Dec. 14, 1954 C. M. ANDERSON 2,696,913

REVOLVING CURRENT FLOTATION MACHINE

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FIG. 1.

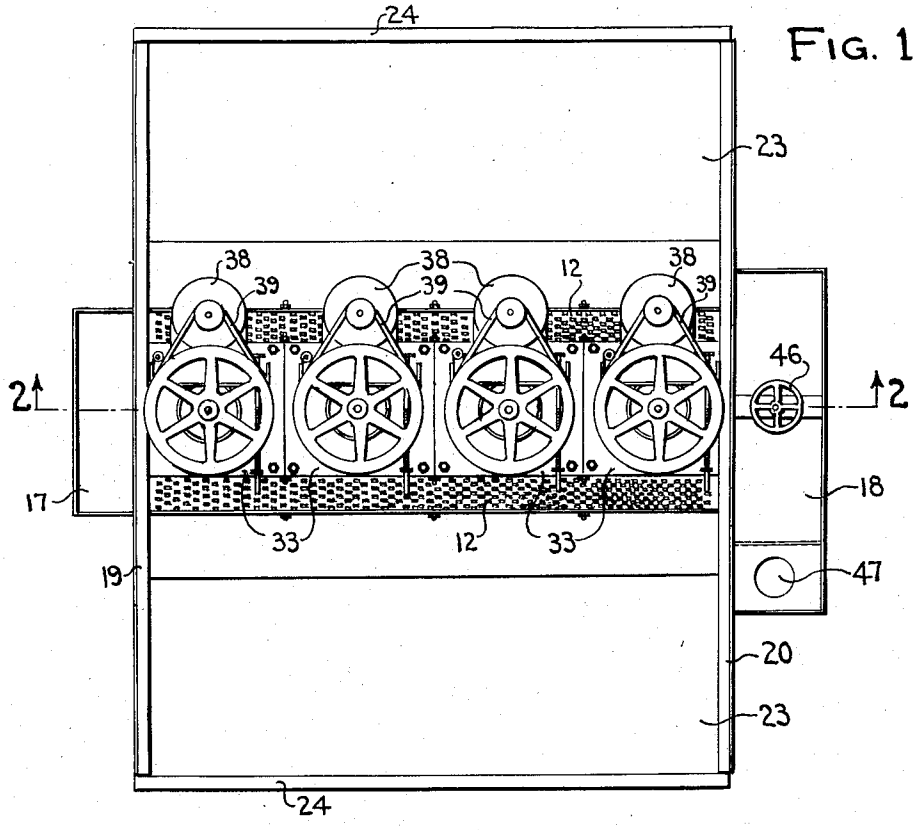
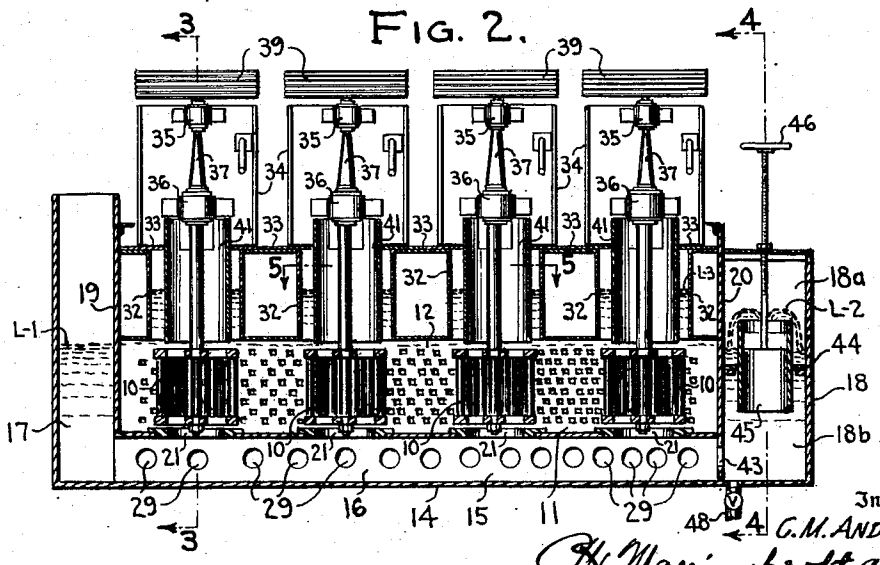


FIG. 2.



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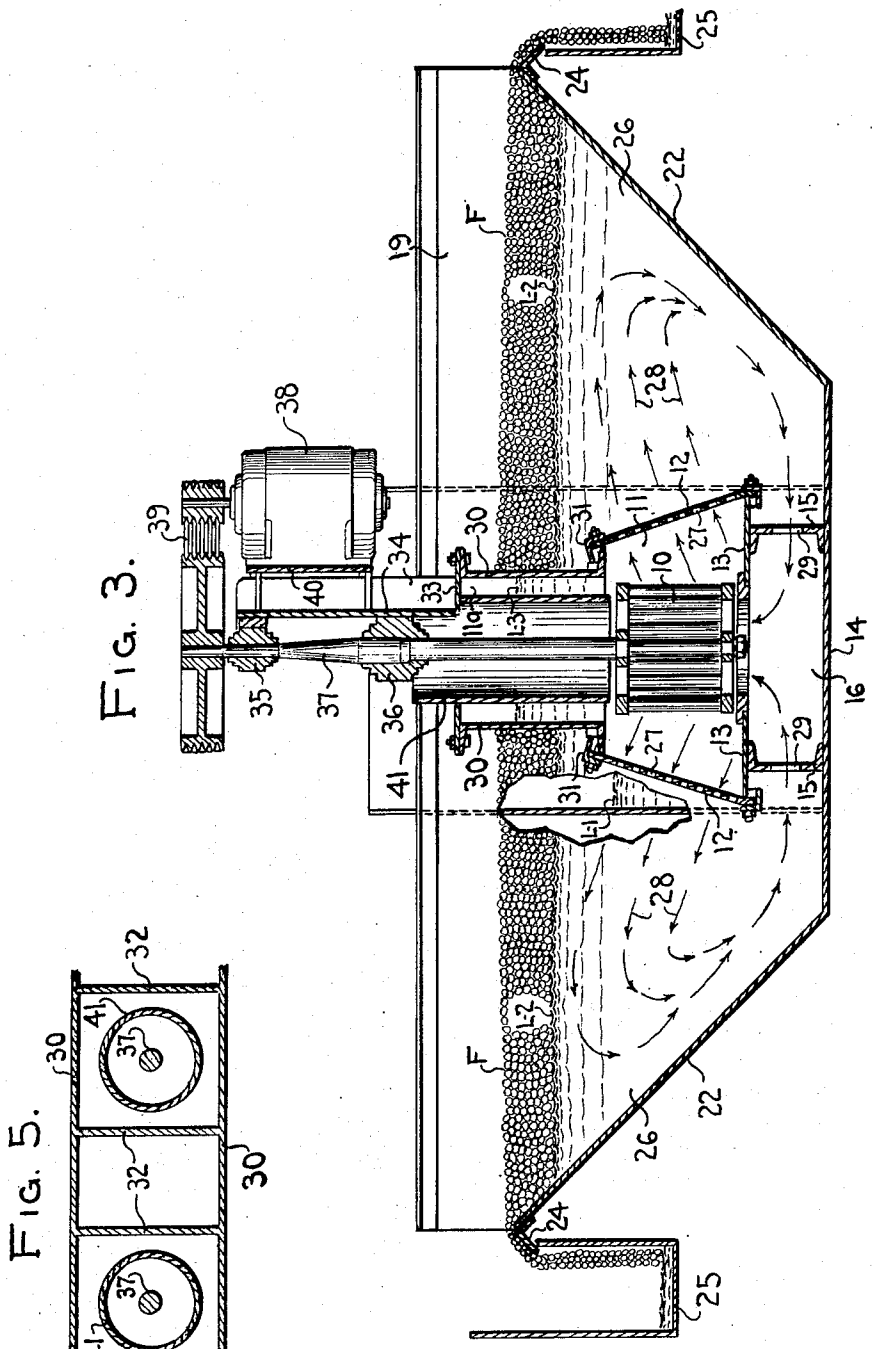


FIG. 3.

FIG. 5.

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FIG. 4.

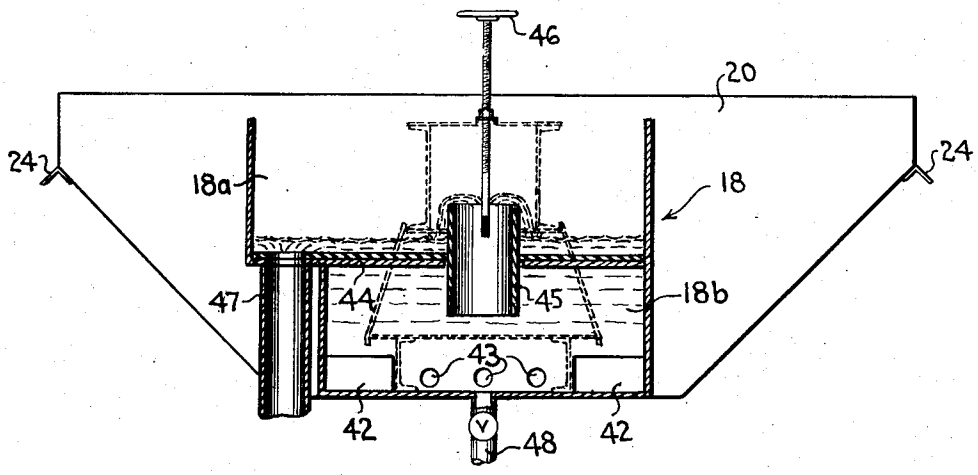


FIG. 6.

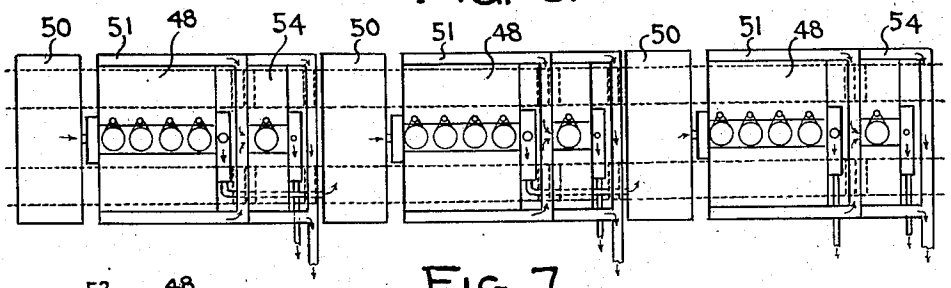
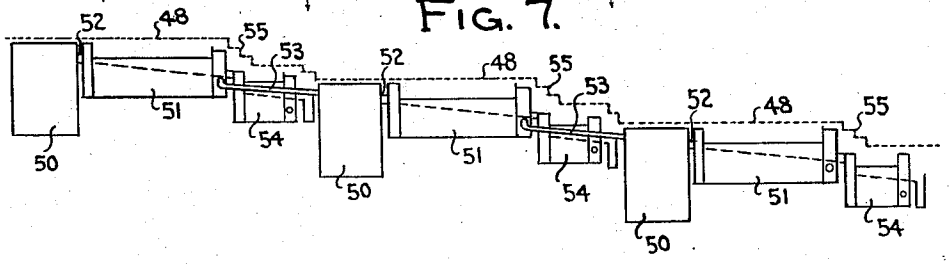


FIG. 7.

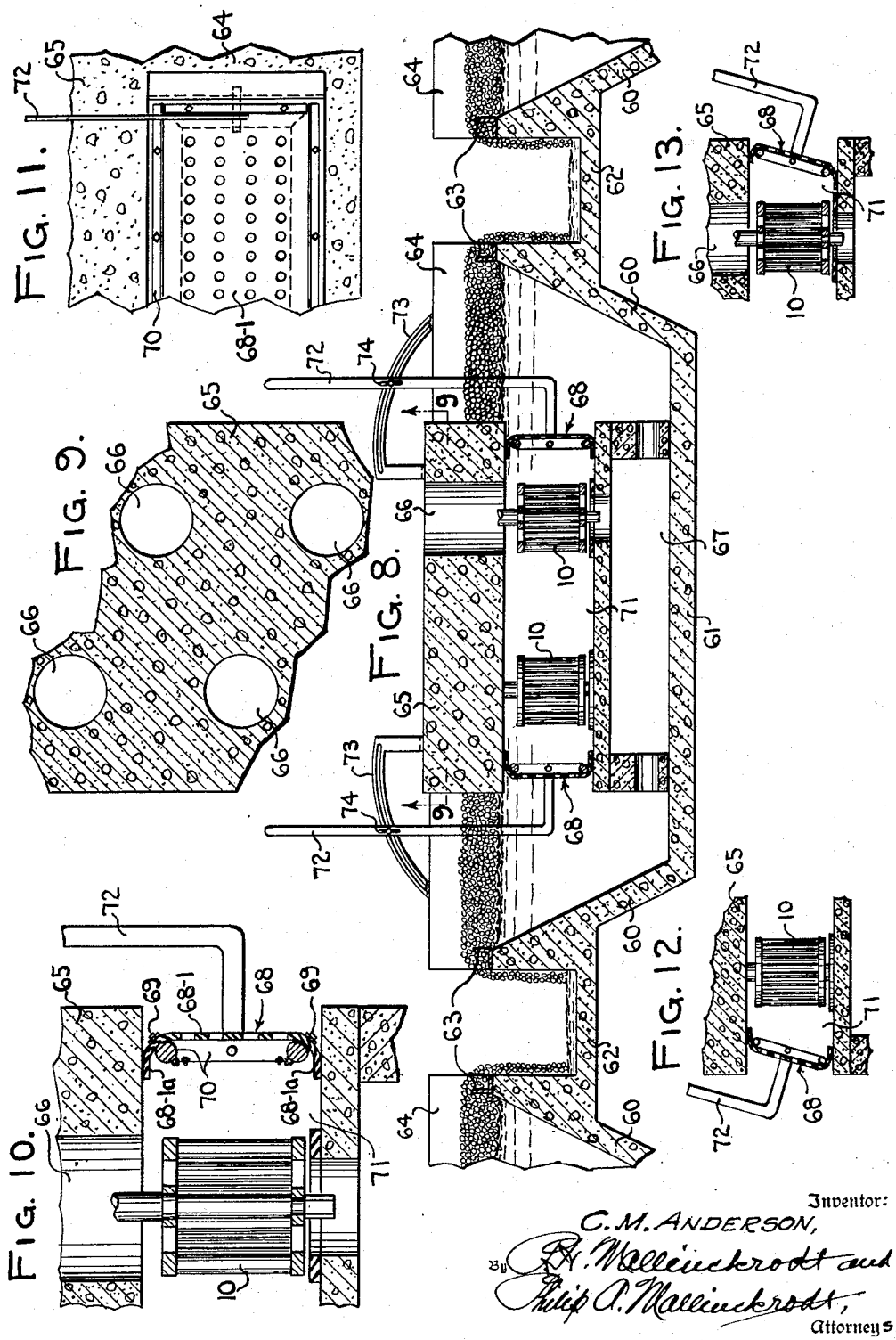


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REVOLVING CURRENT FLOTATION MACHINE

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REVOLVING CURRENT FLOTATION MACHINE

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FIG. 14.

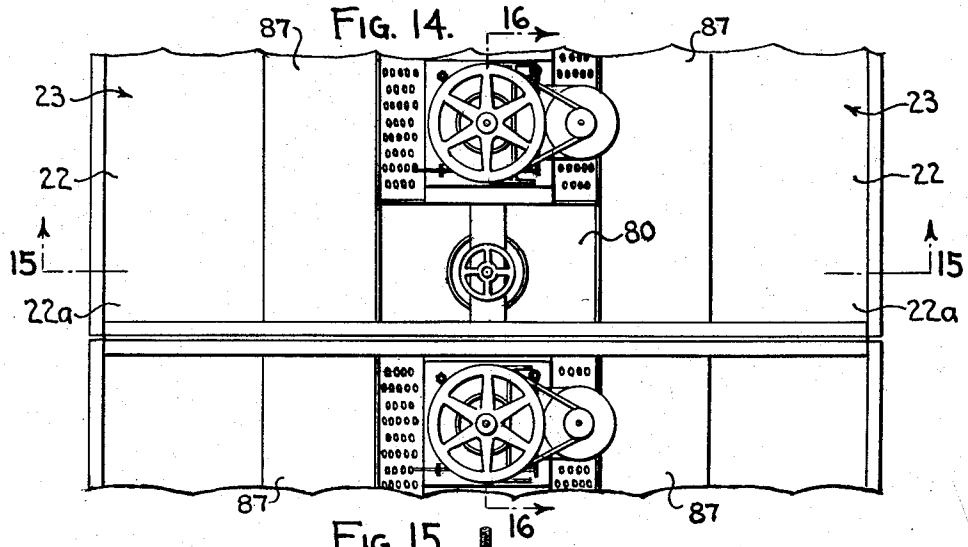


FIG. 15.

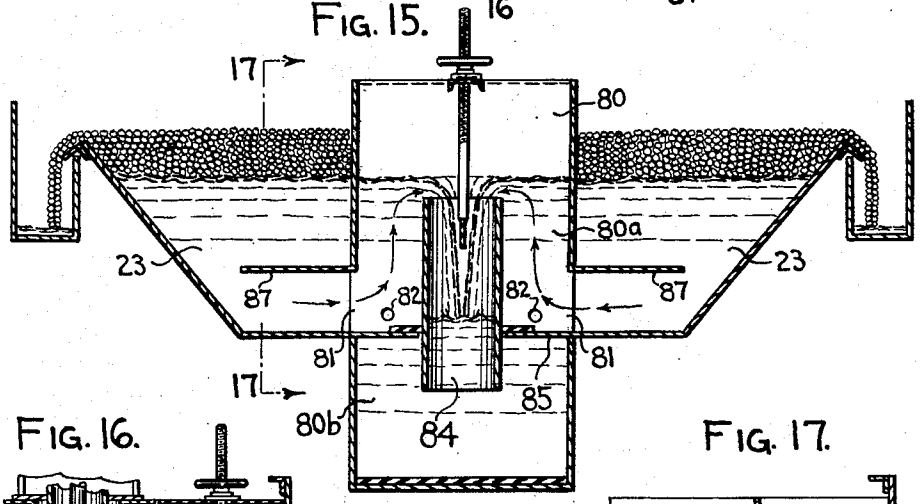


FIG. 16.

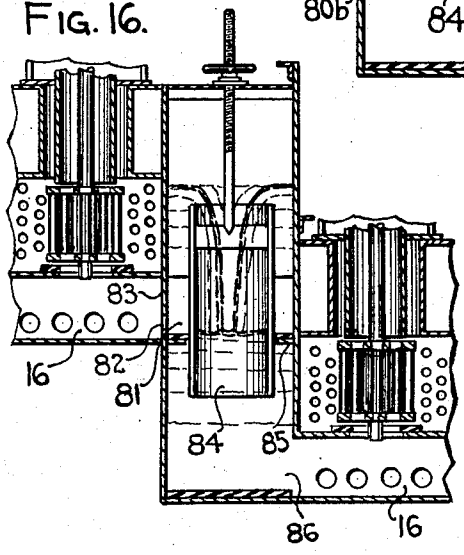
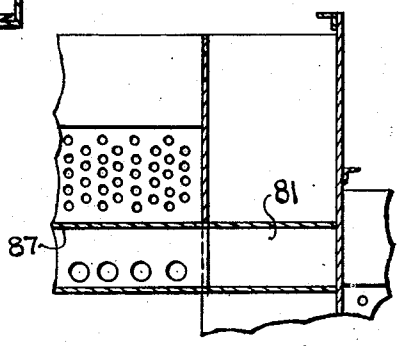


FIG. 17.



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United States Patent Office

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REVOLVING CURRENT FLOTATION MACHINE

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Application December 8, 1949, Serial No. 131,836

23 Claims. (Cl. 209—169)

This invention relates to flotation machines and to systems thereof as used, for example, in the art of metallurgy. It relates particularly to the mechanical agitation type of machine, and to systems utilizing the same.

Principal objects of the invention are:

To provide a flotation machine of the type concerned wherein there is achieved flow of aerated pulp at substantially right angles to the froth overflow lip or lips, and within recirculating paths of revolution disposed in side-by-side parallel relationship along the length of the machine.

To eliminate cell partitions in all compartments of a machine, thus allowing freer bubble formation and entailing less bubble breakage.

To achieve a positive and superior recirculation of the pulp.

To speed the movement of froth to and over the overflow lip or lips.

To eliminate all bleeder gates.

To provide a machine that is short and wide, as compared to conventional machines, and undivided into a series of individual cells, yet one which, in effect, embodies a plurality of cells.

To increase the rate of recirculation of a flotation pulp, and the rate at which air is added thereto, as such pulp travels progressively through a machine.

To decrease the surface area of a flotation pulp as it progresses through a machine.

To greatly shorten the froth-receiving launders, so they may be sloped considerably more than is feasible with conventional machines, thereby reducing the amount of water necessarily added.

To enable the placing of relatively wide walkways on top, instead of along the sides, of a machine, thereby economizing space and affording more convenient access during operation.

To considerably reduce the extent of inside wall surface of a flotation machine, so that more bubbles reach the surface of the pulp.

To considerably reduce the size of a flotation machine of given capacity, thereby reducing the floor area required in the mill.

To provide a new and improved flotation system utilizing gravity flow of pulp from conditioner to flotation machine and from circuit to circuit.

In the attaining of these objects of the invention, I provide a series of impellers within an undivided agitation chamber defined longitudinally by oppositely disposed and ported, rectilinear, pulp-directing walls which serve, in effect, as stators. Pulp discharged forcibly from the impellers flows through the ports of such walls into respective bubble chambers, which are longitudinally coextensive with the walls. The flow of aerated pulp across the bubble chambers is thus along respective paths which are disposed in side-by-side parallel relationship along the length of the machine. Respective froth overflow lips are provided along the tops of the outer longitudinal walls of the bubble chambers, such lips being disposed in parallel relation to the ported walls and across the widths of the respective bubble chambers therefrom. Thus, the flow of aerated pulp is at substantially right angles to such froth overflow lips. Walkways extending longitudinally of the machine may be placed above such bubble chambers.

A continuous and undivided pulp feed compartment or conduit extends longitudinally of the machine immediately below the agitation chamber, and opens into

the undersides of the respective impellers. Such feed compartment communicates laterally with the respective bubble chambers, and provides for recirculation of the pulp along respective paths of revolution comprehending the outward flow paths of aerated pulp.

The ports of the pulp-directing walls become progressively more numerous and more closely spaced from the feed end to the discharge end of the machine, in order to progressively increase the rate of recirculation of the pulp and the rate at which air is added thereto.

The usual bleeder gates are eliminated by constructing the tailings discharge so that sands are forced back into the recirculating pulp through cleaner ports disposed at the discharge end of the machine. Accumulation of sands is effectively prevented by this expedient.

Hydrostatic heads are advantageously maintained at different levels in the machine, as will hereinafter appear, for aiding in the operation thereof.

In the flotation system, I provide a single machine of suitable capacity for each recovery circuit, the same being arranged, together with the respective conditioner units, in downwardly stepped series, so that flow of pulp through the system will be by gravity.

Further objects and features will become apparent from the following detailed description of the presently preferred specific embodiments illustrated in the accompanying drawings for the purpose of exemplifying the generic characteristics of the invention.

In the drawings:

Fig. 1 represents a top plan view of the machine;

Fig. 2, a longitudinal vertical section taken on the line 2—2 of Fig. 1;

Fig. 3, a transverse vertical section taken on the line 3—3 of Fig. 2;

Fig. 4, a similar view taken on the line 4—4 of Fig. 2;

Fig. 5, a fragmentary horizontal section taken on the line 5—5 of Fig. 2, and drawn to an enlarged scale;

Fig. 6, a diagrammatic plan view of a flotation system utilizing the machine of the above figures in each of its three recovery circuits;

Fig. 7, a diagrammatic side elevation of the same;

Fig. 8, a view corresponding to that of Fig. 3, but drawn to a reduced scale and illustrating a machine utilizing concrete construction, a double row of impellers, and adjustable stators;

Fig. 9, a fragmentary horizontal section taken on the line 9—9 of Fig. 8;

Fig. 10, a fragmentary portion of Fig. 8 including an impeller and stator drawn to an enlarged scale to illustrate minor details;

Fig. 11, a side elevation of the structure appearing in Fig. 10, the view being taken from the right in Fig. 10;

Fig. 12, a fragmentary portion of Fig. 8, including the left-hand impeller and stator, and illustrating the stator in an alternate adjusted position;

Fig. 13, a similar view, but including the right-hand impeller and stator, and illustrating the stator in a different adjusted position.

Fig. 14, a fragmentary top plan view of a somewhat different arrangement of tailings discharge applied to the machine of Figs. 1 through 5, the view comprehending the tailings discharge portion of one machine and the pulp inflow portion of a succeeding machine;

Fig. 15, a transverse vertical section taken on the line 15—15 of Fig. 14;

Fig. 16, a fragmentary, longitudinal, vertical section taken on the line 16—16 of Fig. 14; and

Fig. 17, a similar section taken on the line 17—17 of Fig. 15.

Referring to the drawings: the flotation machine of Figs. 1 through 4 is illustrated as constructed of structural steel and equipped with a single row of impellers.

Pulp agitation

In accordance with the novel structural concepts of the invention, the machine includes a series of impellers, which may be of conventional type, such as the vertically mounted squirrel cage impellers **10** illustrated, the same being positioned within an undivided, elongate, agitation chamber **11** defined longitudinally of the machine by

oppositely-disposed, ported, pulp-directing walls **12**, serving as stators.

Pulp feed

The floor **13** of the agitation chamber **11** is spaced above the bottom **14** of the machine, and rests upon oppositely-disposed, longitudinal stringers **15**, which are conveniently structural steel channels, as illustrated. A longitudinally extending compartment **16** is thus formed immediately below the agitation chamber **11**.

Such compartment **16** opens at one end into a pulp feed box **17**, and opens at the other end through suitably arranged ports into the bottom portion of a tailings discharge box **18**, the former being divided from the agitation chamber by an end wall **19** of the machine, and the latter by an end wall **20** of the machine. A series of apertures **21** through the floor **13** of the agitation chamber establishes passage from the compartment **16** to the interiors of the respective impellers **10**. Thus, the compartment **16** becomes, in effect, a pulp feed conduit.

One of the three different hydrostatic heads in the machine during operation thereof is established by the level L–1 of pulp maintained in the feed box **17**.

Bubble columns and froth discharge

Defined laterally of agitation chamber **11**, by respective side walls **22**, Fig. 3, and the end walls **19** and **20** of the machine, are bubble chambers **23** having froth overflow lips **24**, respectively, leading into respective launders **25**. The side walls **22** preferably slope upwardly and outwardly from bottom **14** of the machine, so as to establish broad froth collection zones "F" superficially of the bubble columns **26** during operation of the machine.

The pulp-directing walls or stators **12** are of suitable abrasive-resistant material, such as rubber or a rubber composition. Preferably, pure gum natural rubber at least ½ inch in thickness is employed for the purpose. Such stators are provided with numerous relatively small ports **27**, which are desirably staggered in position and progressively increase in number per unit length from the feed end of the machine to the discharge end thereof, the exact size and spacing of the ports being determined in any given instance according to accepted engineering practice with respect to rotor-stator design. In a machine having the general proportions of that illustrated, ports approximately one inch square are appropriate. The walls **12** are in most instances sloped upwardly and inwardly, as shown, so that the pulp will be directed somewhat upwardly as it flows outwardly through the ports, as indicated by the respective pulp-flow circuits **28** in Fig. 3.

It should be noted that the flow of aerated pulp from the ports **27** of the pulp-directing walls or stators **12** is substantially straight-line and parallel in character. To take best advantage of such character of flow of the aerated pulp, the bubble chambers **23** and froth overflow lips **24** are longitudinally coextensive with and parallel to the agitation chamber **11** and stators **12**.

Another of the three different hydrostatic heads existing in the machine during operation thereof is established by the level L–2 of the aerated pulp in the bubble chambers **23**.

Pulp recirculation

The stringers **15** are provided with respective series of apertures **29** along their lengths, see Fig. 2, providing for recirculation of pulp. As in the case of the ports **27**, such apertures **29** progressively increase in number per unit length from the pulp feed end to the tailings discharge end of the conduit **16** to accommodate progressively increased circulation of the pulp.

The pulp recirculative flow takes place along the circuits or paths of revolution **28**, the same being disposed substantially at right angles to the walls **22** and froth over-flow lips **24**.

Impeller assemblies and air intake

Forming structure upon which the several impeller motors are mounted, as well as upward continuations **11***a* of the agitation chamber **11** at the respective impellers **10**, are longitudinally extending beams **30**, Fig. 3, advantageously being structural steel channels, as shown. The lower out-turned flanges thereof receive and support, in this embodiment, the upper margins of the respective

stators **12**, as by means of longitudinal fastening elements **31**. Between such beams **30**, at intervals determined by the positions of the several impellers, are secured box-like partitions **32**, Figs. 2 and 5, and across the tops thereof and of the intervening spaces are secured cover plates **33**.

Supporting standards **34** for the respective impeller assemblies are secured to and rise from the cover plates **33** at the said intervening spaces. Such standards are conveniently I-beams. Bearings **35** and **36**, projecting out over the spaces from such standards **34**, serve to rotatably mount respective impeller shafts **37**, which are driven from respective motors **38** through conventional belting arrangements indicated at **39**. The motors **38** are conveniently mounted on the respective frames **34** by means of respective brackets **40**.

Air is drawn into the impellers **10** through respective tubular conduits **41**, which extend vertically through cover plates **33** and between adjacent partitions **32** to terminations appropriately short of the upper ends of the impellers.

The third hydrostatic head existing during operation of the machine is established within the upward continuations **11***a* of the agitation chamber **11** by the pulp level L–3, Fig. 3.

Tailings discharge

The tailings pass from bubble chambers **23** into the tailings discharge box **18** by way of discharge openings **42**, Fig. 4. The greater part of any sands tending to accumulate at the bottom of such discharge box **18** are recirculated into feed conduit **16** through cleaner ports **43**, Figs. 2 and 4.

As illustrated in Fig. 4, the tailings discharge box **18** is divided horizontally by a septum **44**, through which a tubular weir **45** is raised or lowered by means of a handwheel **46**. The upper open trough portion **18***a* of the box has a tailings discharge pipe **47** leading therefrom.

A valved drain **48** leads from the bottom of the lower portion **18***b* of the box, to permit periodic flushing of any sands which may accumulate.

Access

It will be noted that the superficial froth collection surfaces of the bubble chambers are relatively broad, and permit the placement thereover of walkway gratings **48**, Figs. 6 and 7. Such gratings are supported at their ends by the end walls **19** and **20** of the machine, which rise a sufficient height to properly position the gratings relative to the froth accumulations.

Thus, access to the working parts of the machine is conveniently attained, and considerable space is saved over the conventional manner of placing walkways.

Operation

In operation, pulp is continually fed into conduit **16** from pulp feed box **17**, and is sucked up into the impellers **10** through apertures **21**, being aided, of course, by the hydrostatic head at level L–1.

Aerated pulp is flung radially outwardly by the impellers, and passes toward and through the ports **27** of stators **12**, from where it travels directly outwardly along substantially straight and parallel lines, without structural interference. The hydrostatic head at level L–3, which is established by the action of impellers **10**, plays an important part in forcing the aerated pulp through the stator ports.

The above-mentioned straight line, parallel flow of the pulp, and the recirculation thereof along the flow circuit or paths of revolution **28**, insure thorough aeration and efficient, high recovery of metallurgical values.

The tailings which pass through discharge openings **42** into tailings discharge box **18** are thoroughly impoverished.

Froth is recovered in conventional manner by the respective launders **25** after discharge over the lips **24**.

The system

The machine of the invention makes possible the provision of flotation systems having unique attributes and advantages.

The system illustrated diagrammatically in Figs. 6 and 7 is typical, and includes three circuits for the successive recovery of lead, zinc, and iron.

Conditioner tanks **50** for the respective successive circuits are arranged at approximately the same level as

the flotation machines **51** which they serve, so that pumping is eliminated, and flow from the conditioner tanks to the corresponding flotation machines is accomplished through respective feed pipes **52**. On the other hand, flow from the tailings box of one machine to the conditioner tank of a successive circuit is accomplished by gravity through a pipe **53**.

Respective cleaner cells **54** are interposed as illustrated, and the walkway gratings **48** of the respective machines are joined by walkway flights **55**.

The entire system is stepped downwardly from a first level, corresponding to the first recovery circuit, through successive levels corresponding to successive circuits.

This arrangement permits a great saving in space over conventional systems, wherein the conditioner tanks are placed on a lower floor of the mill and contents thereof are pumped into the feed box of the rougher cell of the corresponding recovery circuit. In such conventional systems, one circuit occupies approximately the same space as all three circuits of the present system.

Furthermore, by reason of the walkway gratings being placed as they are with respect to the component units of the system, operation of the several circuits is made easier. An entire circuit can be seen by an attendant from one vantage point.

Concrete construction

The machine and system of the invention are well adapted for reinforced concrete construction in the obtaining of longer operative life than is possible with machines fabricated from steel plate.

As illustrated in Figs. 8 through 13, where an installation having a series of machines disposed side-by-side is shown, side walls **60**, bottom **61**, and launders **62** are constructed integrally, throughout the series, of reinforced concrete, the overflow lips **63** being advantageously provided by superimposed structural steel members, as shown.

Likewise, the end walls of the machine, as indicated at **64**, are integral with and serve to support a longitudinally extending slab **65**, through which air shafts **66** for the respective impellers **10** extend. Such end walls and slab are, as illustrated, of reinforced concrete.

As here shown, the impellers **10** are arranged in staggered relationship within double, parallel rows, see especially Fig. 9. This exemplifies the versatility of arrangement possible in the machine of the invention, without sacrificing advantageous operative characteristics thereof.

The pulp feed conduit, indicated here at **67**, is defined by walls also made of reinforced concrete. Thus, all of the essential structural components of the machine can be made highly wear-resistant and substantially permanent.

Adjustable stators

In this embodiment of the invention, I have chosen to illustrate how the pulp-directing walls or stators **68** of the machine may be made adjustable, so the recirculation paths of revolution may be modified for any given run of the machine to suit special requirements for maximum recovery.

As shown in Figs. 10 and 11, each stator **68** comprises a sheet of flexible and resilient abrasion-resistant material **68–1**—preferably the pure, natural gum rubber mentioned hereinbefore—securely fixed, as by means of bolts **69**, to a longitudinally-extending and adjustable frame **70** which is pivoted, preferably centrally thereof, to the opposite end walls of the machine. Ample marginal flaps **68–1***a* overlap the frame **70**, and bear outwardly against the overlying and underlying walls, respectively, to provide seals longitudinally of the agitation chamber **71**.

A manually-operable handle **72**, secured to the frame **70** and extending upwardly for convenient access by an attendant, provides for angular adjustment of the stator to either side of the vertical within a range indicated generallv by Figs. 12 and 13.

The adjustment is guided and fixed by any suitable means, for example, by a slotted guide **73**, Fig. 8, and anchor screw **74**.

Alternative tailings discharge

In Figs. 14 through 17 is illustrated an alternative form of tailings discharge, the same being applicable in its essentials to any of the foregoing embodiments of the invention, but, for illustrative purposes, being here shown in connection with the steel construction of Figs. 1 through 5.

As illustrated, the side walls **22** defining bubble chambers **23** are extended, as at **22***a*, to comprehend the tailings discharge box, here indicated **80**. Such tailings discharge box **80** has its inflow passages **81** from respective bubble chambers **23** disposed laterally thereof. Only the several sand openings **82** from pulp feed compartment or conduit **16** enter through the front wall **83** of the box **80**.

Above the inflow passages **81**, tailings discharge box **80** is open to provide free upward passage for tailings to an outflow level established by a tubular weir **84**. Such outflow level is preferably and normally established at substantially the level of pulp in the bubble chambers.

The weir **84** extends through a horizontally-disposed partition **85**, which divides the discharge box **80** into an upper chamber **80***a* and a lower chamber **80***b*. The lower end of the discharge box **80** has an outlet **86**, which, in the case of an installation involving a series of machines, as illustrated in Fig. 16, opens directly into the pulp feed compartment or conduit **16** of the succeeding machine. Thus, the upper chamber **80***a* of the discharge box **80** serves directly as a tailings discharge box, while the lower chamber **80***b* may serve, in effect, as a pulp feed box for a succeeding machine of a series.

In this embodiment, horizontal baffles **87** extend from the junctions between stators **12** and pulp feed compartment or conduit **16** at respectively opposite sides of the machine, for positively guiding pulp recirculation. This feature is optional in the several embodiments of the invention.

Conclusion

While three different hydrostatic heads are advantageously maintained by three different pulp levels established during operation of the machine in certain forms of the invention, it can be seen from the concrete construction of Figs. 8 to 13 that in some instances structural considerations will control. Thus, in the particular concrete construction illustrated, no provision is made for a pulp level corresponding to L–3 in the first-described embodiment, thereby eliminating the hydrostatic head ordinarily maintained by such level of pulp in the machine. In this instance, the centrifugal flinging action of the impellers, alone, forces the aerated pulp through the stator ports.

It has been convenient to illustrate the several embodiments as comprising a container for pulp in which the aeration chamber is defined along the central longitudinal axis of the container, forming double bubble chambers symmetrically flanking the aeration chamber at opposite sides thereof. It should be realized, of course, that a single bubble chamber may be utilized where conditions warrant, and, further, that the sides of the container may slope at various angles or may be vertically disposed, all as a matter of choice in particular instances.

Whereas this invention is here illustrated and described with respect to a certain presently preferred specific embodiment thereof, it should be understood that various changes may be made therein and various other forms may be constructed on the basis of the teachings hereof, by those skilled in the art, without departing from the protective scope of the following claims.

I claim:

1. A flotation machine, comprising an elongate container for pulp; a ported wall extending longitudinally of the container, as a stator, defining within said container an elongate agitation chamber flanked by an elongate bubble chamber, both said aeration chamber and bubble chamber being substantialy uninterrupted and undivided along their lengths; a series of aeration impellers operatively disposed within and spaced apart along said agitation chamber; a froth overflow lip formed along the top of the container side wall which defines, in part, said bubble chamber; wall means defining an elongate compartment extending longitudinally beneath said agitation chamber, said compartment opening into the agitation chamber at the respective impellers and serving as a pulp feed conduit; means for feeding pulp into one end of said compartment; passage means extending from said bubble chamber into said compartment, for pulp recirculation; and tailings discharge means leading from said bubble chamber.

2. The combination recited in claim 1, wherein the

container side wall and the stator wall is substantially parallel longitudinally of the machine.

3. The combination recited in claim 1, wherein the stator wall is fixed in position and slopes upwardly inwardly of the machine, so that aerated pulp is directed diagonally upwardly across the bubble chamber.

4. The combination recited in claim 1, wherein the ports of the stator wall and the passage means from bubble chamber to the pulp feed conduit increase in number per unit area from the pulp feed and to the tailings discharge end of the machine.

5. The combination recited in claim 1, wherein the stator wall is adjustable about a longitudinal axis.

6. The combination recited in claim 1, wherein air-intake conduits extend from above the highest working level in the machine down to the respective impellers; and wherein respective wall means surrounding said air-intake conduits provide upward continuations of the agitation chamber.

7. The combination recited in claim 6, wherein the impellers are of squirrel-cage type.

8. The combination recited in claim 1, wherein a double row of impellers extend longitudinally of the agitation chamber.

9. The combination recited in claim 1, wherein the tailings discharge means comprise a tailings discharge box at the end of the machine which is opposite the pulp feed end; and passage means from the bubble chamber into said tailings discharge box.

10. The combination recited in claim 9, wherein openings for the passage of sand are provided between the tailings discharge box and the adjacent end of the pulp feed compartment.

11. The combination recited in claim 10, wherein the tailings discharge box is divided by a septum into an upper compartment and a lower compartment, and a tubular weir establishes flow communication between said compartments.

12. The combination recited in claim 11, wherein the passage means from the bubble chamber enters the upper compartment of the tailings discharge box; and a tailings outlet is provided in the lower compartment.

13. The combination recited in claim 1, wherein opposite end walls of the container extend well above the froth overflow lip; and longitudinally-extending walkway structure is supported by said opposite container end walls.

14. The combination recited in claim 1, wherein a substantially horizontal, longitudinally extending baffle projects out across a portion of the width of the bubble chamber from between the agitation chamber and the pulp feed compartment for positively directing pulp recirculation.

15. The combination recited in claim 1, wherein the tailings discharge means comprise a tailings discharge box at the end of the machine which is opposite the pulp feed end; wherein the bubble chamber is extended so as to flank said tailings discharge box; and wherein the tailings discharge means further comprises laterally disposed passage means from said bubble chamber into said tailings discharge box.

16. A flotation machine comprising an elongate container for pulp; two oppositely disposed, ported walls extending longitudinally and spaced apart transversely of the container, as stators, to define an elongate agitation chamber extending along the longitudinal central axis of the container, and two longitudinally extending bubble chambers flanking said agitation chamber at respectively opposite sides thereof, the said agitation chamber and the said bubble chambers being substantially uninterrupted and undivided along their lengths; a series of aeration impellers operatively disposed within and spaced apart along said agitation chamber; froth overflow lips formed along the tops of the respective side walls of the container which define, in part, said bubble chambers; an elongate compartment extending longitudinally beneath said agitation chamber, said compartment opening into the agitation chamber at the respective impellers and serving as a pulp feed conduit; means for feeding pulp into one end of said compartment; passage means extending from said bubble chambers into said compartment for pulp recirculation; and tailings discharge means leading from said bubble chambers.

17. The combination recited in claim 1, wherein the compartment defining the pulp feed conduit rises above the level of the bottom of the bubble chamber.

18. The combination recited in claim 17, wherein the wall means defining said compartment is ported laterally to provide the passage means extending from said bubble chamber into said compartment.

19. The combination recited in claim 16, wherein the compartment defining the pulp feed conduit rises above the level of the bottom of the bubble chamber.

20. The combination recited in claim 19, wherein the wall means defining said compartment is ported laterally to provide the passage means extending from said bubble chambers into said compartment.

21. In a flotation machine provided with pulp-recirculating passage means, tailings discharge structure, comprising a box; a septum dividing said box substantially horizontally into an upper compartment and a lower compartment; a tubular weir extending through said septum and establishing flow communication between said compartments; tailings inflow passage means leading into one of said compartments; tailings outflow passage means leading from the other of said compartments; and cleaner ports establishing flow communication between said one compartment and said pulp-recirculating passage means.

22. The combination recited in claim 21, wherein the tailings inflow passage means leads into the lower compartment, and the said tailings outflow passage means leads from the upper compartment.

23. The combination recited in claim 21, wherein the said tailings inflow passage means leads into the said upper compartment, and the said tailings outflow passage means leads from the lower compartment.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,413,723	Groch	Apr. 25, 1922
1,457,077	Janney	May 29, 1923
1,744,785	McTaggart	Jan. 28, 1930
1,942,803	Daman	Jan. 9, 1934
1,963,122	Fagergren	June 19, 1934
2,054,249	Fagergren	Sept. 15, 1936
2,143,669	Weinig	Jan. 10, 1939
2,168,942	McClave	Aug. 8, 1939
2,178,239	McKenna	Oct. 31, 1939
2,252,576	MacIntosh	Aug. 12, 1941
2,259,243	Daman	Oct. 14, 1941
2,466,995	McMurray	Apr. 12, 1949

FOREIGN PATENTS

Number	Country	Date
584,306	Great Britain	Jan. 13, 1947
681,212	Germany	Aug. 31, 1939

OTHER REFERENCES

Denver Equipment Company Bulletin No. F10.B29 on Denver "Sub-A" Flotation, received in Patent Office August 5, 1949.