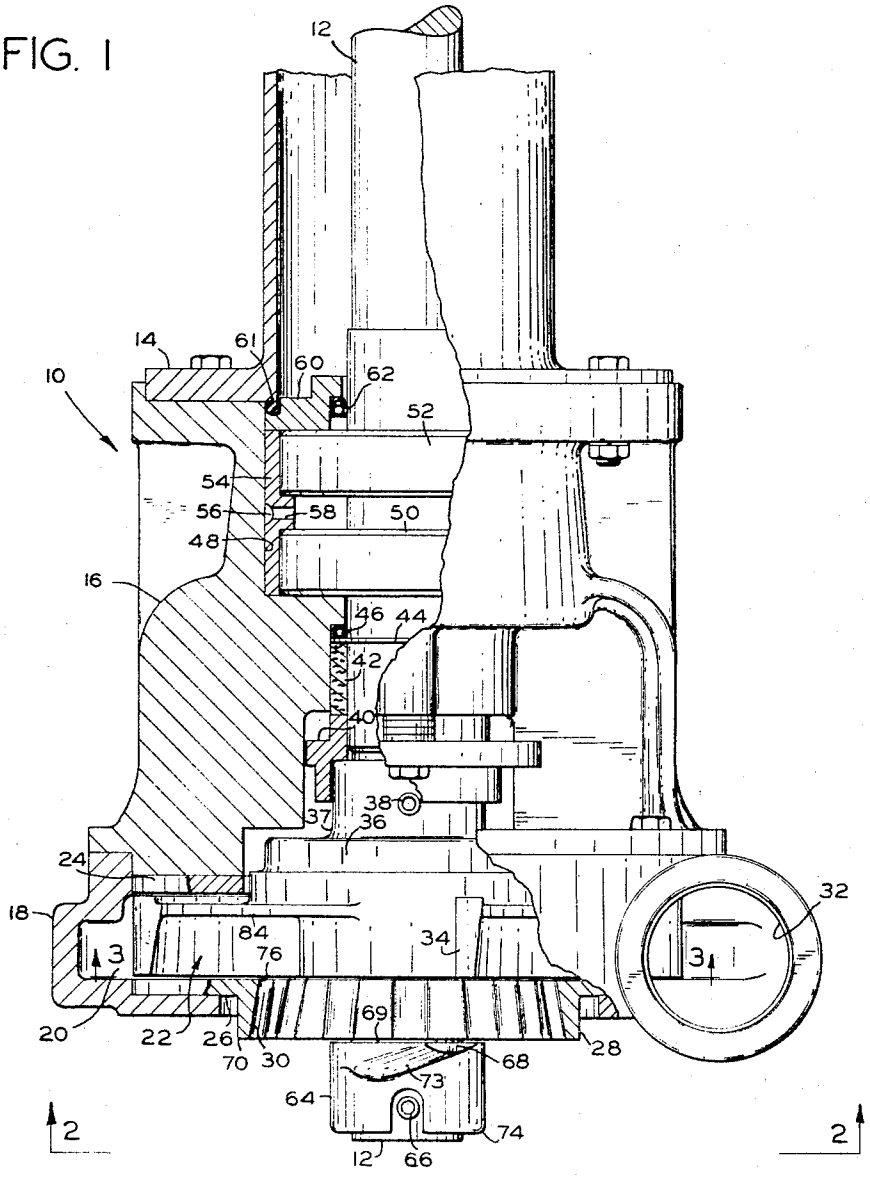
May 20, 1969 R. W. SUTTON 3,444,818

CENTRIFUGAL PUMP

Filed Oct. 10, 1966 Sheet 1 of 2

FIG. 1



ROBERT W. SUTTON
INVENTOR

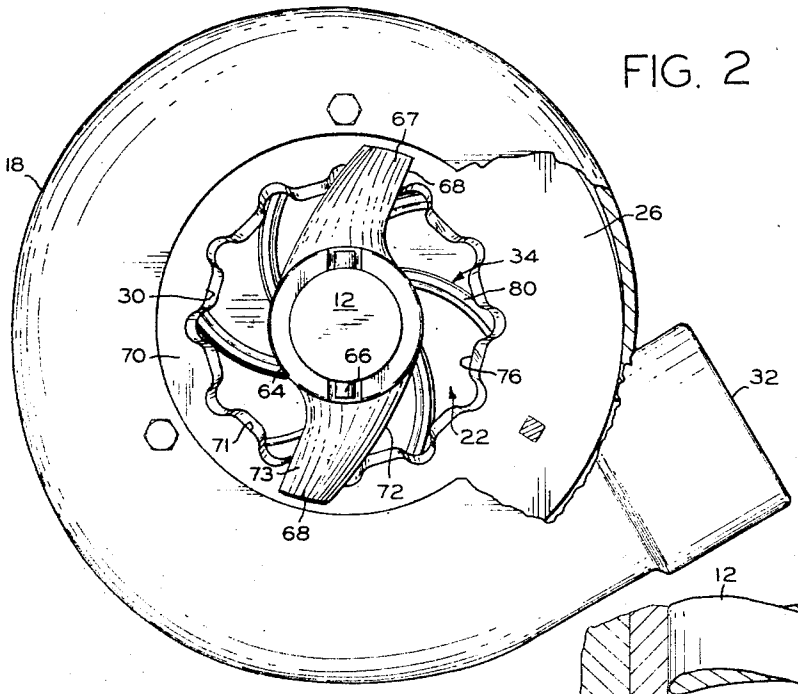
BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

May 20, 1969 R. W. SUTTON 3,444,818

CENTRIFUGAL PUMP

Filed Oct. 10, 1966 Sheet 2 of 2

FIG. 2



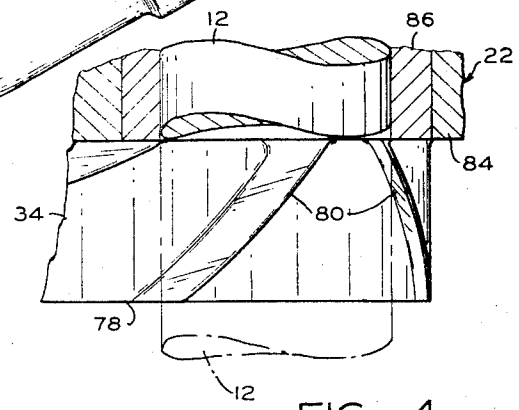
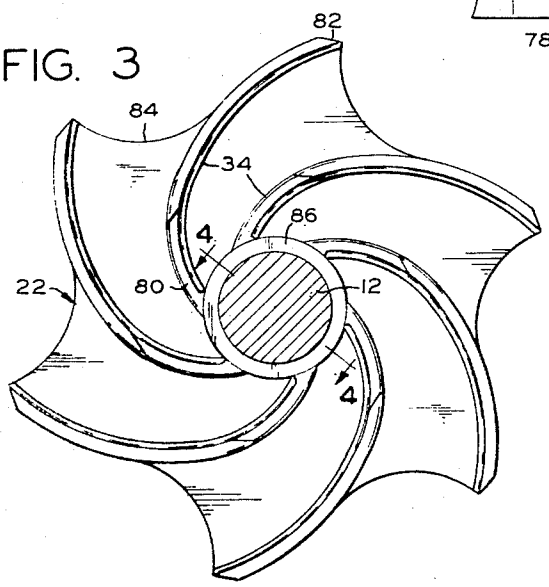


FIG. 4

FIG. 3



ROBERT W. SUTTON
INVENTOR

BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

United States Patent Office

3,444,818

Patented May 20, 1969

3,444,818

CENTRIFUGAL PUMP

Robert W. Sutton, Rte. 1, Box 668, Wilsonville, Oreg. 97070

Filed Oct. 10, 1966, Ser. No. 585,535
Int. Cl. F04d *29/00, 1/04;* B02c *18/40*
U.S. Cl. 103—111 5 Claims

ABSTRACT OF THE DISCLOSURE

A centrifugal pump for pumping mixtures of solids and liquids including a housing defining an intake passage with annular inner and outer serrated cutting edges. Rotating blades of a chopper outside the housing coact with the outer serrated edge to shred incoming solids to a size sufficient to prevent clogging the intake passage, and radial cutting edges of impeller blades within the housing coact with the inner serrated edges to further reduce the size of solids to permit their passage through the pump. Inclined leading edges on the impeller blades direct solids toward the blade cutting edges.

The present invention relates to centrifugal pumps and more particularly to such pumps for pumping a mixture of liquids and solids such as manure, sewage and other waste materials.

Prior pumps designed especially for handling liquid borne solids have commonly included a rotatable cutting element for shredding solids drawn into the pump chamber. In some prior pumps, the functions of shredding and impelling have been combined in a single blade unit while in other prior pumps the two functions have been performed by separate elements. Nevertheless, regardless of the design and the placement of the cutting and impeller blades of prior pumps, solids, and particularly stringy solids such as straw, have had a tendency, once within the chamber, to accumulate on the impeller and eventually clog the pump.

The pump of the present invention is an improvement over prior pumps for handling mixtures of liquids and solids primarily in that it has an improved impeller that does not tend to collect solids within the pump chamber and in fact that serves as a positive means for shredding solids to an acceptable size within the chamber and impelling them toward the pump's discharge passage.

Accordingly, a primary object of the present invention is to provide a new and improved centrifugal pump that will not clog when pumping mixtures of solids and liquids.

A more specific object of the invention is to provide a centrifugal pump as aforesaid having an improved impeller for preventing the accumulation of solids within the pump.

Another specific object is to provide an improved impeller for a pump as aforesaid which also serves as an efficient cutting element for reducing the size of solids entering the pump chamber.

A further important object is to provide a pump as aforesaid with an improved stationary cutting edge configuration for coaction with the movable cutting elements of the pump.

Still another object is to provide a pump as aforesaid having an improved preliminary chopper blade which is especially resistant to wear and which serves to lengthen the life of the stationary cutting element with which it coacts.

Other important objects are to provide a centrifugal pump as aforesaid which is economical to construct, operate and maintain.

The above and other objects and advantages of the present invention will become more apparent from the following detailed description which proceeds with reference to the accompanying drawings wherein:

FIG. 1 is an elevational view, partly in section, of a pump in accordance with the invention;

FIG. 2 is a bottom end view taken along the line 2—2 of FIG. 1 with a portion of the outer casing broken away;

FIG. 3 is a horizontal sectional view taken along the line 3—3 of FIG. 1 showing the pump impeller; and

FIG. 4 is a vertical sectional view taken along the line 4—4 of FIG. 3 showing on an enlarged scale a portion of the impeller blade construction.

With reference to the drawings FIG. 1 illustrates a pump **10** in its vertically disposed operative position. The pump normally would be positioned in a sump such as, for example, in a dairy barn for pumping liquidfied manure. The pump includes a central driven shaft **12** which extends upwardly from the main body of the pump to a connection with the drive shaft of a suitable motor (not shown) at the upper end of the sump. The pump includes an outer casing consisting of a flanged upper shaft housing section **14** which is bolted to an intermediate casing section **16**, the lower end of which is in turn bolted to a lower casing section **18**. The lower casing section defines a main pump chamber **20** housing an impeller **22** rotatable on the drive shaft **12**.

The pump chamber is generally cylindrical in shape and is bounded at its upper end by upper wear plate **24** and at its lower end by a lower wear plate **26**. Lower wear plate **26** has a hub portion **28** which defines a central intake passage **30** leading into the pump chamber. A peripheral portion of lower casing section **18** defines a tangential discharge passage **32** leading from the chamber.

Impeller **22** is a one-piece member which includes a series of impeller blades **34** within the chamber and a hub portion **36** which extends through a central opening in the upper wear plate. Impeller hub **36** has an upper portion **37** of reduced cross section which is joined by a roll pin **38** to the pump shaft **12** so that the impeller rotates with the shaft. Surrounding upper hub portion **37** is a keeper ring **40**, the upper end of which defines the lower extremity of a sealing chamber packed tightly with packing material **42** so that water cannot rise above this point between the outer casing and the shaft. The upper end of the packing chamber is bounded by a thin metal collar **44** which is retained in place axailly by the packing and by an upper sealing member **46**. Above this point middle housing section **16** defines a bearing chamber **48** within which a pair of axially spaced roller bearings **50** and **52** mount the pump shaft and are retained by a retainer member **54**. Retainer **54** has an annular oil passage **56** with periodic lateral passages **58** leading into the bearing chamber so that the bearings can be conveniently oiled through an access passage (not shown) from outside the pump casing. An upper bearing retainer **60** defines the upper end of the bearing chamber and is sealed at **61** at its juncture with the housing and at **62** at its juncture with the drive shaft. Thus the bearing chamber is sealed against liquids at both ends.

The pump shaft extends centrally through all three sections of the pump casing and projects out through intake openings **30** at its lower end. A chopper member **64** is fixed to the lower end of the shaft by a roll pin **66**. Referring especially to FIGS. 1 and 2, the chopper member includes a pair of opposed chopper blades **67, 68.** The flat upper surfaces **69** of these blades wipe across an outer surface portion **70** of lower wear plate **26** and across an outer scalloped cutting edge **71** at the intersection of the

outer wear plate surface and the interior wall of the plate defining intake passage **30** so that the leading edges **72** of the blades chop incoming solids to an acceptable size before they enter the intake passage. The lower surface **73** of each chopper blade is curved and streamlined in a direction from its leading edge **72** to its trailing edge. Furthermore, the hub **74** of the chopper is slidably mounted on shaft **12** for movement within limits along the shaft from a position wherein the chopper blades are in cutting relationship to scalloped cutting edge **71** to a position wherein the chopper blades are spaced from such cutting edge. Thus, upon rotation of the chopper blades, fluid flow over the streamlined lower blade surfaces tends to lift the blades away from the lower wear plate. However, when a large mass of solid material is drawn toward the intake passage, the mass will strike the lower surfaces of the chopper blades and thus force the blades upwardly into cutting relationship with scalloped cutting edge **71** to chop the mass to a size small enough to enter the intake passage without clogging it. The foregoing chopper construction lengthens the life of both the lower wear plate and the chopper blades far beyond what their lives would normally be if the blades were in constant cutting relationship with the outer surface of the wear plate. The limited axial play of the chopper also provides a self-compensating adjustment for blade and plate wear.

As is evident from FIG. 2, the entire length of the interior wall of the wear plate which defines intake passage **30** is scalloped so as to define both the outer scalloped cutting edge **71** with which the chopper blades coact and also an inner scalloped cutting edge **76** at the juncture of the intake passage with the pump chamber. The inner cutting edge coacts with generally radial lower edges **78** of impeller blades **34** to shred solids within the pump chamber to a still smaller size so that they can be passed between the impeller blades and out through discharge passage **32**. The interior wall of wear plate **26** is tapered inwardly and upwardly toward the pump chamber so that such wall intersects the inside surface of the wear plate at less than a right angle, thereby providing cutting edge **76** with a more effective cutting angle.

With reference to FIGS. 3 and 4, each impeller blade is formed as an integral part of the plate-like impeller unit **22** and curves in a generally radial direction from a leading edge **80** at a central portion of the chamber to a trailing edge **82** adjacent the periphery of the chamber. The leading edge of each blade is beveled rearwardly to lessen the resistance of such blades in passing through liquid and to reduce the tendency of solids to collect on such edge. The individual blades are joined together by a web portion **84**, as shown best in FIG. 3, which extends parallel to and adjacent the top of the impeller chamber. The impeller unit has a central opening through which the pump shaft **12** extends, and such opening is of a slightly larger diameter than that of the shaft. The impeller unit, including leading edges **80** of the impeller blades, is spaced from the shaft by an annular spacer member **86**.

An important feature of the impeller blades is the rearward inclination of leading edges **80** as shown best in FIG. 4. The inclination is rearwardly from the upper extremities of the blades to the intersection of their leading edges and their radial cutting edges **78** adjacent the scalloped cutting edge **76**. Thus the leading edges recede downwardly and rearwardly away from the pump shaft and toward stationary cutting edge **76** so that solids which would otherwise tend to collect on such leading edges are urged by centrifugal force downwardly along the leading edges and against stationary cutting edge **76** where they are cut to sizes small enough to pass between the impeller blades.

It should also be noted that the rearward inclination of leading edges **80** of the impeller blades causes adjacent ones of such leading edges to diverge in a downward direction to define progressively increasing spaces between the leading edges in the same direction. Thus, solids which are too large to pass through the small spaces between blades at the upper part of the chamber will be urged by centrifugal force down along the diverging leading edges of the blades until the opening between blades widens sufficiently to pass the solids toward the periphery of the chamber. If the solids are too large to pass between the leading edges of the blades at their widest spacing, such solids will eventually be thrown against scalloped cutting edge **76** and sheared to smaller sizes by the lower cutting edges of the impeller blades. It is the foregoing described inclination and diverging nature of the leading edges of the impeller blades in cooperation with the stationary scalloped cutting edge of the wear plate that contributes most to the pump's unique nonclogging action. This action is believed to be considerably superior to the nonclogging tendencies of prior pumps designed for the same purpose.

Summarizing the operation of the pump, pump shaft **12** is driven, thereby rotating the impeller blades and the chopper blades simultaneously. Thus, liquid and liquid borne solids are drawn toward the intake passage where the spinning chopper blades reduce the size of excessively large solid materials before they enter the intake passage. As the liquid and the solids carried thereby reach the pump chamber they are impelled by the impeller blades toward the periphery of the chamber and thence out through the discharge passage. However, if the solids reaching the chamber are unable to pass between the impeller blades at their leading edges, they are thrown downwardly and rearwardly along such leading edges and sheared to a reduced size sufficient to pass between the blades by the coaction of the lower edges of the impeller blades and the stationary scalloped inner cutting edge of the wear plate.

Another advantage of the pump as described is that the upper and lower wear plates **24** and **26** can be replaced periodically as necessary without replacing any other pump elements. This is done simply by removing the lower section **18** of the outer casing and then unbolting the lower wear plate from such section and unbolting the upper wear plate from the middle section **16** of the casing.

Having described a preferred embodiment of the invention, it should be apparent to those having skill in the art that the invention permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claims.

I claim:

1. A centrifugal pump for pumping a mixture of liquid and solid material comprising:

a housing including means defining a pump chamber and an intake passage opening into one end of said chamber, a closed opposite end and a discharge opening,

means defining an inner cutting edge at the inner end of said intake passage within said chamber and an outer cutting edge at the outer end of said intake passage outside said chamber,

impeller means rotatable within said chamber including impeller blades having cutting edges in cutting relationship with said inner cutting edge,

a chopper member including a chopper blade rotatable outside said chamber in cutting relationship with said outer cutting edge,

a drive shaft extending through said chamber and mounting said impeller means and said chopper member for rotation,

means mounting said chopper member on said shaft for axial sliding movement along said shaft from a position in cutting relationship with said outer cutting edge to a position spaced from said outer cutting edge,

said chopper blade having a broad outer surface facing away from said outer cutting edge with a streamlined

cross sectional configuration so that fluid passing over said surface upon rotation of said chopper blade will tend to lift said blade out of engagement with said outer cutting edge and thereby prolong the life of both said blade and said edge.

2. A centrifugal pump comprising:

means defining a housing including a main pump chamber, an inlet opening and an outlet opening,

means defining an annular stationary cutting edge at the entrance of and in surrounding relationship to said inlet opening into said chamber,

impeller means rotatable within said chamber, including multiple impeller blades, each having a generally radial cutting edge which passes in shear-cutting relationship across said annular stationary cutting edge upon rotation of said impeller means,

said radial cutting edge of each said blade intersecting a generally axially extending leading edge of said blade at a radial position next adjacent said annular stationary cutting edge,

said leading edge of each blade extending from a position radially inwardly of and axially spaced from said stationary cutting edge and being inclined so as to recede in a direction proceeding from the axis of said impeller means toward said radial cutting edge and toward the periphery of said chamber whereby solids drawn into said chamber are urged by water pressure and guided by said leading edges toward said radial and annular stationary cutting edges,

said leading edges of adjacent impeller blades diverging from one another proceeding in a direction toward their respective radial cutting edges so as to define spaces between said leading edges which become progressively wider in a direction toward said radial cutting edges, the maximum width of said spaces between adjacent blades at the leading edges of said blades being substantially less than the diameter of said inlet and said outlet openings whereby solids too large to pass between adjacent leading edges are guided along said leading edges against said stationary cutting edge so as to be reduced to a size small enough to pass between said adjacent leading edges and through said pump chamber,

said annular stationary cutting edge being concentric with respect to the axis of said impeller means and extending continuously about said intake opening,

said annular continuous stationary cutting edge including circumferentially extending edge portions interupted at intervals by radially recessed cutting edge portions defining with said circumferential cutting edge portions a continuous scalloped cutting edge.

3. A centrifugal pump comprising:

means defining a housing including a main pump chamber, an inlet opening and an outlet opening,

means defining a stationary cutting edge at the entrance of said inlet opening into said chamber,

impeller means rotatable within said chamber, including impeller blades each having a generally radial cutting edge which passes in cutting relationship said stationary cutting edge upon rotation of said impeller means,

said radial cutting edge of each said blade intersecting

a generally axially extending leading edge of said blade at a radial position next adjacent said stationary cutting edge whereby said radial cutting edge does not extend appreciably radially inwardly of said stationary cutting edge,

said leading edge of each blade extending from a position radially inwardly of and axially spaced from said stationary cutting edge and being inclined so as to recede in a direction proceeding from the axis of said impeller means toward said radial cutting edge and toward the periphery of said chamber whereby solids drawn into said chamber are urged by said leading edges toward said radial and said stationary cutting edges,

means defining an intake passage having an outer cutting edge at the outer entrance end of said intake passage,

a chopper element rotatable outside said intake passage,

said chopper element including a chopper blade coacting with said outer cutting edge to shred large solids before they enter said intake passage.

4. A pump according to claim 3 wherein said means defining said intake passage comprises a replaceable wear plate having a circumferential series of axially extending flutes extending the length of said intake passage so as to define at the inner and outer ends of said passage, respectively, a serrated inner cutting edge for shearing coaction with said impeller blades and a serrated outer cutting edge for shearing coaction with said chopper blade.

5. A pump according to claim 3 including a drive shaft extending centrally through said chamber for driving said impeller means and said chopper, said chopper being mounted on said drive shaft for rotation therewith but being slidable within limits axially of said shaft from a position in cutting relationship with said outer cutting edge to a position spaced from said outer cutting edge, said chopper blade having a broad flat surface facing said outer cutting edge and an opposite broad surface facing away from said cutting edge, said opposite surface being streamlined so that upon rotation of said blade fluid flow over said outer surface tends to lift said chopper blade away from said outer cutting edge to prevent excessive wear of said outer cutting edge and said blade.

References Cited

UNITED STATES PATENTS

2,050,104	8/1936	Lauchenauer	103—111.1
2,371,681	3/1945	Durolin	103—111.1
1,763,595	6/1930	Paatsch	103—115
2,245,035	6/1941	Hartman	103—111.1
2,658,453	11/1953	Walters	105—111.1

FOREIGN PATENTS

538,150	3/1955	Belgium.
542,597	5/1922	France.
1,377,185	9/1964	France.

HENRY F. RADUAZO, *Primary Examiner.*

U.S. Cl. X.R.

103—103, 115; 241—162