United States Patent

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[33] **Great Britain**
[31] **19,432/68**

[54] **CHOPPING MACHINES**
7 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **146/68,** 146/124
[51] **Int. Cl.** **B02c 18/12**
[50] **Field of Search** 146/68, 192, 124; 241/258, 260, 298, 296, 46, 46.06, 46.11, 46.17

[56] **References Cited**

UNITED STATES PATENTS

2,496,017	1/1950	Newell et al.	241/258 X
2,855,157	10/1958	Edgar	241/260 X
3,369,583	2/1968	Schnell	146/192
211,248	1/1879	Michel	241/46.11 X
375,212	12/1887	Soderling	241/46.11 X
2,357,640	9/1944	Eppenbach	241/46.11
2,888,212	5/1959	Albert et al.	241/296 X
3,073,535	1/1963	Vokes	241/46.11

FOREIGN PATENTS

313,932	7/1919	Germany	241/260
430,729	1935	Great Britain	241/298
1,143,382	2/1963	Germany	241/258
635,509	3/1928	France	241/296

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ABSTRACT: A chopping machine comprising a stationary member and a rotary member each of which carries a plurality of cutting edges each of which has an edge of a copying lathe tool of triangular-section prism shape. The rotary and stationary members are spring-biassed towards one another and impeller blades are provided on the rotary member to cause flow of liquid vehicle and material to be chopped within the container in which the rotary and stationary members are disposed. Guide vanes are provided for placing a constraint on the direction of flow of the liquid vehicle and material to be chopped.

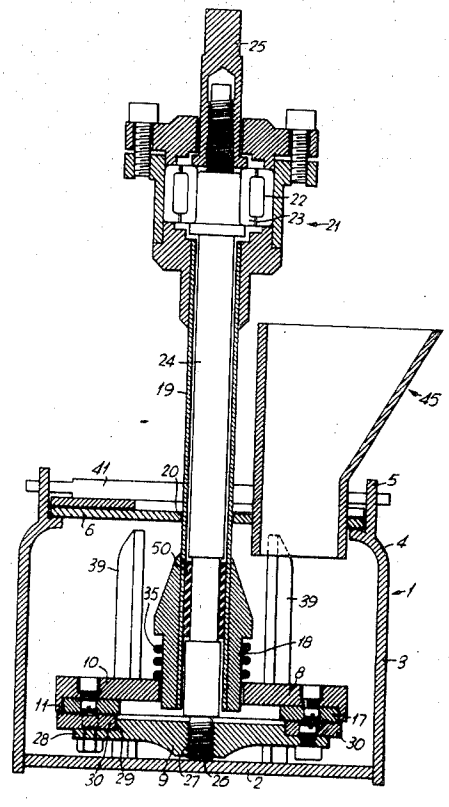
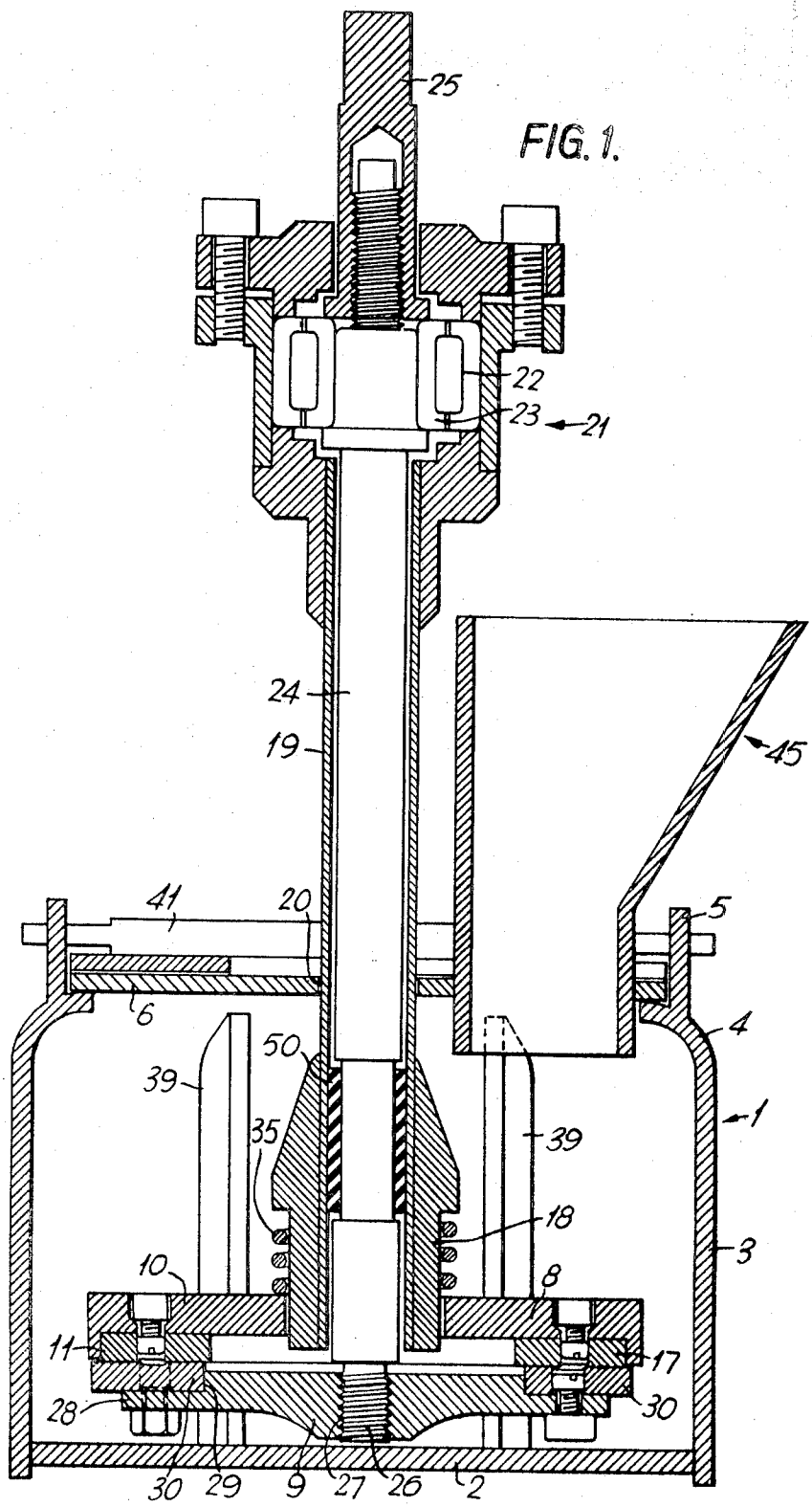


FIG. 1.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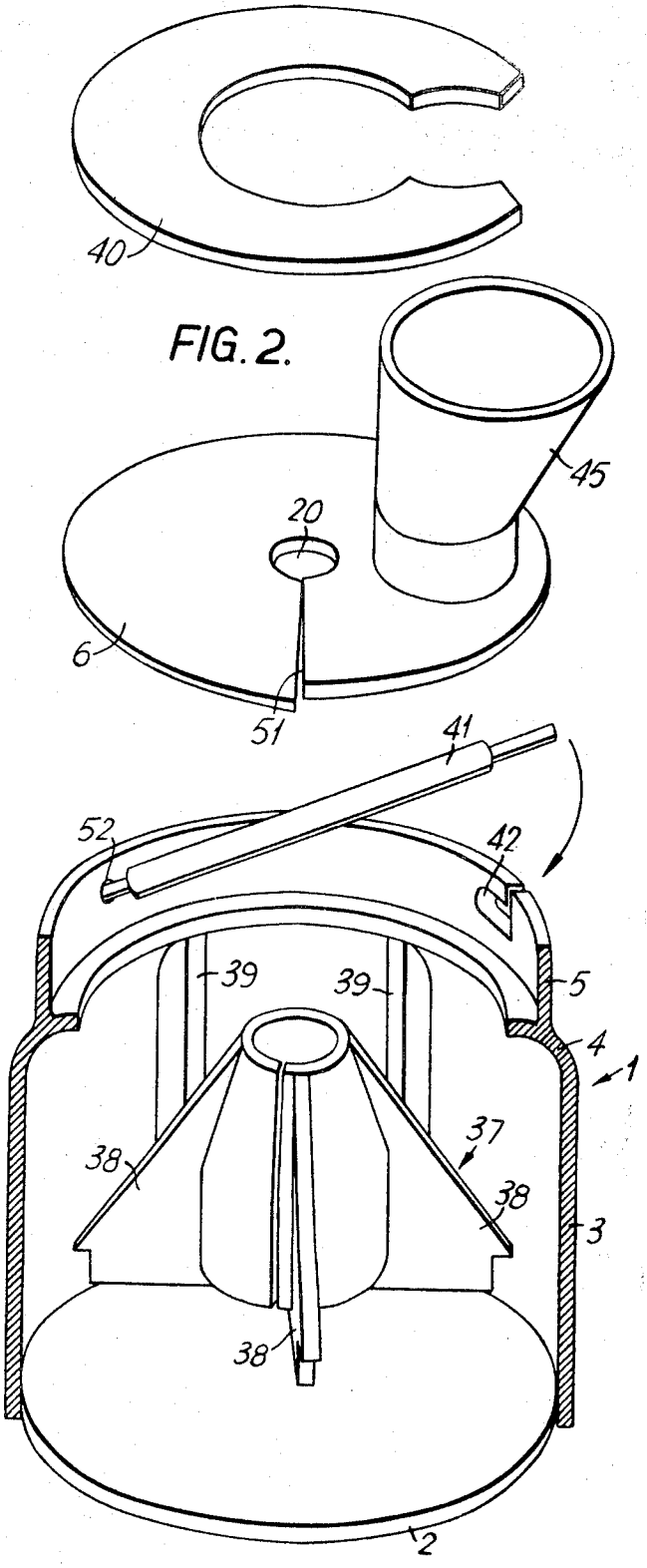

FIG. 2.

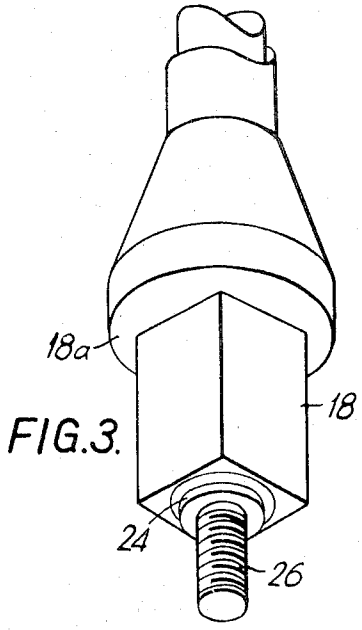
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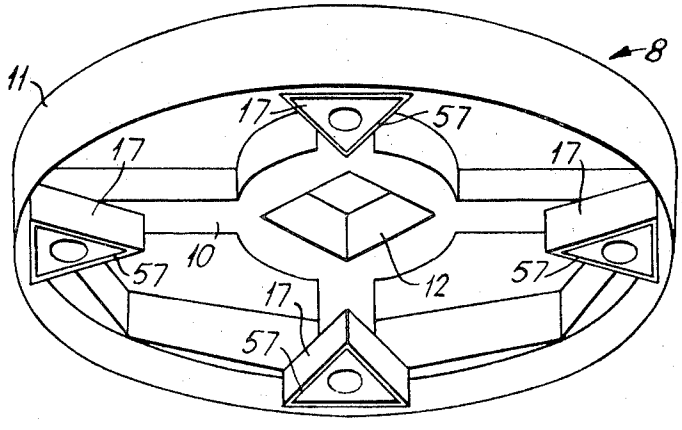
FIG.3.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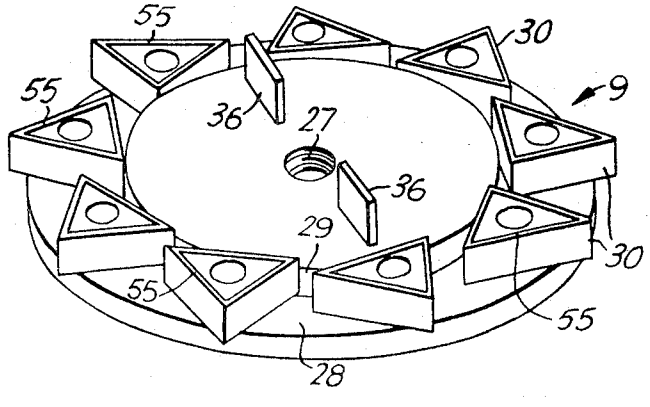
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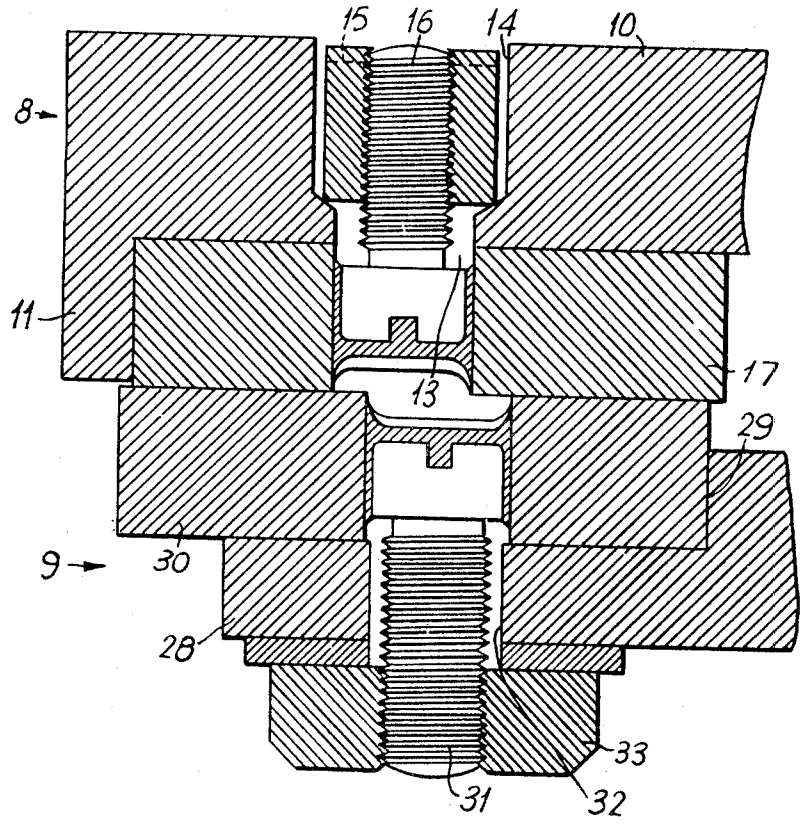
FIG. 4.



CHOPPING MACHINES

The present invention relates to chopping machines.

In the analysis of wet-fibrous material, such as silage, it is desirable that the silage be finely chopped so that with the finely chopped silage in aqueous suspension the homogeneity of the mixture is such that volumetric aliquots may be taken from the mixture with a satisfactory degree of accuracy with respect to the quantity of organic matter contained in the aliquot.

According to the present invention there is provided a chopping machine including a container for a liquid vehicle for material to be chopped, a chopping device disposed within the container and comprising a stationary member having a plurality of cutting edges disposed about and spaced from an axis and disposed in an imaginary surface generated by rotation of a line intersecting the axis about the axis, each of the cutting edges being inclined to a line in the said imaginary surface and intersecting both the axis and the cutting edge, a rotary member rotatable about the said axis and having a plurality of cutting edges cooperatively engageable with the cutting edges of the stationary member upon rotation of the rotary member, each cutting edge of the rotary member being disposed in the said imaginary surface and inclined to the cutting edge of the stationary member with which it is temporarily in cooperating engagement and also inclined to a line in the said imaginary surface and intersecting both the axis and the cutting edge, and means for causing flow of the liquid vehicle and material to be chopped in a general axial direction to the region between the cutting edges and the axis and subsequently in an outward direction away from the axis between the stationary and rotary members.

The said imaginary surface may be a plane normal to the axis of rotation of the rotary member and each of the cutting edges may be one edge of a known form of copying lathe tool of triangular-section prism shape.

The rotary member may be secured to a rotary drive shaft disposed within a stationary tubular member, said stationary tubular member cooperating with said stationary member to prevent rotation of the stationary member.

The stationary member may be movable relative to the tubular member in the direction of the axis of rotation of the drive shaft and in this case the stationary member may be spring-biassed towards the rotary member.

The means for causing flow of the liquid and material to be chopped may include impeller blades attached to the rotary member for causing flow in said outward direction and stationary guide vanes for constraining the liquid vehicle and material to chopped to flow in a general axial direction to said region between said cutting edges and the axis.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a chopping machine in accordance with the present invention;

FIG. 2 is an exploded view of some parts of the machine illustrated in FIG. 1;

FIG. 3 is an exploded view of other parts of the machine illustrated in FIG. 1; and

FIG. 4 is a sectional view, on an enlarged scale, of two cooperating cutters, illustrating the manner in which they are mounted.

The chopping machine illustrated in the drawings comprises a container 1 having flat, circular bottom 2 and a cylindrical sidewall 3. The upper portion 4 of the sidewall 3 is directed inwards and is of arcuate sectional form. A short cylinder 5 is mounted on and secured to the outer surface of the upper sidewall portion 4 and serves to locate a closure 6 for the container and for engagement with means for retaining the closure 6 on the container 1.

Disposed within the container 1 is a cutting device comprising a stationary member 8 and a rotary member 9. As best seen in FIG. 3, the stationary member 8 comprises a four-legged spider 10 carrying a peripheral cylindrical skirt 11 and having a square aperture 12 at its center. Each of the legs of

the spider 10 has formed therein adjacent its radially outer end a bore 13 and counterbore 14. A nut 15 is disposed in the counterbore 14 for threaded engagement with a screw-threaded stud 16 of a cutter 17 (see FIG. 4).

Received as a loose fit within the square aperture 12 is a hollow, square-section spigot 18 carried by the lower end of a cube 19 which extends axially out of the container 1 through an aperture 20 in the closure 6.

The upper end of the tube 19 is carried by a housing 21.

The housing 21 carries the outer race 22 of a roller bearing, the inner race 23 of which is carried by a shaft 24 which extends axially through the tube 19 and projects below the lower end of the tube 19 and the spigot 18. The lower end of the shaft 24 is steadied within the tube 19 by a split Tufnol bush 50. The upper end of the shaft 24 is connected to a shaft 25 which may be driven in rotation by means (not shown). Thus, the housing 21 serves to support and locate not only the tube 19 but also the shaft 24. The bearing 22, 23 includes thrust washers for axial location of the shaft 24 within the tube 19.

The unit consisting of the housing 21, tube 19 and shaft 24, and rotary and stationary members is supported by any convenient means, for example, a clamp carried by a stand and gripping the housing.

A lower end portion 26 of the shaft 24 is screw threaded for screw threaded engagement with an internally threaded bore 27 at the center of the rotary member 9.

The rotary member 9 includes a disc with an outer annular portion 28 of reduced thickness. A cylindrical shoulder 29 is formed at the junction of the thicker and thinner portions of the disc.

A plurality, in the present example, nine, of cutters 30 are mounted on the reduced thickness portion 28 of the disc of the rotary member 9. As can best be seen in FIG. 4, the cutters 30 are mounted by means of a screw-threaded stud 31 on each cutter 30 which extends downwardly through an aperture 32 in the disc and is engaged by a nut 33 at the underside of the disc.

The cutters 17 and 30 are of triangular-section prism shape and are formed of tungsten carbide. Each of the lower three edges in the case of each upper cutter 17 and each of the upper three edges in the case of the lower cutters 30 is a cutting edge. Sandvik Coromant T -MAX -P, TNMZ 433 E copying lathe tools are suitable for use as the cutters. The studs 16 and 31 are retained in the central apertures of the cutters 17 and 30, respectively, by silver solder, the surface of which is sprayed with plastics material.

Each of the upper cutters 17 is held against rotation about the axis of its stud 16 by abutment of two vertical, corner edges of the cutter 17 against the inside surface of the skirt 11. One of the three triangularly disposed faces of each cutter therefore forms a chord of the circular internal form of the skirt 11 and the other two faces are each disposed at an angle of 30° to a line radial to the axis of the shaft 24 and passing through the angle between the two faces.

Each of the lower cutters 30 is held against rotation about the axis of its stud 31 by abutment of one vertical, corner edge of the cutter against the shoulder 29. The vertical edge of each cutter 30 which abuts against the shoulder 29 is the trailing vertical edge of the cutter when the rotary member 9 is rotated. The direction of rotation of the rotary member 9 is clockwise when looked down upon from above.

As mentioned above, the stationary member 8 is a loose fit on the spigot so that the stationary member 8 may have some freedom of movement relative to the spigot 18 and the stationary member 8 is biased against the rotary member 9 by a coil spring 35 disposed about the spigot 18 and taking purchase on a shoulder 18*a* at the upper extremity of the spigot 18.

The rotary member 9 is provided with impeller blades 36 to cause flow of liquid vehicle radially outwardly between the cutter 17, 30 upon rotation of the rotary member 9.

The spigot 18 is enveloped by a member 37 (see FIG. 2) which prevents material to be chopped wrapping round, and

getting trapped by the spring 35. The member 37 carries four vanes 38 which serve to prevent substantial rotary motion of liquid and material to be chopped, about the axis of the shaft and hence wrapping of material to be chopped about the legs of the spider, which might otherwise occur, is prevented. The inner surface of the container 1 is provided with guide vanes 39 for a similar purpose. The member 37 is not illustrated in FIG. 1 for the sake of clarity.

The closure 6 is formed of plastics material and is split at 51 (see FIG. 2) so that it may be removed from and placed in encompassing relationship with the tube 19. The aperture 20 is a close fit with the tube 19. A C-shaped seal 40 is provided to form a seal over the split 51 in the closure. The seal 40 and closure 6 are held in position by two rods 41, one end of each of which is received in a respective aperture 52 and the other end of which is received in a respective L-shaped slot 42 in the cylinder 5. Only one rod 41 is illustrated in the drawings. The other rod 41 is generally parallel to the illustrated rod 41 and is at the other side of the coaxial tube 19 and shaft 24 arrangement.

The closure 6 is provided with a funnel 45 for the introduction of material to be chopped, into the closed container. The funnel is extended downwardly beneath the lower surface of the closure.

In operation for chopping silage, the container contains a required volume of water which is sufficient to at least immerse the stationary member.

The rotary member 9 is driven in rotation through the shaft 24. Silage to be chopped is initially minced and then fed into the container 1 through the funnel 45.

Rotation of the rotary member causes a general turbulence in the liquid and an overall flow which includes a flow in a general axial direction downwardly between the vanes 38 and the legs of the spider which is followed by an outwards flow away from the axis of rotation between the rotary and stationary members and hence across the path traversed by the cutter. Thus, there is a continuous recirculation of the water vehicle and the silage which, after a short period in the water, is uniformly dispersed throughout the water. As the silage passes across the path traversed by the cutters it is subjected to a shearing action between the radially outer cutting edge 55 of each cutter 30 and the edge 57 of each cutter 17 and is chopped on each occasion that it is subjected to a shearing action.

It will be realized that the cutting edges 55 and 57 are disposed in an imaginary surface generated by rotation about the axis of rotation of the rotary member, of a line which intersects the axis and, in the present example, is normal to the axis, i.e., in the present example the cutting edges are disposed in a plane normal to the axis of rotation. Each of the cutting edges is inclined to a line in the said imaginary surface intersecting both the axis of rotation and the respective cutting edge. The present example wherein each cutting edge 57 is inclined at an angle of 30° to a radius intersecting the radially inner end of the cutting edge 57 and wherein each cutting edge 55 is inclined at an angle of just greater than but approximating to 30° to a radius bisecting the respective cutting edge 55, is particularly satisfactory.

Although only one cutting edge of each three cutting-edged cutter is operative for cutting at any one time, the advantage of using cutters of the form described is that they are readily available and if the cutting edge in use should become blunted each cutter can be turned through 60° to present a new cutting edge.

As an example, suspensions are prepared in a total volume of 300 ml. of water (including the moisture content of the silage sample) as a concentration of 4 percent of dry matter. The time required to prepare a sample with a chopping machine as described above, is 4 minutes. Aliquots of 12.5 ml. (containing 0.5 gm. dry matter) are taken from the suspension, which is stirred slowly during sampling. It has been found that a chopping machine as described above makes such a homogeneous mixture that the variation of organic matter in such 12.5 ml. aliquots is within ±0.0028 gm.

A further advantage of a machine in accordance with the present invention is that undried silage may be chopped in a liquid vehicle. This eliminates the need for drying (a necessary preliminary step in conventional milling) and thus avoids changes in composition which result from drying of such materials.

In the embodiment described above, there are four cutters in the stationary member and nine cutters in the rotary member. It has been found that it is desirable to have the cutters in at least one member well-spaced apart in order not to restrict outwards flow of material to be chopped. The stationary member needs to have openings to allow flow of material to the region between the cutters and the axis of rotation.

The arrangement of mounting the cutters of the rotary member on a reduced thickness portion of the disc reduces the effective bulk of the cutters which would otherwise impede outwards flow of material in the liquid vehicle.

Because the stationary member is spring-biassed against the rotary member, it is, of course, necessary to ensure that the spacing between the lower cutters is not such that an upper cutter can bed down in the space between two adjacent lower cutters.

In the embodiment of the invention particularly described above, the studs 16, 31 are secured to the cutters 17, 30 respectively, by silver solder. Whilst this is a functionally satisfactory manner of providing means for securing the cutters to the stationary and rotary members 8, 9, it has been found that mounting of the cutters may be simplified, and hence replacement made easier, by the use of countersunk screws fitting underflush into countersinks formed in the cutters by spark erosion.

What is claimed is:

1. A chopping machine including:
a container for a liquid vehicle for material to be chopped;
a chopping device disposed within said container and comprising:
a stationary member;
a rotary member rotatable about an axis;
said stationary member having a plurality of straight cutting edges disposed about and spaced from the axis and disposed in an imaginary surface generated by rotation of a line intersecting said axis about said axis;
each of said cutting edges being inclined to a line which both lies in said imaginary surface and intersects both said axis and the respective said cutting edge;
a rotary member rotatable about said axis;
said rotary member having a plurality of straight cutting edges cooperatively engageable with said cutting edges of said stationary member upon rotation of said rotary member;
each cutting edge of said rotary member being disposed in said imaginary surface and inclined to the cutting edge of the stationary member with which it is temporarily in cooperating engagement and also inclined to a line which both lies in said imaginary surface and intersects both said axis and respective said cutting edges in temporary cooperating engagement; and
means adapted to inhibit rotary motion of said liquid vehicle and material to be chopped flowing in a generally axial direction towards the region between the cutting edges and the axis and means adapted to cause subsequent flow of such vehicle and material away from said axis in directions lying generally in said imaginary surface whereby to pass between said cutting edges of said rotary and stationary members and thereafter to recirculate within said container and again approach said region in said general axial direction.

2. A chopping machine as claimed in claim 1, wherein
said imaginary surface is a plane normal to the axis of rotation of the rotary member; and
each of said cutting edges is one edge of a copying lathe tool of triangular-section prism shape with external cutting edges.

3. A chopping machine as claimed in claim 1 including:
a stationary tubular member;

a rotary drive shaft disposed within said stationary tubular member;
said rotary member being secured to said rotary drive shaft;
said stationary tubular member being adapted to cooperate with said stationary member whereby to prevent rotation of said stationary member.

4. A chopping machine as claimed in claim 3, wherein;
said stationary member is adapted for movement relative to said tubular member in the direction of the axis of rotation of said drive shaft; and
spring means are provided to bias said stationary member towards said rotary member.

5. A chopping machine as claimed in claim 1 wherein:
said means adapted to cause flow of the liquid and material to be chopped includes:
impeller blades attached to said rotary member and adapted to cause flow in said outward direction; and
stationary guide vanes adapted to constrain the liquid vehicle and material to the chopped to flow in a general axial direction to said region between said cutting edges and said axis.

6. A chopping machine including:
a container for a liquid vehicle for material to be chopped;
a chopping device disposed within said container and comprising:
a stationary member;
a rotary member rotatable about an axis;
said stationary member having a plurality of cutting edges disposed about and spaced from and in a plane normal to said axis
each of said cutting edges being inclined to a line which both lies in said plane and intersects both said axis and the respective said cutting edge;
said rotary member having a plurality of cutting edges cooperatively engageable with said cutting edges of said stationary member upon rotation of said rotary member;
each cutting edge of said rotary member being disposed in said plane and inclined to the cutting edge of the stationary member with which it is temporarily in cooperation engagement and also inclined to a line which both lies in said plane and intersects both said axis and the respective said cutting edge of the rotary member; and
means adapted to inhibit rotary motion of said liquid vehicle and material to be chopped flowing in a generally axial direction towards the region between the cutting edges and the axis and means adapted to cause subsequent flow of such vehicle and material away from said axis between said stationary and rotary members.

7. A chopping machine as claimed in claim 6 wherein:
each of said cutting edges is one of a copying lathe tool of triangular-section prism shape with external cutting edges.

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