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Okada et al.

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[54] **CRUSHING APPARATUS**

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[52] **U.S. Cl.** **241/68;** 241/73

[51] **Int. Cl.** **B02c 13/282**

[58] **Field of Search** 241/52, 55, 68, 69, 73

[56] **References Cited**

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[57] **ABSTRACT**

The crushing apparatus comprises a housing, a route provided in upper portion of the housing for throwing matters to be disposed of, a rotary hammer provided in lower portion of the housing, a screen provided below the hammer, and a route provided above the hammer for exhausting floating matters. Completely crushed matters among the matters to be disposed of, are taken out of the screen, and the uncrushed matters among the matters to be disposed of, are floatingly selected through ascending air currents caused, within the housing, by rotation of the hammer and, thereafter, are taken out of the housing through an exhausting route.

10 Claims, 4 Drawing Figures

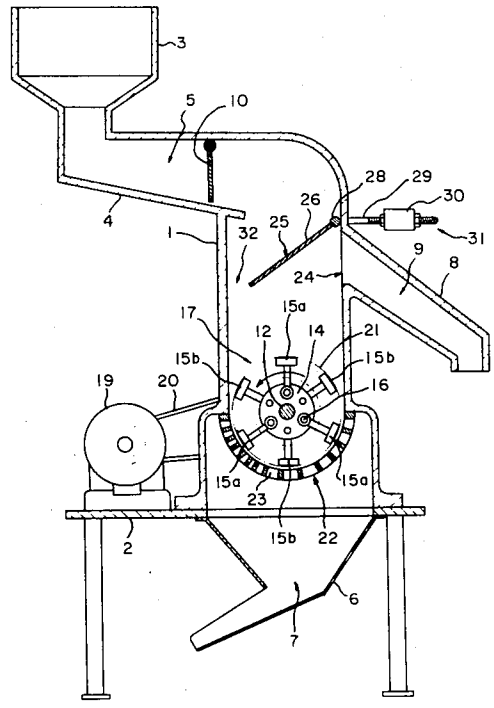

Fig. 1

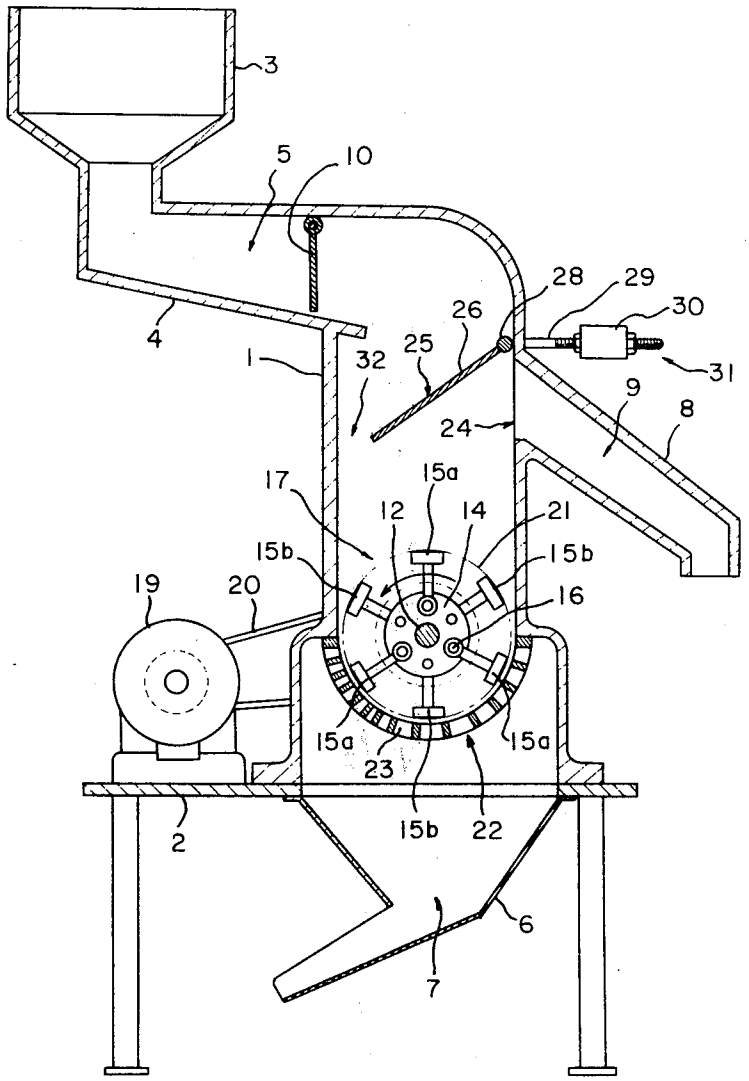
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Fig. 2

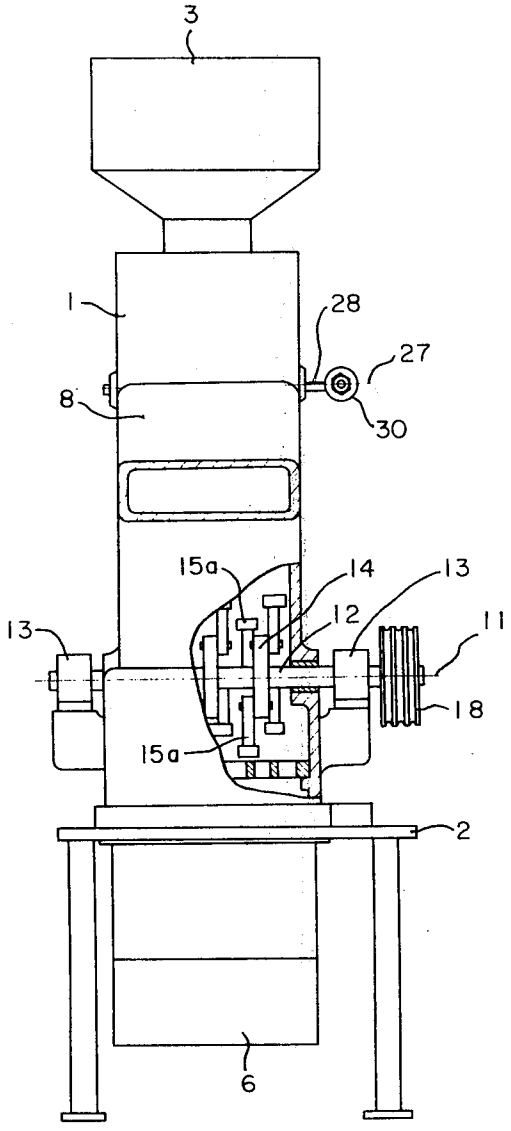


Fig. 3

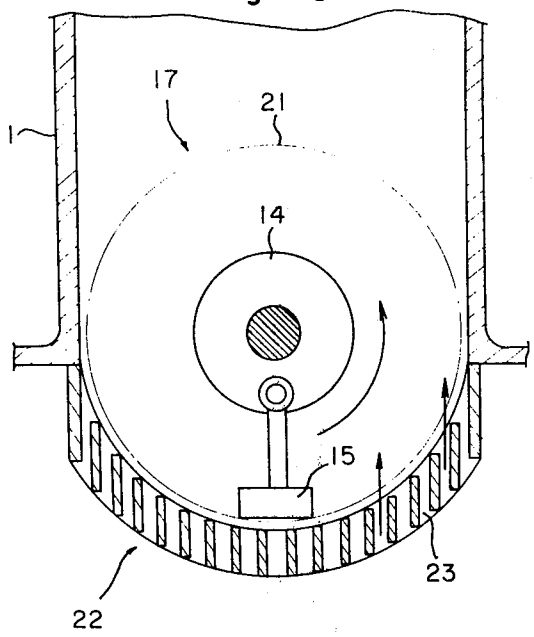
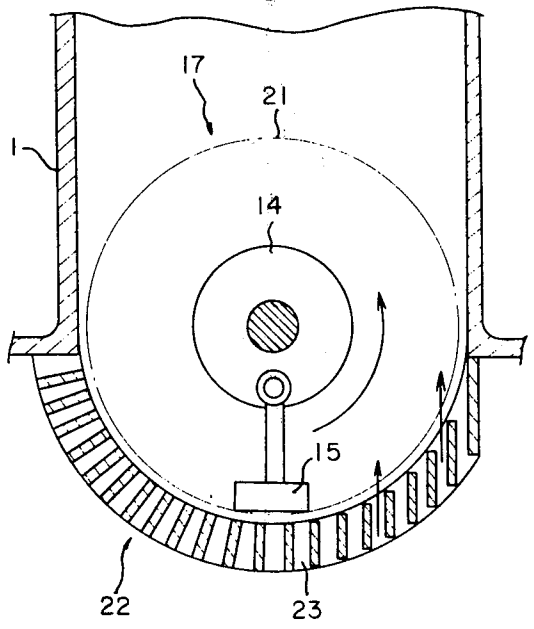


Fig. 4



CRUSHING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for crushing and floatingly selecting a mixture of first materials which are crushable by impact force and second materials which are more difficult to be crushed as compared with the first materials but are easier to be floated by the ascending gas currents. As an example of the mixture described above, rubber tire is mentioned. In order to reclaim rubber base materials only from old rubber tires, cut pieces of tires are refrigerated and frozen with liquefied nitrogen, etc., thereby enhancing brittleness of the rubber. Thereafter, impact is given to the tires to crush the rubbers, and fibers which are more difficult to be crushed by impact as compared with the rubber even if refrigerated and which are buried in the rubber for reinforcement purposes are separated from the rubber base materials. However, if the mixture of the first and second materials as described above are disposed of by means of a conventional rotary impulse type crusher, whose hammer is rotated a gridiron or a screen, meshes of the gridiron or screen are often clogged with the second materials, thus decreasing disposal efficiency and sometimes rendering an impossibility of continuous operation of the crushers.

To explain more concretely, in order to improve the separation of the first material from the second material where the second materials are buried in the first materials of the refrigerated tires, it is required to crush the first material as finely as possible. Accordingly, meshes of the gridiron or screen should be finer. However, if the meshes of the gridiron or screen are fine, the meshes are often clogged with the second materials which are more difficult to be crushed or the second materials are accumulated and are wound around the rotary mechanism of the hammer. Further, if the meshes of the gridiron or screen are coarser, the clogging of the meshes is avoidable to some extent, but separation efficiency of mixture of the first materials and the second materials is lowered as the size of grain of the first materials crushed is greater.

SUMMARY OF THE INVENTION

The present invention relates to an impact crushing apparatus for mixtures of the first materials which are crushable by impact force and the second materials which are more difficult to be crushed by the impact force as compared with the first materials and are likely to be floated by ascending gas currents, comprising, a housing having a first route for feeding the mixtures into the interior of the housing, a second route for exhausting the first materials crushed from the interior of the housing and a third route for exhausting the second materials from the interior of the housing, the third route being open towards the interior of the housing in a position above the second route, crushing means rotatable on substantially horizontal first axis located between the second route and the third route, driving means for rotating the crushing means, selection means provided along the rotation path of the tip end of the crushing means in a state of interrupting the second route, the selection means having a plurality of openings of a predetermined diameter for passing the first materials crushed, gases inhaled into the housing through the second route by rotation of the crushing means being ascended in the housing and thereafter being exhausted from the housing through the third route, a level difference sufficient to floating by select the first materials from the second materials by the ascending gas currents being disposed between the third route and the crushing means.

To explain further, the mixtures which are fed manually or mechanically in continuous or intermittent manner from the first route into the housing are crushed by means of the impact force by operation of the crushing means. The first materials crushed in complete fineness are exhausted from the housing through the openings of the selection means and the second route and the first materials which are not crushed finely and the second materials are floated by operation of rotation of the crushing means and function of the ascending gas currents in the housing. The floated first and second materials are selected floatingly by the ascending gas currents. As a result, the first materials and the second materials to which the first materials cling and fall again to receive the crushing operation again by means of the crushing means, and the second materials completely separated from the first materials are carried by the ascending gas currents and are exhausted from the housing through the third route.

Since the impact crushing of the first materials, the separation of the first materials from the second materials, and furthermore operation of exhausting the first and the second materials from the interior of the housing are performed as described hereinbefore, the second materials in excess of permissible quantity do not remain in the housing. Accordingly, the closing of the meshes of the selection means with the second materials and an increase in rotation load of the crushing means is controlled. Therefore, the meshes of the selection means may be made finer so that separation of the first materials and the second materials is improved and a long and continuous operation of the apparatus is performed.

A primary object of the present invention is to provide an apparatus which is capable of positively and continuously crushing the first materials and separating the first materials from the second materials.

Another object of the present invention is to provide an apparatus which is capable of crushing the mixtures through a long and continuous operation of the apparatus.

A further object of the present invention is to provide an apparatus which is capable of selecting floatingly the first and the second materials more positively by the ascending gas currents.

The other objects and advantages of the present invention will become apparent from description to be made hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of the crushing apparatus.

FIG. 2 is a partially cutaway elevational view partly in section taken along a line II—II of FIG. 1.

FIG. 3 is a fragmentary vertical sectional view showing the essential portions of another embodiment of the crushing apparatus.

FIG. 4 is a fragmentary vertical sectional view of the essential portions showing a further embodiment of the crushing apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The main housing 1 comprises at the upper portion thereof an entry throat 5 to which various types of materials may be fed through the intake hopper 3. The bottom portion of the housing 1 includes an enlarged area within which exchangeable grids 22 may be positioned and adjacent thereto is provided the rotary hammer mill which will be described in greater detail later herein. Beneath the enlarged area of said housing 1 is provided a discharge chute 7 which also has the dual function of admitting air to the housing 1 which is later discharged to atmosphere through conduit 8.

Various materials some of which are more conducive to being reduced by pulverization to a screenable size that may be discharged through the bottom screen 22 as well as others that are more difficult to pulverize, and thus have a tendency to float in the housing 1 may be introduced manually or automatically by a conveyor means into the hopper 3 to the throat 5 and thence to the mill.

A damper 10 provided inside of the conduit 4 can be freely shut or opened and it can be employed for controlling the mixture amount to be fed or for preventing blow-off of the gas through the throat 5 from the interior of the housing 1.

Materials that are capable of being crushed by the impact force are by way of example refrigerated rubber, synthetic resin and iron or concrete block under normal temperature, etc. Other materials that are more difficult to be crushed by means of the impact force and are caused to float by the ascending gas currents, are for example, fibrous materials, copper or iron under normal temperature, etc.

The mixtures of any combination of these materials such as, for example, old tires or conveyor belts which are cut to sizes suitable for the crushing operation and thereafter are frozen by liquefied nitrogen, etc. naturally have fibrous materials buried in them. In addition, frozen electric appliances such as motors wherein copper and iron are compositively used, as well as frozen synthetic resin films integrated with cloth, and other frozen carrier means wherein rubber cloth, etc. are compositively used, may be discharged into the hopper.

A rotary shaft 12, which is provided between the second route or discharge chute 7 and the third route or air discharge outlet 9 within the housing 1 and is rotated around the substantially horizontal first axis 11, is pivotally supported by means of bearings 13-13 which are mounted in opposite sides of the housing 1.

Within the housing 1, the rotary shaft 12 is provided with a plurality of disk members 14 substantially equidistantly in a direction of the first axis 11. Each one of the disk members 14 is provided with three hammer members 15a substantially equi-distantly peripherally on one surface thereof and three hammer members 15b on the other surface thereof at different phase from the above surface so that all hammer members 15 may be equi-distant in view of a direction of the first axis 11. Each one of the hammer members 15 is rotatable with respect to pin 16 which has an axis substantially parallel to the first axis 11. The hammer member 15 required is at least one which may be fixed to the disk member 14 or may be fixed to the rotary shaft 12. In short, the means that rotates on the first axis 11 to perform operation of impact crushing of the mixtures is denoted as a crushing means 17. A pulley 18 provided at one end of the rotary shaft 12 is driven by a belt 20 with a pulley (not shown) provided on an electric motor or other driving means 19 such as an internal combustion engine to enable rotational driving of the crushing means 17 by a driving means 19.

The exchangeable selection means 22 such as a grid-iron, screen, etc. is provided along the rotary track 21 of the tip end of the crushing means 17 for the purpose of controlling discharge through outlet 7. The screen means 22, is readily detachable from the housing 1. Further, the screen means 22 is provided with a plurality of openings 23 of a predetermined diameter employed for passing therethrough the materials crushed by the crushing means 17, the longitudinal axis of the opening 23 being in a direction of the radius of the rotary track 21 of the crushing means 17. The materials crushed to the fineness desired by the crushing means 17 flows downwardly and out the discharge outlet 7 by gravity. Atmospheric air drawn into the housing 1 through the inlet 7 and the openings 23 by reason of the flailing action of the hammers rotating in an upward direction, (see Arrow in FIGS. 3 and 4) and thereafter is exhausted from the housing 1 through the conduit 9. In order to control the flow of air as described above, an inlet opening 24 in the sidewall of the housing is provided adjacent to air outlet conduit 8 with a counterbalanced baffle 25 pivotally mounted on the housing wall causing the disturbed air created by the flailing hammers to traverse to conduit 8.

The air discharge route 9 and the crushing means 17 are positioned on different levels, to allow a discharge of the materials through the screen 22 while the other materials are carried by the ascending air currents in the housing 1 causes a dispersion in the housing. Accordingly, the mixture of the several materials crushed by the crushing means 17 are blown up in the housing 1 by the rotating force of the crushing means 17 and as a consequence the resultant mixture blow up and emitted through the conduit 8 thus the heavier materials are completely separated from the lighter weight materials and are carried out from the housing 1 through the conduit 9 by the air flow accordingly clogging of the meshes of the screen means 22 or an increase in rotation load of the crushing means 17 caused by overaccumulation of the heavier materials which are difficult to be crushed in the housing 1 are controlled.

Further, the heavier materials are caused to be continually thrown about and fall again to receive impact crushing operation of the hammer means 17.

According to what is described hereinbefore, generation of the ascending air currents within the housing 1 is effected only by rotation of the crushing means 17. However, the generation of the ascending air currents may be further by utilizing a blower disposed in the outlet conduit 9 as an example or means for feeding the air disposed at lower portion of the housing 1.

Still further, it would be advantageous to adjust the difference of level between the crushing means 17 and the opening 24 of the outlet conduit 9 for floating selection depending on the mixture to be crushed by, for example, having the housing 1 varied in a vertical dimension.

And still further, the velocity of the ascending air currents may be adjusted to suit the separation of the several materials by floating selection by means of a damper positioned in the outlet conduit 9.

The guiding or baffle means 25 comprises a plate member 26 which, extends across substantially the width of the housing 1 in a direction of the first axis 11 as well as from near the top end of the opening 24 of the conduit 9 to a position overlying the rotary track 21 of the crushing means 17. The lowermost surface of the plate member 26 is inclined so that it may be positioned in graduation of the side of the opening 24 of the conduit 9 being elevated in view of a direction of the first axis 11. The plate member 26 is located near the top end of the opening 24 of the conduit 9 and is mounted on the shaft 28 which is rotatable on the housing 1 around the second axis 27 substantially parallel to the first axis 11. The rotary shaft 28 is arranged to project through and outside of housing 1 and a rod member 29 is mounted on the extended portion of the rotary shaft 28 which extends in a direction opposite to the plate member 26 in view of a direction of the second axis 27. A weight member 30 is threadedly engaged on the rod member 29 so as to allow the position thereof to be changed in a direction of axis of the rod member 29. Accordingly, the lowermost surface of the plate member 26 is maintained in an inclined posture as described above with respect to the guiding means 25. A spring or a plurality of springs may be used to enable the plate member 26, to move with oscillation in a given posture as a substitute of a posture controlling means 31 which comprises the rod member 29 and the weight member 30.

The mixture fed into the housing 1 through the throat 5 pushes down the plate member 26 by gravity and falls through the opening 32 formed between the plate member 26 and the inner wall surface of the housing 1.

When the guiding means 25 is provided to enable oscillation as described hereinbefore, it is not only possible to prevent the several materials which are not completely separated from one another, after being blown up vigorously by the crushing means 17, from being discharged into the conduit 9 caused by rebouncing from the guiding means 25, but also it is possible to shake off the materials which are likely to cling to the uppermost and lowermost surfaces of the guiding means 25, by oscillation of the guiding means 25 caused by collision of the guiding means 25 and the materials. It is advantageous to provide for oscillating the of the guiding means 25, however, it is conceivable that under certain conditions it may be provided in a fixed state without being oscillatable.

Further, it is possible to adjust a staying period of the several materials in the housing by varying the inclined angle of the lowermost surface of the guiding means 25. Thus, the operating conditions suitable to obtain better efficiency of the crushing and separating depending on the extent of difficulty for impact crushing of one material or separation of the one material from a second material can be satisfied. For example, in a case that difficulty exists in crushing some portions of the first material or in separating the first material from the second material, the lowermost surface of the guiding means 25 is given a more downward angular slope. Thus, the materials which are difficult to be crushed or to be separated are discharged into the conduit 9 by rebouncing from the guiding means 25 and thus exhausted from the housing 1.

The diameter of the material which is exhausted from the housing 1 through the outlet 7 is determined depending on the nature of the particular material, requirements for re-use of said material, etc. and further the diameter is determinable by adjusting the diameter of the opening 23 of the selection means 22, rotation speed of the crushing means 17, and the spacing between the rotation track 21 of the tip end of the crushing means 17.

FIG. 3 shows a modified type of selection means 22 wherein all of the openings 23 have a longitudinal axis in a substantially vertical direction and are symmetrical in shape in view of a direction of the first axis 11. The openings 23 in the central portion have a greater diameter than the openings 23 in the right and left side portions.

FIG. 4 shows a further modified type of the selection means 22 wherein the openings 23 facing a region where the crushing means 17 is rotated upwardly have a longitudinal axis in a substantially vertical direction, while the openings 23 facing a region where the crushing means 17 is rotated downwardly have a longitudinal axis in a substantially radius direction of the track of the crushing means 17.

As shown in FIGS. 3 and 4, the entrance of air into the housing 1 through the openings 23 which is caused by rotation of the crushing means 17 can be enhanced by setting the axis of the openings in an upward direction so that the axis of the openings 23 face a region where the crushing means 17 is beginning to rotate upwardly, thus preventing the clogging of the meshes of the selection means 22.

Further, as shown in FIG. 3, the selection means 22 has a symmetrical and is quite durable since it can be continuously used by merely rotating the screen about a vertical axis 180° to assure equal wear thereof.

What we claim is:

1. A crushing apparatus for an admixture of materials which are crushable by impact force comprising, in combination: a housing having a hopper which communicates with a throat means for feeding the mixture into the interior of said housing; an outlet for exhausting the crushed materials from the interior of said housing; a conduit for exhausting secondary materials from the interior of said housing, said conduit being located to communicate with the interior of said housing beneath and in opposition to said throat means; crushing means having a terminal extent rotatable on a substantially horizontal first axis located within said housing between said outlet and said conduit; driving means for rotating said crushing means; selection means positioned adjacent to the path of rotation of said terminal extent of said crushing means, said selection means having a plurality of openings of a predetermined diameter to permit entry of the material crushed into said outlet; and guiding means supported on said housing above said conduit to direct floatable material toward said conduit while simultaneously serving to deflect heavy material back toward said crushing means.

2. An apparatus according to claim 1, further comprising, a damper provided for closing and opening the throat.

3. An apparatus according to claim 1, in which the guiding means has a free terminal end portion which extends beyond the first axis of the crushing means.

4. An apparatus according to claim 3, in which the guiding means is arranged to oscillate.

5. An apparatus according to claim 4, in which the oscillatable guiding means is counterbalanced by means mounted exteriorly of the housing.

6. An apparatus according to claim 1, in which the means defining openings in said selection means all lie in parallel planes.

7. An apparatus according to claim 6, in which the selection means can be rotated substantially 180° to equally distribute the wear thereof.

8. An apparatus according to claim 1, in which some of the means defining openings in the selection means are arranged to extend radially relative to the first axis of the crushing means.

9. An apparatus according to claim 1, in which the first axis of the crushing means is arranged to support spacedly arranged disk members having side means and said disk members are associated with hammer means disposed on opposite sides of said side means.

10. An apparatus according to claim 9, in which the hammer means are spaced equi-distantly about said disk member.

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