

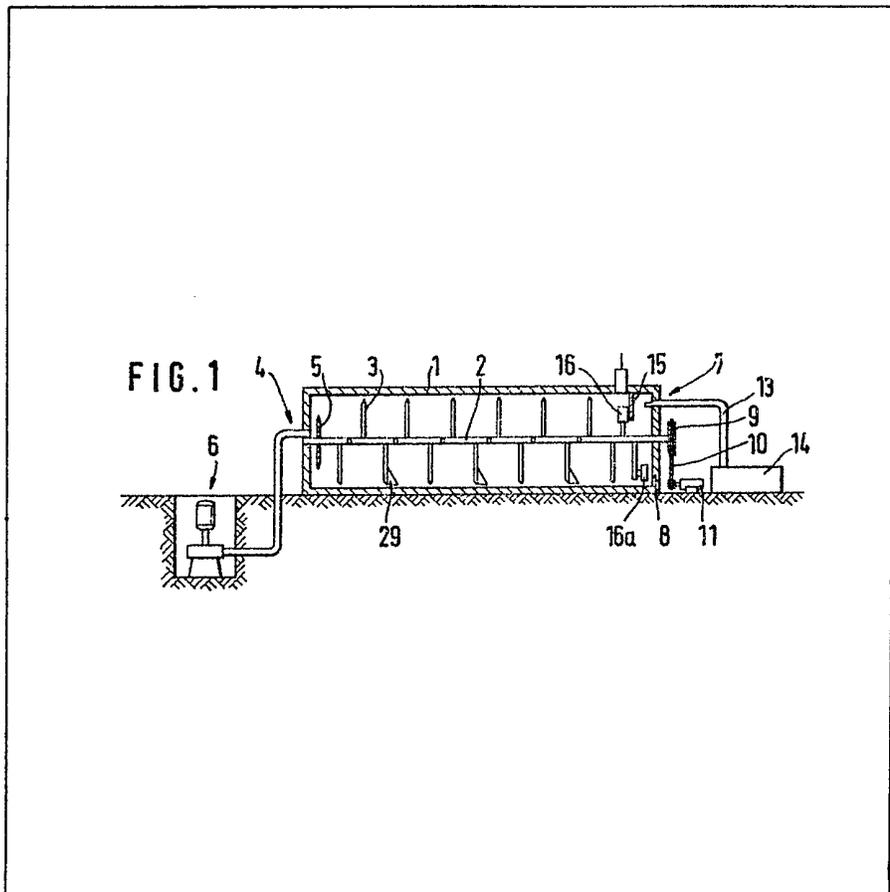
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(71) Applicant  
Xaver Lipp, Hohenstaufen  
Strasse 30, D—7090  
Ellwangen, West  
Germany  
(72) Inventor  
Xaver Lipp  
(74) Agents  
McNeight & Lawrence,  
Regent House, Heaton  
Lane, Stockport, Cheshire  
SK4 1BS

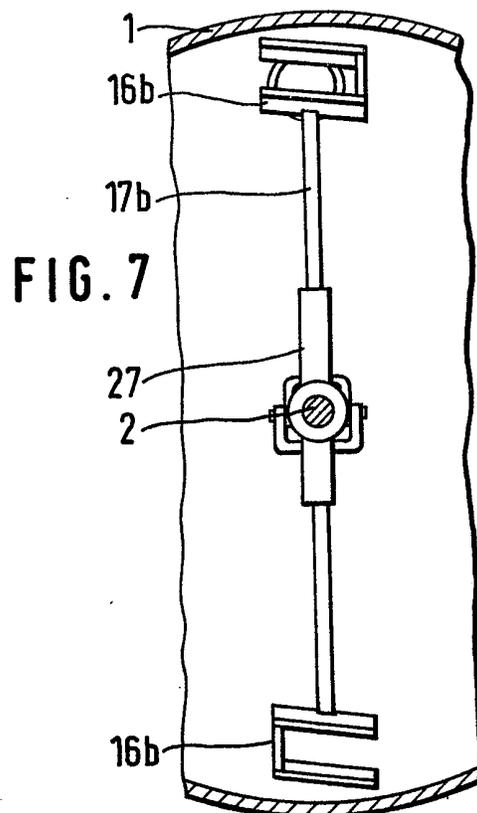
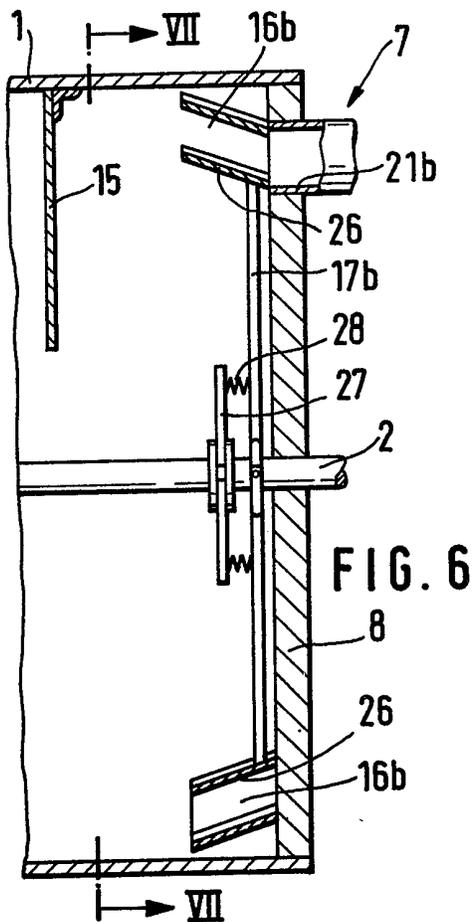
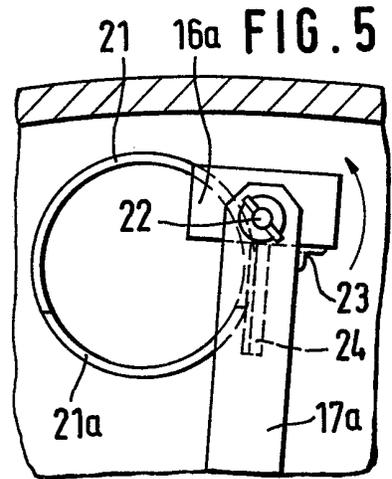
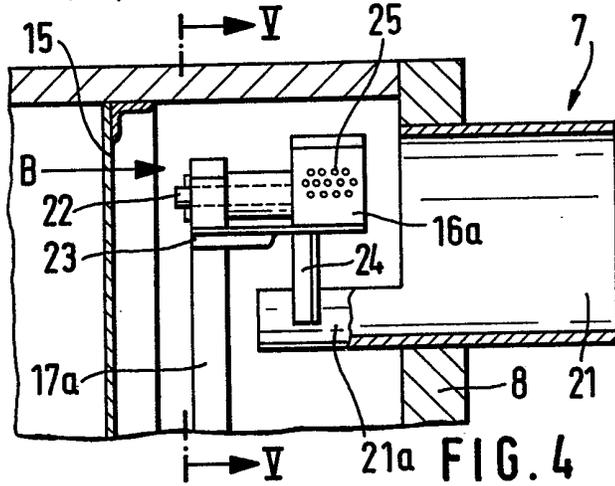
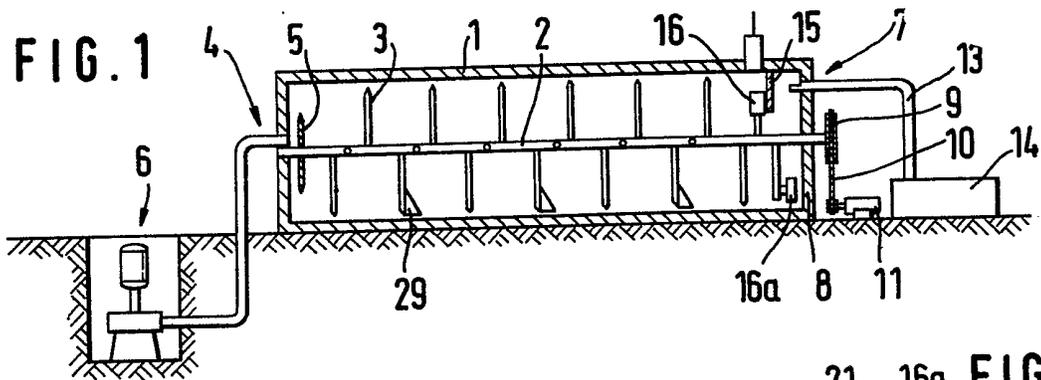
(54) Apparatus for the production of biogas

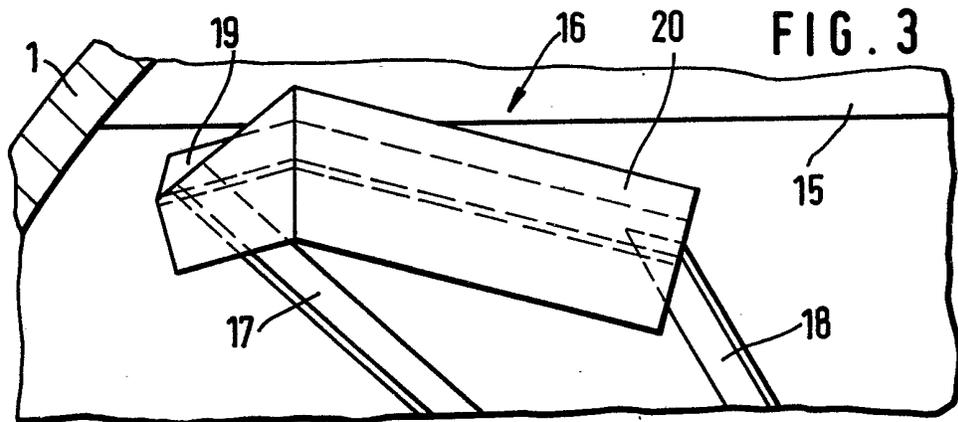
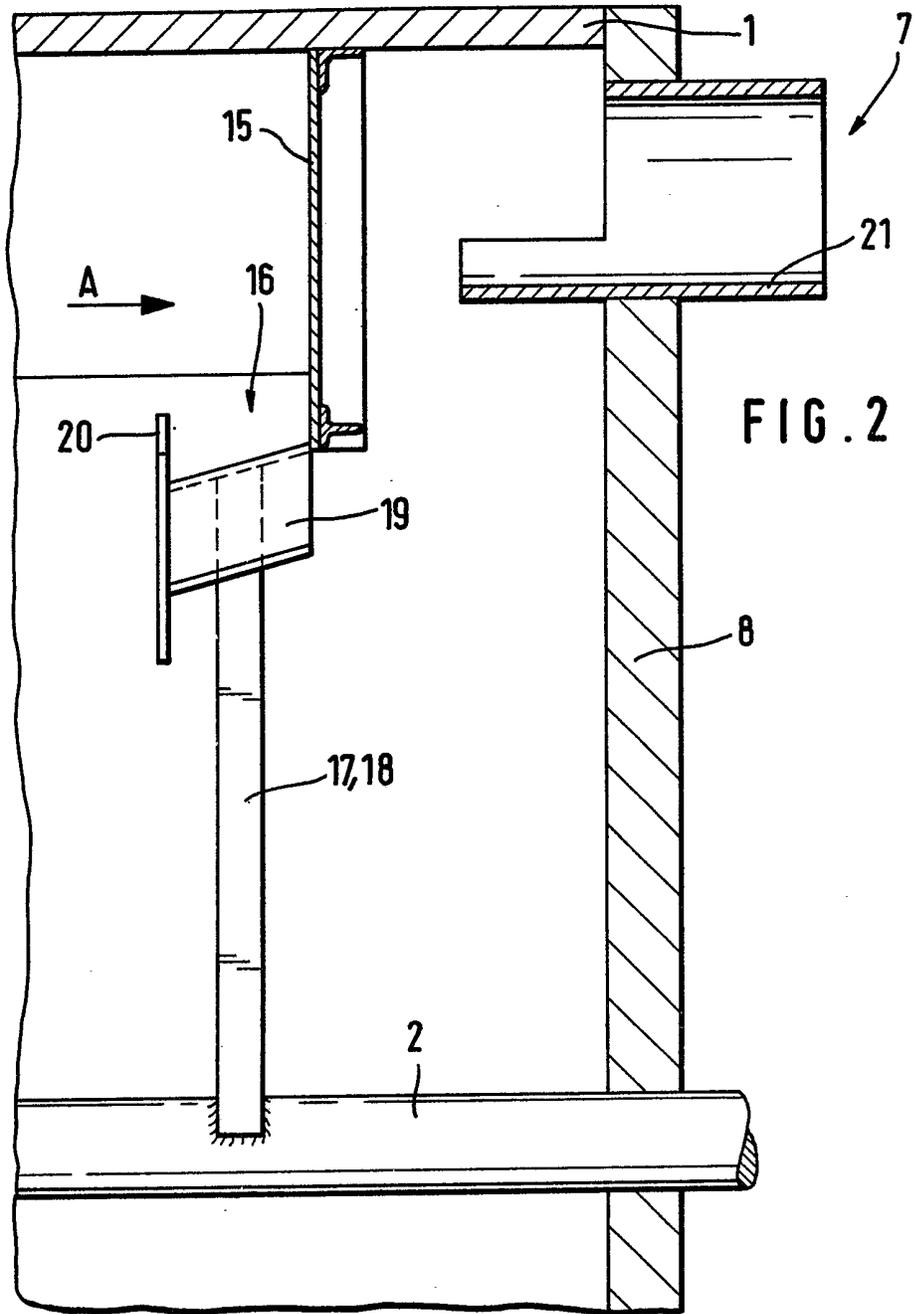
(57) An apparatus for producing biogas includes a fermenting tank (1) with conveying members for removal of surface scum and/or sediment. A downwardly extending baffle wall (15)

has its lowest edge immersed in the scum and a first conveying member (16) moves across that wall and downwardly into the top of the scum, carrying scum to below the wall and pushing it toward the outlet (7). A second conveyor (16a) scoops sediment and lifts it to the outlet where it is dumped.



GB 2 073 166 A





## SPECIFICATION

**Apparatus for the production of biogas**

This invention relates to an apparatus for receiving a quantity of biologically-active material, or biomass, and for producing biogas therefrom.

In a known apparatus, described in German Offenlegungsschrift 2,839,861, a container for receiving biologically-active material is provided with stirring arms having, at least in part of the apparatus, flat or blade-like stirring blades, which swivel backward during operation upon exceeding a predetermined torque counter to the action of a spring. With the help of these stirring blades, the relatively lighter materials in the upper region of the fluid of the biomass are moved downwardly and the heavier parts located in the lower area of the biomass are moved upwardly and are thoroughly mixed in this manner and simultaneously conveyed in the direction toward the outlet of the container. It has been found that, especially in the case of a biomass mixed with straw, a scum forms which is not moved outwardly by the stirring mechanism to the extent required in order to guarantee operation of the apparatus free from breakdown. The same is also true for the sediment forming from the biomass. The scum, which becomes greater in quantity during operation, and steadily increasing sediment will, in the course of time, disturb the production of biogas if from the very beginning that portion of the biomass is not kept very small which would normally be expected to form scum and sediment.

An object of the present invention is to provide an apparatus with which portions of the scum and sediment can be discharged to an increased extent.

The invention comprises apparatus for the production of biogas, comprising a fermenting tank for a biomass which may form a surface scum and/or a sediment, an inlet and an outlet therefrom, and a horizontally-disposed stirring shaft in the tank, said blade having scum and/or sediment collecting means adapted to collect scum and/or sediment to discharge it from the outlet.

In a preferred form, the invention includes an improved apparatus for the production of biogas, the apparatus being of the type including a fermenting tank for the reception of a biomass which forms a surface scum and sediment, the apparatus having an inlet and an outlet, a baffle wall extending downwardly into the scum, and a horizontally-disposed stirring shaft in the tank with stirring blades on the shaft for mixing and conveying the biomass, wherein the improvement includes first and second conveying members mounted on the stirring shaft for rotation therewith for conveying scum and sediment, respectively, toward the outlet of the tank, the first conveying member comprising a first support arm extending outwardly from the shaft, and a blade portion mounted on the first arm and disposed at an acute angle relative to the axis of the shaft with the angle opening toward the outlet for seizing a

65 portion of the scum from above as the shaft rotates, the blade portion being supported for movement substantially parallel with and closely adjacent to the side of the baffle wall facing away from the outlet; and the second conveying member comprising a second support arm extending outwardly from the shaft and a dipping vessel mounted on said second arm for movement on the opposite side of the baffle wall from the first member to dip into said sediment.

70 While the stirring blades are developed especially for the thorough mixing and moving of the biomass, the two conveying members serve especially for the movement of parts of the scum and sediment in the direction of the outlet, as a result of which parts of the scum and sediment are removed in the course of the operation to an extent related to the rate at which parts forming the scum and sediment are fed to the biomass, so that scum will not collect in the fermenting tank to an extent capable of disturbing its operation and, similarly, no operation-disturbing sediment.

In order that the manner in which the foregoing and other objects are attained in accordance with the invention can be understood in detail, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of the specification, and wherein:—

Figure 1 is a side elevation, in longitudinal section, of an apparatus incorporating the present invention;

Figure 2 is an enlarged side elevation of a portion of the apparatus of Figure 1;

Figure 3 is an end elevation, in partial section, viewed in the direction of Arrow A of Figure 2;

Figure 4 is an enlarged partial side elevation, in section, of a portion of the apparatus of Figures 1—3, but with the components in a different position;

Figure 5 is an end elevation, in partial section, along line V—V of Figure 4;

Figure 6 is a partial side elevation, in section, of a further embodiment of an apparatus in accordance with the invention; and

Figure 7 is an end elevation along line VII—VII of Figure 6.

As seen in Figure 1, the overall apparatus includes a fermenting tank 1 which is an elongated cylindrical tank, generally circular in cross-section, and about 8 metres to 14 metres in length, the diameter being about 2 to 4 metres. The central axis of the tank lies in a horizontal plane and the exterior of the tank is normally thermally insulated around its periphery in a manner not shown. A stirring shaft 2 extends horizontally along the central axis of the tank and carries a plurality of stirring blades 3 which are axially spaced along the shaft from each other. At the left end of the tank, as shown in Figure 1, and somewhat above the end journal for shaft 2, is an inlet 4 which is screened by a shroud 5 through which the stirring shaft extends, the shroud being provided so that biomass delivered through inlet 4 minimally disturbs the biomass located in the

fermenting tank 1. In conventional fashion, inlet 4 is connected by a conduit with a motor driven pump which is accommodated in a pit and which delivers biomass to the tank.

5 At the end of the tank opposite inlet 4 is a discharge 7 which is located in the upper part of end wall 8 of tank 1. This end wall is penetrated by the stirring shaft 2 which, at the end protruding out of the tank, is provided with a chain or sprocket wheel 9 coupled to a chain 10 which is also coupled to the chain pinion of a driving motor 11. Thus, stirring shaft 2 is rotated by the driving motor around its axis, but this rotation is accomplished only a few times a day. Discharge 7 is connected by way of a pipe 13 with a receiving tank 14 for fermented biomass.

15 Within the tank and spaced from the discharge 7 is a substantially vertical wall 15 which is supported on the upper portion of the tank itself and extends transversely across the interior of the tank and downwardly to a level such that the lower distal edge of wall 15 dips into the biomass and reaches to a level below the scum at the surface thereof. Located on the side of baffle wall 15 facing away from discharge 7 is a conveying member 16 which cooperates with wall 15, conveying member 16 being supported by a pair of support arms 17, 18, best seen in Figures 2 and 3. Arms 17 and 18 are fixedly attached to shaft 2 and to conveying member 16. Member 16 includes a blade portion 19 which is bent from a single piece of sheet metal, the bend being to an obtuse angle approximating  $150^\circ$ , the portion closest to the side wall of tank 1 being approximately one-third of the length of the remaining portion. This blade portion 19 is mounted on arms 17 and 18 in such a way that its two sections enter the biomass through the scum surface at approximately the same angle, each such angle being acute. Additionally, the blade portion 19 is disposed at an acute angle relative to the axis of stirring shaft 2 in such a way that the vertex of that angle points toward the end of the tank having inlet 1. Stated differently, the angle, which is the angle best seen in Figure 2, opens toward the end of the tank containing outlet 7. The blade portion 19 is mounted so that its uppermost edge passes closely adjacent to wall 15, there being only sufficient clearance to permit movement. Conveying device 16 further includes a flat generally vertically-extending plate 20 which is fixedly attached to blade portion 19 on the side of the blade away from wall 15, plate 20 being perpendicular to the axis of shaft 2. Viewed in the direction of Arrow A, plate 20 is angularly formed so that it bends in approximately the same manner as blade 19 with that blade being attached approximately at the vertical centre of the plate, as shown in Figure 3.

60 The conveying member 16 is formed and located such that, as shaft 2 rotates and carries arms 17 and 18 with it, the blade also rotates in the direction of Arrow 19a, Figure 3, rises out of the biomass and, as it comes down, engages the scum at the top of the biomass adjacent plate 15,

70 seizes a portion of that scum from above, and carries it downwardly to and below the lower distal edge of wall 15, thereby freeing it for movement under the wall in the direction of outlet 7, this movement being facilitated by the acute angle at which plate 19 lies. It will be observed from Figure 2 that outlet 7 includes a pipe section 21 protruding into the tank in the direction of wall 15, under the scum but at a distance which does not adversely influence the action of the conveying member. As shown in Figure 1, above conveying member 16 there is a place for removal of the biogas. The pipe section 21 preferably has a partial closure, as at 21a, to prevent discharging biomass running back into the fermenting tank 1. Alternatively the pipe section 21 can be downwardly inclined from the inside to the outside of the tank 1.

85 As can also be seen in Figure 1, a second conveying member 16a is mounted on shaft 2 and is carried by a support arm 17a which extends away from the shaft in the direction opposite arms 17, 18 and member 16. Arm 17a and member 16a are axially spaced closer to end wall 8 so that member 16a passes between the end wall and baffle wall 15 as shaft 2 rotates. Conveying member 16a is formed in the shape of a bucket and is pivotably mounted on arm 17a so that it can pivot or swivel about an axis which extends generally parallel to the axis of the stirring shaft and transversely to the longitudinal axis of the bucket, this structure being best seen in Figures 4 and 5. The swivel mounting includes a peg or shaft 22 which penetrates arm 17a, the peg being surrounded by a spacer which maintains the bucket in a laterally offset position from arm 17a. A stop member 23 protrudes toward wall 8 from arm 17a and is positioned to limit the pivoting of member 16a in the clockwise direction, as seen in Figure 5, so that during movement of the conveying member through the sediment in the bottom of the tank its longitudinal axis is maintained in perpendicular relationship to the axis of arm 17a. An arm 24 protrudes downwardly in a direction which is generally parallel with arm 17a as seen in Figure 5 from conveying member 16a, the purpose of arm 24 being to accomplish emptying of the bucket. As will be seen from Figure 5, as the arm 17a rotates with shaft 2 in the direction of Arrow 19a, arm 24 comes in contact with the projecting portion 21a of outlet pipe 21, causing member 16a to rotate about the axis of peg 22, causing the contents of the bucket to be dumped into the semi-circular lower portion of pipe 21. After passing the outlet, the fluid causes the bucket to return the position, relative to arm 17a, shown in Figure 5.

115 As seen in Figure 4, the trailing end of the bucket, with respect to the normal direction of rotation of the apparatus, is provided with holes 25 which allow gas and fluid to pass therethrough, but not to permit passage of the sediment of the biomass.

130 A further embodiment of conveying apparatus in accordance with the invention for the removal

of sediment is shown in Figures 6 and 7. The conveying member identified in those figures as 16*b* is open on the front side, with respect to the direction of rotation of stirring shaft 2, as well as on the side facing end wall 8. The part 26 facing the stirring shaft 2 is disposed at an acute angle relative to the axis of the stirring shaft so that the vertex of that angle points in the direction of the outlet. In order that the open side of the conveying member 16*b* can be guided along the surface of end wall 8, arm 17*b* carrying the conveying member 16*b* is pivotally mounted for movement about an axis perpendicular to shaft 2 as best seen in Figure 7. A radially-extending arm 27 is fixedly attached to shaft 2 for rotation with that shaft, and a compression spring 28 is disposed between arm 27 and arm 17*b*. Thus, arm 17*b* and conveying member 16*b* is pressed towards the end wall. The section of outlet pipe, identified in this embodiment as 21*b*, terminates flush with the inside surface of wall 8. As will be recognized, substantially identical structures extend in opposite directions from shaft 2 in this embodiment, only one side of this arrangement having been described in detail.

During the rotational movement of shaft 2, the conveying member 16*b* dips into the sediment of the biomass in the bottom of fermenting tank 2 and carries this sediment along, conveying the sediment to the pipe 21*b* whereupon, because of the slantingly disposed part 26 of the bucket, is discharged into the pipe, thus reaching the outlet of tank 1.

As can be seen in Figure 1, at the outer ends of some of the stirring blades 3, there are blades 29 distributed from the inlet 4 to the outlet 7 for facilitating the movement of the sediment on the bottom of the fermenting tank 1. Blades 29 can be formed essentially in the shape of a triangle and can be disposed at a generally transverse angle to the axis of the stirring shaft so that they exert a conveying force on the sediment in the direction toward the discharge 7.

While certain advantageous embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

## 50 CLAIMS

1. Apparatus for the production of biogas, comprising a fermenting tank for a biomass which may form a surface scum and/or a sediment, an inlet and an outlet therefrom, and a horizontally-disposed stirring shaft in the tank, said blade having scum and/or sediment collecting means adapted to collect scum and/or sediment to discharge it from the outlet.

2. An improved apparatus for the production of biogas, the apparatus being of the type including a fermenting tank for the reception of a biomass which forms a surface scum and sediment, the apparatus having an inlet and an outlet, a baffle wall extending downwardly into the scum, and a

65 horizontally disposed stirring shaft in the tank with stirring blades on the shaft for mixing and conveying the biomass, wherein the improvement includes first and second conveying members mounted on said stirring shaft for rotation therewith for conveying scum and sediment, respectively, toward the outlet of said tank, said first conveying member comprising a first support arm extending outwardly from said shaft, and a blade portion mounted on said first arm and disposed at an acute angle relative to the axis of said shaft with the angle opening toward said outlet for seizing a portion of said scum from above as said shaft rotates, said blade portion being supported for movement substantially parallel with and closely adjacent to the side of said baffle wall facing away from said outlet; and said second conveying member comprising a second support arm extending outwardly from said shaft, and a dipping vessel mounted on said second arm for movement on the opposite side of said baffle wall from said first member to dip into said sediment.

3. An apparatus according to claim 2 wherein said blade portion, viewed in its plane of motion, is bent at an obtuse angle and is disposed to enter the scum with both bent portions forming, at most, acute angles with the scum surface.

4. An apparatus according to claim 3 wherein said first conveying member further includes a side plate mounted on said blade portion at an angle relative to said stirring shaft, said side plate protruding radially beyond both sides of said blade portion.

5. An apparatus according to any one of claims 2 to 4 wherein said dipping vessel is in the form of a bucket having its central axis extending generally perpendicularly to the axis of said second supporting arm.

6. An apparatus according to claim 5 wherein said outlet includes a projecting member extending to the path of travel of said dipping vessel, and wherein said second conveying member includes means for pivotally mounting said vessel on said second arm for pivotal movement about an axis generally perpendicular to the axis of said second arm, a stop member on said arm for contracting said vessel as it pivots to limit the extent of pivotal movement thereof in one direction, and a contact arm on said vessel disposed to contact said projecting member for causing said vessel to pivot in the opposite direction.

7. An apparatus according to claim 5 wherein said dipping vessel is rigidly mounted on said second arm with its axis inclined relative to the axis of said second arm at an angle such that the vertex of the angle points outwardly away from said stirring shaft; wherein said tank includes an end wall supporting said outlet; and wherein said dipping vessel moves and is guided along said end wall to said outlet.

8. An apparatus according to claim 7 wherein said second support arm is pivotally mounted on said shaft for movement about an axis generally

perpendicular to said shaft, said apparatus further including spring means for urging said second arm toward said end wall.

5 9. An apparatus according to any of claims 4 to 7 wherein said vessel has a normal direction of

rotation with said shaft, and wherein the trailing end of said vessel includes a plurality of holes dimensioned to permit passage of fluid and prevent passage of sediment.