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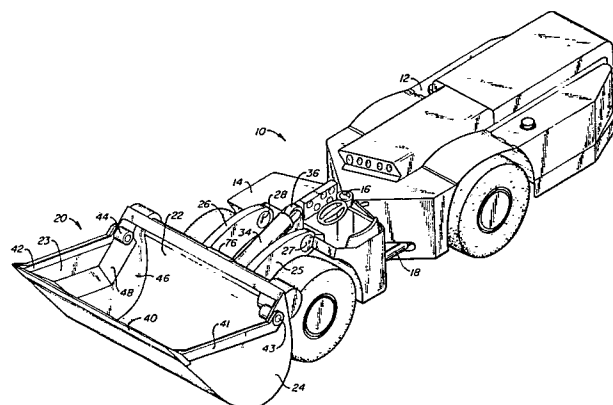
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⑤④ **Compact resonance drive for earth-working equipment.**

⑤⑦ A mechanism for resonantly driving a moveable cutter blade located at the base of a concave tool is disclosed. An angulate beam has first and second legs meeting at a juncture at an included angle of less than 180°. The beam includes a mounting flange which extends inwardly from the juncture between the legs. The beam has a resonant frequency, when restrained at the mounting flange, with a node at the juncture and first and second anti-nodes at the ends. One end of the beam receives a vibratory input or near the resonant frequency so that the second end vibrates about a neutral position. The mounting flange is attached to the tool so that the angulate beam conforms to the concave shape of the tool. The neutral position of the second end of the beam is spaced from the back of the cutter blade within striking distance of the blade. The input vibration at the first end of the beam causes the second end to vibrate about its neutral position and impart forward impulses to the cutter blade to drive the blade intermittently forward.



COMPACT RESONANCE DRIVE FOR
EARTH-WORKING EQUIPMENT

This application is a continuation-in-part application of a co-pending application entitled RESONANT BEAM FOR TOOL DRIVING APPARATUS, Serial No. 025,085, filed March 30, 1979, in which Raymond A. Gurries is named as sole inventor.

Background of the Invention

This application relates to resonance driving equipment, and in particular to the application of resonance technology to loader buckets and similar earth-working equipment.

Many attempts have been made to apply resonant technology, i.e., the use of a member vibrating at or near resonance, to earth-working equipment. Typically, such resonant devices use a straight beam which vibrates about two nodes, one end of the beam having a vibratory input and the other end of the beam providing a vibratory output. An example of such a device is found in a patent to Shatto, U.S. Patent No. 3,633,683. In certain situations, the ends of the vibrating beams are bent to apply forces at a desired angle, as illustrated in a second Shatto patent, U.S. Patent No. 3,563,316. However, most attempts to date to apply

resonant technology to earth-working equipment have generally met with failure, perhaps the principal reason being that the equipment necessary to generate the desired output force was too cumbersome to serve
5 as a practical adjunct to existing equipment.

Summary of the Invention

The present invention provides a mechanism for resonantly driving a moveable cutter blade located at the base of a concave tool. An angulate
10 beam has first and second legs meeting at a juncture at an included angle of less than 180° . The beam includes a mounting flange which extends inwardly from the juncture between the legs. The beam has a resonant frequency, when restrained at the mounting
15 flange, with a node at the juncture and first and second anti-nodes at the ends.

One end of the beam receives a vibratory input at or near the resonant frequency so that the second end vibrates about a neutral position. The
20 mounting flange is attached to the tool so that the angulate beam conforms to the concave shape of the tool. The neutral position of the second end of the beam is spaced from the back of the cutter blade within striking distance of the blade. The input
25 vibration at the first end of the beam causes the second end to vibrate about its neutral position and impart forward impulses to the cutter blade to drive the blade intermittently forward.

In the present invention, the beam is capable of being mounted to the tool on which the beam operates because of the mounting flange which extends inwardly between the legs of the beam.

5 Accordingly, the angulate beam can be attached directly to the tool, and an outside source of support is not required. Moreover, the beam adapts to the concave shape of the tool, forming a compact unit. As a result, the resonance device of the

10 present invention provides a reasonable alternative to simple actuators now in common use in such devices.

The novel features are characteristic of the invention, as to organization and method of operation, together with further objects and advantages

15 thereof will be better understood from the following description considered in connection with the accompanying drawings in which a preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the

20 drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

Brief Description of the Drawings

Fig. 1 is a perspective view of a mining

25 transporter incorporating the resonant system of the present invention;

Fig. 2 is a side elevation view of the mining transporter of Fig. 1 with portions cut away;

Fig. 3 is an enlarged, side elevation view of the loading bucket of the mining transporter of Figs. 1 and 2 with portions cut away.

Description of the Preferred Embodiment

5 A mining transporter 10 incorporating the features of the present invention is illustrated by way of reference to Figs. 1-3. However, it is to be understood that the apparatus of the present invention could equally as well be incorporated in other types
10 of earth-moving equipment employing an earth-working tool such as a loading bucket or mold board.

 Mining transporter 10 includes a rear power section 12 and a forward control section 14 connected by articulating joints 16. Hydraulic
15 actuators such as 18 connect sections 12 and 14 of the vehicle for steering.

 A loading bucket 20 is located at the front of transporter 10. Loading bucket has a generally concave portion 22 and side walls 23, 24;
20 forming a forwardly and upwardly opening enclosure. A pair of lift arms 25, 26 are pivotably attached to the forward section 14 of transporter 10 by pins 27, 28. The forward ends of lift arms 25, 26, attach to bucket 20 with a pin connection such as 30. Hydraulic
25 cylinders such as 32 run from the forward section 14 of transporter 10 to the midpoint of each lift arm 25, 26 to control vertical movement of loader bucket 20.

- 5 -

A dump cylinder 34 extends from a post 36 on the forward section 14 of transporter 10 to a pin connection 38 on loader bucket 20. Dump cylinder 24 extends or retracts to rotate loader bucket 20 about the pin connections such as 30 on lift arms 25, 26 to move the loader bucket from a forwardly opening loading and unloading position to an upwardly opening carrying position.

A cutter blade 40 is located at the lower front edge of loader bucket 20, and spans the entire width of the loading bucket. Cutter blade 40 is suspended by a pair of hanger arms 41, 42 having pin connections 43, 44 respectively at the upper portion of the bucket. Accordingly, cutter blade 40 is free to reciprocate forwardly and backwardly with respect to the lower front edge of loading bucket 20.

A pair of compartments 45, 46 are located at the opposite ends of loading bucket 20. Each compartment 45, 46 has a respective forward member 47, 48 having a generally concave configuration.

An angulate resonant beam such as 50 is located in each compartment 45, 46. Beams 50 are mirror images of one another and act in unison. Each angulate beam 50 includes a pair of legs 51, 52 meeting at a central juncture 54. Leg 51 has an integral housing 56 at one end, and an eccentric weight oscillator 58 is located within the housing. Leg 52 has an enlarged portion 60 at its free end forming a hammer, described in more detail hereinafter.

Legs 51, 52 of angulate beam 50 meet at an included angle of preferably about 90°, and in any event substantially less than 180°. A flange 62 extends inwardly between legs 51, 52 and bisects the included angle between them. A pair of ears 63, 64 extend laterally from flange 62. Bolts 65, 66 fasten ears 63, 64 of each beam 50 to the forward surfaces 47, 48 of the respective compartments 45, 46.

Each compartment such as 45 includes a cavity such as 70 projecting forwardly to the forward edge of loading bucket 20. Cutter blade 40 includes a pair of extensions such as 72 extending rearwardly through cavity 70 to a position proximate the front surface of hammer 60 at the end of leg 52.

A motor is located within a housing 76 at the upper back surface of loading bucket 20. The motor has output shafts such as 74 extending transversely in each direction, and the eccentric weight oscillators such as 58 are mounted on the output shafts of the motor. Eccentric weight oscillator 58 is rotated at a frequency at or near the resonant frequency of beam 50, exciting the beam to at least near resonance.

At its neutral or rest position, hammer 60 is spaced slightly behind the extension 72 projecting rearwardly from cutter blade 40. When input vibrations are applied to beam 50 by oscillator 58, hammer 60 at the end of leg 52 vibrates about its neutral position, and strikes the rear of extension 72 during its forward stroke. As a result, forward impulses are applied to cutter blade 40 to drive the cutter blade forward.

In the use of mining transporter 10, a situation often occurs in which the vehicle is unable to provide sufficient forward tractive force to drive loading bucket 20 into the material to be loaded. When this situation occurs, eccentric mass oscillators 58 are actuated, resulting in forward impulses being applied by resonant beams 50 to cutter blade 40. These forward impulses drive the cutter blade into the material and dislodge earth which cannot be penetrated by the transporter acting alone. As a result, the necessity for loosening the earth prior to loading is substantially reduced, rendering the loading operation far more efficient than conventional loading techniques. The compact nature of the resonant system allows its incorporation in the device without the necessity for large, complex supports rendering prior resonant systems impractical.

While a preferred embodiment of the present invention has been illustrated in detail, it is apparent that modifications and adaptations of that embodiment will occur to those skilled in the art. However, it is to be expressly understood that such modifications and adaptations are within the spirit and scope of the present invention, as set forth in the following claims.

WHAT IS CLAIMED IS:

1. Apparatus for resonantly driving
a moveable cutter blade located at the base of
a concave tool comprising:

an angulate beam having first and second
5 legs meeting at a juncture at an included angle of
less than 180° and a mounting flange extending from
the juncture inwardly between the legs, said beam
having a resonant frequency, when restrained at
the mounting flange, with a node at the juncture and
10 first and second anti-nodes at the respective ends;

means for vibrating the free end of
the first leg of the beam at or near the resonant
frequency so that the free end of the second leg
vibrates about a neutral position; and

15 means for attaching the mounting flange to
the tool so that the angulate beam conforms to the
concave shape of the tool with the neutral position
of the free end of the second leg spaced from the
back of the cutter blade within striking distance
20 thereof so that vibration of said second leg imparts
forward impulses to the cutter blade to drive the
blade intermittently forward.

2. The apparatus of claim 1 wherein the free end of the first leg of the angulate beam is located immediately behind the top of the tool so that the shape of the angulate beam corresponds generally to the shape of the back surface of the tool.

3. The apparatus of claim 1 wherein the legs meet at an angle of approximately 90°.

4. The apparatus of claim 1 wherein the vibrating means comprises an eccentric mass oscillator formed as an integral part of the free end of the first leg of the beam.

5. The apparatus of claim 1 wherein the free end of the second leg of the beam includes an enlarged portion providing a weighted hammer for striking the back surface of the cutter blade.

6. Apparatus for resonantly driving a moveable cutter blade located at the base of a concave tool, said apparatus comprising:

5 an angulate beam having first and second ends meeting at a juncture at an included angle of approximately 90° and a mounting flange extending from the juncture inwardly between the legs, said beam having a resonant frequency, when restrained at the mounting flange, with a node at the juncture and
10 first and second anti-nodes at the respective ends, said beam including an integral housing at the free end of one leg of the beam and an enlarged portion providing a weighted hammer at the free end of the second leg of the beam;

15 an eccentric oscillator located within the housing to apply vibrational forces to the beam at or near the resonant frequency so that the second end vibrates about a neutral position; and

means for attaching the mounting flange to
20 the tool so that the angulate beam conforms to the concave shape of the tool with a first end proximate the top edge of the tool and the neutral position of the second end spaced from the back of the cutter blade within striking distance thereof so that
25 vibration of said second end imparts forward impulses to the cutter blade to drive the blade intermittently forward.

- 11 -

7. The apparatus of claim 1 or 6 and comprising a pair of said angulate beams spaced laterally from one another and attached to opposite ends of the tool to strike the cutter blade at its opposite ends, said beams being mirror images of one another and operating in unison to impart forward impulses to the cutter blade at its opposite ends.

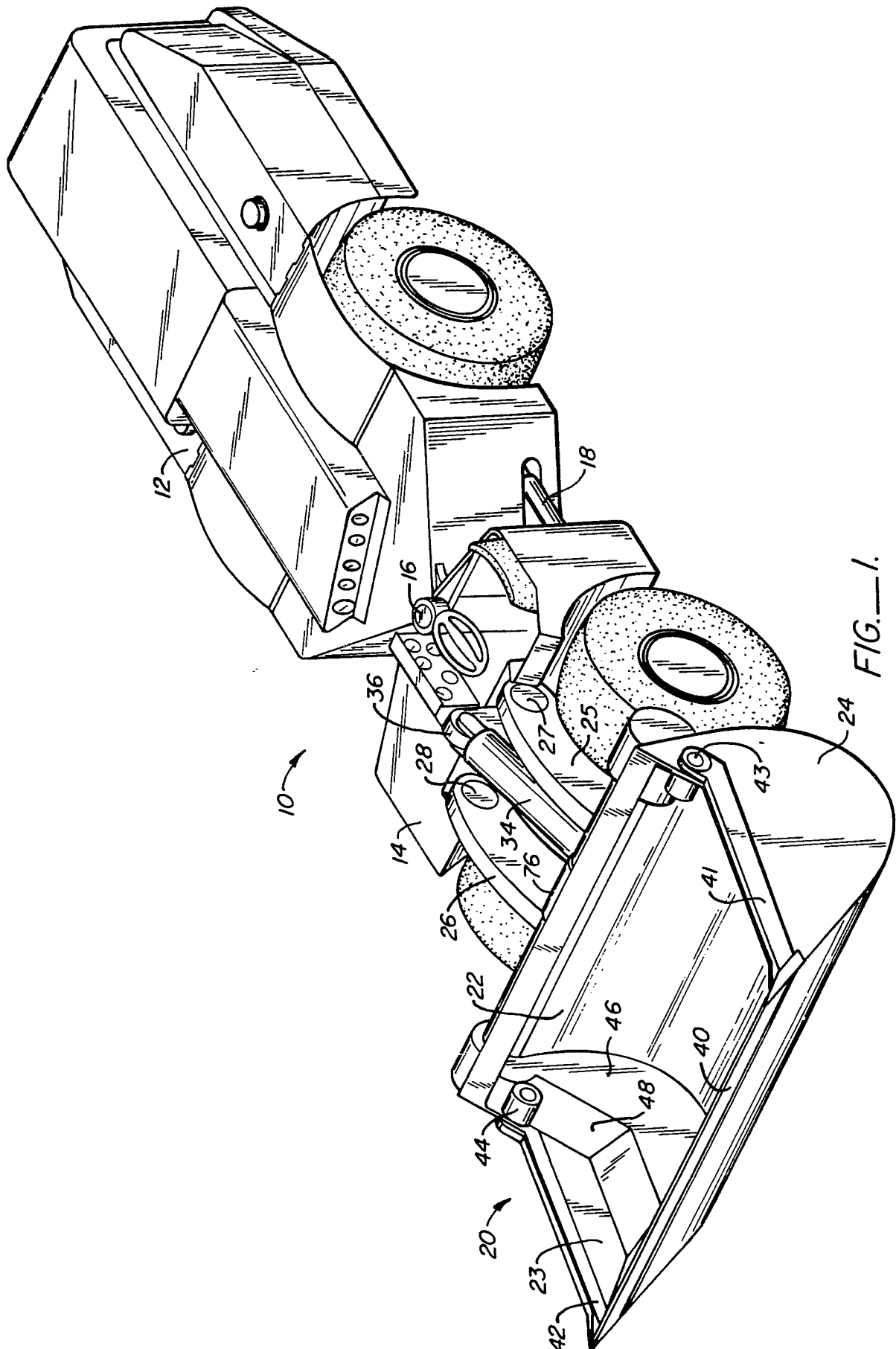
8. The apparatus of claim 1 or 6 wherein the tool comprises a loading bucket for an earth-moving device.

9. The apparatus of claim 8 wherein the earth-moving device is a mining transporter.

10. The apparatus of claim 1 or 6 wherein the tool includes a compartment formed in the front surface of the tool and extending frontwardly with respect to the working surface of the tool, said compartment having a generally concave forward surface, and wherein the mounting flange is attached to the back of the forward surface of the compartment.

11. The apparatus of claim 10 wherein
the tool has a pair of said compartments on opposite
ends thereof, and wherein the beam comprises a
matched pair of beams located in the respective
5 compartments.

12. The apparatus of claim 1 or 6 wherein
the cutter blade has a rearward extension extending
to a position within striking distance of the
cutter blade.



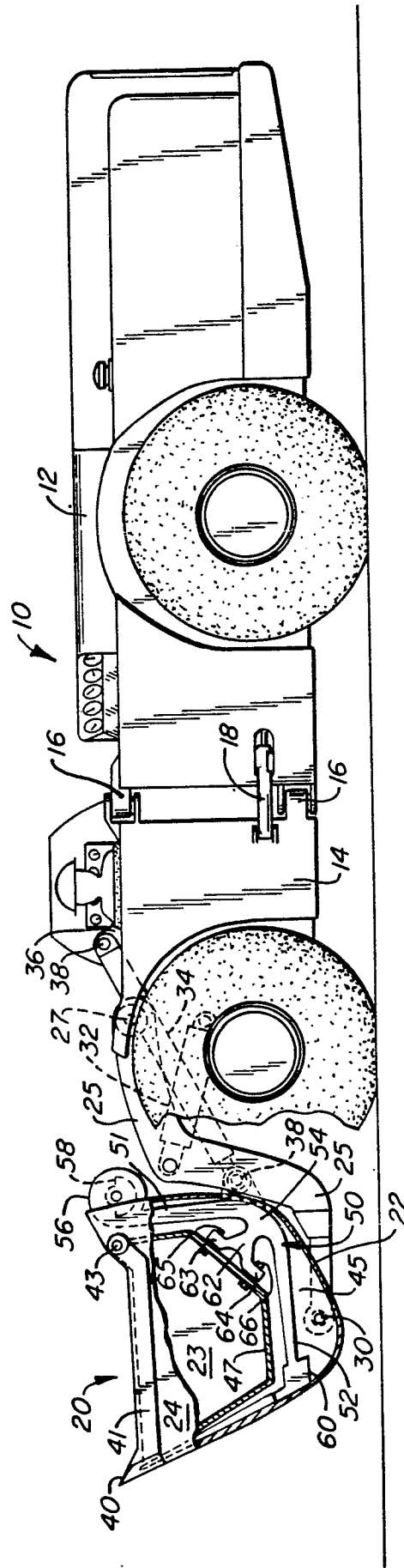


FIG.—2.

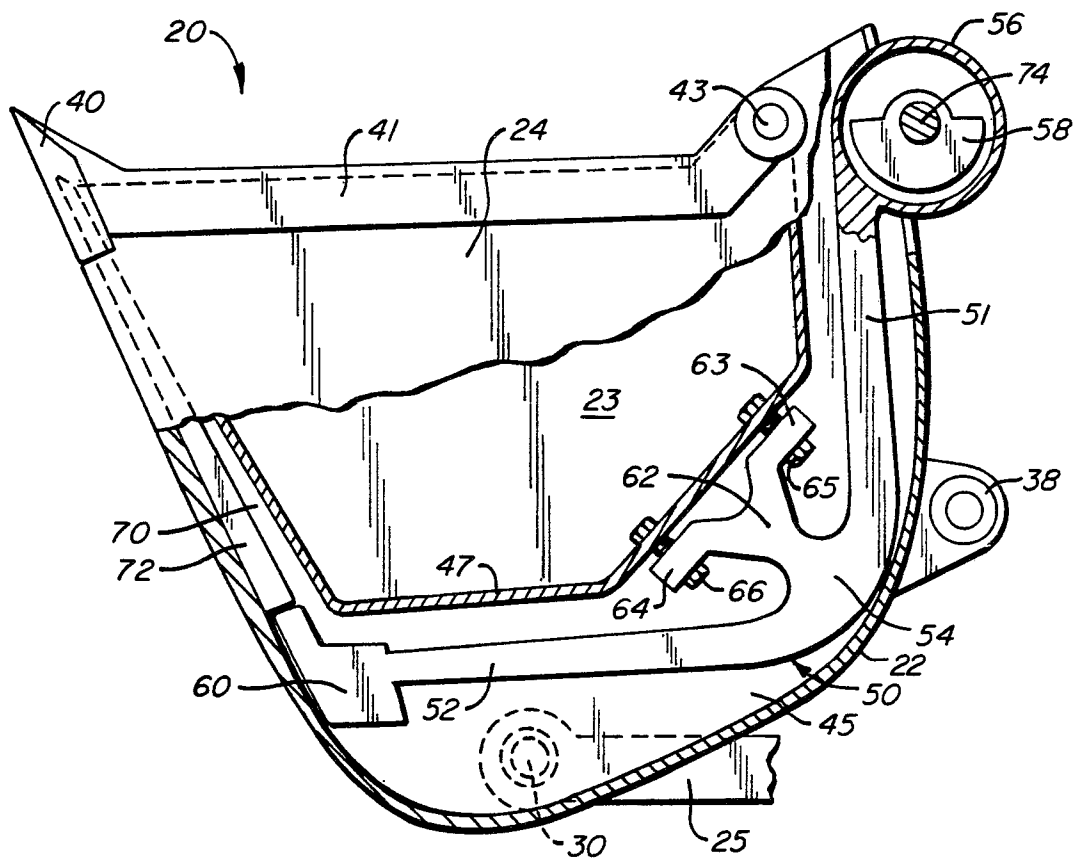


FIG. 3.