Nov. 3, 1964 J. E. VAUGHAN 3,155,046

CENTRIFUGAL NONCLOGGING PUMP

Filed April 23, 1962 2 Sheets-Sheet 1

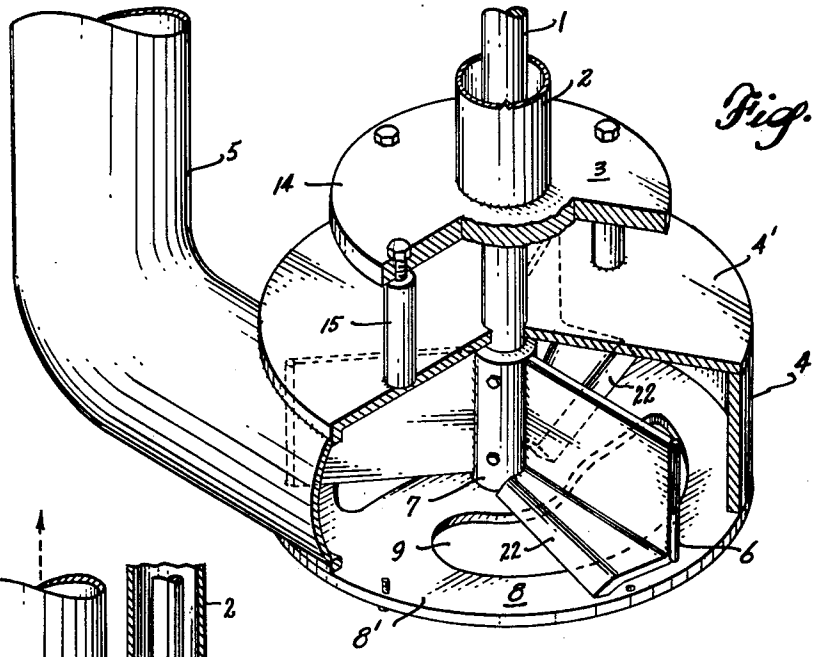


Fig. 1.

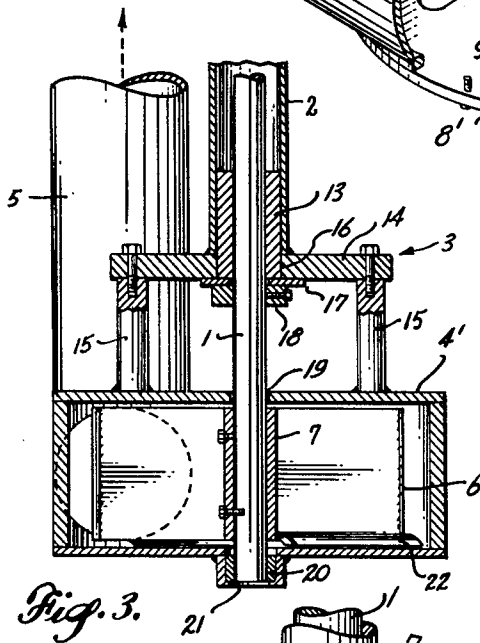


Fig. 3.

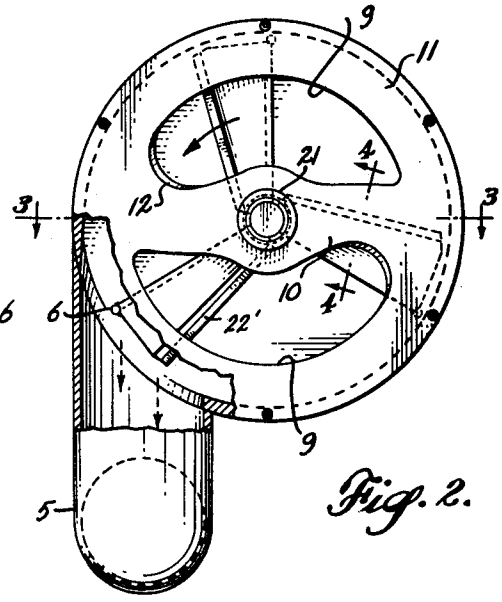


Fig. 2.

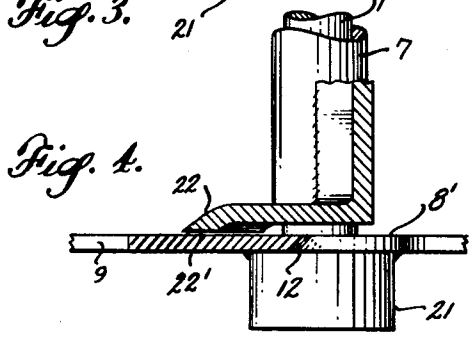


Fig. 4.

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CENTRIFUGAL NONCLOGGING PUMP

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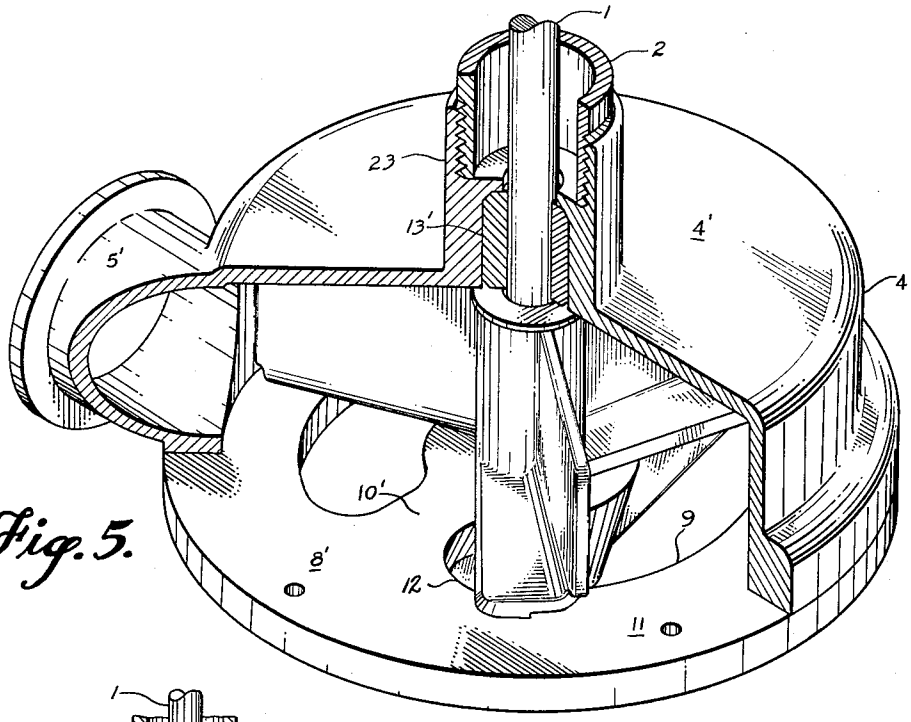


Fig. 5.

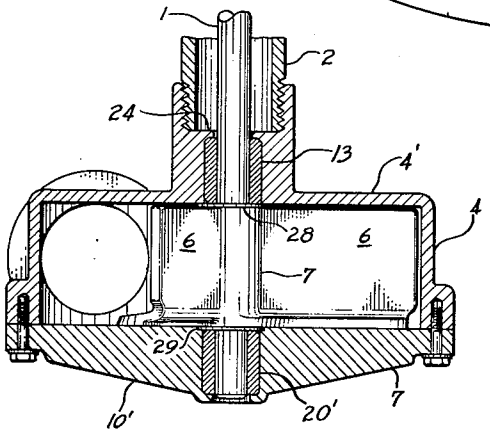


Fig. 7.

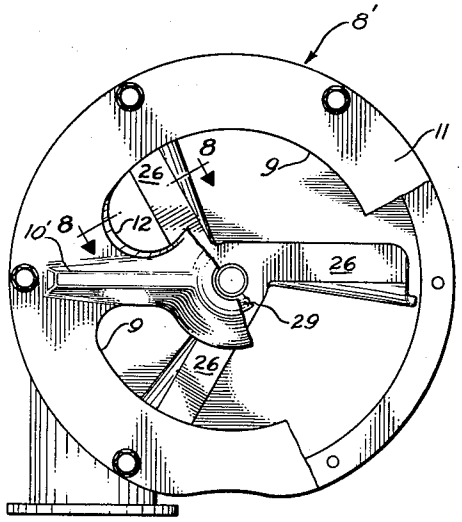


Fig. 6.

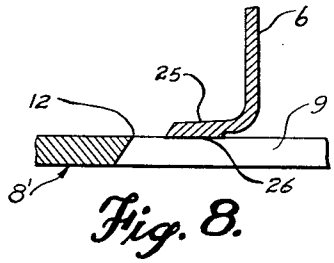


Fig. 8.

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United States Patent Office 3,155,046 Patented Nov. 3, 1964

3,155,046

CENTRIFUGAL NONCLOGGING PUMP

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Filed Apr. 23, 1962, Ser. No. 189,627
5 Claims. (Cl. 103—103)

This invention relates to a centrifugal pump by which liquid manure or sewage can be removed from a tank even though containing stringy materials, such as hay, straw, paper or rags. This application is a continuation-in-part of my previous application Serial No. 43,394 filed July 18, 1960 for Centrifugal Non-Clogging Pump, now abandoned.

A principal object of this invention is to provide a centrifugal pump in which solid or stringy material is chopped as necessary for passage through the pump. Impeller blades of the pump cut the material and force the liquid containing such material upward through a discharge pipe that is of a size which cannot be clogged with such chopped material.

Another object is to provide a shaft casing and shaft support assembly which protects the driving shaft outside the pump casing and the pump impeller in the casing from entanglement by stringy material so that the entire mechanism can be submerged within the liquid to be pumped.

The main advantages of a centrifugal pump when compared to other types of pumps are simplicity of structure providing economical construction, low pressure flow of large volume and continuous flow of material.

An object of this invention is to preserve these features of a centrifugal pump and at the same time give it better pumping action. Such a nonclogging pump can provide a continuous flow of liquid material containing foreign matter that would clog conventional centrifugal pumps.

The foregoing objects can be accomplished by a centrifugal pump having impeller blades of angle cross section, each including an upright flange and a lower horizontal flange having its edge sharpened to form a cutting or shearing edge. The impeller is received in a housing having openings in its lower end plate of arcuate shape and located concentrically with the pump's impeller. One of the generally radial, curved edges of each opening is beveled and sharpened to cooperate with the sharpened edges of the impeller blades. Interaction between the sharpened edges of the end plate apertures and the impeller blades chops solid or stringy material drawn into the housing with such liquid by the suction of the impeller.

FIGURE 1 is a top perspectvie of the entire pump mechanism with a portion cut away to show internal structure.

FIGURE 2 is a bottom plan with parts broken away.

FIGURE 3 is a vertical section taken on line 3—3 of FIGURE 2.

FIGURE 4 is a detail section taken on line 4—4 of FIGURE 2.

FIGURE 5 is a top perspective of modified pump mechanism with portions broken away.

FIGURE 6 is a bottom plan of the modified pump.

FIGURE 7 is a vertical section through the modified pump.

FIGURE 8 is a detail section of the pump on line 8—8 of FIGURE 6.

At stock feeding stations or other manure accumulating locations on farms it is often desirable to pump liquid manure from a collection and storage tank into which hay or straw or other foreign matter such as wire, nails and sticks may have fallen. A necessary operation in

many sewer systems is the transfer of sewage from one tank into another, and in sewage treatment plants the removal of sludge from a clarifier tank collection hopper. Such sewage and sludge usually contains some stringy material such as rags. The centrifugal nonclogging pump of the present invention may be installed near the bottom of a farm liquid manure storage tank or a sewage tank to pump out liquid containing various types of solid waste material. The pump effectively chops any stringy foreign matter into short lengths and at the same time effectively removes from the tank liquid containing such materials.

The pump comprises an upright driving shaft 1 extending downward through a tubular casing 2 to a shaft support assembly 3. Such assembly is mounted on housing 4 into which the shaft projects. A discharge pipe 5 extends upward from the housing to the desired discharge location. Inside the pump housing are impeller blades 6 of angle cross section spaced axially slightly from the upper and lower plates of the casing 4. Such blades are integral with the collar 7, shown as being welded to it. One flange of each angle is disposed upright and the other flange forwardly in the direction of rotation of the driving shaft.

Mounted on the open bottom of the pump housing 4 is an end plate 8 having two arcuate intake slots 9 concentric with the impeller's axis, separated by a diametral band 10 and encircled by a marginal flat ring 11. Viewing the pump from its bottom, as shown in FIGURE 2, each of the arcuate slots has a concave edge at the end toward which the impeller blades move, ground on an incline forming a sharpened edge 12 at the inner or top surface 8' of the end plate. The edge portion of the lower flange of each angle impeller blade is bent downward to form a scoop toe 22. The undersurface 22' of such flange edge portion is ground so that it will be parallel to the casing's lower end plate 8 and located axially to pass close to its upper surface 8' in shearing relationship to the sharpened edges 12.

Above the shaft support assembly 3 the driving shaft 1 is spaced inward from its enclosing tubular casing 2. In this space within the casing is received a bushing 13 in which the shaft is journaled. The lower end of casing 2 is fixed to the shaft support assembly 3 which includes a circular plate 14 supported by a plurality of legs 15 attached to the top 4' of the pump housing. The upper plate 14 of the shaft support assembly has in it an aperture 16 through which the driving shaft then passes. A washer 17 serving as a thrust bearing is located between the underside of plate 14 and set collar 18 secured to the shaft.

The driving shaft 1 then passes through aperture 19 in the top plate 4' of the pump housing 4. The impeller collar 7 is secured by set screws to the lower portion of the shaft. The lower end of the shaft is journaled in a bearing 20 which is received in collar 21 attached to the lower side of diametral band 10 of the end plate 8.

As the impeller blades rotate inside the pump housing, liquid is drawn through the arcuate openings 9 in the end plate 8. The lower flange of the impeller scoops up such liquid with such solid material as it may carry and circulates it to and out through the discharge pipe 5. Any undesirably long stringy material or chunks of material carried by the liquid are chopped up before entering the pump housing by the shearing action between the sharpened end plate aperture edge 12 and the impeller blade toe 22 which crowds such material into the concavity of such aperture edge.

Clogging by stringy material or chunks cannot occur within the pump housing because of such cutting interaction of the impeller blades and the sharpened aperture edges. The discharge pipe has an inside diameter suffi-

ciently large to receive chopped material from the impeller without impeding the flow of the liquid mixture. The pump shaft 1 is protected from entanglement by stringy material by the tubular casing 2, the mounting plate 14, the legs 15 and the lower bearing 20.

In the somewhat modified pump construction shown in FIGURES 5, 6, 7 and 8 the pump housing 4 is similar to that of the pump structure shown in FIGURES 1 to 4, except that the open bottom portion of the housing and the outlet pipe 5 are cast as a single piece instead of the top plate 4' being secured to the side wall of the housing, such as by welding. In this instance the upper plate 4' of the housing has projecting upward from it a hollow boss 23, the upper portion of which is threaded internally to receive the threaded lower end of the tube 2 through which the impeller drive shaft 1 extends. The radial bearing 13' fits in a recess in the bottom of the boss 23 which opens to the inside of the housing so that a bearing collar can be slid from the inside of the housing into the hollow in the boss until the outer end of the bearing collar engages a shoulder 24 in the bore through the boss. The boss and tube 2 thus enclose completely the drive shaft 1.

The bottom plate 8' of the housing 4 also is similar to that of the pump shown in FIGURES 1 to 4, inclusive, having the arcuate apertures 9 inwardly of the marginal ring 11. In this construction the diametral band 10' between the apertures 9 is stiffened by a downwardly projecting rib which tapers outwardly from the center.

In the construction of FIGURES 5 to 8, inclusive, thrust bearings restrict movement of the impeller 6, 7 in either axial direction by direct engagement between the impeller and the housing 4. As has been discussed previously, the blades 6 of the impeller are of angle cross section and the flange 25 disposed substantially perpendicular to the rotative axis has a flat bottom 26. The thrust bearing structure of this pump guides the impeller so that such flat bottom rotates closely adjacent to the upper side of the housing's lower plate without appreciable contact with such plate. An important feature of this rotor construction is that the flat surfaces 26 on the bottoms of the blades are coplanar with an annular flat central portion of the impeller bottom.

The upper thrust bearing for the impeller 6, 7 is a large washer 28 encircling the shaft 1 and extending radially beyond the periphery of the bearing 13' so that its periphery engages directly the central portion of the housing's inner surface. The lower bearing 20' may be of substantially the same size as the upper bearing and is inserted from the inner side of the end plate 8' into a bearing-receiving cavity. The inner portion of such cavity is countersunk to receive a spacer washer 29 which is of a thickness such that its inner face projects inwardly slightly beyond the inner surface of the plate 8'. The central annular flat portion of the impeller bottom will bear on this spacer washer to provide clearance between the flat surfaces 26 of the impeller blade bottoms and the inner surface of the end plate 8'. Pressure between the impeller blade and a shearing edge 12 will be resisted by pressure of the upper side of the impeller against the upper spacer thrust washer 28.

It has been found that the pump of the present invention not only will not be clogged by stringy material or chunks of material because such material will be cut up, but the suction action is very powerful even though the impeller is rotating at a relatively slow speed. A pump having a housing with an internal diameter of only 12 inches and operated at a speed of only 700 r.p.m. is capable of pumping to a height of 20 or 30 feet very thick material which is virtually a mush. This pump is therefore very proficient in pumping such materials as sewage sludge and liquid manure which may contain not only soft solids but chunks of congealed material and stringy material such as hay, straw, feathers, grass, string and rags. Such solid or stringy material can be cut

easily by the substantially radial leading edge of an impeller blade flange perpendicular to the axis of rotation of the impeller forcing such material into the concave circumferential end of an aperture 9 where such material is confined in order to shear it, the cutting action being facilitated by the beveled plate edge 12 and the beveled leading edge of the impeller blade.

I claim as my invention:

1. A centrifugal pump for pumping a mixture of liquid and stringy solid material suspended in such liquid, comprising a housing having a cylindrical peripheral wall with a discharge aperture therein, a closed end and an open end, an end plate extending across and secured on the open end of said housing, a discharge duct extending upward from such discharge aperture in said peripheral housing wall to a location a substantial distance above said housing, a rotary shaft in said housing extending substantially perpendicular to said end plate, and an impeller secured on said shaft, rotatable thereby and including radially disposed impeller blades, each blade being of angle cross section and having a first flange disposed in a plane substantially parallel to the axis of said shaft and extending radially from such axis and a second flange projecting in the direction of rotation of said impeller from the edge of said first flange adjacent to said end plate and disposed close to said end plate, said end plate having therein arcuate intake apertures concentric with said shaft and spaced apart circumferentially to enable material to be pumped to enter said housing therethrough, and the edge of said second flange of each impeller blade cooperating with one edge of each intake aperture to sever by the interaction of such edges stringy material extending through such an intake aperture in said end plate.

2. A centrifugal pump for pumping a mixture of liquid and stringy solid material suspended in such liquid, comprising a housing having an intake aperture in one wall thereof and a discharge aperture, a discharge duct extending from such discharge aperture, a rotary shaft extending into said housing substantially perpendicular to its intake aperture wall, and an impeller secured on said shaft, rotatable thereby and including a plurality of impeller blades disposed substantially radially, each blade having an edge at its leading side in the direction of blade rotation disposed adjacent to the intake aperture wall of said housing, such intake aperture being spaced radially from said rotary shaft and having a radial width spannable by each of said rotatable impeller blades, and such intake aperture having an edge extending generally radially of said rotary shaft toward which said rotatable blades are moved by rotation of said shaft, the edge of an impeller blade adjacent to the intake aperture wall cooperating in shearing relationship with such generally radial edge of such intake aperture and at least one of such edges being sharpened to sever by the interaction of such blade and aperture edges stringy material extending through such intake aperture.

3. The centrifugal pump defined in claim 2, in which the intake aperture is of circumferentially arcuate shape substantially concentric with the axis of rotation of the rotary shaft and the generally radial edge of such aperture toward which the impeller blades are moved by rotation of the shaft is of concave profile and is beveled, forming a sharpened inner edge cooperating with the leading edges of the impeller blades.

4. A centrifugal pump for pumping a mixture of liquid and stringy solid material suspended in such liquid, comprising a housing having an intake aperture in a planar wall thereof and a discharge aperture, a discharge duct extending from such discharge aperture, a rotary shaft extending into said housing substantially perpendicular to its intake aperture wall, and an impeller secured on said shaft, rotatable thereby and including a plurality of impeller blades disposed substantially radially and a hub connecting said blades, each blade being of angle cross

section and having an edge flange adjacent to the intake aperture wall of said housing, the sides of said blade flanges and the adjacent end of said hub forming an uninterrupted planar surface, such intake aperture being spaced radially from said rotary shaft and having a radial width spannable by each of said rotatable impeller blades and such intake aperture having an edge extending generally radially of said rotary shaft toward which said rotatable blades are moved by rotation of said shaft, the edge of each impeller blade adjacent to the intake aperture wall cooperating with such generally radial edge of such intake aperture to sever by the interaction of such blade and aperture edges stringy material extending through such intake aperture.

5. A centrifugal pump for pumping a mixture of liquid and stringy solid material suspended in such liquid, comprising a housing having a cylindrical peripheral wall with a discharge aperture therein, a closed end and an open end, a discharge duct extending upward from such discharge aperture in said peripheral housing wall to a location a substantial distance above said housing, an end plate extending across and secured on the open end of said housing, a rotary shaft in said housing extending substantially perpendicular to said end plate, said end plate having therein an arcuate intake aperture disposed substantially concentric with said shaft and extending circumferentially less than 360 degrees to enable material to

be pumped to enter said housing therethrough, an an impeller secured on said shaft, rotatable thereby and including radially disposed impeller blades which pass across such end plate aperture during rotation of said impeller, each blade having an edge at its leading side in the direction of blade rotation disposed close to said end plate, the edge of such intake aperture toward which said impeller blades move in passing across such end plate intake aperture being sharpened at its inner side for shearing cooperation with the edge of each impeller blade close to said end plate to sever by the interaction of such edges stringy material extending through such end plate intake aperture.

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