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HYDROCYCLONES

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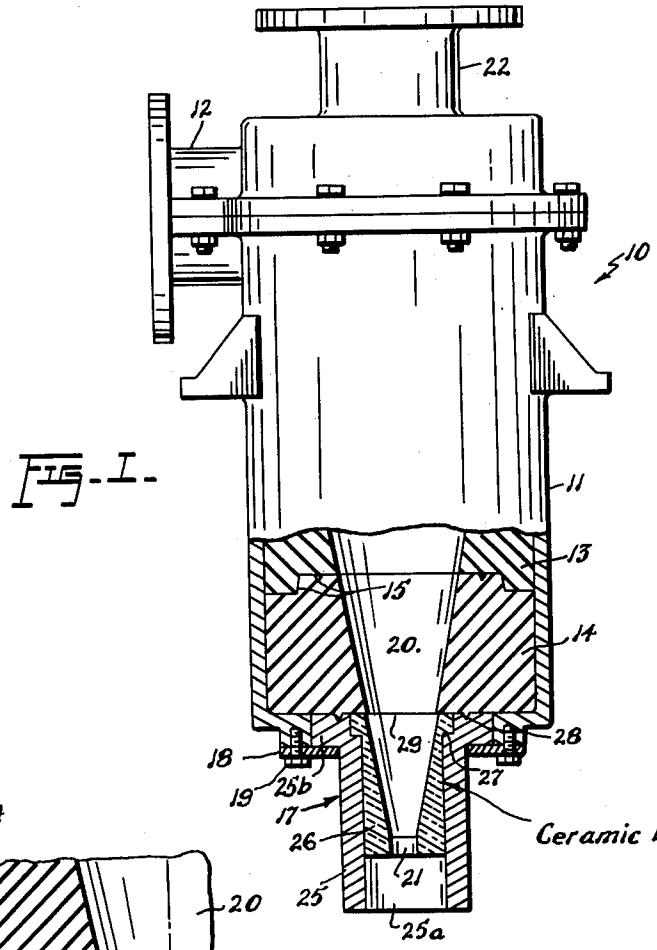

FIG. 1.

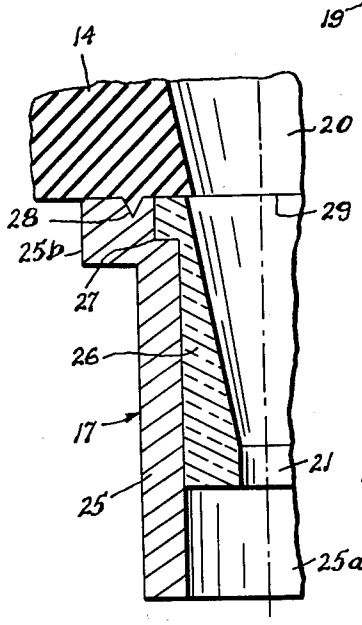

FIG. 2.

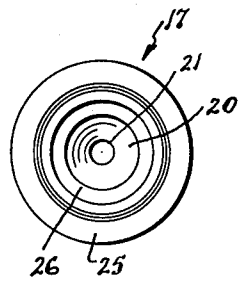

FIG. 3.

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HYDROCYCLONES

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This invention relates to new and useful improvements in so called hydrocyclones of the type used in the oil well drilling art for the purpose of separating sand from drilling mud or slurry, and in particular the invention relates to an improved underflow nozzle for such hydrocyclones.

A conventional hydrocyclone, for example such as is disclosed in United States Patent No. 2,816,658, issued December 17, 1957 to R. T. Braun et al., consists of a vertically elongated housing provided adjacent the top thereof with a conduit receiving drilling mud or slurry under pressure, the housing containing a set of liners providing a frusto-conical chamber which terminates at its lower, relatively small end in an underflow nozzle through which particles of sand are ejected as the result of downward spiraling flow and centrifugal force in the passage of mud through the chamber, while de-sanded mud travels centrally upwardly through the chamber and is discharged through an overflow at the top of the housing. The aforementioned chamber forming liners are made of material such as molded rubber which possesses reasonably good wear resistant properties in the presence of abrasive action of the sand, when the apparatus is used in certain locations where sand particles are rounded and substantially free from sharp edges or points. However, in other locations where sharp edged or sharp pointed sand particles exist, the abrasive action thereof on the liners is so pronounced that the liners become worn out after only a few days of use and must be replaced.

As already noted, the drilling mud or slurry delivered into the hydrocyclone chamber under pressure follows a downwardly spiraling path in which the velocity of the mud is progressively increased by the progressively decreasing diameter of the frusto-conical chamber, until a maximum velocity is attained in the underflow or sand outlet nozzle itself. Since the abrasive action of the sand particles increases with the velocity of the mud, the effect of abrasion is greatest in the underflow nozzle and the latter is usually the first to become damaged thereby. However, once the underflow nozzle becomes worn by the effects of abrasion, the wear progresses upwardly in the chamber until all the liners are damaged.

Accordingly, the principal object of the invention is to materially prolong the useful life of hydrocyclone liners, particularly under deleterious conditions created by highly abrasive particles of sand. This object is attained by the provision of an improved underflow nozzle which effectively resists the abrasive action and, by remaining unaffected by wear for substantial periods of time, prevents or greatly reduces the possibility of damage by wear from spreading to the molded rubber liners in the hydrocyclone chamber above the underflow nozzle.

Another important feature of the invention resides in forming the improved underflow nozzle in such manner that an annular step exists at the junction of the nozzle with the overlying molded rubber liner, which step, while not interfering with the downward spiraling flow of mud, effectively assists in preventing damage by abrasive wear from spreading from the nozzle into the overlying liner.

Some of the advantages of the invention reside in its simplicity of construction, in its efficient operation, in its adaptability to economical manufacture, and in its adaptability for use in hydrocyclones of various sizes and types.

With the foregoing more important objects and features

in view and such other objects and features as may become apparent as this specification proceeds, the invention will be understood from the following description taken in conjunction with the accompanying drawings, wherein like characters of reference are used to designate like parts, and wherein:

FIGURE 1 is a side elevational view, partially in section, showing a hydrocyclone embodying an underflow nozzle in accordance with the invention;

FIGURE 2 is an enlarged, fragmentary sectional detail showing the improved nozzle and the relationship of the overlying molded rubber liner relative thereto; and

FIGURE 3 is a top plan view of the underflow nozzle per se.

Referring now to the accompanying drawings in detail, the general reference numeral **10** designates a conventional hydrocyclone such as is disclosed in the aforementioned patent No. 2,816,658, although it is to be understood that the use of the invention is by no means limited to this particular hydrocyclone and that the invention may be used with other hydrocyclones of various sizes and types.

In any event, for illustrative purposes, the hydrocyclone **10** embodies a vertically elongated housing **11** provided adjacent its upper end with a conduit **12** for receiving drilling mud or slurry under pressure, the housing containing a plurality of molded rubber liners, two of which are shown at **13** and **14**. To prevent lateral shifting, the liners are interfitted as indicated at **15**, and provided under the liner **14** is an underflow nozzle or valve, designated generally by the reference numeral **17**, which is held assembled to the housing **11** by a ring **18** and bolts **19**. The liners **13**, **14** and the nozzle **17** coact to form a frusto-conical chamber **20**, wherein drilling mud delivered under pressure through the conduit **12** follows a downward spiraling path with progressively increasing velocity which reaches its maximum at the relatively small, lower end of the chamber wherein particles of sand, driven against the walls of the chamber by centrifugal force, are ejected through an outlet opening **21** in the nozzle **17**, while de-sanded mud travels centrally upwardly through the chamber and is discharged through an overflow nozzle **22** at the top of the housing **11**. Apart from the underflow nozzle **17**, the arrangement and operation of the hydrocyclone are conventional and require no further description herein.

In accordance with conventional practice, the nozzle **17**, like the liners **13**, **14**, is made of molded rubber and is subjected to the abrasive action of sand particles which is most pronounced in the region of greatest mud velocity adjacent the outlet opening **21**. Thus, if the sand particles are sharp edged or sharp pointed rather than round or smooth, their abrasive action is so great that the nozzle wears out quickly and prematurely. Moreover, once the nozzle is damaged by wear, the damage spreads quickly upwardly in the chamber **20**, until all the liners in the chamber are worn.

The invention eliminates this disadvantage by the provision of the nozzle **17** which embodies in its construction a substantially tubular metallic shell **25**, having a ceramic liner or insert **26** cemented therein. The shell is somewhat longer than the liner, so that the downwardly projecting portion of the shell, below the lower end of the liner constitutes a guard **25***a* for preventing ejected sand particles from spreading too far laterally. The liner **26** is provided at its upper end with an outturned, annular flange which is seated in a counterbore formed in the upper end of the shell as indicated at **27**, and the upper end of the shell itself is formed with an outturned, annular flange **25***b* for clamping the entire nozzle **17** to the housing **11** by the aforementioned ring **18** and bolts **19**, as will be clearly apparent.

The top face of the flange 25*b* of the shell **25** is provided with a V-shaped annular groove **28** to receive a V-shaped annular projection formed at the lower face of the overlying liner **14** and thereby prevent any lateral displacement of the liner **14** relative to the nozzle **17**.

It is to be particularly noted that the inside diameter of the liner **26** at its upper end is somewhat greater than the inside diameter of the liner **14** at its lower end, so that an annular step or shoulder **29** exists at the junction of the upper face of the liner **26** with the lower face of the liner **14**. The orientation of this annular step is so that the step does not interfere with the downward spiraling flow of drilling mud in the chamber **20**, but it does present an obstacle to any abrasive action and wear spreading from the nozzle **17** upwardly into the chamber **20**, so as to safeguard the rubber liners **13**, **14**, against injury.

The material of the ceramic liner **26** is of particular importance, the same being fired with a very smooth surface and possessing a remarkable quality of hardness, so that it is virtually unaffected by wear from the abrasive action of sand particles to which it is subjected. Thus, in the virtual absence of wear in the liner **26** and with the annular step **29** acting to effectively resist spreading of wear upwardly from the nozzle **17**, the rubber liners **13**, **14** of the hydrocyclone are safeguarded against premature wear, even under conditions of most pronounced abrasive action of sharp edged and pointed sand particles.

While in the foregoing there has been described and shown the preferred embodiment of the invention, various modifications may become apparent to those skilled in the art to which the invention relates. Accordingly, it is not desired to limit the invention to this disclosure and various modifications may be resorted to, such as may lie within the spirit and scope of the appended claims.

What is claimed as new is:

1. In a hydrocyclone, the combination of a vertically elongated housing, liner means of rubber-like material provided in said housing and forming therein a frusto-conical chamber having its minor end at the bottom of the housing, and an underflow nozzle including a ceramic member provided at the bottom of said housing, said ceramic member being formed with a frusto-conical chamber portion constituting a downward continuation of the housing liner chamber and terminating at its lower end in a discharge opening wherein the upper end of said frusto-conical chamber portion in said ceramic member is of a larger diameter than the lower end of said chamber in said rubber liner means, whereby to provide an annular shoulder at the junction of said ceramic member with said rubber liner means.

2. In a hydrocyclone, the combination of a vertically elongated housing, liner means of rubber-like material provided in said housing and forming therein a frusto-conical chamber having its minor end at the bottom of the housing, an underflow nozzle comprising a tubular metallic shell removably attached at its upper end to the bottom of said housing and extending downwardly therefrom in axial alignment with said chamber, a ceramic member removably positioned in said shell and provided with a frusto-conical chamber portion, said chamber portion constituting a downward continuation of the chamber in said rubber liner means and terminating at the lower end of the ceramic member in a discharge opening, the lower end portion of said shell projecting below the lower end of said ceramic member and providing a tubular guard below said discharge opening, the upper end of said ceramic member being in abutment with the lower end of said rubber liner means, the upper end of said chamber portion in said ceramic member being of a greater diameter than the lower end of the chamber in the rubber liner means whereby to provide an annular shoulder at the junction of the ceramic member with said rubber liner means, said annular shoulder facing the chamber portion in said ceramic member, and said ceramic member having a higher resistance to wear by abrasion than said rubber liner means.

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