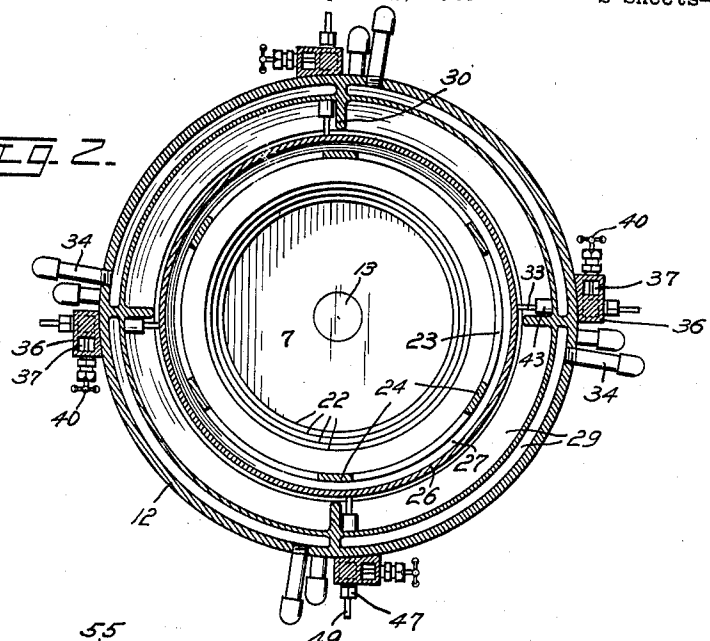
E. S. ECCLESTON

CENTRIFUGAL SEPARATOR

Filed April 2, 1925

2 Sheets-Sheet 2

Fig. 2.



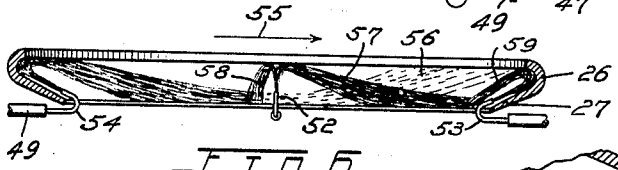
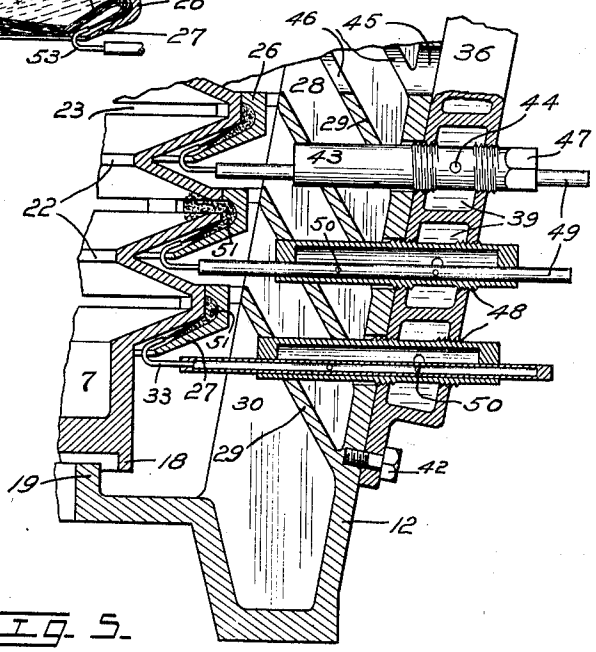


Fig. 6.

Fig. 3.



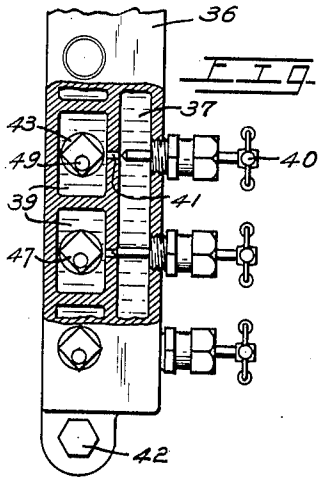
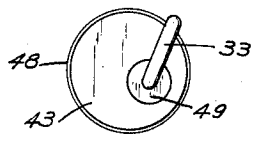


Fig. 4.

Fig. 5.



Inventor;
Earle S. Eccleston,
per Arthur J. Farnsworth.
Attorney.

Patented Aug. 3, 1926. 1,594,501

UNITED STATES PATENT OFFICE.

EARLE S. ECCLESTON, OF LOS ANGELES, CALIFORNIA.

CENTRIFUGAL SEPARATOR.

Application filed April 2, 1925. Serial No. 20,217.

In this specification, and the accompanying drawing, I shall describe and show a preferred form of my invention, and specifically mention certain of its more important objects. I do not limit myself to the forms disclosed, since various changes and adaptations may be made therein without departing from the essence of my invention as hereinafter claimed; and objects and advantages, other than those specifically mentioned, are included within its scope.

My invention relates to centrifugal separators for treating ores and other substances in liquid, semi-liquid, or powdered form, for separating and concentrating the particles of higher specific gravity by the action of centrifugal force. The more important objects of the invention are; first, to provide means for greatly increasing the operating yield of devices of this nature; second, to produce a centrifugal separator embodying regulating adjustments whereby it is adapted to handle materials of widely different character under a great variety of operating conditions; third, to improve the operating efficiency of machines of this class expressed in yield per unit of power expended and yield per unit of cubical capacity; and, fourth, to accomplish the above results in a very simple and relatively inexpensive manner.

My objects are attained in the manner illustrated in the accompanying drawings in which I have shown a specific form of my invention adapted primarily for concentrating ores. In the drawings—

Figure 1 is an elevation of the complete machine shown partly in section to disclose the interior construction;

Figure 2 is a horizontal section of the above machine taken on the line 2—2 of Figure 1;

Figure 3 is an enlarged sectional detail of a portion of the lower part of the separating bowl and housing and showing particularly my improved nozzle construction;

Figure 4 is a fragmentary elevation of the nozzle manifold and method of regulating the flow to the individual nozzles, the manifold being shown broken and partly in section, this view being drawn to the same scale as Figure 3;

Figure 5 is an elevation of the operating end of the nozzles and its adjusting features per se and on an enlarged scale; and

Figure 6 is a diagram showing an axial section of one of the skirt rings surrounding the separating bowl and the action of plural nozzles as embodied in my invention.

Similar reference numerals refer to similar parts throughout the several views.

My improved separator is adapted for continuous operation, the material to be treated being fed into the machine at its intake at any rate within its capacity, and the concentrates and sludge being separately discharged in a more or less continuous stream in accordance with the manner of feeding.

The construction comprises a rotatable bowl 7 which is preferably made in the form of an inverted truncated cone. This bowl has a cover plate 8 at the top having a short hollow shaft 9 through which the material to be treated is fed. Shaft 9 is rotatable in the bearing 10 mounted upon cover 11 of the separator housing 12. At the bottom the bowl is mounted upon a shaft 13 rotatable in bearings 14 and is driven by a pulley 15 intermediate the bottom shaft bearings. The weight of the rotatable parts is taken by means of a ball thrust-bearing 16.

The two bottom bearings and thrust are supported and kept in alignment by means of a suitable hanger 17 concentrically suspended from the bottom of the separator housing. The bottom of the bowl is provided with a downwardly extending annular flange 18 and the bottom of the housing has an upwardly extending annular flange 19 within the bowl flange, this construction being to protect the bottom bearings from gritty material in a manner that will be apparent from the drawings. The whole separator is supported on a base plate 20 having a circular flange 21 concentric with the housing.

Bowl 7 is provided with a series of riffles 22 on its inner surface and arcuate circular orifices 23 between the riffles. The orifices are relatively narrow and are nearly continuous around the periphery of the bowl, but in order to make an integral construction it is of course necessary to space the orifices of each stage by means of the integral connecting strips 24.

At the top of the bowl there is also a series of arcuate circular orifices 25 adjacent the cover.

On the outside of the bowl is a series of skirt rings 26 opposite orifices 23. These skirt rings are interiorly grooved in such a manner as to constitute an annular chamber outside of the orifices. The skirts 27 of these rings extend downwardly and inwardly toward the axis of the bowl and are slightly spaced therefrom.

Housing 12 has a series of downwardly extending pockets 28 formed by the sloping annular partitions 29. The openings of the pockets are respectively opposite the lower edges of the skirts 27. A plurality of longitudinal ribs 30 subdivide each of the circular pockets and the number of these ribs is determined in accordance with the duty of the machine in a manner that will be explained presently. At the upper end of the housing is an annular launder 31 on a sloping plane and having discharge outlet 32 for sludge.

A series of small jet nozzles 33 extends under each skirt and upwardly and outwardly for the purpose of dislodging concentrated material banks maintained in the annular chambers of the skirt rings by centrifugal action when the machine is running. These nozzles are part of the construction that will be described below and are located adjacent vertical ribs 30. On the other side of these ribs are a series of nipples 34 for separately discharging the contents of each of the subdivided pockets 28. An additional nipple 35 at the bottom of the housing is for the purpose of discharging material thrown off by the bottom skirt.

The nozzle construction comprises a plurality of cellular manifolds 36. These manifolds contain longitudinal compartments 37 running the full length of the manifolds and connected to a source of water supply as by the pipe 38. A series of cells 39 adjacent the longitudinal compartment also run the full length of each manifold and valves 40 separately control the admission of water from the longitudinal compartment to the cells through orifices 41. These manifolds are attached to the housing in any convenient manner as by the bolts 42.

Each of the manifold cells is pierced by a closed end tube 43 perforated as at 44 within the cell. The inner ends of these tubes extend into the housing through holes 45 provided therefor and co-axial holes 46 in the sloping partitions 29. The outer ends of these tubes may be squared as at 47 so that they may be turned in their threads 48.

The ends of the above tubes are eccentrically pierced by opposed holes and smaller tubes 49 are inserted therethrough. These inner tubes are perforated as at 50 and are rotatable and longitudinally slidable within the large tube. The inner ends of these small tubes are provided with jet nozzles 33 extending under the skirts and then upwardly and outwardly as shown most clearly in Figure 3. The outer ends of the small tubes extend beyond the larger tubes for manipulating purposes and these ends may also be squared if preferred, but have not been so shown in the drawings.

From the above description it will be evident that water may be admitted to each of the jet nozzles by means of its respective valve 40 through cell 39, perforation 44 and perforations 50. It will also be evident that due to the eccentric mounting of the small tubes in the larger tubes the smaller tubes may be laterally adjusted in position by rotating the larger tubes. Furthermore, it will be seen that the small jet nozzles may be positioned longitudinally and angularly by sliding and turning the small tubes 49 independently of the larger tubes.

The above nozzle construction allows for independent operation and control of pressure on each jet. It also allows of placing the jet in the position in which it will operate most advantageously.

The form of my machine above described and shown in the drawings is particularly designed for the purpose of recovering values from ores. The ore pulp is delivered to the interior of the bowl through hollow shaft 9 and falls to the bottom. Due to the centrifugal action of the inverted conical shape of the bowl the material is thrown outwardly and tends to travel upwardly against riffles 22. The heavier materials, however, will first be thrown outward through orifices 23 and will collect in the annular chambers of the skirt rings in the form of a bank maintained there by centrifugal force. When this bank is formed, therefore, the orifices are virtually sealed and no more pulp or concentrates can pass outward therethrough. The pulp then is forced to travel further upward to the next orifice and so on to the top of the bowl.

In the above manner, a bank of concentrated material is formed in each of the annular chambers on the inside of the skirt rings and if the machine is being properly operated the pulp by the time it has reached the upper riffle will have been robbed of all of its values. This valueless pulp will then continue upward and be thrown outward through orifices 25, into the annular launder 31 and be discharged therefrom through the outlet 32.

When the machine has reached the operative condition just described, it can not do any further concentrating until some of the concentrates that have been collected in the skirt rings are removed. If the concentrates are not removed the introduction of further pulp containing values would be useless as the whole body of pulp would pass upward across the riffles and be discharged through outlet 32. For the continuous operation of the machine, therefore, it is necessary to

continually remove the concentrates from each of the skirt rings at the proper rate. This is the function of jet nozzles 33.

The operating condition as above described, is illustrated in Figure 3 in which the concentrates indicated at 51 are maintained in the annular chambers of the skirt rings by the action of centrifugal force. If now a jet under sufficient pressure is discharged from nozzle 33 it will tend to wash the concentrates downward and thus free the corresponding orifices and permit more concentrates to pass therethrough. The downward washing of the jet is, however, opposed by the tendency of the concentrates to move upwardly due to the action of the centrifugal force.

Referring now to Figure 6, we will first assume that nozzles 52 and 53 are closed and that nozzle 54 is open and operating. The skirt ring is supposed to revolve in the direction indicated by arrow 55. The jet from nozzle 54 will wash the concentrates downward over the skirt and a portion of these will be discharged from the bottom edge thereof and thrown outwardly into the corresponding pocket 28 in the housing. Ordinarily, however, they will not all be thus thrown outwardly and if not, what remains on the skirt will again be thrown upwardly as indicated by dotted lines 56. We will now assume that nozzle 52 is opened and permitted to operate. A portion of its stream will throw downward some of the concentrates in the path 57 and a portion will be used to wash off the concentrates from nozzle 54 in the manner indicated at 58. Thus none of the concentrates released by nozzle 54 are permitted to remain on the skirt as they otherwise might do. When nozzle 53 is opened it acts similarly as at 59 on the concentrates released by nozzle 52.

The effect of multiple nozzles used in the manner described increases the yield of a separator in a most surprising manner. I have found experimentally that in one case the use of three nozzles in this way resulted in nine times the yield of one. The use of four nozzles gave twelve times the yield of one in this same instance, and again the use of eight nozzles caused the yield to drop back to three times the yield of one. In this particular machine under the same conditions of operation, the use of two nozzles gave almost exactly twice the yield of one. It will, therefore, be seen that the use of plural nozzles in the manner described may be made to multiply the yield instead of merely increasing it proportionally to the number of nozzles.

From the above experiment it is evident that when two nozzles were used their action was entirely independent. In other words, each nozzle discharged a certain yield of concentrates and the use of two doubled the yield of one, since neither operation affected the other. When a third nozzle was put in action, however, the yield instead of being three times the normal yield of one was nine times, clearly exhibiting the great efficacy of the washing down action diagrammatically shown in Figure 6. In this case, therefore, the nozzles were co-operative, each nozzle being assisted in its operation by the succeeding nozzle. When the fourth nozzle was added we again got the same rate of increase in yield, showing that four nozzles were also properly co-operative. It at first appeared to be surprising that when eight nozzles were used the total yield dropped back to only three times the yield of one, but the explanation appears to be quite simple in view of Diagram 6. In this latter case, the nozzles were not properly co-operating, but on the contrary, they were interfering with each other in their operation. In other words, the spacing of the nozzles was too close and the material released from each instead of being allowed to wash downwardly to the bottom of the skirt was actually washed upward again by the succeeding nozzle.

It is evident from the above that it is perfectly possible to enormously increase the yield by the use of plural nozzles in a manner entirely out of proportion to the mere plurality. It is also obvious that the actual number of nozzles must be determined with relation to the peripheral speed of the skirt rings and the diameter of the latter. Also there are doubtless other factors such as jet pressure, specific gravity of concentrates, consistency of concentrates, etc., which are more or less variable and which at the present time have not been fully determined.

I desire to point out particularly that the use of plural nozzles in the manner described is radically different from the use of a mere multiplicity of nozzles. In my invention the nozzles function co-operatively to produce a common result entirely out of proportion to the multiplicity, and the yield may be made to greatly exceed the added effect of the same number of nozzles functioning independently.

I also wish to call attention to the fact that the great flexibility of nozzle adjustment permits my separator to be used under a wide variety of conditions for separating materials varying greatly in character.

I claim as my invention:

1. In a separator adapted for centrifugally segregating circumferential banks of material upon a rotary member, means for directing a plurality of angularly spaced jets against each of said banks for removing said material; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from

being centrifugally returned to its bank.

2. In a separator adapted for centrifugally segregating circumferential banks of material upon a rotary member, means for directing a plurality of angularly spaced jets against each of said banks whereby said material may be removed; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank; and the direction of the jets being variable with respect to the direction of motion of the banks.

3. A centrifugal separator comprising; a rotatable bowl having a circumferentially riffled interior surface and arcuate orifices between the riffles; means on the outside of the bowl for centrifugally retaining banks of material discharged from the orifices to variably obstruct the flow therethrough; and means for directing a plurality of angularly spaced jets against each of said banks whereby said material may be removed; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank.

4. A centrifugal separator comprising; a rotatable bowl having a circumferentially riffled interior surface and arcuate orifices between the riffles; means on the outside of the bowl for centrifugally retaining circumferential banks of material discharged from the orifices to variably obstruct the flow therethrough; and means for directing a plurality of angularly spaced jets against each of said banks whereby said material may be removed; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank; and the direction of the jets being adjustable with respect to the direction of motion of the banks.

5. A centrifugal separator comprising; a rotatable bowl in the form of an inverted truncated cone having a circumferentially riffled interior surface and arcuate orifices between the riffles; rings on the outside of the bowl having downwardly and inwardly directed skirts spaced from the bowl, forming annular pockets for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therethrough; and means for directing a plurality of angularly spaced jets upwardly and outwardly under each of said skirts whereby said material may be washed downwardy from said banks to be centrifugally thrown from the skirt bottoms; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank.

6. A centrifugal separator comprising; a rotatable bowl in the form of an inverted truncated cone having a circumferentially riffled interior surface and arcuate orifices between the riffles; rings on the outside of the bowl having downwardly and inwardly directed skirts spaced from the bowl, forming annular pockets for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therethrough; and means for directing a plurality of angularly spaced jets upwardly and outwardly under each of said skirts whereby material may be washed downwardly from said banks to be centrifugally thrown from the skirt bottoms; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank; and the direction of the jets being adjustable with respect to the direction of motion of the banks.

7. A centrifugal separator comprising; a rotatable bowl having a circumferentially riffled interior surface, arcuate orifices between the riffles, and a tubular journal through which material may be introduced; means on the outside of the bowl for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therefrom; means for directing a plurality of angularly spaced jets against each of said banks whereby said material may be washed therefrom to be centrifugally thrown from the bowl; and a housing surrounding the bowl having interior circumferential pockets respectively adapted to catch the material thrown off from the banks; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank.

8. A centrifugal separator comprising; a rotatable bowl having a circumferentially riffled interior surface, arcuate orifices between the riffles, and a tubular journal through which material may be introduced; means on the outside of the bowl for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therefrom; means for directing a plurality of angularly spaced jets against each of said banks whereby said material may be washed therefrom to be centrifugally thrown from the bowl; and a housing surrounding the bowl having interior circumferential pockets respectively adapted to catch material thus thrown off from the banks; said jets being positioned in such manner that each is adapted to co-

operate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank, and the direction of the jets being adjustable with respect to the direction of motion of the banks.

9. A centrifugal separator comprising; a rotatable bowl in the form of an inverted truncated cone having a circumferentially riffled interior surface, arcuate orifices between the riffles, discharge openings at its upper extremity, and a tubular journal through which material may be introduced; rings on the outside of the bowl having downwardly and inwardly directed skirts spaced from the bowl, forming annular pockets for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therethrough; means for directing a plurality of angularly spaced jets upwardly and outwardly under the skirts against each of said banks whereby material may be washed downwardly from the banks to be centrifugally thrown from the skirt bottoms; and a housing surrounding the bowl having interior circumferential pockets respectively adapted to catch material thrown off from the skirts; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank; and the housing pockets being sub-divided by radial partitions adjacent the respective jets.

10. A centrifugal separator comprising; a rotatable bowl in the form of an inverted truncated cone having a circumferentially riffled interior surface, arcuate orifices between the riffles, discharge openings at its upper extremity, and a tubular journal through which material may be introduced; rings on the outside of the bowl having downwardly and inwardly directed skirts spaced from the bowl, forming annular pockets for centrifugally retaining banks of discharged material opposed the orifices to variably obstruct the flow therethrough; means for directing a plurality of angularly spaced jets upwardly and outwardly under the skirts against each of said banks whereby material may be washed downwardly from the banks to be centrifugally thrown from the skirt bottoms; a housing surrounding the bowl having interior circumferential pockets respectively adapted to catch material thrown off from the skirts, and radial partitions adjacent the respective jets subdividing the housing pockets; and means for separately discharging the contents of said subdivided pockets; said jets being positioned in such manner that each is adapted to cooperate with the preceding jet of its series by preventing dislodged material from being centrifugally returned to its bank, and the direction of the jets being adjustable with respect to the direction of motion of the banks.

11. In a device of the character described, rotatable nozzle supporting members; and independently rotatable and longitudinally slidable nozzles eccentrically mounted upon said members; said nozzles having geniculate discharge ends, and the axes of said nozzles and supporting members being parallel.

12. In a device of the character described; a cellular fluid header; closed-end rotatable tubes piercing the cell walls of the header and perforated within the cells; and smaller intermediately perforated nozzle tubes extending longitudinally through the first said tubes and eccentrically piercing the ends thereof; said nozzle tubes having closed outer ends, geniculate discharge ends, and being independently rotatable.

13. In a device of the character described; a cellular fluid header having valves for independently regulating the flow of fluid into the cells thereof; closed end rotatable tubes piercing the cell walls of the header and perforated within the cells; and smaller intermediately perforated nozzle tubes extending longitudinally through the first said tubes, parallel to the axes thereof, and eccentrically piercing both ends of the first said tubes; said nozzle tubes having closed outer ends, geniculate discharge ends, and being independently rotatable and longitudinally slidable.

EARLE S. ECCLESTON.