ADJUSTABLE HARD CERAMIC UNDERFLOW OUTLET FOR HYDROCYCLONE


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Claims, 2 Drawing Figures

ABSTRACT

A hydrocyclone underflow outlet of hard ceramic material which is relatively strong under compression but weak under tension can be made adjustable in length by a series of grooves formed in its exterior surface permitting the member to be broken off to desired length by hammering a breaking tool wedged in the appropriate groove so that the tension at the base of the groove produced by pressure of the tool sides on the groove sides pulls the material apart at the base of the groove. The body may be frustoconical so that adjustment in length changes the size of an end opening in the body.

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Primary Examiner—Frank W. Lutter
Assistant Examiner—Ralph J. Hill
Attorney—Edgar H. Kent

1 Claims, 2 Drawing Figures
ADJUSTABLE HARD CERAMIC UNDERFLOW OUTLET FOR HYDROCYCLONE

This invention relates to tubular bodies formed of hard ceramic material useful in equipment for treating abrasive materials such as cyclone separators (which term as herein used includes hydrocyclones).

Because of their great wear resistance, hard ceramic materials are finding increasing usage for forming the walls of tubular bodies in which abrasive materials are treated. For example, cyclone separators wherein abrasive particles are segregated by centrifugal force against the tubular wall thereof frequently have such wall formed of hard ceramic material, at least adjacent the outlet end where abrasive wear is greatest.

In many cases it is necessary to reduce the length of such a body as supplied by the manufacturer to the installation site and this presents a problem in that the ceramic materials used for the purpose, such as ceramic materials of high alumina content, are so hard (their hardness being of the order of 75 to 81 as measured on a Rockwell 45N scale which is approximately equal to 1,000 to 1,100 on a Vickers hardness scale) that a diamond wheel is required to cut them. Since such equipment is not usually available at installation sites, the body must either be returned to the manufacturer or sent elsewhere for cutting to desired length or a replacement part of proper length obtained. This problem has been severe, for example, in the case of cyclone separators which normally have an abrasive particle discharge outlet end formed as a frustum of a cone so that the length thereof determines the diameter of the outlet in the end. When, as in many cases, it is desirable to cut off part of the outlet to enlarge the opening, if the outlet is formed of hard ceramic material, the above-mentioned cutting problem has been encountered. To avoid it, it has been common practice for the manufacturer to provide cyclones initially with temporary frustoconical outlet ends formed of a relatively soft, non-wear resistant but easily cut plastic. These plastic ends, made long enough to provide a minimum diameter outlet opening, are cut at the installation site to a length corresponding to the size of outlet determined by cut and try method for best performance, then an order is placed with the manufacturer for replacement with a body formed of ceramic material of the correct length and outlet size.

The principal object of this invention is to obviate the problem discussed above by providing tubular bodies of hard ceramic material so constructed that they may be readily severed at the installation site to adjust the length thereof as desired. A special object is to provide such a body so constructed that an outlet end is the correct outlet end of a cyclone.

In accordance with the invention the tubular body of hard ceramic material is provided externally with a plurality of grooves surrounding the axis of the body and extending partially through the wall thereof, preferably terminating in a V-shaped end or an end curved concavely on a small radius, so that the groove is deepest approximately at its centerline. I have found that if a breaking tool such as a chisel has an end of a size to fit within such a groove with a wedging action on the sides thereof is so positioned and hammered, the material severs cleanly at the base of the groove entirely around its axis so that the portion of the body beyond the groove is removed, even though the thickness of the material below the groove is ample, such as about 3/16 inch, to withstand breakage under use conditions and under the strains imposed by such severing at any other groove. This surprising result with a material of such great hardness (e.g., harder than stainless steel) is apparently due to its peculiar contrasting properties of hardness at the surface, which may be of the order of 300,000 p.s.i., but relatively low resistance to tension, its tensile strength being of the order of only one-tenth or less of its compressive strength. Thus the pressure of a hammered chisel on the sides of a groove actually pulls apart the material at the base thereof by the tension induced there with the lands at the sides of the groove sufficiently to cause rupture of the material elsewhere even at other grooves.

The grooves are preferably narrow, such as of the order of 1/16 inch in width. They are spaced apart to provide the desired frequency of grooves for adjustment purposes which may be of the order of ½-inch spacing. The ceramic material is usually formed to a wall thickness of about ¾ to be of such thickness I have found that grooves extending half-way through the wall work satisfactorily. Straight-sided grooves are preferred except at their inner ends which are desirably V-shaped or concavely curved on a small radius. A groove width of about 1/16 to ½ inch is suitable but not critical, the function of this dimension being to receive the point of an ordinary chisel until the chisel wedges against the sides of the groove. Due to the great difficulty of cutting grooves into the hardened ceramic material it is preferred to form them in the material while it is on the mold before it is heat hardened.

The invention will be further described in connection with the accompanying drawing wherein:

FIG. 1 is a view in transverse section of a tubular body embodying the invention attached as a discharge passage to abrasive material processing equipment partially indicated;

FIG. 2 is a view partly in elevation and partly in longitudinal section showing a cyclone separator embodying the invention.

Referring to FIG. 1, a tubular body designated generally 10 has its wall formed of hard ceramic material. Body 10 as shown in frustoconical, terminating in an outlet opening 14 at its smaller end and having at its larger end an outlet 16 extending outwardly with a longitudinal projection 18 on its outer part. Projection 18 forms a recess in which is seated the annular end 20 of tube partially shown at 22. Tube 22 is provided with an annular flange 24 through which extend bolts 26 fastened to a ring 28 engaged under rim 16 to clamp body 10 to tube 22. The passage in body 10 thus forms a continuation of the passage in tube 22 and these passages collectively may provide an outlet for abrasive material from processing equipment therefor, such, for example, as a cyclone or a feed hopper or tank containing abrasive material.

In accordance with the invention the hard ceramic wall 12 is provided externally with a series of annular grooves 30 extending partly through wall 12 and providing between them lands 32. Grooves 30 are shown V-shaped at their base and otherwise are straight-sided. Their dimensions may be as set forth above and are such that the bevelled edge of a breaking tool such as a chisel may be inserted therein to wedge between the sides and, when hammered, to cause the wall 12 to pull apart under the induced tension at the base of the particular groove selected so that the wall portion behind the groove is removed without disturbing the remainder of the wall.

Where the passage through body 10 is tapered as shown, breaking off the body opposite a groove not only shortens the body by the distance of the groove from the original outlet, but also enlarges the outlet by an amount determined by that distance and the cone angle or angle of taper of the passage. By providing a plurality of grooves and minimum size original outlet opening it becomes possible, by breaking off at successive grooves, to determine experimentally and provide in situ the correct larger size outlet opening needed to suit operating requirements.

In cases where adjustment in length only and not in end opening size is desirable, for example, in making connections to other equipment, the passage through body 10 will be of uniform size throughout rather than tapered as shown. A circular cross section for the body is not essential and it may have various polygonal shapes. It is important, however, that each groove be separated from every other groove and surround the axis of the body completely, which which may be of the order of 3/16 of an inch, or less, and the intentional or substantial interruption of a groove is likely to prevent proper functioning, the center of the groove lying substantially in a single plane intersecting the body axis.

FIG. 2 shows a hydrocyclone of a common type provided with the invention to enable increase in size of the apex outlet as may be required to suit particular operating conditions. The hydrocyclone has a tubular body formed of a cylindrical section 40 and a convergent section 42 terminating in an outlet
opening 44. An inlet 46 at the end of section 40 supplies a slurry containing abrasive particles to be separated. The slurry spirals about the wall of sections 40 and 42 forming an outer vortex in which a fraction containing abrasive particles separates toward the wall and is discharged from outlet opening 44. As the outer vortex nears the outlet end of the convergent section an inner vortex forms proceeding in reverse direction toward the inlet end near which it passes into the open end of a vortex finder 48, which extends through the end of section 40 and discharges the slurry fraction forming the inner vortex from the unit.

Body sections 40, 42 are formed of hard ceramic material and the wall of section 42 at the outlet end thereof is provided externally with a series of grooves 50 like and with the same functional utility as grooves 30 of the FIG. 1 embodiment.

While it is common to make hydrocyclone bodies entirely of hard ceramic material, it is also common to make them of metal except in the region of the outlet from the convergent section which is made of the harder ceramic material. In such case, the invention may take the form of a tubular member of the hard ceramic material, grooved and attached to the remainder of the hydrocyclone body as shown in FIG. 1.

I claim:

1. A hydrocyclone separator comprising a tubular member having an inlet adjacent one end, an outlet adjacent said inlet and a tubular body of frustoconical shape at the opposite end of said tubular member defining another outlet, said tubular body being formed of abrasive-resistant hard ceramic material having a hardness of the order of 75 to 81 measured on a Rockwell 45 N scale and having a compressive strength at least 10 times its tensile strength, said body having therein a plurality of external grooves, each said groove extending partially through the wall of said body and essentially completely around the axis thereof with its centerline lying substantially in a single plane, each said groove being dimensioned to receive therein with a wedging action against the sides thereof the end of a breaking tool, the tensile strength of said material being sufficiently low so that when such tool is inserted in a groove and hammered, said body pulls apart at the base of said groove under the tension there induced by the pressure of the tool sides on the groove walls.

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