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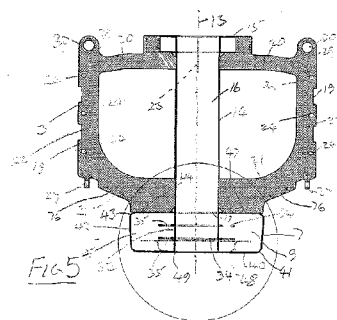
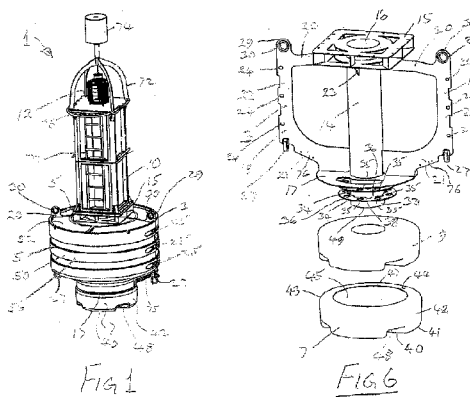
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(54) Title: A BUOY, AND A METHOD FOR PRODUCING A BUOY



(57) Abstract: A marker buoy (1) comprising a support framework (3) compris-
ing a central tubular member (14) and a pair of side plates (19) defining upper
and lower cross-members (20) and (21) joined by side members (22). An upper
platform (15) is secured to the central tubular member (14) and to the side plates
(19) and a lower platform (17) is secured to the central tubular member (14) and
to the side plates (19). A pair of hollow flotation elements (5) located between
the upper and lower platforms (15,17) are secured to the support framework (3)
with the support framework (3) sandwiched between the flotation elements (5). A
ballast housing (7) comprising a ballast element (9) of reinforced concrete, which
is cast in the ballast housing (7) is keyed and secured to the support framework (3)
by keying plates (34) carried on a tubular carrier member (32) extending down-
wardly from the central tubular member (14) of the support framework (3) and
centrally into a hollow interior region (45) of the ballast housing (7) through an
open mouth (47) thereof prior to casting of the concrete in the ballast housing (7).
An upper structure extends upwardly from the upper platform (15) with a lantern
(12) mounted on top thereof.

"A buoy, and a method for producing a buoy"

The present invention relates to a buoy, and in particular though not limited to a marker buoy of the type suitable for marking a shipping lane in the sea or in an estuary through which a river flows into the sea, or
5 a buoy of the type commonly referred to as a weather buoy, which is located in the sea for monitoring both sea and atmospheric conditions at the location of the buoy.

Such buoys, typically comprise a flotation part for maintaining the buoy floating, and a ballast part, generally located beneath the flotation part for maintaining the buoy in an upright state. Typically, such
10 buoys are anchored to the sea or river bed. In general, such buoys are of relatively large size, and typically, from the ballast end to the upper end of the buoy, such buoys may range in height from 3 metres to 9 metres, and at their widest part may be of diameter in the range of 1 metre to 4 metres. Typically, the height of such buoys above the waterline thereof can range from 2.5 metres to 8 metres.

15 According to the invention there is provided a buoy comprising a main support structure, at least one flotation element secured to the main support structure, and a ballast element secured to the main support structure below the at least one flotation element, wherein the ballast element is housed within a ballast housing, and is formed in the ballast housing by casting therein.

20 In one embodiment of the invention the ballast housing defines a hollow interior region and an upwardly facing open mouth communicating with the hollow interior region.

Preferably, the open mouth of the ballast housing is adapted to accommodate the ballast material into the hollow interior region of the ballast housing during casting of the ballast material in the ballast housing.

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Preferably, the open mouth of the ballast housing is adapted to accommodate a securing means therethrough into the hollow interior region for securing the ballast element to the main support structure.

In one embodiment of the invention the securing means for securing the ballast element to the main
30 support structure extends from the main support structure.

In another embodiment of the invention the securing means comprises a keying means extending into the hollow interior region of the ballast housing for keying the ballast element to the securing means.

Preferably, the keying means is carried on the securing means.

5 In another embodiment of the invention the keying means extends outwardly from the securing means, and preferably, extends outwardly from the securing means at an angle in the range of 20° to 90°, and preferably, the keying means extends outwardly from the securing means at an angle in the range of 30° to 90°, and advantageously, at an angle in the range of 60° to 90°.

10 Preferably, the keying means extends outwardly from the securing means at an angle of approximately 90° to the securing means.

In one embodiment of the invention the keying means extends around the securing means, and preferably, extends completely around the securing means.

15 In another embodiment of the invention a pair of keying means is provided on the securing means, and preferably, the keying means of the pair thereof are spaced apart longitudinally along the securing means one above the other.

20 In one embodiment of the invention each keying means comprises a perforated material, and in another embodiment of the invention each keying means comprises a plate member. Preferably, each keying means comprises a metal material.

In another embodiment of the invention the securing means comprises a metal material.

25 In one embodiment of the invention the securing means comprises a carrier member.

In one embodiment of the invention each keying means is secured to the carrier member, preferably, by welding.

30 In another embodiment of the invention the carrier member extends centrally from the main support structure, and preferably, the carrier member extends centrally into the hollow interior region of the ballast housing.

In one embodiment of the invention the carrier member extends through the hollow interior region of the ballast housing.

5 In one embodiment of the invention the carrier member comprises a tubular member having a bore extending therethrough, and preferably, the carrier member extends through the hollow interior region of the ballast housing with the bore of the carrier member extending substantially vertically, and in some embodiments of the invention an opening is formed in the ballast housing communicating the bore extending through the carrier member adjacent a lower end thereof with the exterior of the ballast housing.

10 In one embodiment of the invention the tubular carrier member terminates at its lower end in a downwardly facing open mouth for accommodating water, in which the buoy is floating, therethrough into the bore of the tubular carrier member.

15 In another embodiment of the invention an upper structure is supported on the main support structure, and extends upwardly therefrom.

In another embodiment of the invention the main support structure supports an upper platform, and preferably, the upper platform is adapted to support the upper structure.

20 Preferably, the upper structure extends upwardly from the upper platform.

In another embodiment of the invention the main support structure supports a lower platform, and preferably, the lower platform is spaced apart downwardly from the upper platform, and advantageously, the lower platform is adapted to support the flotation element.

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In another embodiment of the invention the main support structure comprises a central member extending through the main support structure, and preferably, the central member extends from the lower platform to the upper platform.

30 Preferably, the central member of the main support structure extends through the lower platform, and advantageously, the central member terminates in the carrier member.

In another embodiment of the invention the central member extending through the main support structure

comprises an elongated central tubular member having an elongated bore extending therethrough, and preferably, the bore extending through the central tubular member communicates with the bore extending through the tubular carrier member.

- 5 In one embodiment of the invention the central member and the carrier member are integrally formed in one piece from an elongated tubular member.

In another embodiment of the invention the main support structure comprises at least two side members extending radially outwardly from the central member, and preferably, the at least two side members are
10 located spaced apart circumferentially around the central member, and advantageously, the at least two side members are equi-spaced apart circumferentially around the central member.

In another embodiment of the invention each side member is configured for securing at least one of the at least one flotation element thereto, and preferably, each side member is configured for securing a pair of
15 flotation elements thereto, and preferably, the pair of flotation elements are secured to the corresponding side member, with the side member sandwiched between the two flotation elements.

In one embodiment of the invention a pair of flotation elements is provided, and the flotation elements are secured to the main support structure with the main support structure sandwiched between the two
20 flotation elements.

In another embodiment of the invention four side members extending radially from the central member are provided, and four flotation elements are provided, with a pair of adjacent flotation elements secured to an adjacent one of the side members, and preferably, each side member is sandwiched between the
25 corresponding pair of flotation elements. Advantageously, each flotation element is secured to two corresponding side members.

In one embodiment of the invention each flotation element comprises a hollow flotation housing defining a hollow interior region, and preferably, each flotation housing defines an airtight hollow interior region, and
30 advantageously, each flotation housing comprises a gas-filled hollow interior region.

In an alternative embodiment of the invention each flotation housing comprises a buoyant material located within the hollow interior region thereof, and in one embodiment of the invention the buoyant material

comprises an expanded buoyant material, which preferably, when expanded the buoyant material comprises a plurality of closed cells. Advantageously, the expandable material comprises an expandable plastics material, and preferably, a closed cell expandable material.

- 5 In one embodiment of the invention the hollow interior region of each flotation housing is filled with the buoyant material, and preferably, is completely filled with the buoyant material.

In one embodiment of the invention the buoyant material is cast in the hollow interior region of each flotation housing.

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Preferably, each flotation element comprises a plastics material, and preferably, each flotation element is formed by rotational moulding.

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In one embodiment of the invention the ballast material comprises a concrete material, and preferably, a fibre reinforced concrete material.

In a further embodiment of the invention the ballast housing comprises a plastics material, which preferably, is formed by rotational moulding.

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In one embodiment of the invention the ballast housing comprises a base and a side wall extending upwardly from and around the periphery of the base. Preferably, the side wall terminates in an inwardly directed upper lip, and preferably, the base, the side wall and the upper lip define the hollow interior region. Advantageously, the upper lip extends around the side wall, and preferably, defines the open mouth to the hollow interior region of the ballast housing.

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In one embodiment of the invention the ballast housing is circular in plan view.

In one embodiment of the invention the ballast housing comprises a receiving means for receiving forks of a forklift mechanism.

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In an alternative embodiment of the invention the ballast element is secured to the main support structure by at least one, and preferably, a plurality of spaced apart fasteners.

In one embodiment of the invention each fastener comprises a threaded bolt, and preferably, each fastener is adapted to extend through a corresponding bore extending through the ballast element, and preferably, extending through the ballast housing.

- 5 In another embodiment of the invention the fastener is located in the ballast element, and preferably, the securing means is adapted for securing to the main support structure by at least one, and preferably, a plurality of fasteners, and advantageously, by a plurality of fastening elements.

- 10 In another embodiment of the invention the securing means is located in the ballast housing during casting of the ballast element in the ballast housing, and preferably, the securing means is adapted for securing to the main support structure by at least one fastener, and preferably, by a plurality of fastening elements.

- 15 In another embodiment of the invention the main support structure comprises at least one coupling element adapted for coupling to an anchor chain or cable for anchoring the buoy. Preferably, at least two coupling elements are provided for coupling to respective anchor chains or cables.

- 20 Preferably, the coupling elements are located spaced apart circumferentially around the main support structure.

In another embodiment of the invention the main support structure comprises a pair of connecting elements for connecting lifting cables to the buoy.

- 25 In one embodiment of the invention the connecting elements are located spaced apart circumferentially around the main support structure.

- 30 In one embodiment of the invention the upper structure is configured for carrying at least a warning light, and in another embodiment of the invention the upper structure is configured for carrying weather monitoring equipment, and in a further embodiment of the invention the upper structure is configured for carrying a radio transmitter, and in a further embodiment of the invention the upper structure is configured for carrying a radio transmitter and receiver.

In a still further embodiment of the invention the upper structure is configured for carrying electronic

equipment, and preferably, a microcontroller for controlling equipment carried on the upper structure.

The invention also provides a method for producing a buoy, the method comprising providing a main support structure, providing at least one flotation element and securing the at least one flotation element
5 to the main support structure, providing a ballast element and securing the ballast element to the main support structure below the at least one flotation element, the ballast element being housed in a ballast housing, and being cast in the ballast housing.

Preferably, the ballast element is secured to the main support structure by keying thereto.
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In one embodiment of the invention an upper structure is supported on the main support structure, and preferably, extends upwardly therefrom.

In one embodiment of the invention the ballast housing is formed to define a hollow interior region and an
15 upwardly facing open mouth communicating with the hollow interior region.

Preferably, the ballast material is cast in the hollow interior region of the ballast housing through the open mouth thereof to form the ballast element.

20 Preferably, a securing means extends into the hollow interior region of the ballast housing through the open mouth thereof for securing the ballast element to the main support structure. Advantageously, the securing means extends from the main support structure and is located in the hollow interior region of the ballast housing during casting of the ballast element therein.

25 In another embodiment of the invention a keying means is secured to the securing means and is located in the hollow interior region of the ballast housing during casting of the ballast element therein for keying the ballast element to the main support structure.

In one embodiment of the invention a pair of flotation elements are secured to the main support structure
30 with the main support structure sandwiched between the two flotation elements.

In another embodiment of the invention at least two side members are provided extending radially outwardly from a central member of the main support structure, the two side members being located equi-

spaced apart circumferentially around the central member. Preferably, at least one of the flotation elements is secured to one of the side members. Preferably, a pair of flotation elements are secured to the corresponding side member, with the side member sandwiched between the two flotation elements.

5 In another embodiment of the invention four side members extend radially from the central member, and four flotation elements are provided, and a pair of adjacent ones of the flotation elements are secured to an adjacent one of the side members with side member sandwiched between the corresponding pair of the flotation elements.

10 Preferably, each flotation element is secured to two corresponding side members.

In another embodiment of the invention each flotation element comprises a hollow flotation housing defining an airtight hollow interior region.

15 In one embodiment of the invention each flotation element comprises a plastics material. Preferably, each flotation element is formed by rotational moulding.

In another embodiment of the invention the ballast housing comprises a plastics material. Preferably, the ballast housing is formed by rotational moulding.

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In another embodiment of the invention the ballast material comprises a concrete material. Preferably, the ballast material comprises reinforced concrete material.

25 In one embodiment of the invention the ballast element is secured to the main support structure by at least one fastener. Preferably, each fastener comprises a threaded bolt extending through a corresponding bore extending through the ballast element. Advantageously, each fastener extends through a corresponding bore extending through the ballast housing.

30 The advantages of the buoy according to the invention are many. The buoy according to the invention may be used as a marker buoy for marking a shipping lane. The buoy according to the invention may be used as a weather buoy for monitoring weather conditions at sea. The buoy according to the invention may also be used for monitoring wave height in the ocean. Furthermore, the buoy according to the invention may be used for monitoring ocean currents, and additionally, the buoy according to the invention

may be used for monitoring the state of the water in which the buoy is located.

A particular important advantage of the invention results from the construction of the buoy, whereby the buoy in the majority of embodiments of the invention comprises a main support structure with at least one, and preferably, at least two flotation elements secured to the main support structure, and in particular, secured to respective opposite sides of the main support structure with the main support structure substantially tightly sandwiched between the flotation elements. This construction provides a significantly robust buoy which is significantly more robust than conventionally known buoys.

- Another particularly important advantage of the invention results from the construction of the ballast element. By housing the ballast element in a ballast housing by casting the ballast element into the ballast housing produces a particularly advantageous form of the buoy, since the buoy can be readily easily manufactured with precision.
- By forming the ballast element from concrete, and in particular, from a fibre reinforced concrete, a particularly robust buoy is produced. A particularly important advantage of casting the ballast from reinforced concrete in a ballast housing provides the additional advantage that the ballast element of the reinforced concrete, being a relatively brittle material, is protected by the ballast housing. By providing the ballast housing comprising a plastics material, since in general, plastics materials are non-brittle, and capable of withstanding knocks and shocks, the ballast housing protects the ballast concrete element located in the hollow interior region of the ballast housing.

The invention will be more clearly understood from the following description of some preferred embodiments thereof, which are given by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a buoy according to the invention,

Fig. 2 is a front elevational view of the buoy of Fig. 1,

Fig. 3 is a side elevational view of the buoy of Fig. 1,

Fig. 4 is a top plan view of the buoy of Fig. 1,

Fig. 5 is a cross-sectional front elevational view of the portion of the buoy of Fig. 1,

Fig. 6 is an exploded perspective view of a portion of Fig. 5 of the buoy of Fig. 1,

5 Fig. 7 is an enlarged cross-sectional front elevational view of a detail of the portion of Fig. 5 of the buoy of Fig. 1,

Fig. 8 is a front elevational view of a part of the portion of Fig. 5 of the buoy of Fig. 1,

10 Fig. 9 is an underneath plan view of the part of Fig. 8 of the buoy of Fig. 1,

Fig. 10 is a perspective view of a portion of the buoy of Fig. 1,

Fig. 11 is a side elevational view of the portion of Fig. 10 of the buoy of Fig. 1,

15

Fig. 12 is a front elevational view of the portion of Fig. 10 of the buoy of Fig. 1,

Fig. 13 is a top plan view of the portion of Fig. 10 of the buoy of Fig. 1,

20 Fig. 14 is a perspective view of a buoy according to another embodiment of the invention,

Fig. 15 is a front elevational view of the buoy of Fig. 14,

Fig. 16 is a side elevational view of the buoy of Fig. 14,

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Fig. 17 is a top plan view of the buoy of Fig. 14,

Fig. 18 is a cross-sectional front elevational view of a portion of the buoy of Fig. 14,

30 Fig. 19 is an exploded perspective view of the portion of Fig. 18 of the buoy of Fig. 14,

Fig. 20 is an enlarged cross-sectional front elevational view of a part of the portion of Fig. 18 of the buoy of Fig. 14,

Fig. 21 is a perspective view of a buoy according to another embodiment of the invention,

Fig. 22 is a front elevational view of the buoy of Fig. 21,

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Fig. 23 is a side elevational view of the buoy of Fig. 21,

Fig. 24 is a top plan view of the buoy of Fig. 21,

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Fig. 25 is a cross-sectional front elevational view of a portion of the buoy of Fig. 21,

Fig. 26 is an exploded perspective view of the portion of Fig. 25 of the buoy of Fig. 21,

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Fig. 27 is an enlarged cross-sectional front elevational view of a detail of the portion of Fig. 25 of the buoy of Fig. 21,

Fig. 28 is a perspective view of a portion of the buoy of Fig. 21,

Fig. 29 is a front elevational view of the portion of Fig. 28 of the buoy of Fig. 21,

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Fig. 30 is a side elevational view of the portion of Fig. 28 of the buoy of Fig. 21,

Fig. 31 is a top plan view of the portion of Fig. 28 of the buoy of Fig. 21,

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Fig. 32 is a perspective view of a buoy according to another embodiment of the invention,

Fig. 33 is a front elevational view of the buoy of Fig. 32,

Fig. 34 is a side elevational view of the buoy of Fig. 32,

30

Fig. 35 is a top plan view of the buoy of Fig. 32,

Fig. 36 is a cross-sectional front elevational view of a portion of the buoy of Fig. 32,

Fig. 37 is an exploded perspective view of the portion of Fig. 36 of the buoy of Fig. 32,

Fig. 38 is an enlarged cross-sectional front elevational view of a detail of the portion of Fig 36 of the
5 buoy of Fig. 32,

Fig. 39 is a perspective view of a portion of a buoy according to another embodiment of the
invention,

10 Fig. 40 is a perspective view of a part of the portion of the buoy of Fig. 39,

Fig. 41 is a perspective view of a part of the portion of Fig. 39 of the buoy of Fig. 39,

Fig. 42 is a perspective view of a detail of the buoy of Fig. 39,

15 Fig. 43 is a perspective view of a portion of a buoy according to a further embodiment of the
invention,

Fig. 44 is a perspective view of a part of the portion of Fig. 43 of the buoy of Fig. 43,

20 Fig. 45 is a perspective view of another part of the portion of Fig. 43 of the buoy of Fig. 43,

Fig. 46 is a perspective view of a portion of a buoy according to a still further embodiment of the
invention, and

25 Fig. 47 is a perspective view of a part of the portion of Fig. 46 of the buoy of Fig. 46.

Referring to the drawings, and initially to Figs. 1 to 13 thereof, there is illustrated a buoy according to the
invention, which in this embodiment of the invention comprises a marker buoy indicated generally by the
30 reference numeral 1 for marking, for example, a shipping lane in the sea, such as, in a river estuary, to
mark a shipping lane therethrough to a port. The marker buoy 1 comprises a main support structure, in
this case provided by a support framework 3 and a pair of flotation elements 5 secured to the support
framework 3 as will be described below. A ballast housing 7 housing a ballast element 9 of concrete for

providing ballast to the marker buoy 1 is located beneath the flotation elements 5 with the ballast element 9 secured to the support framework 3 as will be described below. An upper structure 10 extends upwardly from the support framework 3 and carries a lantern 12 for producing light signals for warning shipping of the extent of a shipping lane. The use of marker buoys for marking a shipping lane will be well known to those skilled in the art.

Turning initially to the support framework 3, the support framework 3 comprises a central member, in this case provided by an elongated central tubular member 14 of circular transverse cross-section of galvanised steel defining a bore 16 extending therethrough, see for example Figs. 5 to 8. The central tubular member 14 defines a longitudinally extending main central axis 13, and extends downwardly from an upper platform 15 to a lower platform 17. The upper and lower platforms 15 and 17 are of galvanised steel and extend around the central tubular member 14 and outwardly from the central tubular member 14 at an angle of approximately 90° relative to the main central axis 13. The upper platform 15 is configured for mounting the upper structure 10 thereon, and the lower platform 17 is configured for supporting the flotation elements 5 thereon. The central tubular member 14 extends downwardly through the lower platform 17 and centrally into the ballast housing 7 as will be described in more detail below.

A pair of side members, in this embodiment of the invention a pair of side plates 19 of galvanised steel are welded to and extend radially outwardly from the central tubular member 14 and are equi-spaced apart circumferentially around the central tubular member 14 at 180° intervals. Each side plate 19 is profiled in order to reduce weight and forms an upper cross-member 20 and a lower cross-member 21 spaced apart downwardly below the upper cross-member 20, and an upstanding side member 22 extending upwardly from the lower cross-member 21 to the upper cross-member 20 and spaced apart from the central tubular member 14. The upper and lower cross-members 20 and 21 are welded to the central tubular member 14. The upper platform 15 is welded to the central tubular member 14 and to the upper cross-member 20, while the lower platform 17 is welded to the central tubular member 14 and to the lower cross-member 21. A pair of reinforcing gusset plates 23 of galvanised steel plate material extend radially outwardly from the central tubular member 14 and are welded to the central tubular member 14 and to the upper platform 15, and along with the upper cross-members 20 of the side plates 19 act to support the upper platform 15 on the support framework 3.

Three spaced apart bolt accommodating openings 24 extend through the upstanding side member 22 of each side plate 19 for accommodating bolts 25 securing the flotation elements 5 to the support framework

3, as will be described below.

A pair of coupling elements, in this embodiment of the invention coupling shackles 27 are secured to the lower cross-members 21 towards the upstanding side members 22 of the respective side plates 19 for
5 securing to anchor chains or cables for anchoring the marker buoy 1.

A pair of connecting elements comprising connecting members 29 extending upwardly from the upstanding side members 22 of the respective side plates 19 are provided with openings 30 for engaging lifting cables or lifting chains of lifting apparatus for lifting the marker buoy 1, for example, for lifting the
10 marker buoy 1 during transfer of the marker buoy 1 from a quay onto a ship, and during transfer of the marker buoy 1 from the ship into the sea.

The portion of the central tubular member 14 which extends downwardly through the lower platform 17 into the ballast housing 7 forms a securing means for securing the ballast element 9 to the support
15 framework 3. In this embodiment of the invention the securing means comprises a carrier member, in this case, a tubular carrier member 32 formed by the portion of the central tubular member 14, which extends downwardly from the lower platform 17. The securing means also comprises a keying means, in this embodiment of the invention comprising a pair of spaced apart keying plates 34 extending around and outwardly from the tubular carrier member 32 for keying the ballast element 9 to the tubular carrier
20 member 32, and in turn to the support framework 3.

The keying plates 34 extend outwardly from the tubular carrier member 32 at an angle α relative to the main central axis 13 of approximately 90° , and are spaced apart longitudinally along the tubular carrier member 32 one above the other. Each keying plate 34 is of galvanised steel, and is perforated by a
25 plurality of openings 35 extending therethrough to enhance its keying function. Additionally, each keying plate 34 comprises a plurality of inwardly directed tabs 36 which are equi-spaced apart circumferentially around a main central opening 38 through which the tubular carrier member 32 extends. Each keying plate 34 is welded to the tubular carrier member 32 by welding the tabs 36 to the tubular carrier member 32.

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The ballast housing 7 is of a plastics material and comprises a circular base 40 and a side wall 42 extending upwardly from and around the base 40 and joined to the base 40 by a lower radiused portion 4, see for example Figs. 5 to 7. The side wall 42 may be cylindrical, or it may diverge slightly upwardly

outwardly from the base 40. An upper lip 44 extending around and inwardly from the side wall 42 is joined to the side wall 42 by an upper radiused portion 43. The lip 44 defines with the base 40 and the side wall 42 a hollow interior region 45. The upper lip 44 defines a circular upwardly facing open mouth 47 to the hollow interior region 45. A pair of parallel spaced apart fork accommodating recesses 48 are formed in the base 40 of the ballast housing 7 for engaging forks of a forklift truck or other forklift mechanism for lifting and transferring the marker buoy 1 from one location on land to another land location, or onto the deck of a ship. In this embodiment of the invention the ballast housing 7 is manufactured by rotational moulding, but in other embodiments of the invention, the ballast housing may be manufactured by any other manufacturing process suitable for forming plastics material into the ballast housing 7, for example, injection moulding, blow moulding or any other suitable manufacturing process.

In this embodiment of the invention the concrete of the ballast element 9 is cast in the hollow interior region 45 of the ballast housing 7 with the tubular carrier member 32 extending centrally through the open mouth 47 into the hollow interior region 45 with a lower end 49 of the tubular carrier member 32 supported on the base 40 of the ballast housing 7, and with the keying plates 34 located centrally within the hollow interior region 45 of the ballast housing 7 during casting of the concrete in the ballast housing 7, see for example Figs. 5 and 7. Accordingly, when the concrete sets, the concrete and in turn the ballast element 9 is keyed by the keying plates 34 to the tubular carrier member 32, and in turn to the support framework 3. The ballast element 9 is also keyed and retained within the hollow interior region 45 to the ballast housing 7 by virtue of the inwardly directed upper lip 44. The ballast housing 7 and the ballast element 9 define a longitudinally extending central axis which coincides with the main central axis 13 defined by the central tubular member 14. In this embodiment of the invention the concrete of the ballast element 9 comprises fibre reinforced concrete, and is reinforced by strands of plastics and/or metal materials, but may be reinforced by other suitable reinforcing means, and in some cases the concrete may not be reinforced.

Turning now to the flotation elements 5, each flotation element 5 comprises a flotation housing 50 of plastics material rotationally moulded and defines an airtight hollow interior region (not shown), which may be air-filled or gas filled with a suitable gas, and the air or gas may be at atmospheric pressure or pressurised to a pressure exceeding atmospheric pressure. In some embodiments of the invention the hollow interior region (not shown) of each flotation housing 50 may be filled or partly filled by a buoyant material, which may preferably be a closed cell expanded plastics material, an open cell expanded plastics material or other suitable buoyant material. Such an expandable plastics material typically would

be pumped into the hollow interior region of the flotation housing 50 through a suitable sealably closable opening (not shown) in each flotation housing 50 in liquid form to expand within the airtight hollow interior region. In this embodiment of the invention the floatation housings 50 are air filled with air at atmospheric pressure.

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Each flotation housing 50 is of semi-circular shape when viewed in plan, and comprises a semi-circular base 51 and a semi-circular top wall 52. A short semi-circular lower outer side wall 54 extends upwardly from the base 51 and terminates in an upwardly and outwardly diverging lower intermediate wall 55. A main semi-circular outer side wall 56 extends upwardly from the lower intermediate wall 55 to the top wall 52. An inner side wall 58 extends upwardly from the base 51 to the top wall 52 and extends between opposite ends 60 of the lower outer side wall 54, the lower intermediate wall 55 and the main outer side wall 56. The inner side wall 58 is shaped to form a central vertically extending recess 61 of semi-circular cross-section for accommodating a semi-circular portion of the central tubular member 14. The inner side wall 58 defines with the base 51, the top wall 52, the lower outer side wall 54, the lower intermediate wall 55 and the main outer side wall 56, the airtight hollow interior region (not shown). A gusset accommodating recess 62 extends into each flotation housing 50 from the top wall 52 and from the inner side wall 58 adjacent the central vertically extending recess 61 for accommodating the gusset plates 23 which support the upper platform 15 therein.

Six bolt accommodating recesses 64 are formed in the main outer side wall 56 of each flotation housing 50 terminating in bolt accommodating bores 65 for accommodating the bolts 25 therethrough. The flotation housings 50 are secured to the support framework 3 on opposite sides thereof and between the lower platform 17 and the upper platform 15, with the side plates 19 sandwiched between the flotation housings 50 and with the inner side walls 58 of the respective flotation housings 50 abutting the side plates 19. The central tubular member 14 is recessed into the central vertical recesses 61 formed in the inner side walls 58 of the respective flotation housings 50 and into the base 51 and the top wall 52. With the bolts 25 extending through the bolt accommodating openings 65 of one of the flotation elements 5 and then through the bolt accommodating openings 24 in the corresponding side plates 19, and in turn passing through the bolt accommodating openings 65 of the other one of the flotation housings 50, nuts (not shown) are then threaded onto the bolts 25 for securing the flotation housings 50 to the support framework 3 with the side plates 19 tightly sandwiched therebetween.

The upper structure 10 is secured to the upper platform 15 by suitable fixing means, for example, screws

and the like. The upper structure 10 may be of any suitable or desired construction, in this embodiment of the invention the upper structure comprises a hollow housing 70 of square transverse cross-section and of plastics material formed by rotational moulding. The lantern 12 is mounted on top of the hollow housing 70. Control electronics and an electrical power supply, typically, an electrical battery, none of which are shown, are located in the hollow housing 70. A suitable access door (not shown) may be provided in the hollow housing 70 to provide access to the control electronics and the power supply located within the hollow housing 70. A top framework 72 extends upwardly from the top of the hollow housing 70 and supports a top marker 74. The lantern 12 is located within the top framework 12. A ladder 77 of stainless steel material is secured to the hollow housing 70 and extends upwardly from the upper platform 15 to a location 78 adjacent the top of the hollow housing 70 to provide access to the lantern 12.

Sacrificial anodes 75 are secured to lower portions 76 of the lower cross-members 21 which extend downwardly below the flotation elements 5 when the flotation elements 5 are secured to the support framework 3.

To manufacture the marker buoy 1, with the support framework 3 fabricated and the ballast housing 7 formed, the ballast housing 7 and the support framework 3 are jigged together by a suitable jig (not shown) with the tubular carrier member 32 extending centrally into the hollow interior region 45 of the ballast housing 7 through the upwardly facing open mouth 47, and with the lower end 49 of the tubular carrier member 32 supported on the base 40 of the ballast housing 7, and with the keying plates 34 centrally located in the hollow interior region 45 of the ballast housing 7. With the support framework 3 and the ballast housing 7 so jigged together, and with the keying plates 34 centrally located in the hollow interior region 45 of the ballast housing 7, the fibre reinforced concrete is poured into the hollow interior region 45 of the ballast housing 7 through the open mouth 47 until the concrete fills the hollow interior region 45 of the ballast housing 7 up to and including the open mouth 47 to form the ballast element 9. With the support framework 3 and the ballast housing 7 still jigged together, the concrete is allowed to cure and set to form the ballast element 9.

On the concrete being fully cured, the jig (not shown) is removed from the support framework 3 and the ballast housing 7. The flotation elements 5 are then secured to the support framework 3 between the upper and lower platforms 15 and 17 by the bolts 25 and nuts (not shown) with the support framework 3 tightly sandwiched between the flotation elements 5. The upper structure 10 is then secured to the upper platform 15 and the lantern 12 is then secured to the top of the hollow housing 70 of the upper structure

10. The control electronics and power supply are then located in the housing 70 of the upper structure 10, and the lantern 12 is connected to the control electronics and the power supply. The ladder 77 is secured to the hollow housing 70 of the upper structure 10.

- 5 The coupling shackles 27 are then secured to the lower cross member 21 of the side plates 19, and the sacrificial anodes 75 are also secured to the lower cross-members 21.

Referring now to Figs. 14 to 20 there is illustrated a marker buoy according to another embodiment of the invention indicated generally by the reference numeral 80. The marker buoy 80 is substantially similar to
10 the marker buoy 1 described with reference to Figs. 1 to 13, and similar components are identified by the same reference numerals. The main differences between the marker buoy 80 and the marker buoy 1 relate firstly, to the keying means for keying the ballast element 9 to the support framework 3. In this embodiment of the invention only a single keying plate 34 is provided on the tubular carrier member 34.

- 15 Secondly, the ballast housing 7 is not completely circular, but comprises two flat sides 82. The spacing between the flat sides 82 is such as to accommodate the forks of a forklift truck or other suitable forklift mechanism with the ballast housing 7 located between the forks of the forklift, and with the forks located to engage the underside of the lower platform 17 of the support framework 3.

- 20 Thirdly, the upper platform 15 is formed by a single plate as opposed to the double plate upper platform 15 of the embodiment of the marker buoy 1 described with reference to Figs. 1 to 13.

- Fourthly, the upper lip 44 extending inwardly from the side wall 42 of the ballast housing 7 terminates in a downwardly extending inner side wall 83, which extends around and downwardly from the upper lip 44,
25 and defines the open mouth 47 to the hollow interior region 45 of the ballast housing 7.

- Fifthly, the upper structure 10, which is also of rotational moulded plastics material, is provided with an access opening 85 to the hollow interior region of the upper housing 70 which is sealably closed by a hingedly mounted door 87 which is secured in the closed state by a latch 88.

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In this embodiment of the invention the marker buoy 80 is provided with a Saint Andrews Cross 89 mounted on top of the top framework 72 of the upper structure 10.

Otherwise, the marker buoy 80 and its manufacture, construction and use is substantially similar to the marker buoy 1.

Referring now to Figs. 21 to 31 there is illustrated a marker buoy according to another embodiment of the invention indicated generally by the reference numeral 90. The marker buoy 90 is substantially similar to the marker buoy 1 described with reference to Figs. 1 to 13, and similar components are identified by the same reference numerals. The main difference between the marker buoy 90 and the marker buoy 1 lies in the support framework 3, the flotation elements 5 and in the tubular carrier member 32.

10 In this embodiment of the invention the marker buoy 90 comprises four flotation elements 5, and the support framework 3 comprises four side plates 19 extending radially from the central tubular member 14 and equi-spaced apart circumferentially around the central tubular member 14 at 90° intervals. The flotation elements 5 in this embodiment of the invention instead of being of semi-circular shape when viewed in plan are of quarter circular shape, and adjacent ones of each pair of the flotation elements 5 are
15 secured to a corresponding one of the side plates 19 with the side plate 19 sandwiched tightly between the pair of the flotation elements 5.

In this embodiment of the invention the profiling of the side plates 19 is slightly different to that of the side plates 19 of the marker buoy 1 described with reference to Figs. 1 to 13. In this embodiment of the invention each side plate 19, as well as comprising upper and lower cross-members 20 and 21 joined by an upstanding side member 22 extending between the upper and lower cross-members 20 and 21, also comprises an intermediate cross-member 92 extending inwardly from the upstanding side member 22 intermediate the upper and lower cross-members 20 and 21 to the central tubular member 14 to which the intermediate cross-member 92 is welded. The upstanding members 22 of the side plates 19 are of
25 arcuate shape defining respective outer concave arcuate side edges 91.

The tubular carrier member 32, in this embodiment of the invention is provided with a plurality of communicating openings 93 which extend through the wall 94 of the tubular carrier element 32 for accommodating concrete into the bore 16 of the tubular carrier member 32 during pouring of the concrete into the ballast housing 7, so that the concrete ballast element 9 when it cures, fills the entire hollow
30 interior region 45 of the ballast housing 7, and the bore 16 of the tubular carrier member 32. This further enhances keying of the cured concrete carrier element 9 to the support framework 3.

The flotation elements 5 each comprise a rotationally moulded hollow airtight flotation housing 50 substantially similar to the flotation housings 50 of the marker buoy 1, with the exception that each flotation housing 50 is of quarter circular shape as discussed above, and the inner side walls 96 thereof define a quarter circular recess 97 therebetween for accommodating the central tubular member 14.

- 5 Additionally, the inner side walls 96 of each flotation housing 50 form respective recesses 98 defining arcuate side steps 99 for accommodating the corresponding side plates 19 of the support framework 3 therein with the arcuate side edges 91 of the upstanding members 22 of the corresponding side plates 19 located adjacent the arcuate side steps 99 of the respective recesses 98. Accordingly, in this embodiment of the invention surfaces 96a of the inner surfaces 96 of adjacent pairs of the flotation housings 50 abut
- 10 each other when the adjacent pairs of the flotation housing 50 are secured together by the bolts 25 and the nuts (not shown) with the corresponding side plate 19 therebetween. However, the recesses 98 are of depth such that when the adjacent pairs of the flotation housings 50 are secured together with the corresponding side plates 19 located in the recesses 98, the side plates 19 are tightly sandwiched between the respective pairs of the flotation housings 50.

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Otherwise, the marker buoy 90 is substantially similar to the marker buoy 1, and its manufacture, construction and use is likewise similar.

- Referring now to Figs. 32 to 38, there is illustrated a marker buoy according to another embodiment of the invention indicated generally by the reference numeral 100. The marker buoy 100 is substantially similar
- 20 to the marker buoy 1 described with reference to Figs. 1 to 13, and similar components are identified by the same reference numerals. The only significant difference between the marker buoy 100 and the marker buoy 1 lies in the support framework 3. In this embodiment of the invention the marker buoy is of a smaller size than the marker buoy 1 of Figs. 1 to 13, and the support framework 3 is provided without
- 25 the central tubular member 14, and is formed from a single plate, namely, a single plate 101 which forms the two side plates 19. The single plate 101 is profiled to form a lower cross-member 102, a pair of spaced apart upstanding side members 103 extending upwardly from the lower cross-member 102, and a pair of reinforcing struts 105 extending from the upper ends of the respective upstanding side members 103, to the lower cross-member 102 adjacent the other ones of the upstanding side members 103. The
- 30 lower platform 17 is welded to the lower cross-member 102 for supporting the corresponding flotation elements 5 thereon. A tubular carrier member 32 similar to the tubular carrier member 32 of the marker buoy 1 extends downwardly from and is welded to the lower platform 17 and carries a keying plate 34 extending around the tubular carrier member 32 spaced apart downwardly from the lower platform 17 for

keying the ballast element 9 to the support framework 3. In this embodiment of the invention the keying plate 34 is substantially similar to the keying plates of the marker buoy 1 and comprises a plurality of keying openings 35 for accommodating concrete therethrough for keying the ballast element 9 to the support framework 3.

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The flotation elements 5 are secured to the support framework 3 in a similar manner as described with reference to the marker buoy 1.

Turning now to the ballast housing 7, a lower circular opening 106 is formed in the base 40 of the ballast housing 7, and an upwardly extending lip 107 extends from the base 40 around the lower opening 106. The lip 107 engages the bore 16 of the tubular carrier member 32 for centrally aligning the tubular carrier member 32 and the keying plate 34 in the hollow interior region 45 of the ballast housing 7.

The upper structure 10, in this embodiment of the invention, is of a relatively light weight, and is mounted on a mounting ring 108 which is mounted on and secured to the flotation elements 5. In this embodiment of the invention for heavier upper structures, a central tubular member similar to the central tubular member 14 is provided extending centrally upwardly from the tubular carrier member 32 to support an upper platform, similar to the upper platform 15, for in turn supporting such a heavier upper structure.

Otherwise, the marker buoy 100 and its manufacture, construction and use is substantially similar to that of the marker buoy 1 described with reference to the marker buoy 1 of Figs. 1 to 13.

Referring now to Figs. 39 to 42, there is illustrated a portion indicated generally by the reference numeral 110 of a marker buoy according to another embodiment of the invention. The marker buoy according to this embodiment of the invention is substantially similar to the marker buoy 90 described with reference to Figs. 21 to 31, and similar components are identified by the same reference numerals. The support framework 3 of the portion 110 of the marker buoy according to this embodiment of the invention is substantially similar to the support framework 3 of the marker buoy 90, with the exception that the tubular carrier member 32 is secured to the support framework 3 by fastening elements, in this embodiment of the invention a plurality of screws and nuts (not shown).

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The tubular carrier member 32 is of diameter such that the tubular carrier element 32 is engageable in the central bore 16 of the central tubular member 14 adjacent the lower end thereof. A first coupling flange

114 extends around the tubular carrier member 32, and is engageable with a corresponding second coupling flange 115 extending around the central tubular member 14 adjacent the lower end thereof. The first and second coupling flanges 114 and 115 are provided with a plurality of screw accommodating bores 116 and 117, respectively, for accommodating the screws for securing the first and second coupling flanges 114 and 115 together. A plurality of gusset plates 120 extending between the first coupling flange 114 and the tubular carrier member 32 are located equi-spaced apart circumferentially around the tubular carrier member 32 for reinforcing the first coupling flange 114, and are welded to the tubular carrier member 32 and to the first coupling flange 114. A plurality of gusset plates 121 similar to the gusset plates 120 extend between the second coupling flange 115 and the central tubular member 14 equi-spaced apart circumferentially around the central tubular member 14, and are welded to the central tubular member and the second coupling flange 115 for reinforcing the second coupling flange 115 to the central tubular member 14.

A pair of keying plates 34, similar to the keying plates 34 of the marker buoy 1 of Figs. 1 to 13, are welded to and spaced apart longitudinally along the tubular carrier member 32.

The reinforced concrete is cast in the ballast housing 7 with the tubular carrier member 32 and the keying plates 34 centrally located in the ballast housing 7 with the first coupling flange 114 at a level spaced apart above the level of the upper lip 44 of the ballast housing 7 as illustrated in Figs. 39 and 40 in order to facilitate securing of the first and second coupling flanges 114 and 115 together with the screws and nuts (not shown) after the reinforced concrete has been cast and cured in the ballast housing 7. An advantage of this embodiment of the invention is that the concrete can be cast and cured in the ballast housing 7 before securing the support framework 3 to the tubular carrier member 32.

Otherwise, the marker buoy comprising the portion 110 thereof and its manufacture, construction and use is similar to that of the marker buoy 90.

Referring now to Figs 43 to 45, there is illustrated a portion indicated generally by the reference numeral 130 of a marker buoy according to another embodiment of the invention. The marker buoy 130 is substantially similar to the marker buoy 90 described with reference to Figs. 21 to 31, and similar components are identified by the same reference numerals. In this embodiment of the invention the ballast element 9 of fibre reinforced concrete is cast in the ballast housing 7 separately from the support framework 3, and when the concrete has cured in the ballast housing 7, the ballast housing 7 with the

cured concrete ballast element 9 is secured to the support framework 3 by four threaded bolts and nuts (neither of which are shown).

Four bolt accommodating openings 136 are formed in the upper lip 44 of the ballast housing 7 equi-spaced apart around the upper lip 44. Four recesses 133 equi-spaced apart circumferentially around the ballast housing 7 extend radially inwardly into the ballast housing 7 below the respective bolt accommodating openings 136. A bolt accommodating opening 137 extends through the ballast housing 7 in each recess 133, and is aligned with the corresponding bolt accommodating opening 136 above the corresponding recess 133. Four bolt accommodating tubular members 134 extend between
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10 corresponding pairs of the bolt accommodating openings 136 and 137 for accommodating the respective bolts therethrough for securing the ballast housing 7 and the ballast element 9 to the support framework.

A pair of channel members 138 of galvanised steel are secured to the lower platform 17 of the support framework 3. Bores 139 extend through a lower web 131 at each end thereof of the respective channel
15 members 138 for engaging the corresponding threaded bolts (not shown) extending from the ballast housing 7 and the ballast element 9 for in turn securing the ballast housing 7 and the ballast element 9 to the support framework 3.

Otherwise, the marker buoy 130 according to this embodiment of the invention, its manufacture,
20 construction and use is similar to the marker buoy 90 described with reference to Figs. 21 to 31.

Referring now to Figs. 46 and 47, there is illustrated a portion indicated generally by the reference numeral 140 of a marker buoy according to another embodiment of the invention. The portion 140 of the marker buoy according to this embodiment of the invention is substantially similar to the portion 130 of the marker buoy described with reference to Figs. 43 to 45. The only difference between the portion 140 of
25 the marker buoy according to this embodiment of the invention and the portion 130 of the marker buoy of Figs. 43 to 45 is that four channel members 142 of galvanised steel are provided extending from the tubular carrier member 32 equi-spaced apart circumferentially around the tubular carrier member 32. Bores 144 extend through the lower web 145 of each channel member 142 adjacent the distal end thereof
30 for accommodating respective threaded bolts extending through corresponding ones of the bolt accommodating openings 136 and 137 and the bolt accommodating tubular members 134 of the ballast housing 7 for securing the ballast element 9 and the ballast housing 7 to the support framework 3.

Otherwise, the marker buoy comprising the portion 140 thereof and its manufacture, construction and use is similar to the marker buoy 90.

5 The buoys described with reference to Figs. 1 to 47 may be of any suitable height from the base of the ballast housing to the top of the top marker carried on the upper structure, although, in general, the height of the buoys from the base of the ballast housing to the top of the top marker will range from 3 metres to 6 metres, and in some cases may be up to 8 metres. The diameter of the buoys adjacent the flotation elements typically will lie in the range of 0.8 metres to 3 metres, and typically, the diameter of the ballast housing will lie in the range of 0.6 metres to 3 metres, and the height of the ballast housing will range from 10 0.2 metres to 0.7 metres.

While the flotation elements have been described as being of plastics material rotationally moulded, the flotation elements may be of any other suitable material, plastics, metal or otherwise, and may be formed by any other suitable or appropriate forming means appropriate to the material.

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Additionally, the upper structure of the marker buoys may be of any other suitable material besides plastics material rotationally moulded, such as metal or other suitable material, and may be formed by any other suitable formation method or process appropriate to the material.

20 Similarly, the ballast housing may be of any other suitable material besides plastics material, and in some embodiments of the invention may be of a metal material, and may be formed by any other suitable forming means appropriate to the material.

25 While the support framework has been described as comprising galvanised coated steel material, the support framework may be of any other suitable material, and if of a metal material, may be of stainless steel, aluminium, or any other suitable metal or metal alloy material appropriately coated against rust and corrosion, if necessary.

30 Needless to say, the central member of the support framework may be of any other suitable construction besides comprising a tubular member of circular transverse cross-section. The central member may be a solid member, and may be of any other suitable transverse cross-section, for example, square, rectangle, hexagonal, triangular or octagonal cross-section, or the like. Needless to say, the side plates may be of any other suitable profile, and in some embodiments of the invention may comprise plate members

without central portions being removed therefrom in order to reduce the weight of the plate material. Alternatively, the side members may be fabricated instead of being profiled from plate material.

While the coupling means have been described as comprising coupling shackles, any other suitable
5 coupling means for coupling anchor chains or cables to the marker buoy may be provided. Needless to say, in some embodiments of the invention the connecting members for connecting the marker buoys to lifting cables or chains may be omitted, or any other suitable attachments for connecting the marker buoys to lifting mechanisms may be provided.

10 While it is desirable to provide the ballast housing 7 to accommodate the forks of a forklift truck, it is not essential.

While in the various embodiments of the invention the marker buoys have been described as comprising various different components and features, it will be readily apparent to those skilled in the art that various
15 components and features of the marker buoys are interchangeable between the different embodiments of the marker buoys.

It will also be appreciated that while the concrete of the ballast elements has been described as being fibre reinforced, the concrete of the ballast elements may be reinforced or may not be reinforced, and
20 when reinforced may be reinforced by any other suitable reinforcing means besides fibre reinforcing. For example, in some embodiments of the invention the ballast concrete may be reinforced by steel reinforcing, for example, by steel mesh reinforcing material.

While the buoys according to the embodiments of the invention described with reference to the drawings
25 have all been described as being marker buoys, it will be readily apparent to those skilled in the art that the buoys may fulfil many other functions. For example, the buoys may be weather buoys, mooring buoys, buoys for monitoring wave height and/or tidal currents, buoys for monitoring quality of water in which the buoy is floating, or any other buoys. Indeed, in some embodiments of the invention it is envisaged that the buoys may be provided without any upper structure extending from the main support
30 structure.

Although not described, it is envisaged in some embodiments of the invention that an opening may be provided in the base of the ballast housing which would communicate with the bore extending through the

tubular carrier member 32 to accommodate water in which the buoy is floating into the bore of the tubular carrier member 32 and upwardly into the bore 16 of the central tubular member 14 of the support framework of the main support structure. This would allow monitoring of, for example, wave height and/or the quality of the water in which the buoy is floating, and would allow monitoring for pollutants, pathogens and other undesirable elements in the water. Such monitoring of the water would be carried out by appropriate sensors located in the bore of the central tubular member 14, and the sensors would be read by suitable electronic monitoring equipment and control circuitry, which typically, would be located in the upper structure. A communicating means, for example, which may include a sim card or other suitable communicating element, for example, a two-way radio transmission system may be located in the upper structure, and would be operated under the control of the control circuitry for periodically transmitting data relating to the quality of the water or the wave height to a remote monitoring station and/or on request from the remote monitoring station.

Additionally, in some embodiments of the invention where the buoy is configured as a weather buoy, or as a buoy for monitoring wave height, tidal currents and the like, it is envisaged that appropriate monitoring means for monitoring the variables which the buoy is configured to monitor, and a communicating means would be provided which may comprise a sim card or other suitable communicating means, for example, a two-way radio transmission system and would be operated under the control of the control circuitry for periodically, typically, at predefined intervals, transmitting data indicative of the variables being monitored to a remote monitoring station, or on request from the remote monitoring station.

It is also envisaged that a communicating means may be configured to provide two-way communications, so that data stored in, for example, electronic memory of the control circuitry may be interrogated from a remote monitoring station.

While the keying means have been described as comprising keying plates, any other suitable keying means may be provided. For example, the keying means may comprise a plurality of elongated members extending radially outwardly from the securing means or the carrier member and in which case, in general, it is envisaged that such elongated radially extending members would be located at equi-spaced apart intervals around the securing means or the carrier member, although, while it would generally be desirable, it would not be essential that the elongated radially extending members be equi-spaced apart around the securing means or the carrier member. Additionally, while two keying plate members have been described as being located one above the other, in some embodiments of the invention a single

plate member may be provided, or indeed, in other embodiments of the invention three or more plate members or other suitable keying means may be provided.

Claims

1. A buoy comprising a main support structure, at least one flotation element secured to the main support structure, and a ballast element secured to the main support structure below the at least one flotation element, wherein the ballast element is housed within a ballast housing, and is formed in the ballast housing by casting therein.
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2. A buoy as claimed in Claim 1 in which the ballast housing defines a hollow interior region and an upwardly facing open mouth communicating with the hollow interior region.
- 10 3. A buoy as claimed in Claim 2 in which the open mouth of the ballast housing is adapted to accommodate the ballast material into the hollow interior region of the ballast housing during casting of the ballast material in the ballast housing.
4. A buoy as claimed in Claim 2 or 3 in which the open mouth of the ballast housing is adapted to
15 accommodate a securing means therethrough into the hollow interior region for securing the ballast element to the main support structure.
5. A buoy as claimed in Claim 4 in which the securing means for securing the ballast element to the main support structure extends from the main support structure.
20
6. A buoy as claimed in Claim 4 or 5 in which the securing means comprises a keying means extending into the hollow interior region of the ballast housing for keying the ballast element to the securing means.
- 25 7. A buoy as claimed in Claim 6 in which the keying means is carried on the securing means.
8. A buoy as claimed in Claim 6 or 7 in which the keying means extends outwardly from the securing means.
- 30 9. A buoy as claimed in any of Claims 6 to 8 in which the keying means extends outwardly from the securing means at an angle in the range of 20° to 90°.
10. A buoy as claimed in any of Claims 6 to 9 in which the keying means extends outwardly from the

securing means at an angle in the range of 30° to 90°.

11. A buoy as claimed in any of Claims 6 to 10 in which the keying means extends outwardly from the securing means at an angle in the range of 60° to 90°.

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12. A buoy as claimed in any of Claims 6 to 11 in which the keying means extends outwardly from the securing means at an angle of approximately 90° to the securing means.

10 13. A buoy as claimed in any of Claims 6 to 12 in which the keying means extends around the securing means.

14. A buoy as claimed in any of Claims 6 to 13 in which the keying means extends completely around the securing means.

15 15. A buoy as claimed in any of Claims 6 to 14 in which a pair of keying means is provided on the securing means.

16. A buoy as claimed in any of Claims 6 to 15 in which the keying means of the pair thereof are spaced apart longitudinally along the securing means one above the other.

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17. A buoy as claimed in any of Claims 6 to 16 in which each keying means comprises a perforated material.

25 18. A buoy as claimed in any of Claims 6 to 17 in which each keying means comprises a plate member.

19. A buoy as claimed in any of Claims 6 to 18 in which each keying means comprises a metal material.

30 20. A buoy as claimed in any of Claims 7 to 19 in which the securing means comprises a metal material.

21. A buoy as claimed in any of Claims 6 to 20 in which the securing means comprises a carrier

member.

22. A buoy as claimed in Claim 21 in which each keying means is secured to the carrier member.

5 23. A buoy as claimed in Claim 21 or 22 in which the carrier member extends centrally from the main support structure.

24. A buoy as claimed in any of Claims 21 to 23 in which the carrier member extends centrally into the hollow interior region of the ballast housing.

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25. A buoy as claimed in any of Claims 21 to 24 in which the carrier member extends through the hollow interior region of the ballast housing.

15 26. A buoy as claimed in any of Claims 21 to 25 in which the carrier member comprises a tubular member having a bore extending therethrough, the carrier member extending through the hollow interior region of the ballast housing with the bore of the carrier member extending substantially vertically.

27. A buoy as claimed in Claim 26 in which an opening is formed in the ballast housing communicating the bore extending through the carrier member adjacent a lower end thereof with the exterior of the ballast housing.

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28. A buoy as claimed in Claim 26 or 27 in which the tubular carrier member terminates at its lower end in a downwardly facing open mouth for accommodating water, in which the buoy is floating, therethrough into the bore of the tubular carrier member.

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29. A buoy as claimed in any preceding claim in which an upper structure is supported on the main support structure, and extends upwardly therefrom.

30. A buoy as claimed in any preceding claim in which the main support structure supports a lower platform adapted to support the flotation element.

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31. A buoy as claimed in any preceding claim in which the main support structure supports an upper platform.

32. A buoy as claimed in Claim 31 in which the upper platform is adapted to support the upper structure with the upper structure extending upwardly from the upper platform.
- 5 33. A buoy as claimed in any of Claims 30 to 32 in which the lower platform is spaced apart downwardly from the upper platform.
34. A buoy as claimed in any preceding claim in which the main support structure comprises a central member extending through the main support structure, the central member extending from the
10 lower platform to the upper platform.
35. A buoy as claimed in Claim 34 in which the central member of the main support structure extends through the lower platform, and terminates in the carrier member.
- 15 36. A buoy as claimed in Claim 34 or 35 in which the central member extending through the main support structure comprises an elongated central tubular member having an elongated bore extending therethrough, communicating with the bore extending through the carrier member.
37. A buoy as claimed in any of Claims 34 to 36 in which the central member and the carrier
20 member are integrally formed in one piece from an elongated tubular member.
38. A buoy as claimed in any preceding claim in which a pair of the flotation elements is provided, and the flotation elements are secured to the main support structure with the main support structure sandwiched between the two flotation elements.
25
39. A buoy as claimed in any preceding claim in which the main support structure comprises at least two side members extending radially outwardly from the central member, the two side members being located spaced apart circumferentially around the central member.
- 30 40. A buoy as claimed in Claim 39 in which the at least two side members are equi-spaced apart circumferentially around the central member.
41. A buoy as claimed in Claim 39 or 40 in which each side member is configured for securing at

least one of the at least one flotation element thereto.

42. A buoy as claimed in any of Claims 39 to 41 in which each side member is configured for securing a pair of flotation elements thereto.

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43. A buoy as claimed in any of Claims 39 to 42 in which the pair of flotation elements are secured to the corresponding side member, with the side member sandwiched between the two flotation elements.

44. A buoy as claimed in any of Claims 39 to 43 in which four of the side members are provided extending radially from the central member, and four flotation elements are provided, with a pair of adjacent flotation elements secured to an adjacent one of the side members, each side member being sandwiched between the corresponding pair of flotation elements.

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45. A buoy as claimed in any of Claims 39 to 44 in which each flotation element is secured to two corresponding side members.

15

46. A buoy as claimed in any preceding claim in which each flotation element comprises a hollow flotation housing defining an airtight hollow interior region.

47. A buoy as claimed in Claim 46 in which each flotation housing comprises a gas-filled hollow interior region.

20

48. A buoy as claimed in Claim 46 or 47 in which each flotation housing comprises a buoyant material located within the hollow interior region thereof.

25

49. A buoy as claimed in Claim 48 in which the buoyant material comprises an expanded buoyant material.

50. A buoy as claimed in Claim 48 or 49 in which the buoyant material when expanded comprises a plurality of closed cells.

30

51. A buoy as claimed in any of Claims 48 to 50 in which the buoyant material is cast in the hollow interior region of each flotation housing.

52. A buoy as claimed in any preceding claim in which each flotation element comprises a plastics material.
- 5 53. A buoy as claimed in any preceding claim in which each flotation element is formed by rotational moulding.
54. A buoy as claimed in any preceding claim in which the ballast material comprises a concrete material.
- 10 55. A buoy as claimed in Claim 54 in which the ballast material comprises a reinforced concrete material.
56. A buoy as claimed in any preceding claim in which the ballast housing comprises a plastics material.
- 15 57. A buoy as claimed in any preceding claim in which the ballast housing is formed by rotational moulding.
- 20 58. A buoy as claimed in any preceding claim in which the ballast housing comprises a base and a side wall extending upwardly from and around the periphery of the base, the side wall terminating in an inwardly directed upper lip extending around the side wall, the base, the side wall and the upper lip defining the hollow interior region of the ballast housing.
- 25 59. A buoy as claimed in Claim 58 in which the upper lip defines the open mouth to the hollow interior region of the ballast housing.
60. A buoy as claimed in any preceding claim in which the ballast housing is circular in plan view.
- 30 61. A buoy as claimed in any preceding claim in which the ballast housing comprises a receiving means for receiving forks of a forklift mechanism.
62. A buoy as claimed in any preceding claim in which the ballast element is secured to the main

support structure by at least one fastener.

63. A buoy as claimed in Claim 62 in which each fastener comprises a threaded bolt adapted to extend through a corresponding bore extending through the ballast element.

5

64. A buoy as claimed in Claim 62 or 63 in which each fastener is adapted to extend through a corresponding bore extending through the ballast housing.

65. A buoy as claimed in any of Claims 62 to 64 in which each fastener is located in the ballast
10 element for securing the ballast element to the main support structure.

66. A buoy as claimed in any preceding claim in which the securing means is located in the ballast housing during casting of the ballast element in the ballast housing.

15 67. A buoy as claimed in any preceding claim in which the main support structure comprises at least one coupling element adapted for coupling to an anchor chain or cable for anchoring the buoy.

68. A buoy as claimed in any preceding claim in which at least two coupling elements are provided for coupling to respective anchor chains or cables.

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69. A buoy as claimed in Claim 67 or 68 in which the coupling elements are located spaced apart circumferentially around the main support structure.

70. A buoy as claimed in any preceding claim in which the main support structure comprises a pair
25 of connecting elements for connecting lifting cables to the buoy.

71. A buoy as claimed in Claim 70 in which the connecting elements are located spaced apart circumferentially around the main support structure.

30 72. A buoy as claimed in any preceding claim in which the upper structure is configured for carrying one or more of a warning light, weather monitoring equipment, a radio transmitter or a radio transmitter and a receiver.

73. A buoy as claimed in Claim 72 in which the upper structure is configured for carrying electronic equipment for controlling equipment carried on the upper structure.

74. A method for producing a buoy, the method comprising providing a main support structure, providing at least one flotation element and securing the at least one flotation element to the main support structure, providing a ballast element and securing the ballast element to the main support structure below the at least one flotation element, the ballast element being housed in a ballast housing, and being cast in the ballast housing.

75. A method as claimed in Claim 74 in which the ballast element is secured to the main support structure by keying thereto.

76. A method as claimed in Claim 74 or 75 in which an upper structure is supported on the main support structure.

77. A method as claimed in Claim 76 in which the upper structure extends upwardly from the main structure.

78. A method as claimed in any of Claims 74 to 77 in which the ballast housing is formed to define a hollow interior region and an upwardly facing open mouth communicating with the hollow interior region.

79. A method as claimed in Claim 78 in which the ballast material is cast in the hollow interior region of the ballast housing through the open mouth thereof to form the ballast element.

80. A method as claimed in Claim 78 or 79 in which a securing means extends into the hollow interior region of the ballast housing through the open mouth thereof for securing the ballast element to the main support structure.

81. A method as claimed in Claim 80 in which the securing means extends from the main support structure and is located in the hollow interior region of the ballast housing during casting of the ballast element therein.

82. A method as claimed in Claim 80 or 81 in which a keying means is secured to the securing

means and is located in the hollow interior region of the ballast housing during casting of the ballast element therein for keying the ballast element to the main support structure.

83. A method as claimed in any of Claims 74 to 82 in which a pair of flotation elements are secured to the main support structure with the main support structure sandwiched between the two flotation elements.

84. A method as claimed in any of Claims 74 to 83 in which at least two side members are provided extending radially outwardly from a central member of the main support structure, the two side members being located equi-spaced apart circumferentially around the central member.

85. A method as claimed in Claim 84 in which at least one of the flotation elements is secured to one of the side members.

86. A method as claimed in Claim 84 or 85 in which a pair of flotation elements are secured to the corresponding side member, with the side member sandwiched between the two flotation elements.

87. A method as claimed in any of Claims 84 to 86 in which four side members extend radially from the central member, and four flotation elements are provided, and a pair of adjacent ones of the flotation elements are secured to an adjacent one of the side members with the side member sandwiched between the corresponding pair of the flotation elements.

88. A method as claimed in any of Claims 84 to 87 in which each flotation element is secured to two corresponding side members.

89. A method as claimed in any of Claims 74 to 88 in which each flotation element comprises a hollow flotation housing defining an airtight hollow interior region.

90. A method as claimed in any of Claims 74 to 89 in which each flotation element comprises a plastics material.

91. A method as claimed in any of Claims 74 to 90 in which each flotation element is formed by rotational moulding.

92. A method as claimed in any of Claims 74 to 91 in which the ballast housing comprises a plastics material.
- 5 93. A method as claimed in any of Claims 74 to 92 in which the ballast housing is formed by rotational moulding.
94. A method as claimed in any of Claims 74 to 93 in which the ballast material comprises a concrete material.
- 10 95. A method as claimed in any of Claims 74 to 94 in which the ballast material comprises reinforced concrete material.
96. A method as claimed in any of Claims 74 to 95 in which the ballast element is secured to the
15 main support structure by at least one fastener.
97. A method as claimed in Claim 96 in which each fastener comprises a threaded bolt extending through a corresponding bore extending through the ballast element.
- 20 98. A method as claimed in Claim 96 or 97 in which each fastener extends through a corresponding bore extending through the ballast housing.

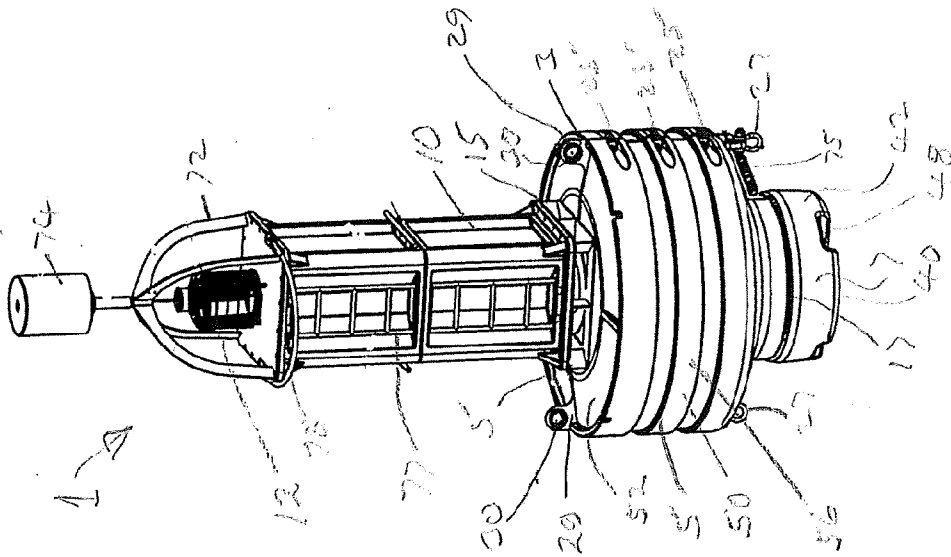


FIG 1

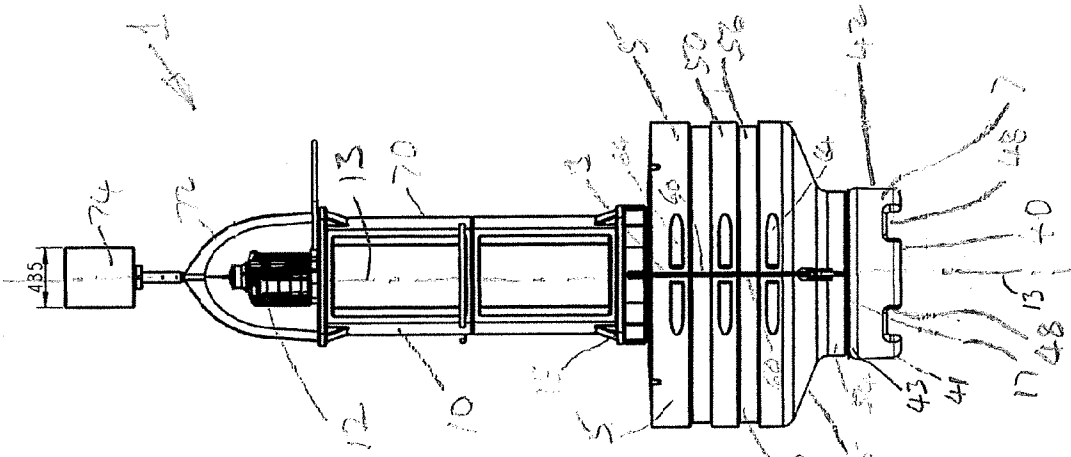


FIG 2

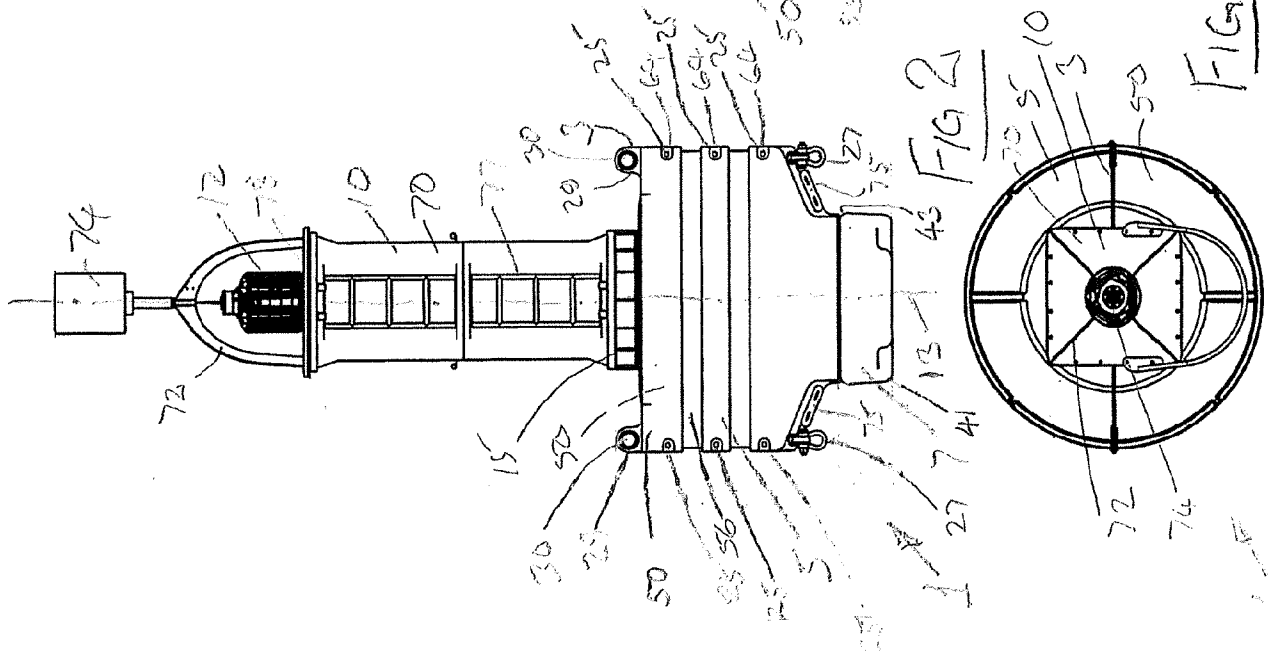


FIG 3

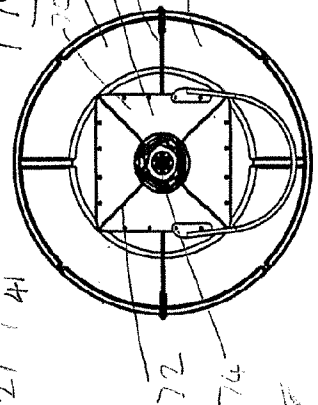
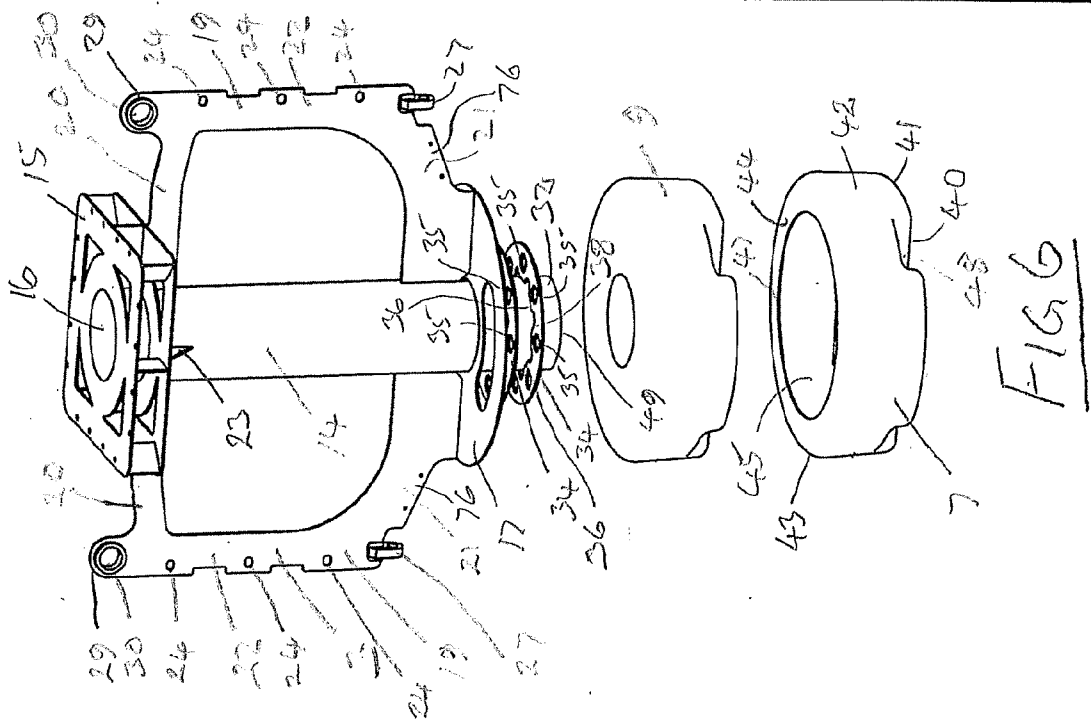
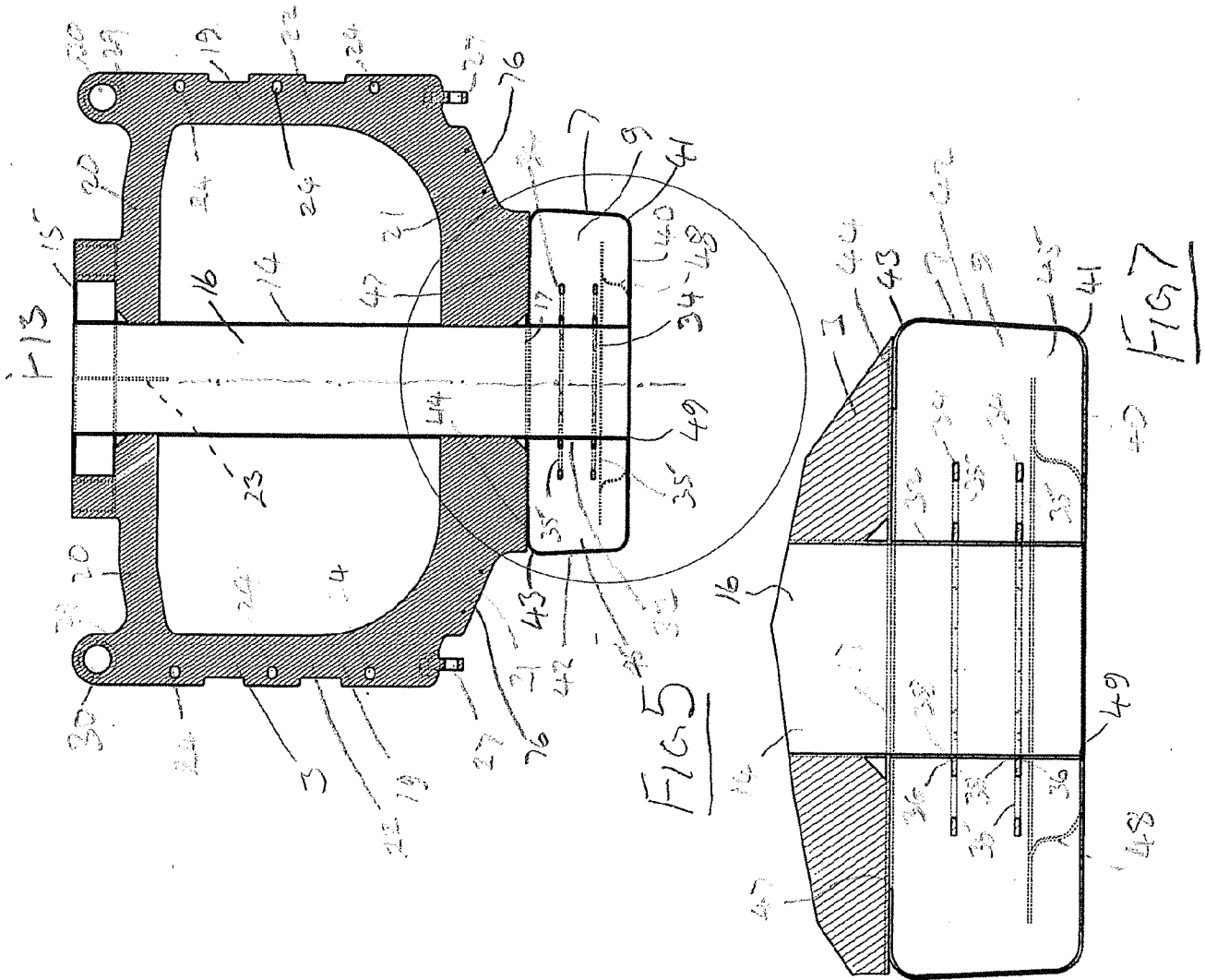


FIG 4



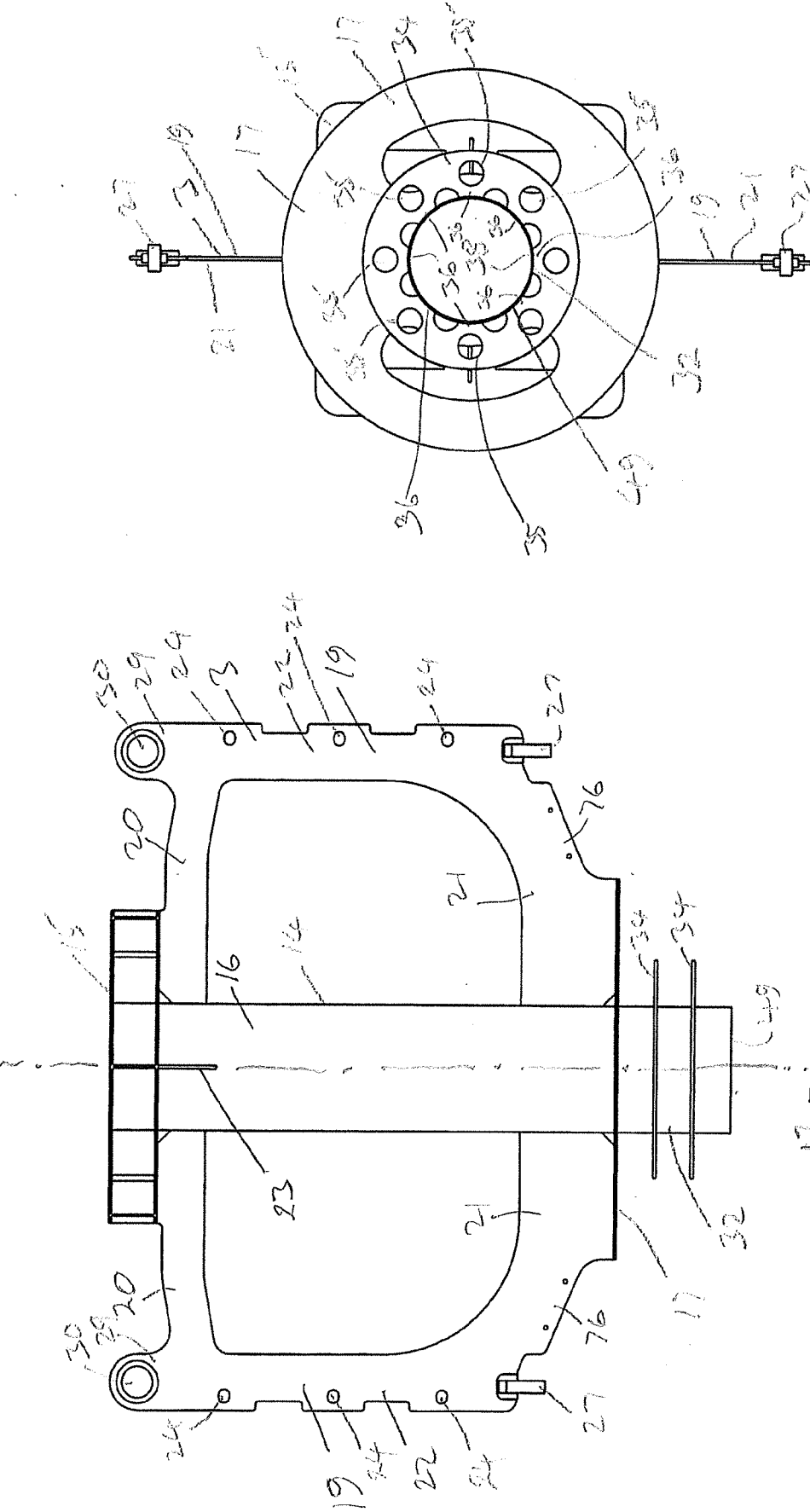
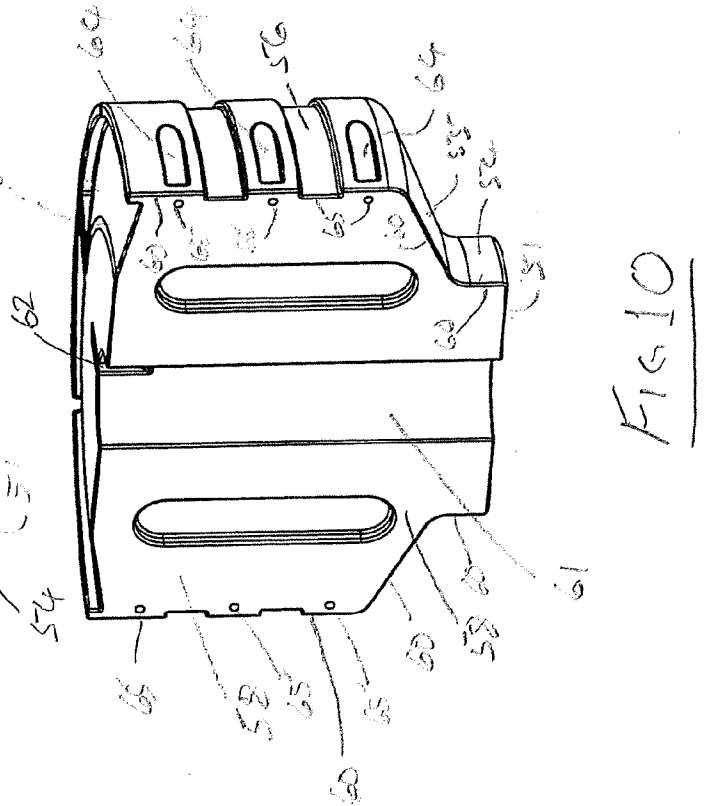
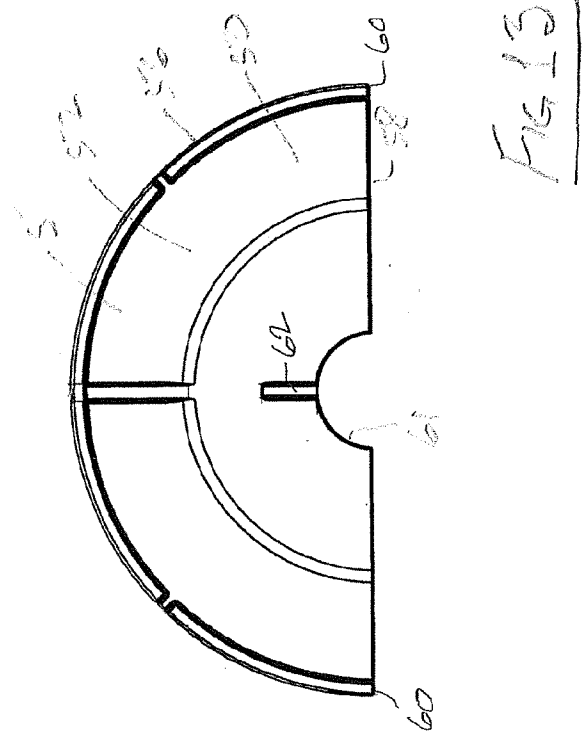
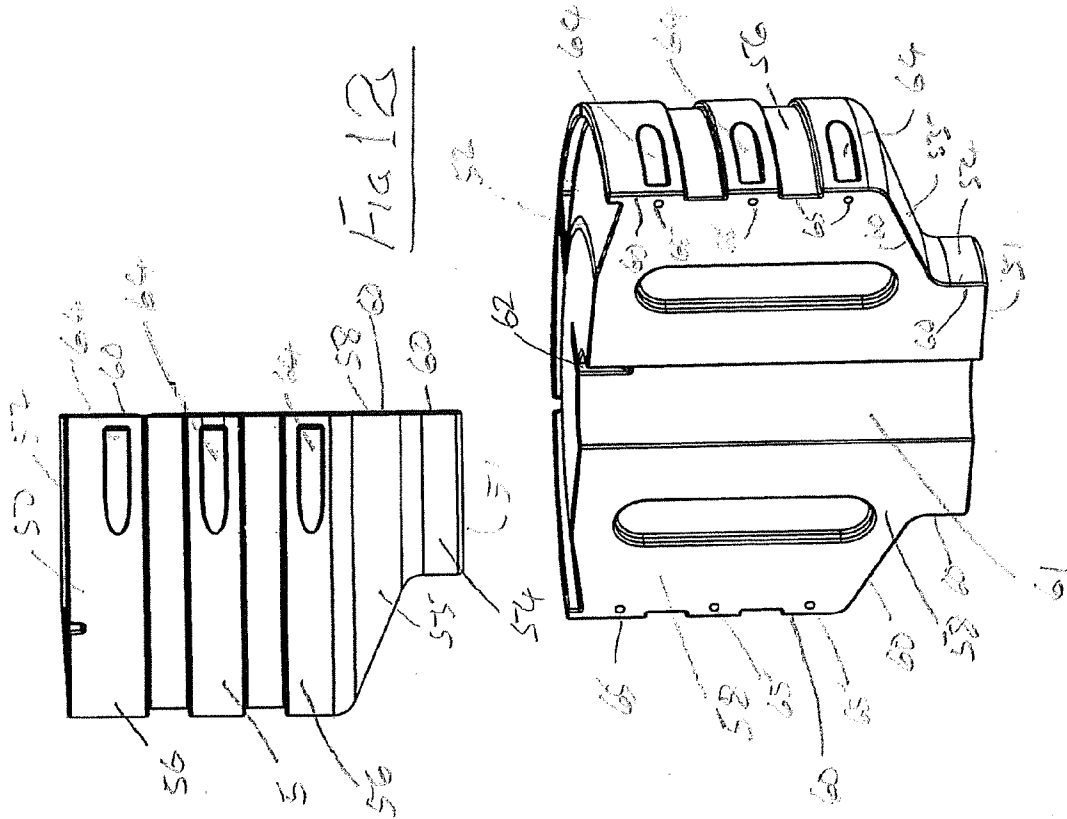
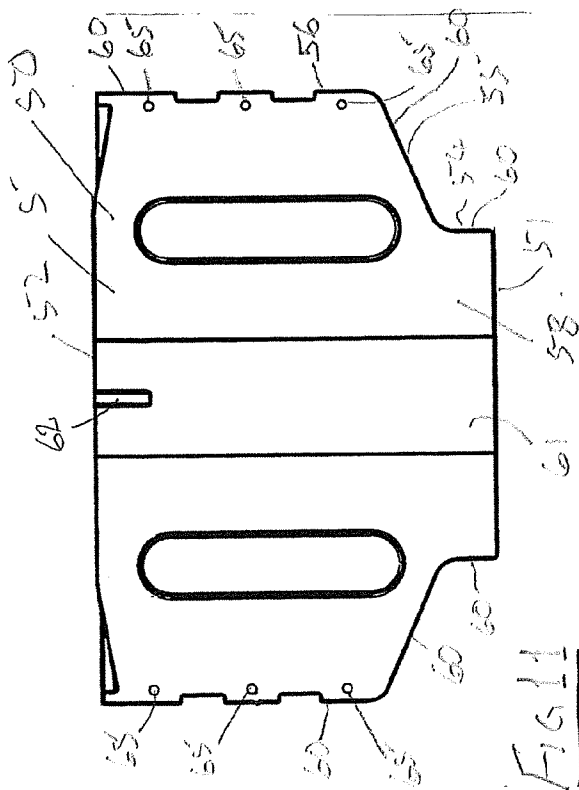


Fig 9

Fig 8



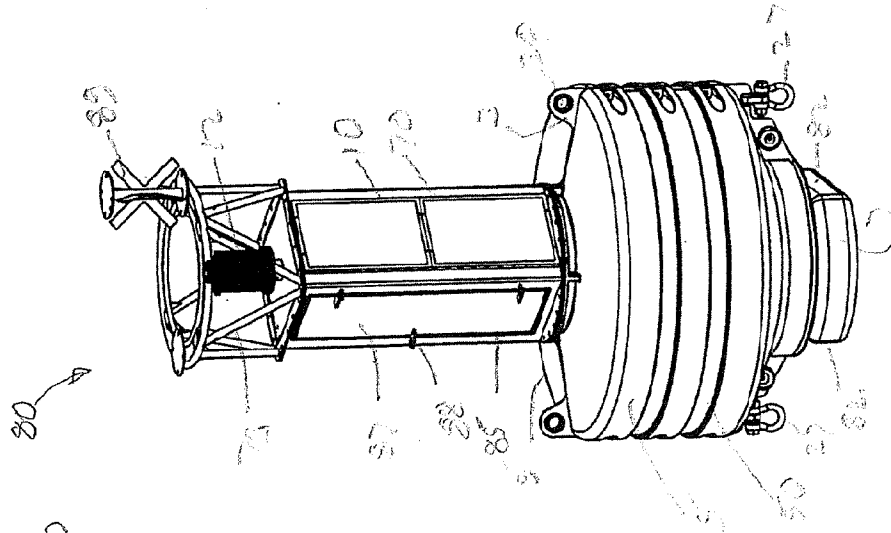


Fig. 14

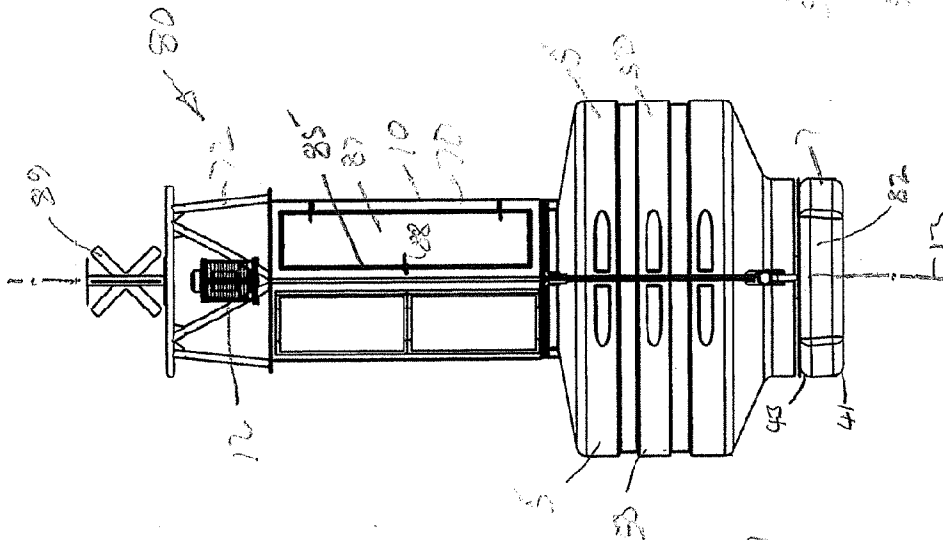


Fig. 16

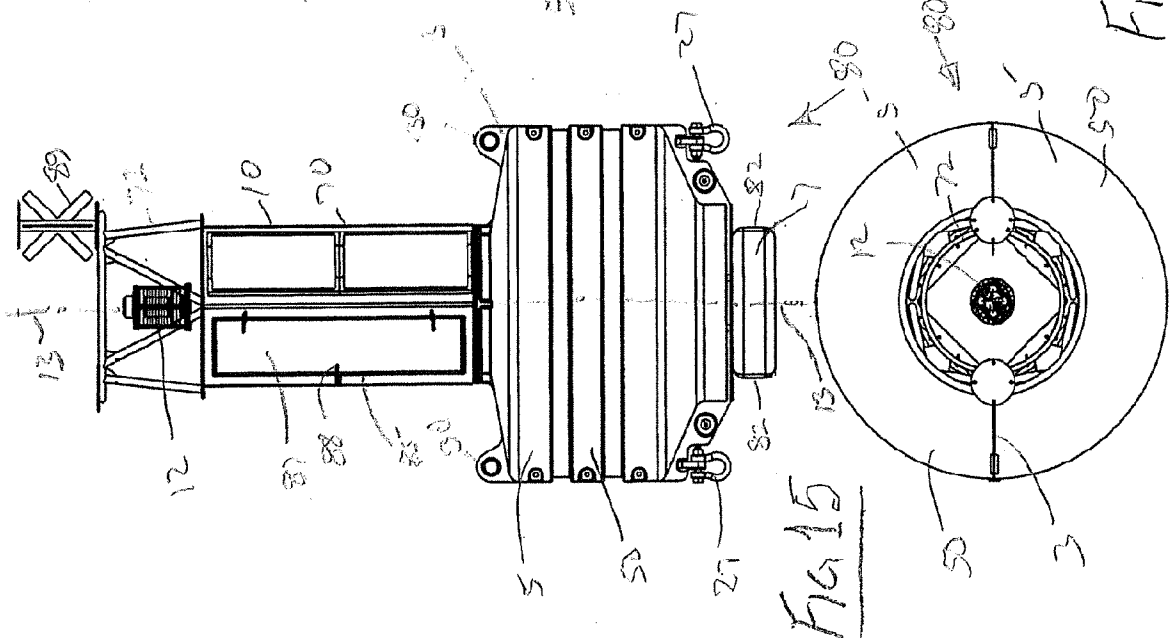
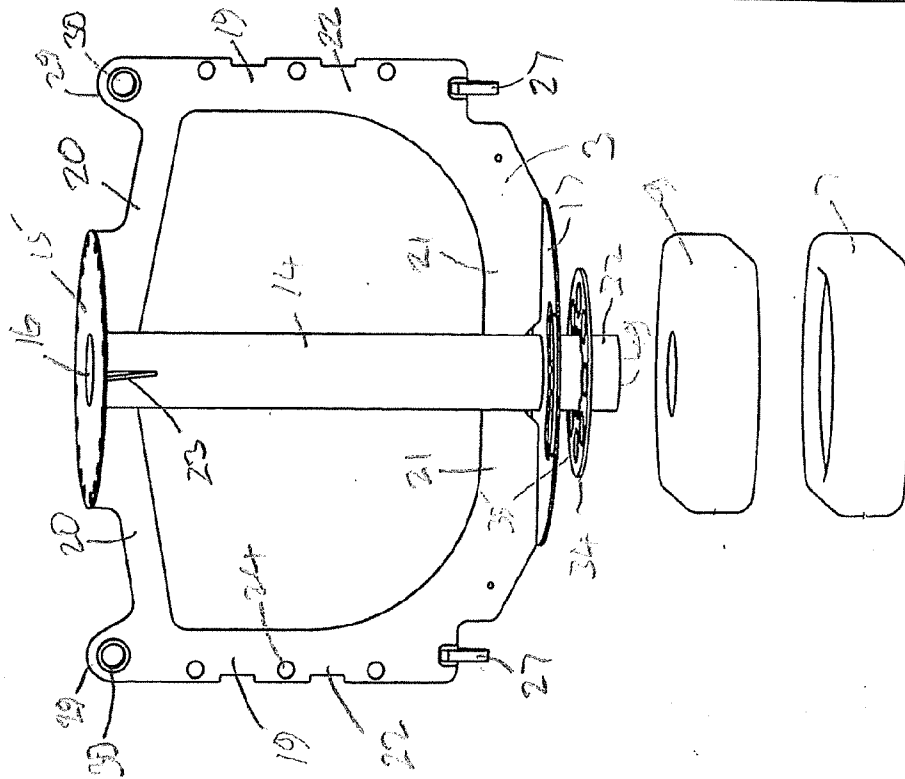
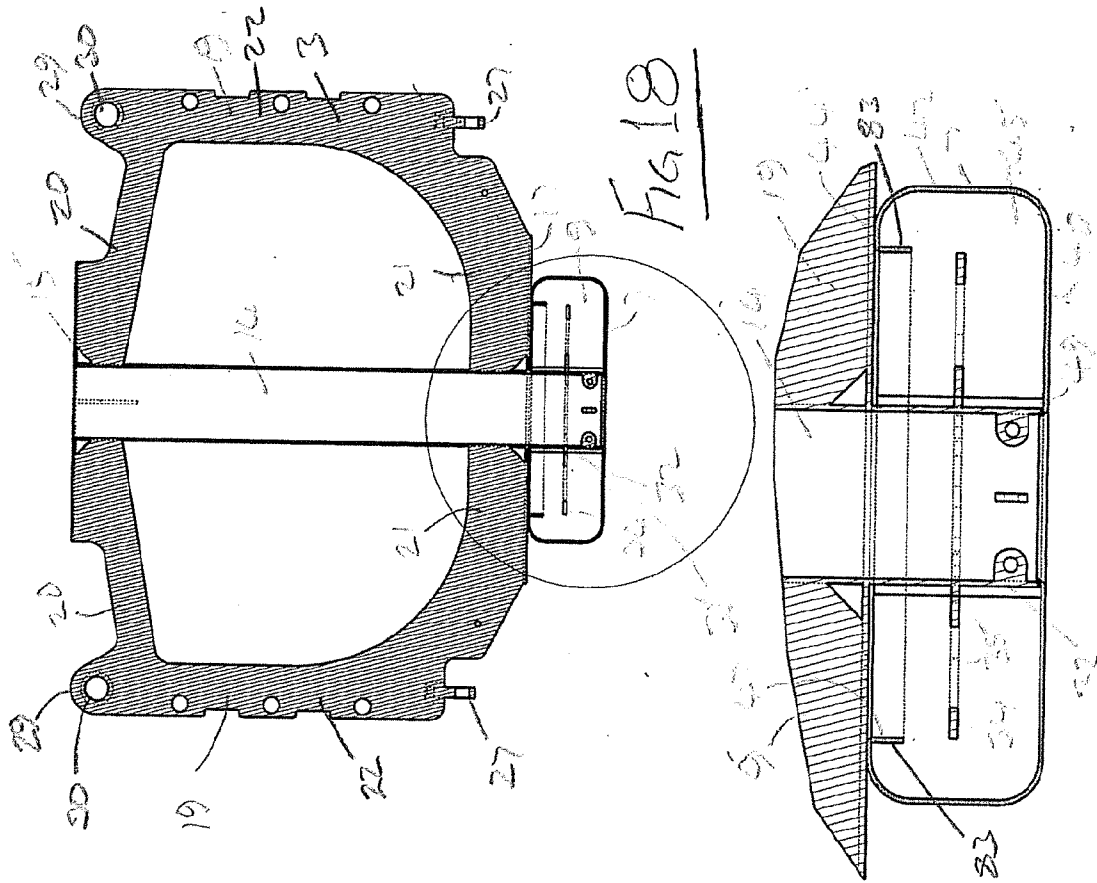


Fig. 15

Fig. 17



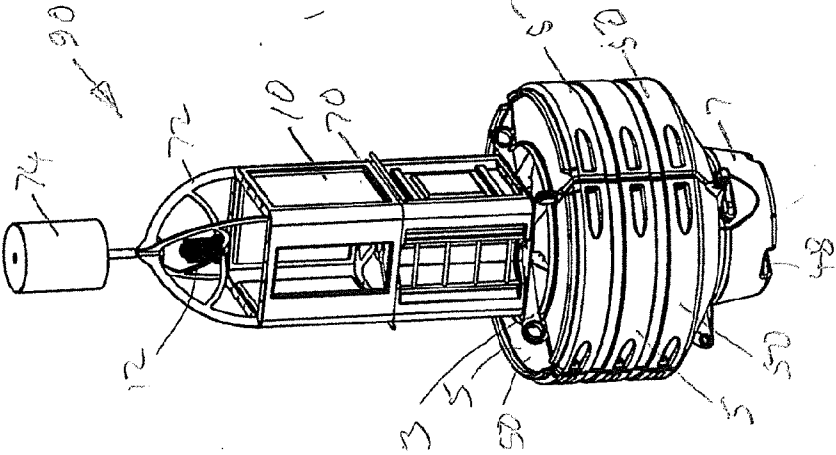


Fig 21

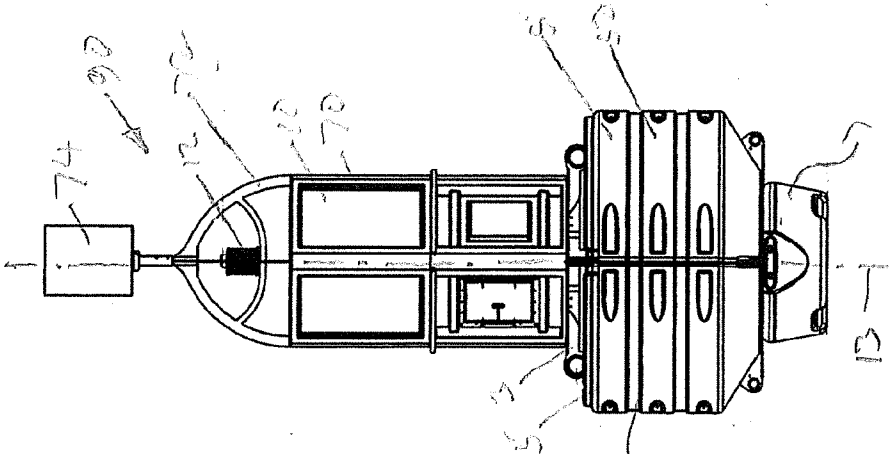


Fig 23

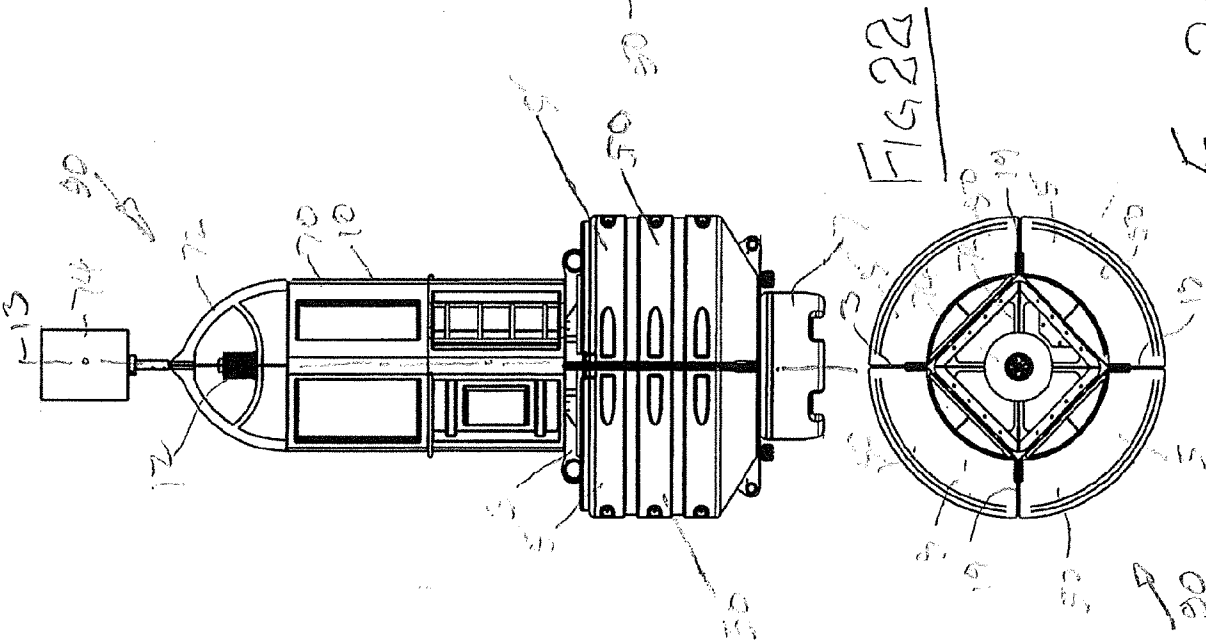
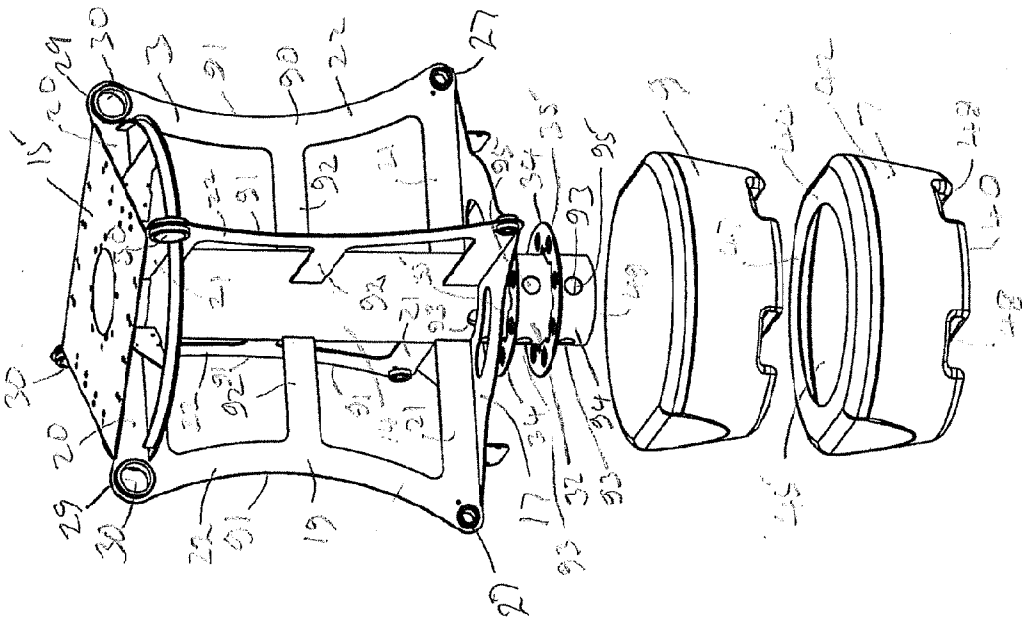
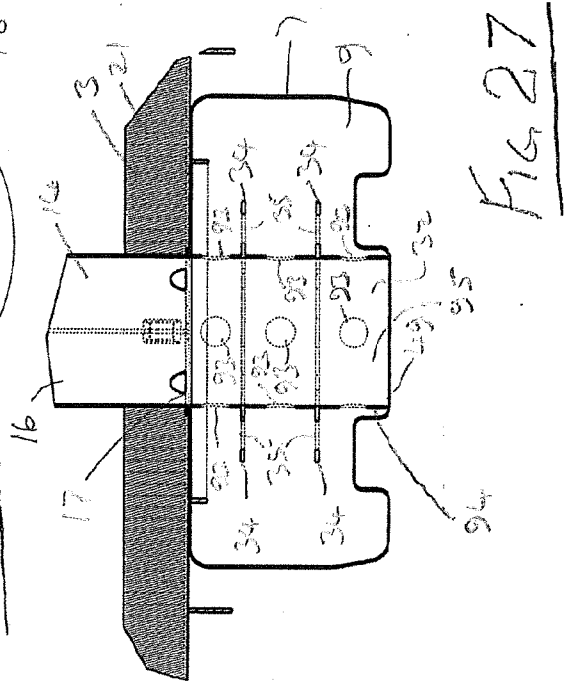
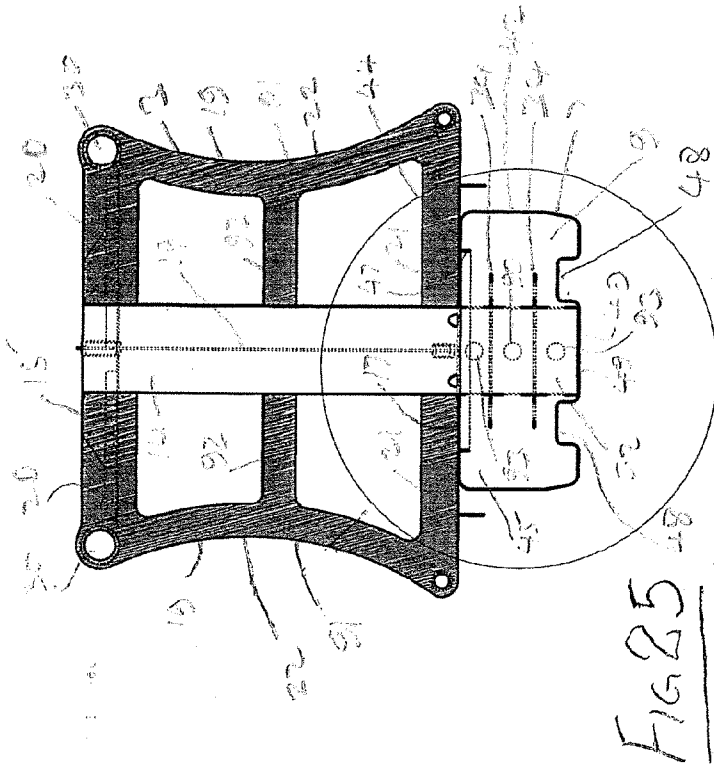


Fig 22

Fig 24



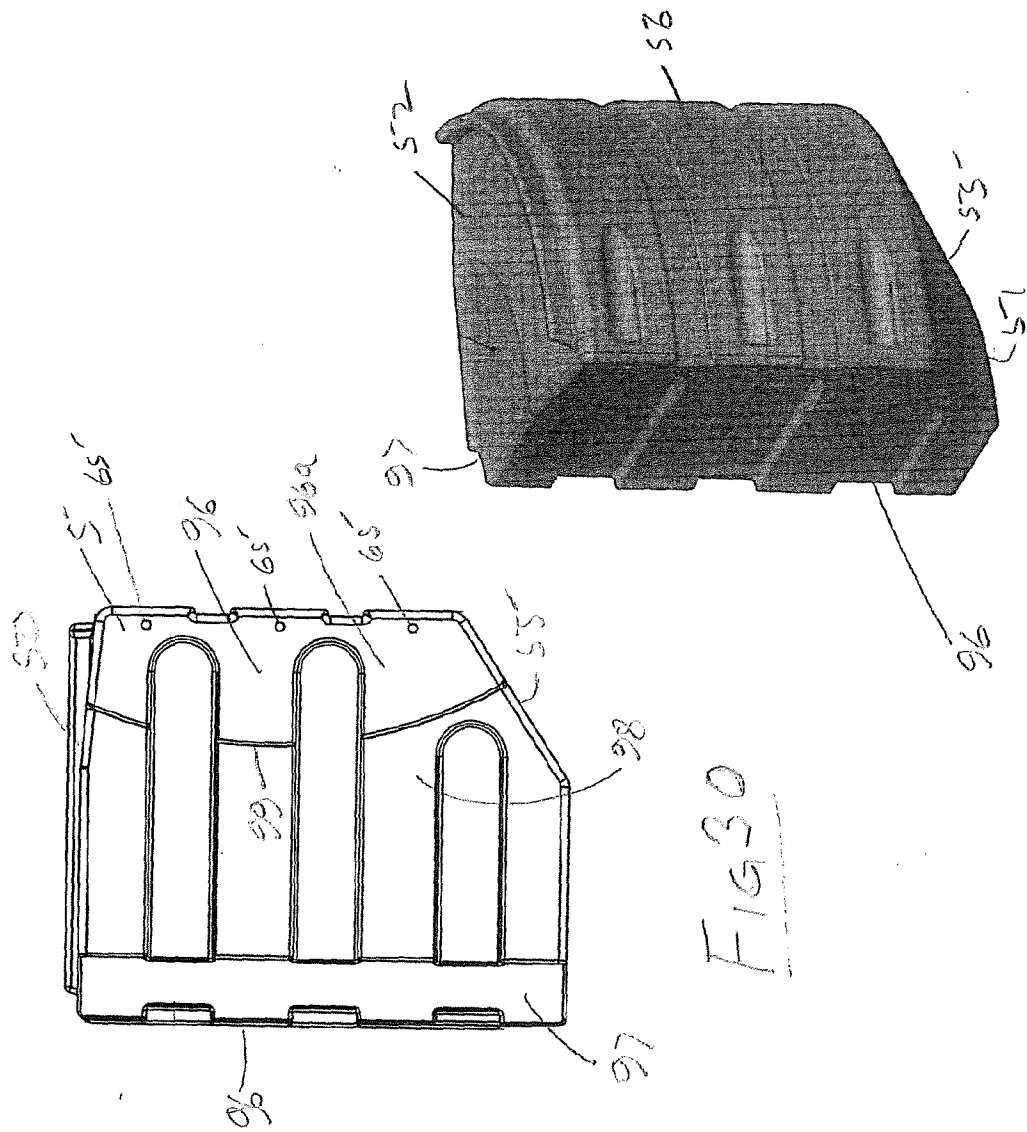


Fig 28

Fig 30

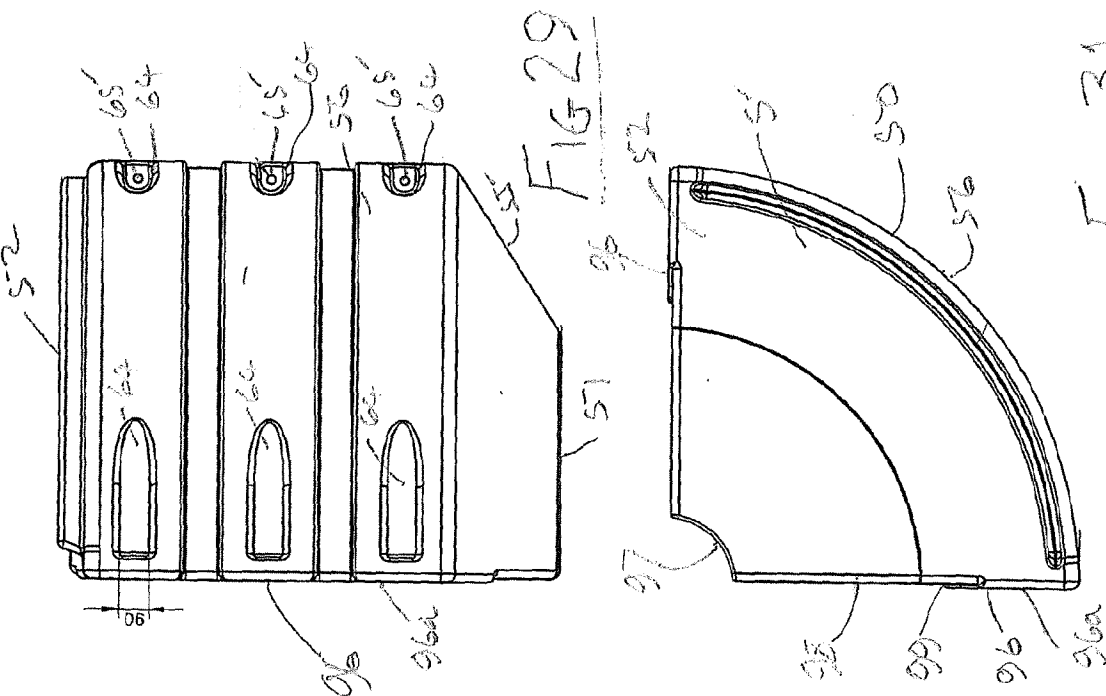


Fig 29

Fig 31

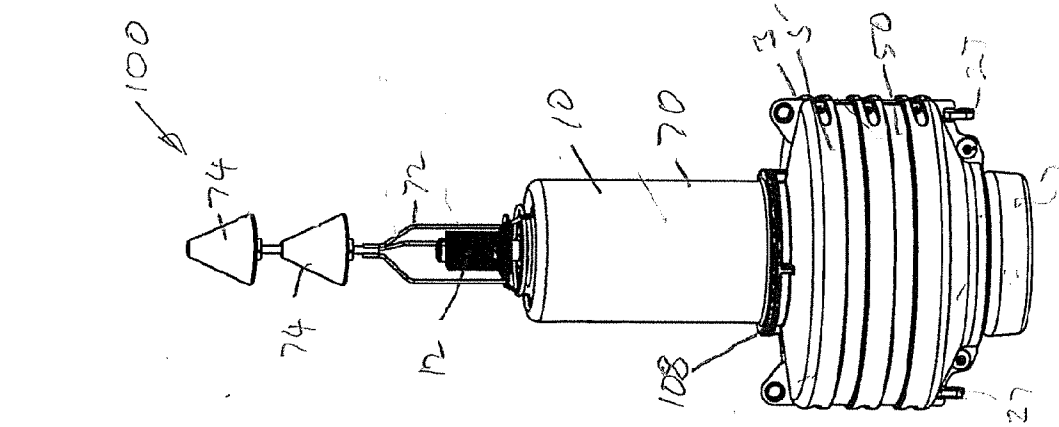


Fig 32

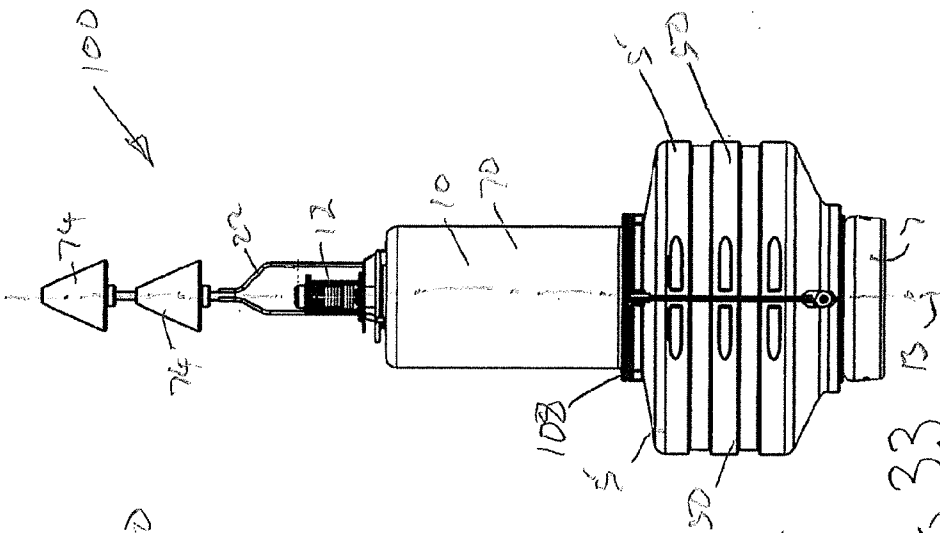


Fig 34

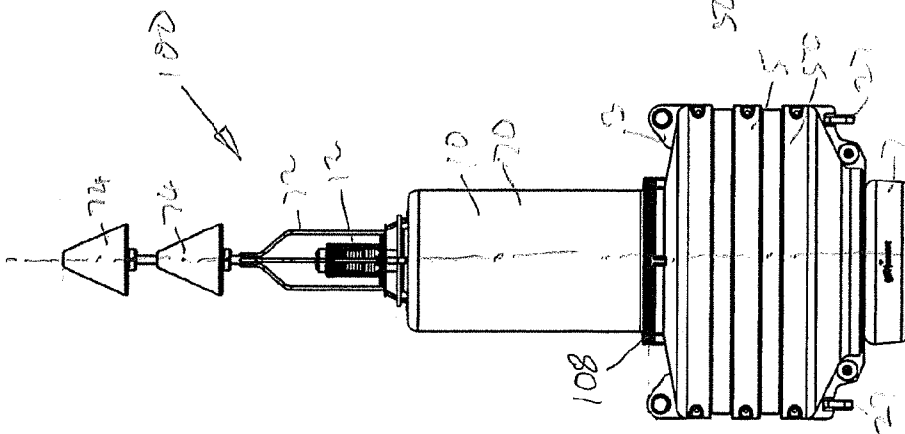
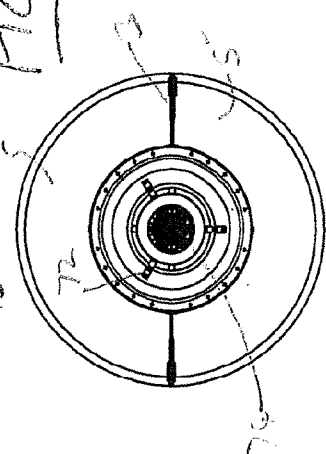
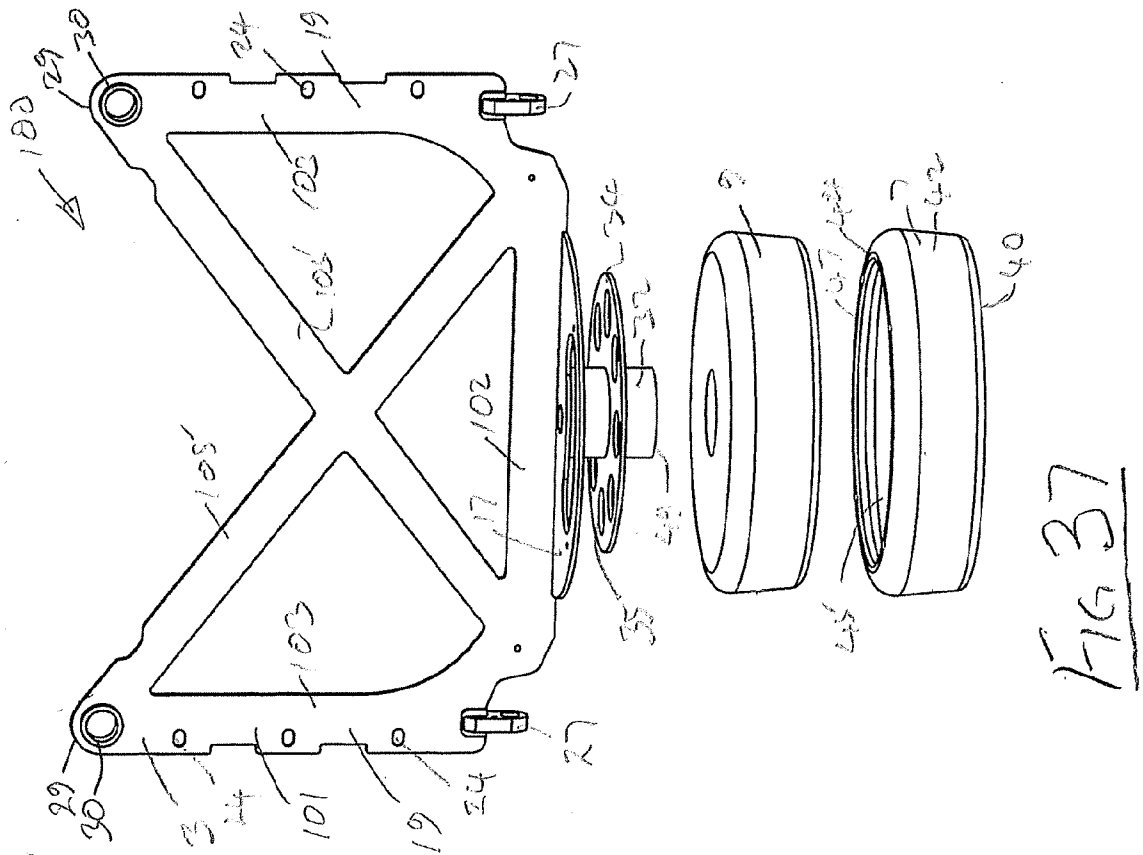
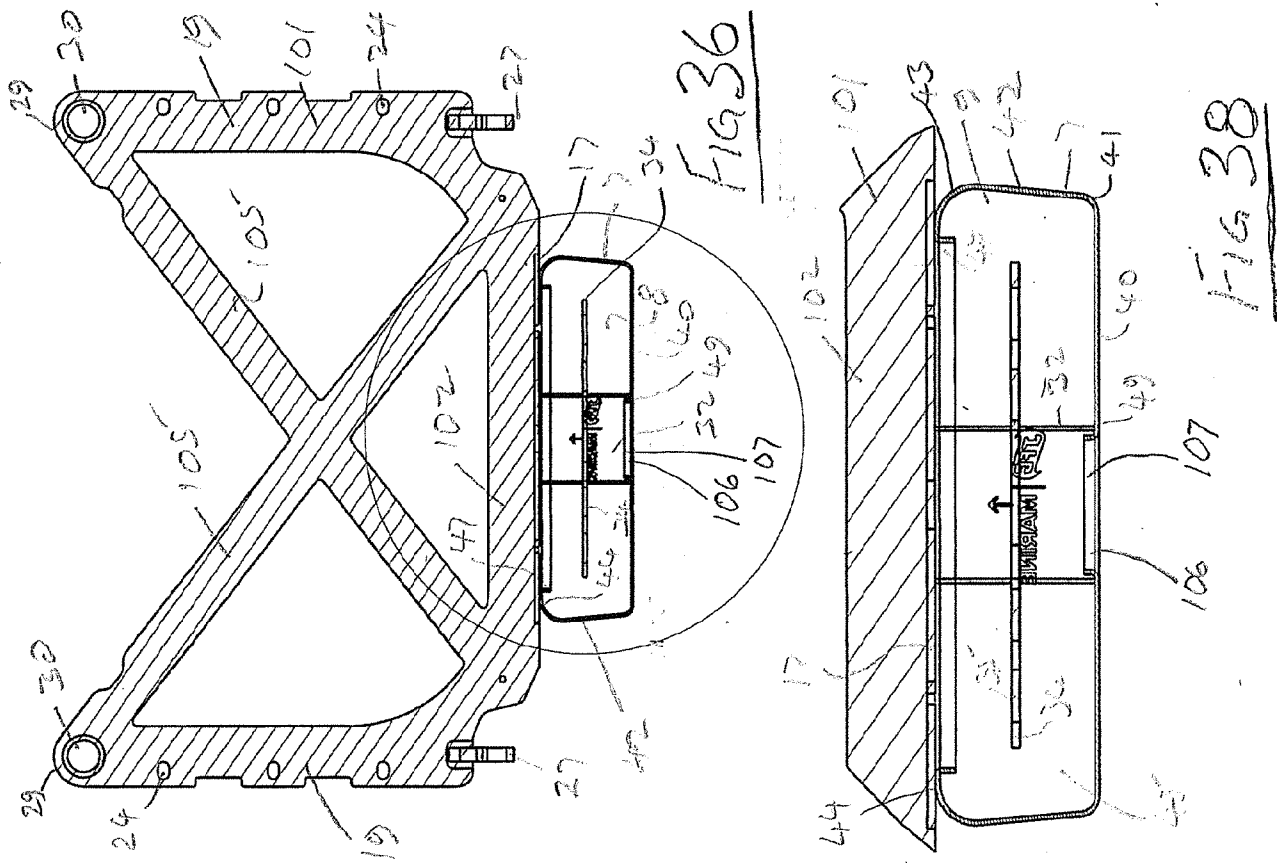


Fig 33

Fig 35





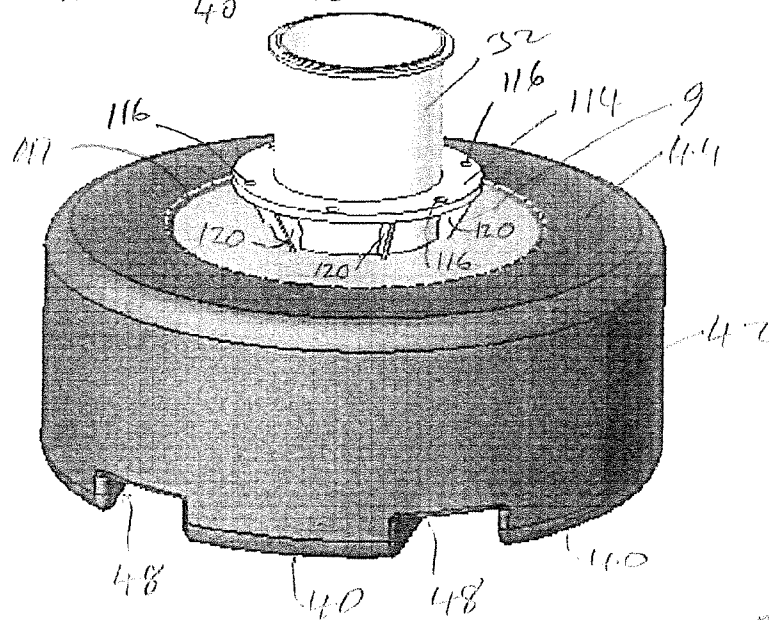
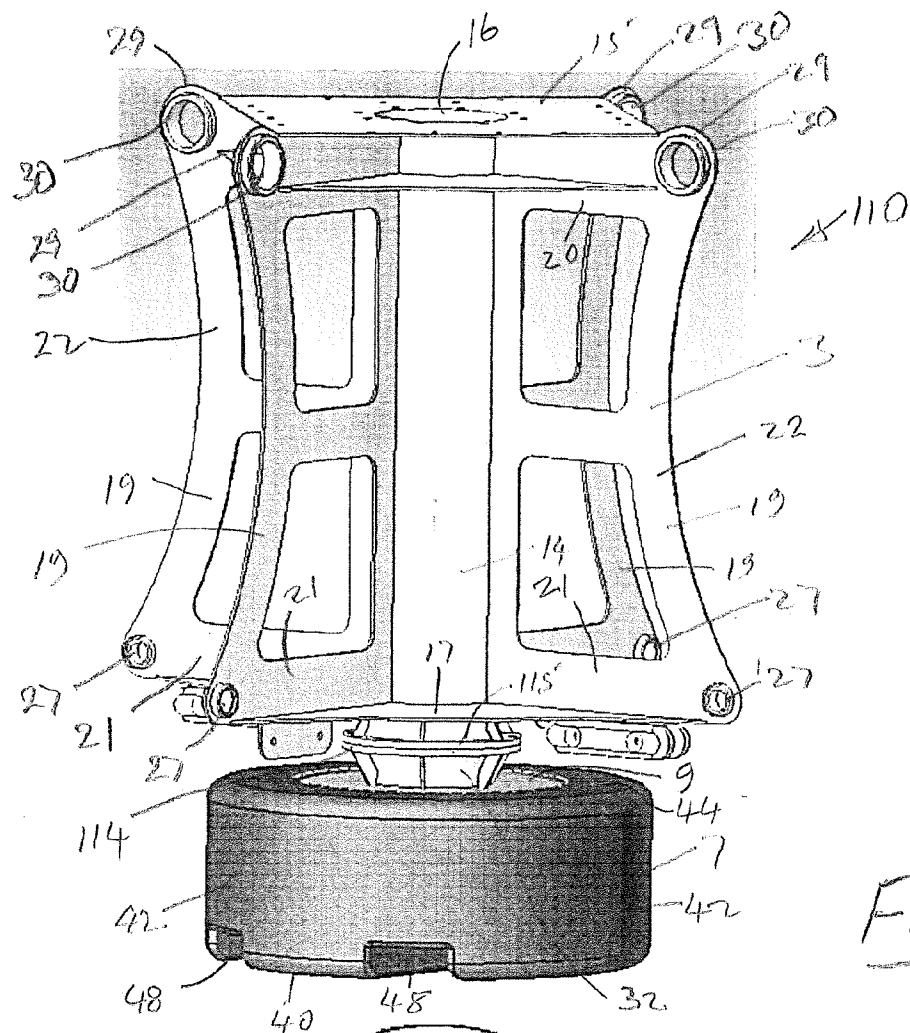


FIG 42

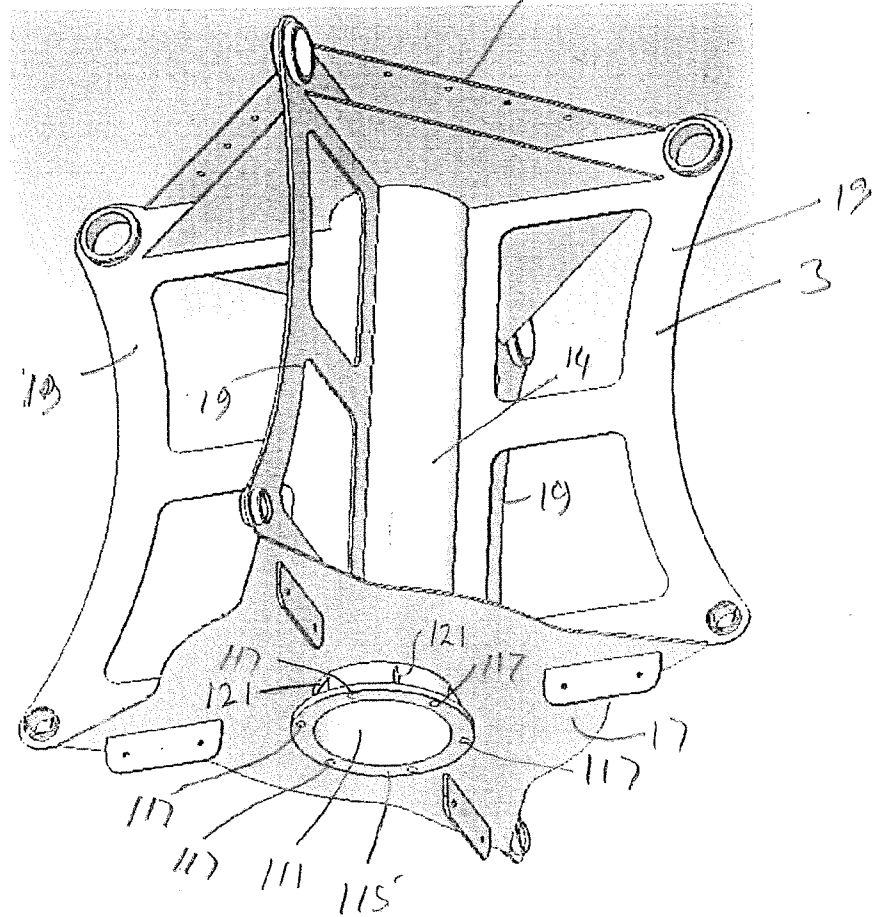
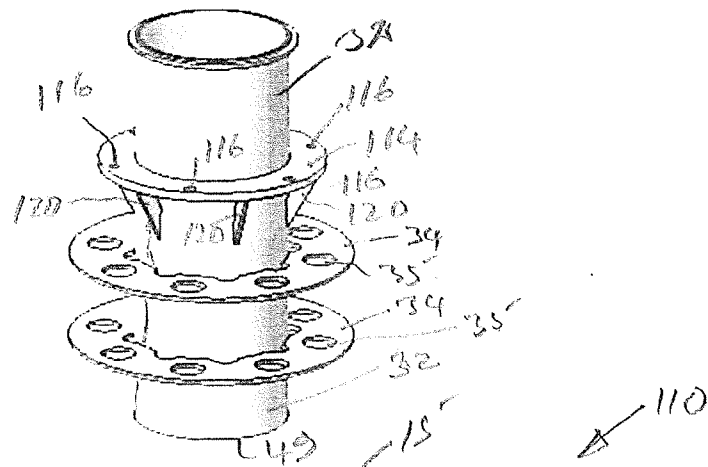


FIG 41

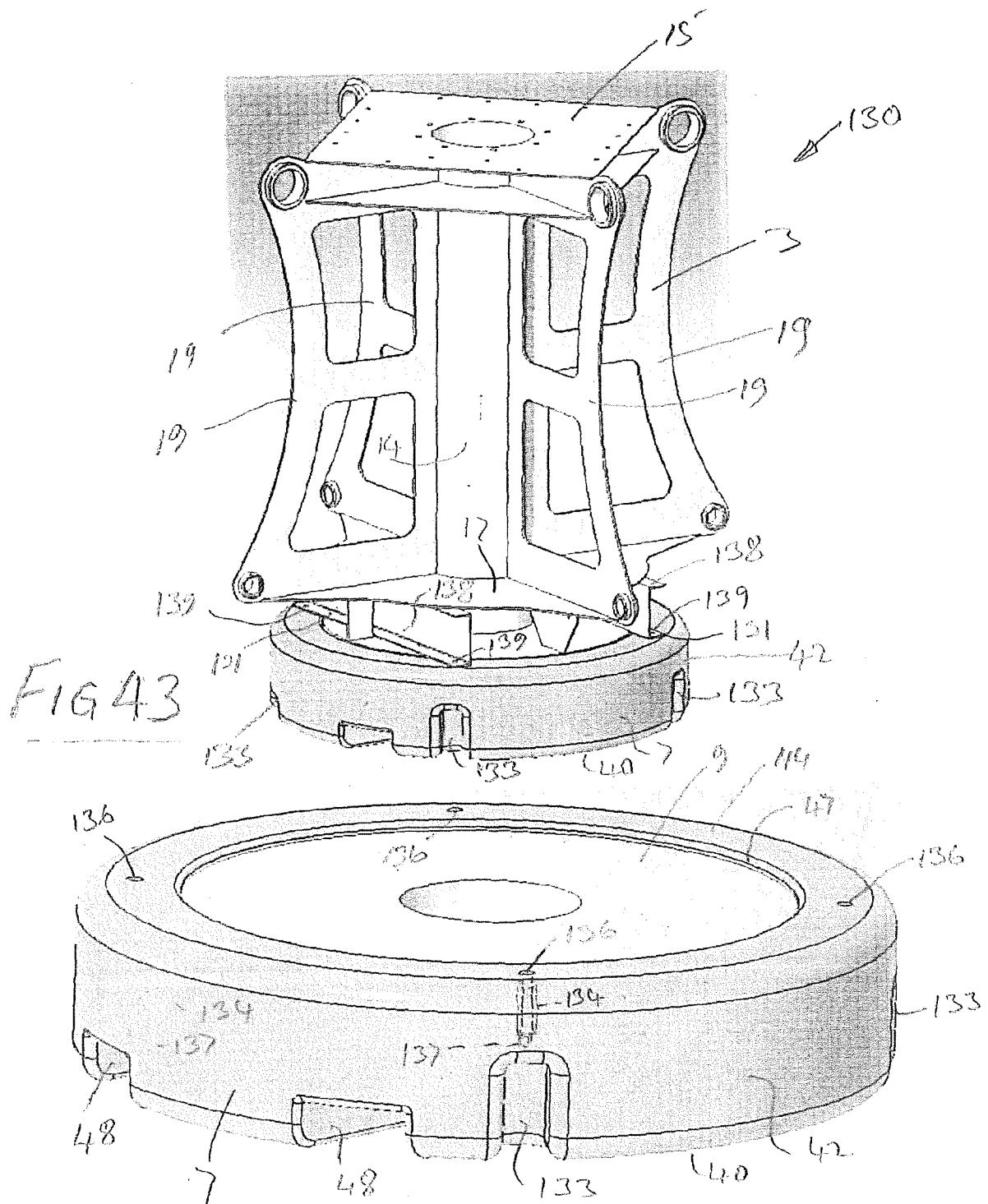


FIG 44

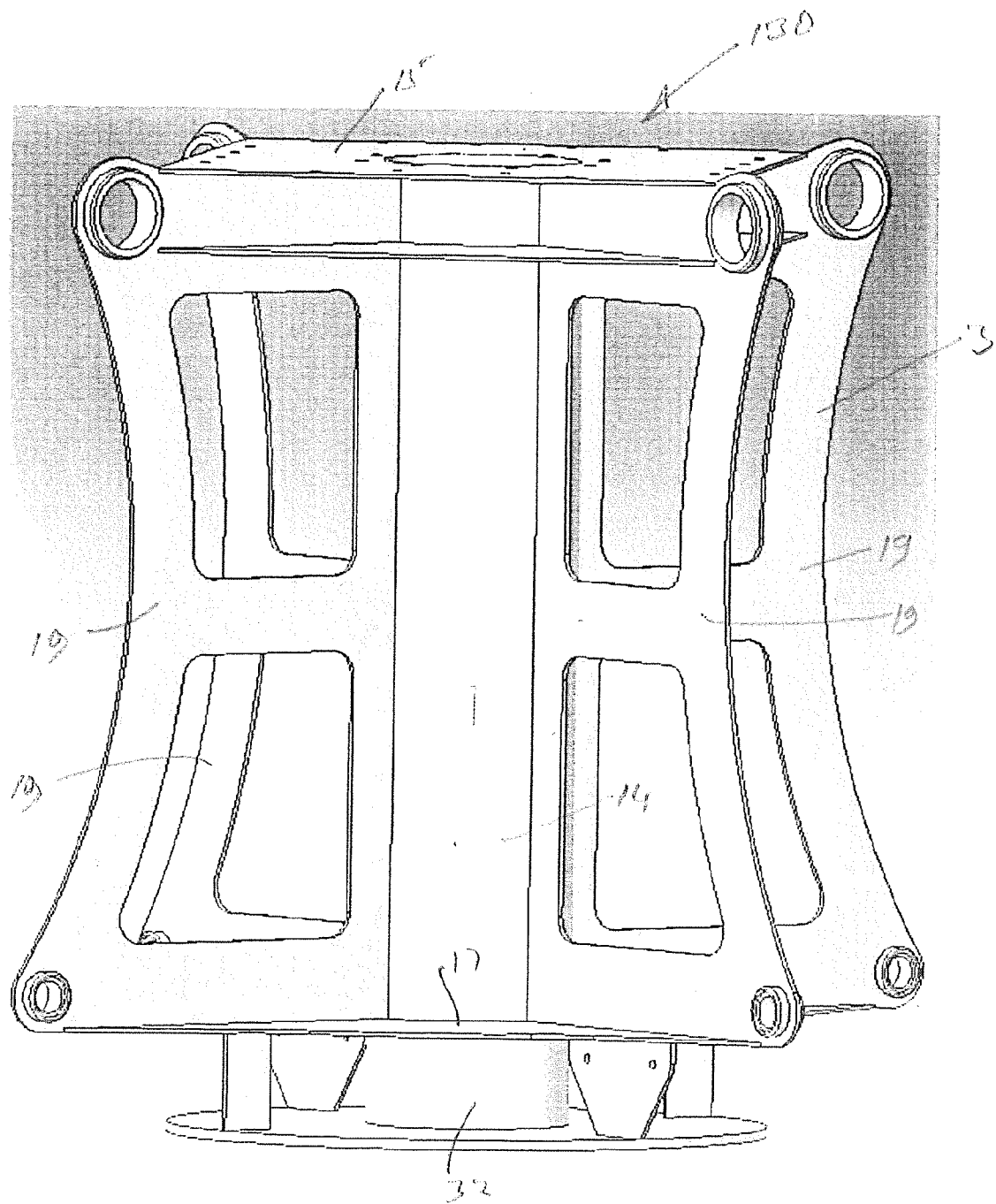


FIG 45

