Jan. 12, 1954 G. G. CHISHOLM 2,665,809

VORTEX CONCENTRATOR

Filed Feb. 9, 1950

2 Sheets-Sheet 1

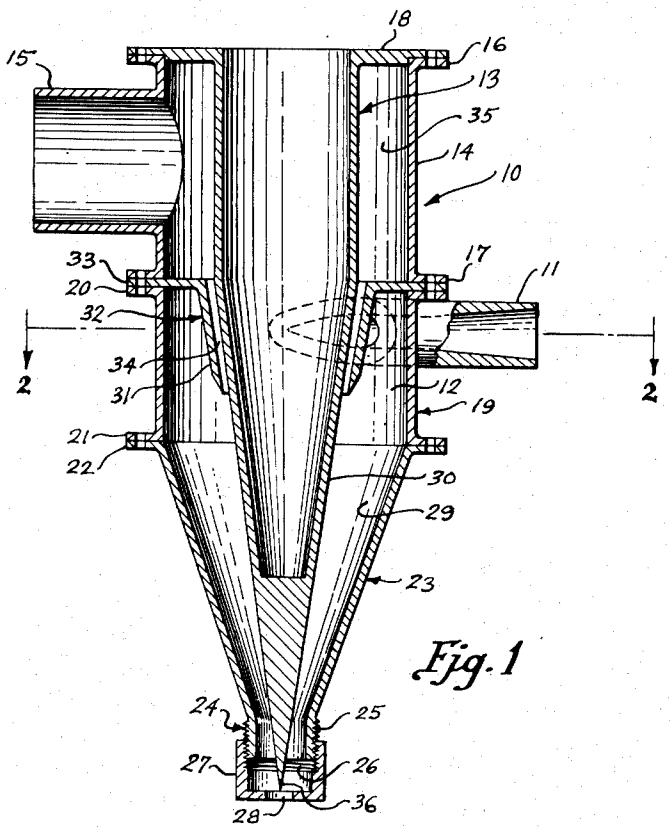

Fig. 1

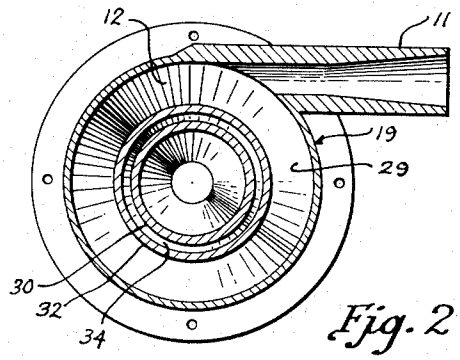

Fig. 2

Inventor
GILBERT G. CHISHOLM
By: Fetherstonhaugh & Co.
Att'ys

Jan. 12, 1954 G. G. CHISHOLM 2,665,809

VORTEX CONCENTRATOR

Filed Feb. 9, 1950

2 Sheets-Sheet 2

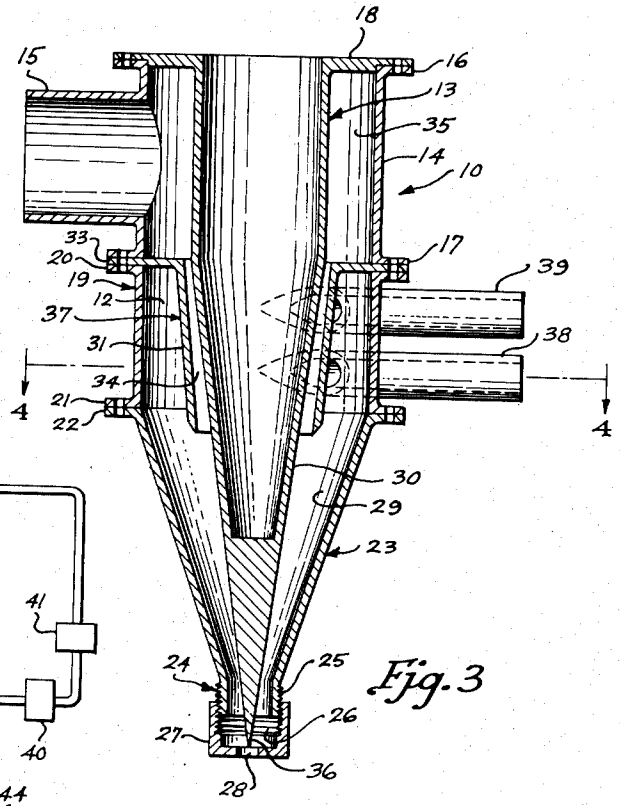

Fig. 3

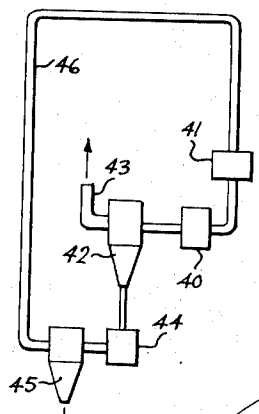

Fig. 5

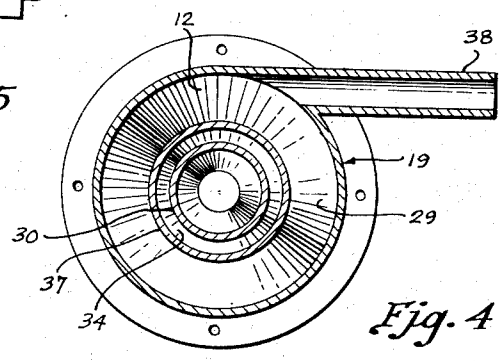

Fig. 4

Inventor
GILBERT G. CHISHOLM
By: Fetherstonhaugh & Co.
Att'ys

Patented Jan. 12, 1954

2,665,809

UNITED STATES PATENT OFFICE

2,665,809

VORTEX CONCENTRATOR

Gilbert G. Chisholm, Lucan, Ontario, Canada, assignor to Ferros Metals Research Company Limited, Toronto, Ontario, Canada

Application February 9, 1950, Serial No. 143,223

1 Claim. (Cl. 209—211)

1

This invention relates to a vortex concentrator of the class which may be employed for mineral separations.

Previous cyclone devices have been employed for dust catching and in the cleaning of fine coal, particularly in a heavy medium. In previous constructions the pulp is pumped into the cyclone structure which is usually in the form of a simple cone-shaped cavity having an outlet at the bottom and an outlet at the top, the latter being in the region of the base of the cone. The pulp is introduced usually near the base of the cone and tangentially under pressure and the heavy or thickened mineral sprays out the bottom end of the cyclone, the light overflow forcing its way out of the opening in the upper regions of the base.

A disadvantage in prior cyclone arrangements for these purposes is that the control in separation is not sufficiently definite by reason of the uncontrolled vortex action within the cyclone concentrator structure.

It is a principal object of the present invention to provide means for controlling the vortex action to more effectively control the separating action.

Another object of the invention is to provide a cyclone separator of a vortex concentrator type embodying an inner cone that spreads the vortex of the pulp flow over a much greater surface than would be the case with a natural vortex thus giving a larger area of action and a more selective operation against the pulp passing through the device.

A still further object of the invention is to provide an inner cone in a cyclone concentrator wherein the sides of the cone are formed to converge to a point substantially coincident with the theoretical convergent point of the inner surfaces of the cone of the cyclone device.

A still further object of the invention is to provide means for feeding a plurality of pulps into a concentrator or a plurality of media of different densities to more effectively control the separating action.

Other objects of the invention will be appreciated by a study of the following specification taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a sectional view of an improved cyclone concentrator according to the invention.

Figure 2 is a sectional view of the concentrator of Figure 1 on the line 2—2 thereof.

Figure 3 is a sectional view of a modified form of concentrator according to the invention including a heavy media input.

Figure 4 is a sectional view of the device of Figure 3 on the line 4—4 thereof.

Figure 5 is a diagram of a method of concentrating ore pulps employing cyclone concentrators according to the invention.

Referring to the drawings, and particularly to

2

Figure 1, the improved concentrator of my invention comprises a relatively conventional cyclone casing 10 having an input nozzle 11 arranged tangentially with respect to the inner cavity 12 thereof, but having disposed therein the inner cone member 13 according to this invention, which serves to spread the vortex of the material moving within the casing over a much greater surface to give a greater area of action and increase the selectivity of the device.

In detail, one practical form of structure may comprise an upper cylinder 14 having an outlet pipe 15 extending therefrom. The cylinder 14 has upper and lower flanges 16 and 17. The upper flange is fastened to the closure plate 18 which forms part of the inner cone 13 and serves to locate the latter centrally within the casing 10. An intermediate cylinder 19 has mounted thereon the injector nozzle 11 which extends therefrom tangentially as indicated in Figure 2. Suitable flanges 20 and 21 are provided on the intermediate cylinder which match the flanges 17 and 22 on the upper cylinder and truncated cone component 23 respectively. The component 23 converges to terminate in a fitting 24 carrying suitable threads 25 designed to mate with the threads 26 of the control nozzle or concentrate regulator 27 having a port 28.

It is particularly important to note that the inner surfaces 29 of the cone component 23 converge theoretically to the same point as the exterior surfaces 30 of the vortex regulating cone 13.

In operation, the pulp is injected through the injector nozzle 11 under considerable pressure between the walls of the intermediate cylinder 19 and the converging walls 31 of the pulp divider 32 which is mounted by a flange 33 extending between the flanges 17 and 20 of the upper and intermediate cylinders. The tangential introduction of the pulp under pressure causes the pulp to circulate rapidly, thus setting up great centrifugal forces. As a result, the heavier fractions tend to move toward the walls of the intermediate cylinder 19 and at the same time the increased force of gravity caused by the centrifugal force draws the pulp downwardly towards the concentrate outlet port 28. The heavier fractions remain on the outside whereas the lighter material remains about the vortex which is in the form of a small air space extending about the converging surface 30 of the vortex regulating cone 13. The lighter fractions tend to rise rapidly against gravity through the annular space 34 between the pulp divider 32 and the surfaces 30 of the vortex regulating cone 13, whereby the lighter fractions arise to the annular chamber 35 in the upper cylinder and pass out of the device through the pipe 15 to tailings discharge.

The arrangement whereby the surfaces of the vortex regulating cone and the lower cone component 23 converge to substantially a common point is important in that all forces are brought

to a common point whereby they may be easily regulated by the concentrate regulator **27**. As the regulator is screwed up the apex **36** of the vortex regulating cone pierces the outlet port **28** reducing the sectional area of the opening and thus causing the vortex created by the circulation of the pulp within the concentrator to carry a larger proportion of the pulp to tailings discharge. The components just described, that is to say, the upper cylinder **10**, pulp divider **32**, intermediate cylinder **19**, and cone component **23** may be fastened together by passing bolts through the holes shown in the flanges thereof and, further, the vortex controlling cone may be mounted in similar manner in conjunction with the upper flange **16** of the upper cylinder **14**.

A modification of the concentrator according to the invention is illustrated in Figure 3, the modification particularly embodying the provision of a pulp divider skirt **37** of apparent greater depth than the skirt of the pulp divider **32** illustrated in Figure 1. The greater depth is necessary by reason of the inclusion of a heavy media ore pulp injector **38** which is placed below the ore pulp injector **39**. In all other respects this structure is similar to that previously disclosed in Figure 1 but the modification embodying the heavy media ore pulp injector is important in the control of separation.

The greater control will allow a cleaner concentrate to be obtained in one operation. Thus, a heavy media pulp is injected at the same pressure as the pulp to be concentrated, the heavy media being injected through the injector nozzle **38** and the pulp being injected through the nozzle **39**. In using the device of Figure 3 in the separation of two minerals of different specific gravities, the latter as a pulp may be introduced into the injector nozzle **39** and a separate medium of a specific gravity adjusted to a value between the specific gravity of the two minerals is introduced by way of the heavy media nozzle **38**. As a result, the lighter mineral, in effect, does not sink but is washed up and out of the cyclone. The heavier mineral is quickly drawn down by the amplified gravitational pull and passes out the outlet port **28** of the concentrate regulator **27**.

The chief operating variables encountered involve the specific gravities of the pulp constituents and the pressure at which the pulp is pumped through the cyclone device. The diameter of the outlet port or orifice **28** is a factor and obviously the viscosity of the pulp is of some importance.

Although the device of Figures 3 and 4 is presented as a modification which will allow a satisfactory concentrate to be obtained in one pass, it is preferred that devices of the type disclosed in Figure 1 be employed in series. Thus, in Figure 5, a pump **40** draws pulp from a reservoir **41** and delivers it through the injector nozzle into a vortex concentrator **42** of the invention. The lighter fractions pass out the pipe **43** to tailings discharge but the concentrate is again pumped by a pump **44** and delivered under pressure into a second concentrator **45** similar in construction to the concentrator **42**. The lighter fractions discharged by this second concentrator are re-circulated by the line **46** to the ore pulp reservoir **41**. The clean concentrate is delivered by the concentrator **45** as indicated.

A capacity of fifteen tons per hour can be accomplished by constructing a device according to Figure 1 of a height of about 17½ inches with

an overall diameter of about 7½ inches thus indicating the relatively small size of the unit required for comparatively large capacities. The grading of the pulp may be from minus ⅛ to less than 120 mesh and, in fact, the concentrator of this invention finds its greatest application in the separation of pulps of a high degree of fineness greater than minus 120 mesh. It is well known that gravity methods heretofore have not been particularly successful in the separating of media of a fineness greater than minus 120 mesh except by the use of cyclone concentrators, the latter being on a small scale. In mineral separation it is important that a maximum degree of control be afforded in the separating action, this being provided in the construction of my invention by the inclusion of a vortex control cone as disclosed herein, and further by incorporation of a heavy media injector nozzle as disclosed herein.

There will be many modifications obvious to skilled persons in respect to specific details of design of the concentrator unit disclosed herein. It is thus intended that this invention should not be construed in any limiting sense other than that indicated by the scope of the following claim.

What I claim as my invention is:

The combination in a concentrator of the cyclone type having separate tailings and concentrate discharge openings, of: a vertically disposed vortex controlling cone converging downwardly to a point; a truncated cone component, the side walls of which are disposed in spaced apart relation to said vortex controlling cone, being coaxial therewith and converging toward the point of said vortex controlling cone; an axially adjustable nozzle on the lower terminus of said truncated cone component having a port adapted to be pierced by said vortex controlling cone, thereby constituting the concentrate discharge opening of said concentrator of adjustable sectional area; a substantially cylindrical casing component at the upper end of said truncated cone component having a tailings discharge opening located at the upper end thereof; an inlet port in said casing including a nozzle designed to direct the pulp into said casing tangentially and disposed in said casing between the concentrate discharge opening and the truncated cone component; and a plup dividing skirt surrounding a portion of said vortex controlling cone being in spaced relation thereto and including a flange of annular form extending to the walls of said cylindric casing between the inlet port and the tailings discharge opening of the latter whereby heavier fractions of pulp injected into said concentrator through the inlet port thereof rise through the space between said skirt and said vortex controlling cone in a manner controllable by adjustment of said nozzle of said tailings discharge opening with respect to said vortex controlling cone.

GILBERT G. CHISHOLM.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,504,944	Atkinson	Apr. 18, 1950

FOREIGN PATENTS

Number	Country	Date
809,570	France	Mar. 6, 1937
149,985	Austria	June 25, 1937
886,187	France	Oct. 7, 1943
608,026	Great Britain	Sept. 8, 1948