(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 759 394 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**26.02.1997 Bulletin 1997/09**

(51) Int Cl.6: **B63H 11/08**, B63H 20/00, B63H 20/20, B63H 20/24

(21) Application number: **96305950.6**

(22) Date of filing: **14.08.1996**

(84) Designated Contracting States:
**DE FR GB IT SE**

(30) Priority: **23.08.1995 US 518368**

(71) Applicant: **Outboard Marine Corporation**
**Waukegan, Illinois 60085-2195 (US)**

(72) Inventors:
- **Varney, Michael A.**
  **Winter Park, Florida 32790 (US)**
- **Martino, John D.**
  **Longwood, Florida 32779 (US)**
- **Hall. Kimball P.**
  **East Setauket, New York 11733 (US)**

(74) Representative: **Harding, Richard Patrick et al**
**A. R. Davies & Co.**
**27 Imperial Square**
**Cheltenham GL50 1RQ (GB)**

## (54) Tractor pump jet

(57) A marine pump jet includes a rotor 132 located upstream and in front of the rotor drive mechanism within a stator hub 134. The lower unit 102 of the tractor pump jet has a rotor housing 106 which substantially surrounds the rotor 132 and a stator housing 108 located downstream of the rotor 132 and rotor housing 106. The drive shaft 34 extending from the powerhead of an outboard motor enters the stator hub 134 where a pinion gear 138 engages a crown gear 140 attached to the rotor shaft 142. This places the rotor drive mechanism downstream of the rotor 132 so that the rotor 132 is substantially the first mechanical element that water initially comes into contact with. The inlet opening 114 ofthe pump jet is larger than the outlet opening 116 at the outlet of the stator housing 108. Because the rotor 132 operates on essentially undisturbed, non-turbulent water, it is more efficient than traditional pump jets where the rotor is located aft ofthe drive mechanism. According to an alternative embodiment, a reverse shifting mechanism permits the tractor pump jet to operate in either the forward or reverse direction.

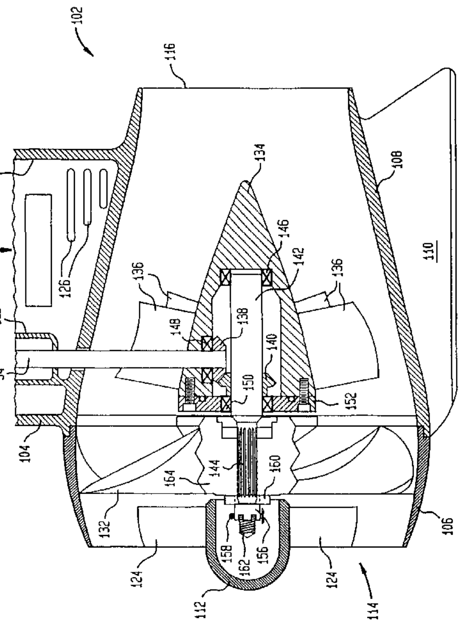



FIG. 4

EP 0 759 394 A1

## Description

### Background of the Invention

1. Field of the Invention

The invention relates to a marine pump jet apparatus in which the rotor is located upstream of the rotor drive mechanism.

2. Description of Related Art

Pump jets have been around for a number of years, but have not been widely used. They are generally characterized by a structure which includes a rotor and a stator section all surrounded by a housing. The upstream inlet of the housing is typically larger than the downstream outlet.

Pump jets, in general, have several advantages over traditional exposed propellers. First, because the rotor mechanism is shielded by the housing, it prevents swimmers, water skiers, skin divers, and the like, from being hit and injured by the rotating blades. This can be also important in areas where endangered wildlife, such as manatees, are located. Second, because the rotor is covered, it tends to be less likely to get caught in tow ropes, kelp, seaweed, etc. Third, under certain circumstances, the pump jet is more efficient than traditional exposed propellers. This makes the pump jet especially suitable for sports and military applications. Conventional pump jets are normally mounted as a retro-fit item onto the lower unit of a conventional outboard. This is a relatively simple and straightforward approach because it requires the minimal amount of modification of the outboard marine engine. A price is paid, however, for mounting the pump jet downstream of the lower unit of the outboard, namely, that the rotor intake operates on water that has been significantly disturbed by the "bullet" portion of the lower unit of the outboard.

A conventional prior art outboard is illustrated in Fig. 1. An antiventilation plate (sometimes referred to as an "anticavitation" plate) is located between the mid-section of the outboard motor and the lower unit. The antiventilation plate prevents the naked rotating propeller from sucking air down from the surface, i.e., aspirating, thereby decreasing the thrust of the propeller. It would be very difficult to place a traditional naked propeller up front of the drive unit because the antiventilation plate would be much less effective in such an arrangement. Therefore, outboard propellers are generally located downstream of the drive unit under the protection of the antiventilation plate. One advantage of pump jets, however, is that they do not need antiventilation plates in view of the fact that the rotor and stator mechanisms are completely covered and protected by a housing.

There has been a moderate amount of effort to develop marine pump jets, even though they have not been widely accepted. Perhaps the best known of the inventors in this area is Dr. Kimball P. Hall whose name appears as inventor or co-inventor on the following U. S. Patents which are representative of the state-of-the-art: 3,389,558; 3,849,982; 4,023,353; 5,273,467; and, 5,325,662. All of the foregoing patents describe marine pump jets which are retrofitted onto the lower drive unit of an outboard motor and, therefore, are located downstream of the rotor drive mechanism. Because the pump jets are located aft of the drive unit, the water intake into the rotor is substantially turbulent and disturbed This reduces the efficiency of the unit.

In view of the foregoing, there appears to be a clear need for a marine pump jet which can take in undisturbed water at the inlet in order to improve efficiency.

### Summary of the Invention

Briefly described, the invention comprises a tractor marine pump jet in which the rotor is located upstream of the rotor drive mechanism. In this manner, the rotor operates on water that is relatively undisturbed. According to the preferred embodiment, the lower unit of the tractor pump jet apparatus is attached to the mid-section of a conventional outboard motor. A drive shaft from the power head of the outboard motor extends through the mid-section and down into a stationary stator housing. A pinion gear attached to the drive shaft engages a crown gear attached to the rotor. The rotor is located upstream of the rotor drive mechanism. A circular housing completely surrounds the rotor. A rotor housing is attached to the stationary stator housing and located upstream thereof. A plurality of stator vanes structurally connect the stator hub to the inside of the stator housing. The rotor housing includes a circular inlet opening which is larger than the outlet opening at the end of the stator housing. A nose assembly protects the nut and cotter pin that attach the rotor to the rotor drive shaft. The nose assembly also extends slightly beyond and ahead of the inlet opening. Because the drive mechanism is located downstream of the rotor, the rotor acts upon inlet water that is relatively non-turbulent. This improves the efficiency of the overall mechanism.

According to an alternative embodiment of the invention, a reversing mechanism is located downstream of the rotor to selectively dnve the rotor in either a forward or reverse direction.

These, and other features of the invention, will be more fully understood by reference to the following drawings.

### Brief Description of the Drawings

Fig. 1 is an elevational, schematic view of a typical, prior art outboard motor equipped with a naked, rotating propeller.

Fig. 2 is an elevational view of the marine tractor pump jet apparatus according to the preferred embodiment of the invention as attached to the powerhead and mid-section of a conventional outboard motor.

Fig. 3A is a front, elevational view of the preferred embodiment of the tractor pump jet invention.

Fig. 3B is a side, elevational view of the tractor pump jet invention illustrated in Fig. 3A.

Fig. 4 is a side, elevational, cross-sectional view of the marine tractor pump jet apparatus according to the preferred embodiment ofthe invention and as illustrated in Figs. 2, 3A and 3B.

Fig. 5A is a detailed, cross-sectional view of the nose cover and rotor retaining nut assembly.

Fig. 5B is a detailed, cross-sectional view of the rotor spline and thrust washer assembly.

Fig. 5C is a detailed, cross-sectional view of the closure plate structure.

Fig. 5D is a detailed, cross-sectional view of the drive shaft and exhaust gas duct system.

Fig. 6A is a perspective rear view of the rotor.

Fig. 6B is a perspective front view of the rotor.

Fig. 6C is a side, elevational view of the rotor.

Fig. 6D is a front, elevational view of the rotor.

Fig. 7A is a cross-sectional view of an alternative embodiment of the invention which includes a reverse shifting mechanism.

Fig. 7B is a cross-sectional view of the drive shaft and shift rod shown in Fig. 7A taken from perspective 7B-7B.

Fig. 7C is a detailed, cross-sectional view of the reverse shifting mechanism shown in Fig. 7A.

## Detailed Description of the Invention

During the course of this description, like numbers will be used to identify like elements according to the different figures which illustrate the invention.

A prior art outboard motor 10 is illustrated in Fig. 1 for reference. The prior art outboard motor 10 is connected to the stern of a boat 12 by a conventional mounting bracket 14. The boat 12 is typically employed in fresh or salt water 16. The powerhead 18 of the outboard motor 10 is structurally attached to a mid-section 20 which is, in turn, connected to a lower unit 22 through a bolt plate 24. An antiventilation plate 26 is located just below the water line and directly above the rotating propeller 28. Antiventilation plate 26 is necessary in all large size outboard motors in order to prevent the propeller 28 from sucking air from the surface of the water 16 into the water stream flowing through the propeller. Air ingested into the propeller 28 significantly decreases the efficiency and thrust of the prior art outboard motor 10. Therefore, antiventilation plates, such as illustrated by 26 in Fig. 1, are necessary when a naked propeller 28 is employed. They are generally not necessary, if a pump jet such as illustrated, for example, in Figs 2 - 7C, is employed. Lower unit 22 includes a "bullet" 30 which houses the propeller drive gear mechanism and a skeg 32 which provides the propeller 28 with some protection against being hit by submerged objects such as rocks, logs, etc. A drive shaft 34 connects the powerhead 18 to the propeller 28 through the gear mechanism in the bullet 30. This causes the propeller 28 to rotate in the direction of arrow 36 thereby propelling the boat 12 in a forward direction indicated by arrow 40 against the flow of water 16 indicated by arrow 38.

Prior art, naked propeller, outboard motors 10, such as illustrated in Fig. 1, have several shortcomings. First, and foremost, they are dangerous because the rotating propeller can hit swimmers, water skiers, seals, manatees, etc. Second, they require antiventilation plates, such as plate 26, in order to prevent the aspiration of air into the wash of propeller 28. If a propeller 28 is removed and retrofitted with a pump jet, such as described, for example, in the following previously cited prior art patents: 3,389,558; 3,849,982; 4,023,353; 5,273,467; and, 5,325,662, then some of the safety and efficiency problems have been addressed, but, because the retrofitted pump jets are located aft of the drive gear bullet, the water flowing into the pump is turbulent thereby decreasing the efficiency of the pump jet. In order to resolve this problem, a tractor pump jet was invented which permitted the rotor to be located upstream of its traditional place so that it can benefit from the intake of relatively undisturbed, nonturbulent flow.

The invention, according to its preferred embodiment, is illustrated in Figs. 2 - 6. The invention is referred to as a manne "tractor pump jet" because the rotor pulls the lower unit along rather than pushes it, as was the case with prior art propellers such as illustrated in Fig. 1. As shown in Fig. 2, the marine tractor pump jet lower unit 102 is attached to, and supported by, the mid-section 20 of the modified outboard motor 100. A bolt plate or plane 24 physically connects the mid-section 20 to the lower unit 102. A support strut 104 extends from the bolt plate 24 and attaches to the exterior of the pump jet housing which includes a rotor housing 106 and a stator housing 108. A skeg 110 is connected to the bottom side of the pump jet stator housing 108 and protects the lower unit 102 in the same manner that the prior art skeg 32 protects the prior art propeller 28 as illustrated in Fig. 1.

A nose cover assembly 112, illustrated in further detail in Fig. 5A, protects the rotor attachment nut 156 and extends upstream of the rotor inlet opening 114. Water 118, located directly ahead ofthe inlet 114 enters the housing 106, 108 and is expelled through the stator outlet opening 116 as a downstream jet 120. Inlet opening 114 is larger in cross-sectional area than outlet opening 116, thereby producing the jet effect.

Fig. 3A is a front, elevational view of the lower unit 102 illustrating the manner in which the easily removable rotor housing 106 is attached with bolts 122 to the stator housing 108. Four inlet struts 124 extend from the nose cover assembly 112 to the inside of the rotor housing 106. Struts 124 provide mechanical support to the nose cover 112 and also help to prevent debris and the like from entering into inlet opening 114.

Fig. 3B is a side, elevational view of the lower unit

102 of the tractor pump jet apparatus illustrated in Fig. 3A. Exhaust gases 127 from the powerhead 18 pass through chamber 128 and out of the exhaust gas exit slots 126, illustrated in further detail in Fig 5D. The drive shaft 34 is shown passing through the lower bolt plate 24. The lower unit 102 is attached to the mid-section 20 of the modified outboard 100 by five bolts 130 which pass through the lower bolt plate 24 and into an upper bolt plate, also 24, which is at the base of the mid-section 20.

Fig. 4 is a cross-sectional, elevational view of the lower unit 102 of the tractor pump jet invention. Rotor 132 is shown inside of rotor housing 106. Rotor 132 is located adjacent the inlet opening 114 so that it drinks in relatively undisturbed, non-turbulent flow, but is located upstream of the rotor drive mechanism which is housed within the stator hub 134 which includes the gear case. Stator hub 134 is attached by eight stator vanes 136 to the inside of the stator housing 108. Drive shaft 34 extends through the lower strut 104 and through the stator housing 108 into the interior of the stator hub 134. A pinion gear 138 is attached to the bottom of shaft 34 and engages a crown gear 140 attached to the rotor shaft 142. A set of splines 144 at the upstream end of rotor shaft 142 engage grooves 172, shown in Figs. 6A - 6D, of the rotor 132. A pair of bearings and seals 146 and 150 support rotor shaft 142. Another bearing/seal 148 locates and protects the shaft 34 at the point that it enters the stator hub 134. A closure plate 152 is attached by bolts 154 to the stator hub 134 as also illustrated in cross-sectional detail in Fig. 5C. A rotor retaining nut 156 is threadably received on the threads 162 at the furthest upstream end ofthe rotor shaft 142. A cotter pin 158 keeps the rotor retaining nut 156 from backing off of the rotor retaining washer 160 and the rotor shaft 142 as illustrated in Fig. 5A. The nose cover 112, which extends beyond the inlet opening 114, protects the rotor attachment elements 156, 158, 160 and 162.

Fig. 5B is a cross-sectional detail ofthe rotor hub 164 illustrating how the splines 144 on the rotor shaft 142 engage with the grooves 172 in the rotor hub 164. A thrust washer 143 surrounds shaft 142 downstream ofthe rotor 132 and serves to transfer thrust forces from the rotor 132 to the rotor shaft 142 at the downstream conical step 145 in the rotor shaft and abuts closure plate 152. Also, as previously discussed, note the groove 172 elements in Figs. 6A - 6D.

The cross-sectional detail of Fig. 5C illustrates how O-ring 166 prevents leakage of water past the closure plate 152 into the stator hub 134.

Fig. 5D is a cross-sectional detail of the drive shaft and exhaust gas duct system. As previously described, exhaust gases 127 enter through chamber 128, as also seen in Figs. 3B and 4, and are discharged through the exhaust exit slots 126. Drive shaft 34 passes through a teardrop-shaped sleeve 168 molded into the major lower strut structure 104. Sleeve 168 extends from the lower bolt plate 24 (at the top) to the upper surface of the stator housing 108 at the bottom. Shaft 34 finally passes through a circular annulus 170 into the interior of the stator hub 134, as also seen in Fig. 4.

Fig. 6A is a rear, perspective view of the rotor 132 including its vanes. The rear face 176 of the rotor hub 164 is visible. Grooves 172 engage with the spline 144 on the rotor shaft 142 as shown in Figs. 4 and 5B. When the rotor 132 rotates, it travels in the direction of arrow 174.

Fig. 6B is a perspective front view of the rotor 132 and vanes showing the front face 178 of the rotor hub 164. When seen in this perspective, the rotor 132 travels in the direction of arrow 174.

Fig. 6C is a side, elevational view of the rotor 132 and vanes showing the relationship of the elements to the central axis 180.

Fig. 6D is a front, elevational view similar to that of Fig. 6B.

In Figs 7A-7C the stator hub 134 is shown containing gearing and shifting elements which enable this part to play the role for the tractor pump jet which is played by the bullet 30 for the outboard motor 10 in Fig. 1 - to provide both forward and reverse thrust

Fig. 7A is a cross-sectional, elevational view of the lower unit 102 of the tractor pump jet invention according to an alternative embodiment 200 of the invention which permits the tractor pump jet to operate in reverse as well as forward. The same element numbers are used to identify the same elements in the alternative embodiment 200 as are used to identify elements in the preferred embodiment 100.

As illustrated in Fig. 7A, rotor 132 is shown inside of rotor housing 106. Rotor 132 is located adjacent the inlet opening 114 so that it drinks in relatively undisturbed, non-turbulent flow, but is located upstream of the rotor drive mechanism which is housed within the stator hub 134 which includes the gear case. Stator hub 134 is attached by eight stator vanes 136 to the inside of the stator housing 108. Drive shaft 34 extends through the lower strut 104 and through the stator housing 108 into the interior of the stator hub 134. A pinion gear 202 attached to the bottom of shaft 34 engages two crown gears attached to the rotor shaft 208, specifically, a "forward" crown gear 204 and a "reverse" crown gear 206. A set of splines 144 at the upstream end of rotor shaft 208 engage grooves 172, shown in Figs. 6A - 6D, of the rotor 132. A combination bearing/seal 212 supports the rotor shaft 208 at its upstream end, and a simple bearing 146 supports the shaft at its downstream end. Another simple bearing 148 locates the drive shaft 34 as it enters the stator hub 134. A closure plate 152 is attached by bolts 154 to the stator hub 134. A rotor retaining nut 156 is threadably received on the threads 162 at the furthest upstream end of the rotor shaft 208. A cotter pin 158 keeps the rotor retaining nut 156 from backing off of the rotor retaining washer 160 and the rotor shaft 208 The nose or bullet cover 112, which extends beyond the inlet opening 114, protects the rotor attachment elements

156, 158, 160 and 162. A thrust washer 143 surrounds shaft 208 downstream of the rotor 132 and serves, during reverse operation, to transfer thrust forces from the rotor 132 to the rotor shaft 208 at the downstream conical step 145 in the rotor shaft and abuts closure plate 152.

Fig. 7B is a cross-sectional detail view taken from perspective 7B - 7B in Fig. 7A showing sleeve 168, which has a teardrop-like shape, containing the drive shaft 34 and the shift rod 214.

The stator hub 134 is shown in further cross-sectional detail in Fig. 7C. A shifter dog 216 is located on a spline on the rotor shaft 208, with the two crown gears 204, 206 flanking it. The crown gears 204, 206, which are free to rotate independently on the rotor shaft 208, are driven by the pinion gear 202, and rotate continuously as long as motive power is supplied to the drive shaft 34.

In Fig. 7C as drawn, the shifter dog 216 is in NEUTRAL position, so that rotor shaft 208 remains stationary, even though drive shaft 34 is rotating. To move the boat 12 forward, the shift rod 214 is pulled upward, as suggested by arrows 230, by suitable linkages similar to those used on prior art outboard motor 10. This in turn lifts the shifter yoke 218, causing the shifting levers 220 (one on each side of the rotor shaft 208) to pivot around the pivot rod 222 (which is affixed to the walls of the stator hub 134 by a press fit or equivalent method). The dog shift pins 224 cause the shifter dog 216 to move to the left on its shifter spline 210. Engagement pins 226 are thereby pushed into engagement sockets 228 in the "forward" crown gear 204, and the rotor shaft 208 commences to rotate the rotor 132 in a direction suitable to cause rearward flow of water, and consequent development of forward thrust.

Similarly, a downward push on the shift rod 214, as also suggested by arrows 230, causes the shifter dog 216 to engage the "reverse" crown gear 206, rotating the rotor 132 in the opposite direction, thereby producing reverse thrust.

The invention is typically used in the following manner. The user would remove the lower unit 22 of a prior art outboard 10, such as that illustrated in Fig. 1. The lower unit 22 would be replaced with the tractor pump jet lower unit 102 as shown in Figs. 2 - 6D or 7A - 7C. Alternatively, the modified outboard motor 100 and tractor pump jet lower unit 102 or 200 can be installed at the factory.

When used, the invention 102 has the following advantages:

First, it operates more efficiently because the water 118 drawn into the inlet 114 is relatively undisturbed and non-turbulent. This results in more efficient and faster exit flows 120 resulting in faster, forward motion 40 of the boat 12.

Second, the traditional antiventilation plate, such as illustrated as element 26 in Fig. 1, is removed, thereby reducing drag.

Third, the operation of the tractor pump jet invention 102 is safer than with prior art naked propellers, such as that illustrated as element 28 on the prior art outboard motor 10 shown in Fig. 1.

Fourth, because the rotor housing 106 protects the rotor 132, the invention 102 is less likely to become fouled and caught up in lines, seaweed, kelp and the like.

While the invention has been described with reference to the preferred embodiment thereof, it would be appreciated by those of ordinary skill in the art, that various modifications can be made to the structure and function of the invention without departing from the spirit and scope thereof.

**Claims**

1. A Tractor Pump Jet apparatus for use on a water borne vehicle which supports a motor, which in turn drives a drive shaft, said water borne vehicle also including a support means for supporting said apparatus, said apparatus comprising:

   a rotor driveable by said drive shaft; and,
   a housing substantially surrounding said rotor and supported by said support means, said housing including an upstream inlet opening and a downstream outlet opening,
   wherein said upstream inlet opening is larger in cross-sectional area than said downstream outlet opening and, wherein said rotor is located between said upstream inlet opening and said drive shaft.

2. The Tractor Pump Jet apparatus of claim 1 wherein said housing comprises: an upstream rotor housing; and,

   a downstream stator housing.

3. The Tractor Pump Jet apparatus of claim 2 further comprising:

   a plurality of stator vanes attached to said stator housing and located downstream of said rotor.

4. The Tractor Pump Jet apparatus of claim 3 further comprising:

   a stator hub attached to said stator vanes;
   a pinion gear attached to said drive shaft and located within said stator hub;
   a crown gear engageable with said pinion gear;
   a rotor shaft attached to said crown gear; and,
   rotor attachment means for attaching said rotor to said rotor shaft.

5. The Tractor Pump Jet apparatus of claim 4 further including:

a nose cover means for protecting the rotor attachment means, wherein said nose cover means extends upstream of said inlet opening.

**6.** The Tractor Pump Jet apparatus of claim 5 wherein said motor comprises the powerhead of an outboard motor.

**7.** The Tractor Pump Jet apparatus of claim 6 further comprising:

reversing means attached to rotor shaft for selectively driving said rotor in either the forward or reverse direction.

FIG. 1
(PRIOR ART)

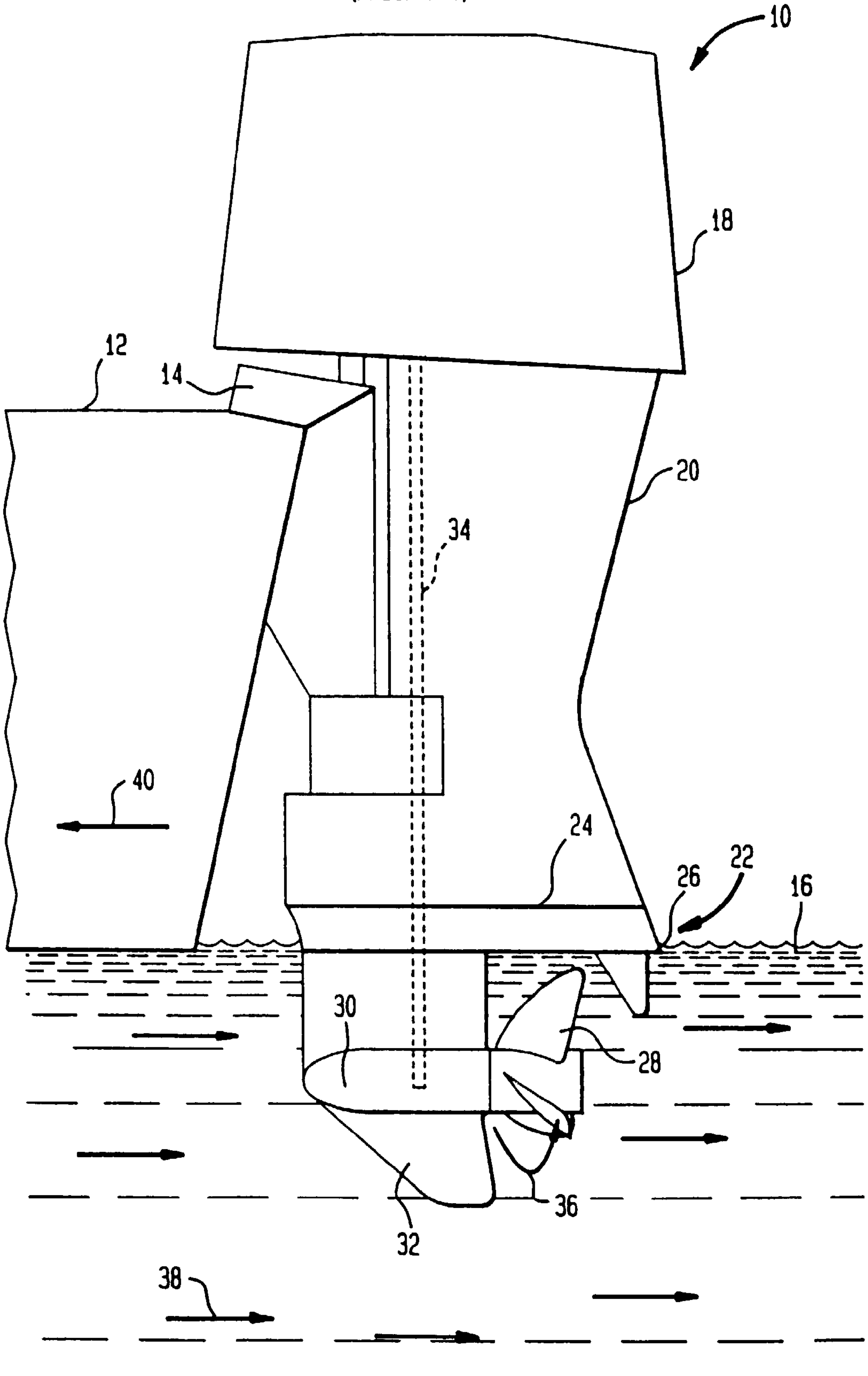


FIG. 2

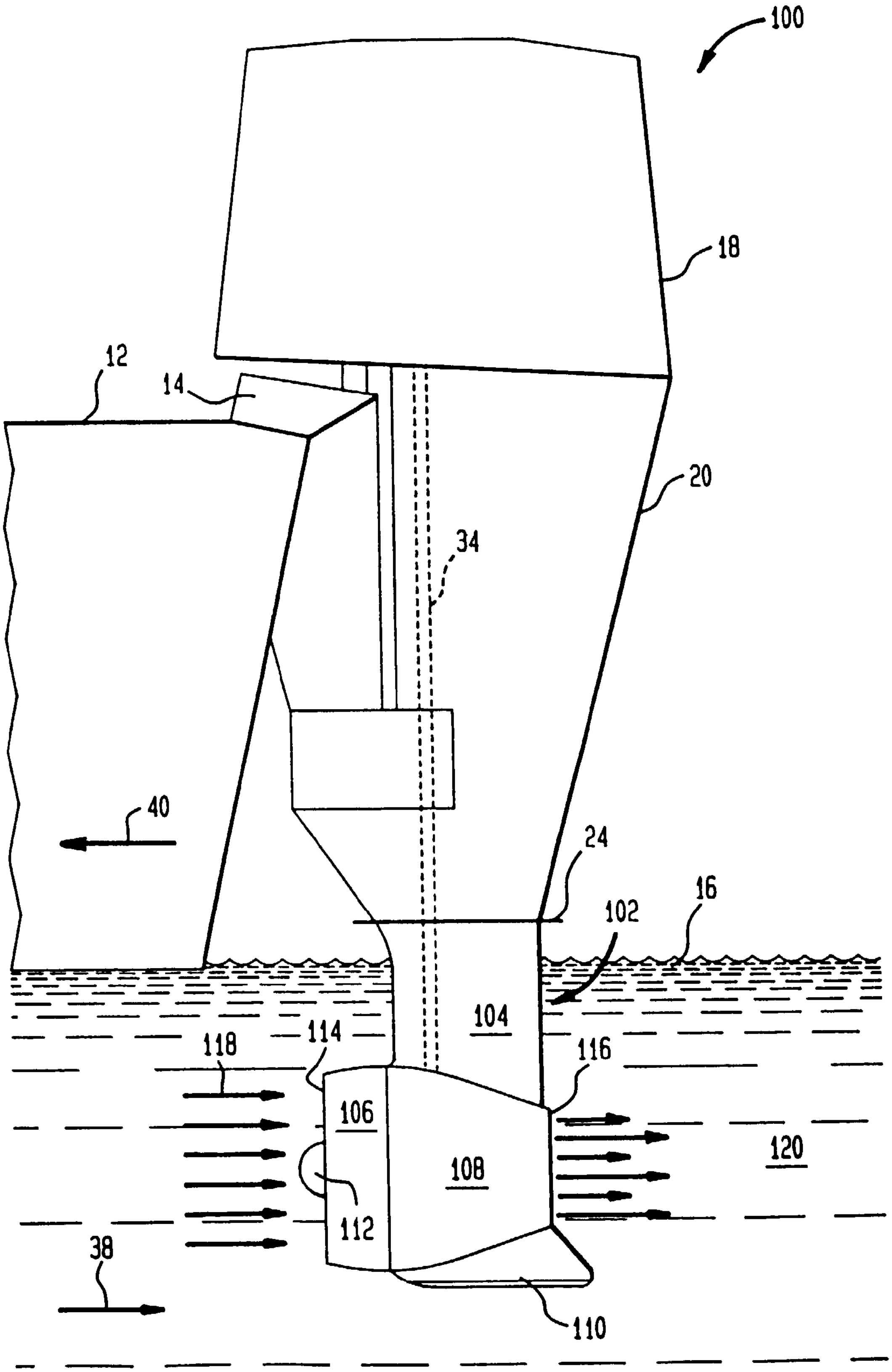

100
18
12
14
20
34
40
24
16
102
104
118
114
116
106
120
108
112
38
110

FIG. 3B

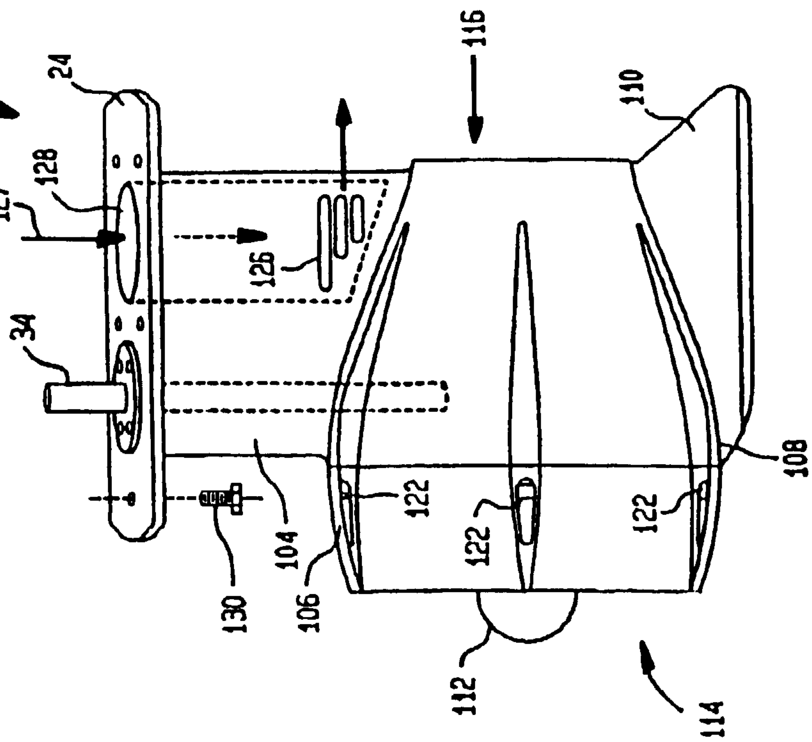
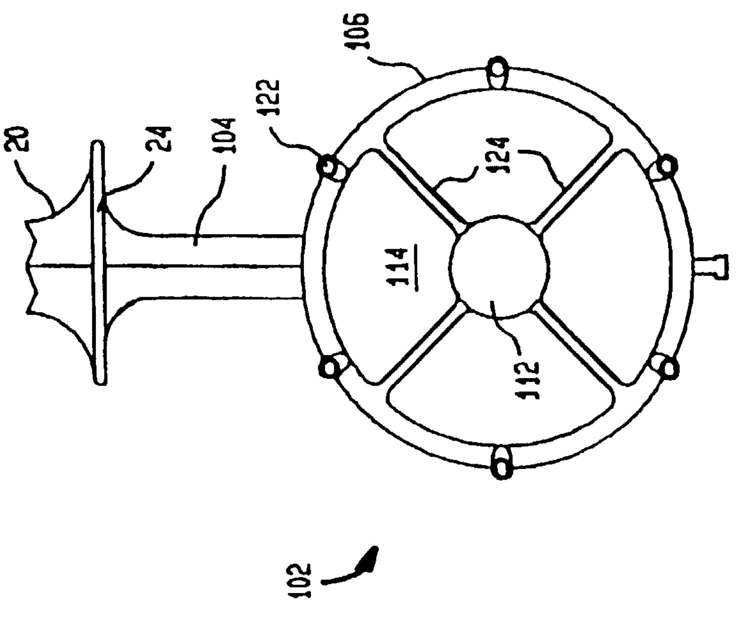

102
24
127
128
34
126
116
110
104
130
106
122
122
122
108
112
114

FIG. 3A


20
24
104
122
106
124
114
112
102

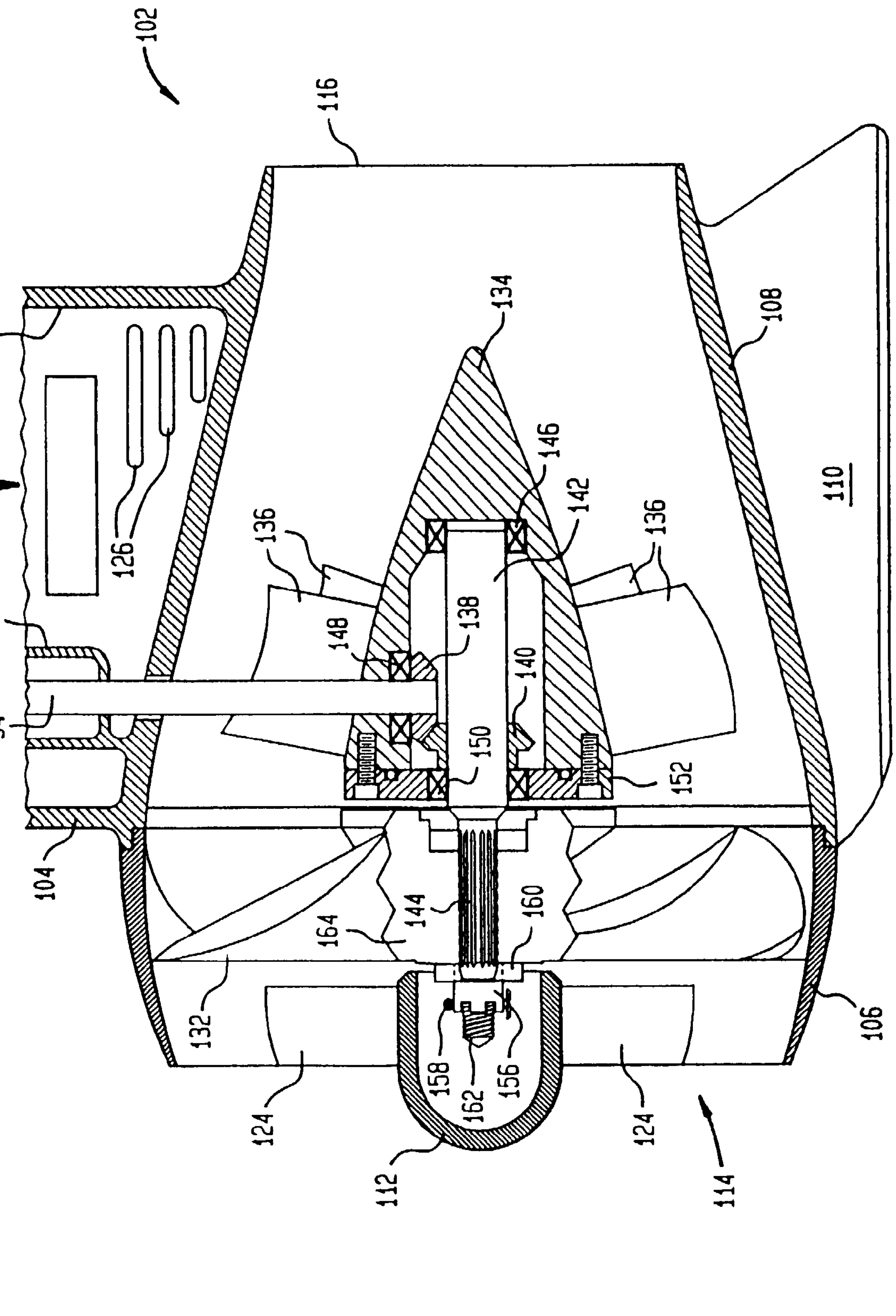

102
116
128
127
134
146
142
136
126
16B
138
148
140
34
150
152
110
108
104
144
164
160
132
158
162
156
106
124
112
114

FIG. 4

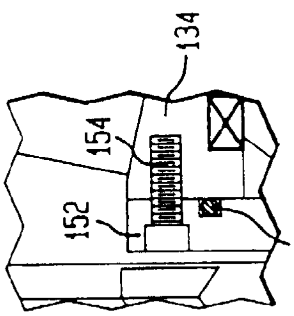



FIG. 5C

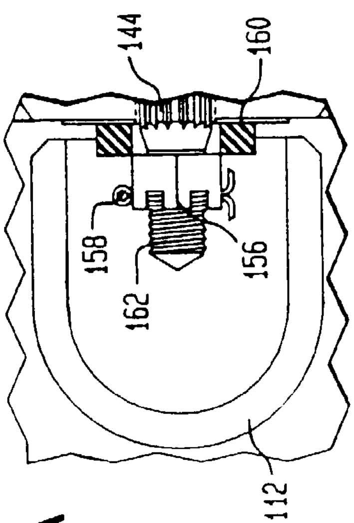



FIG. 5A

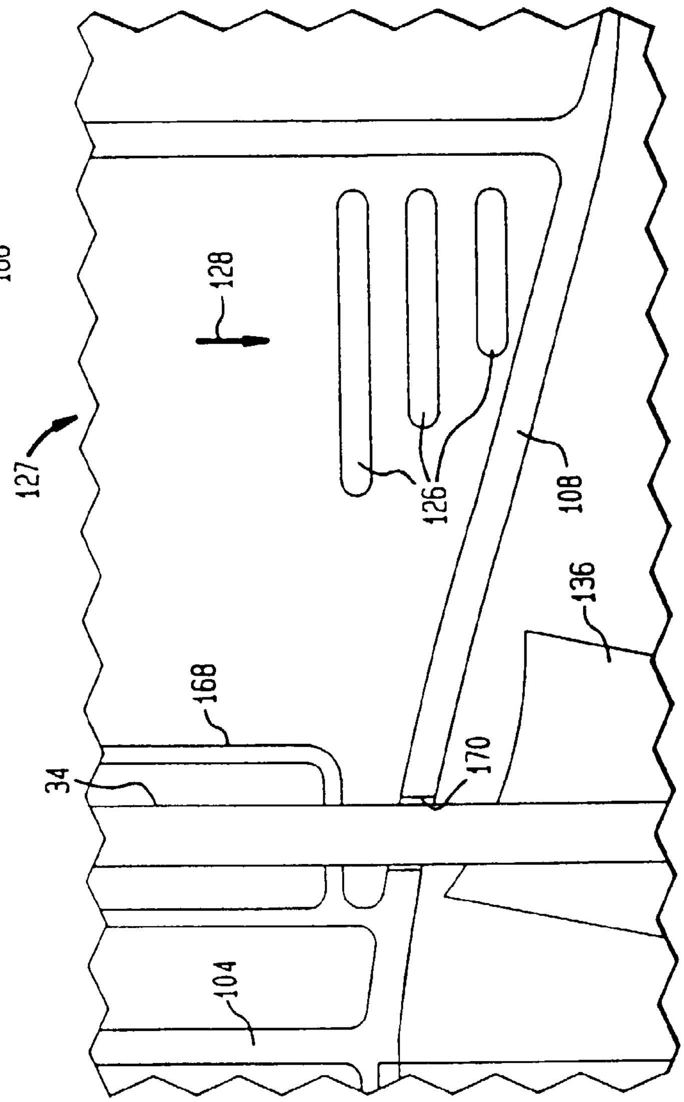



FIG. 5D

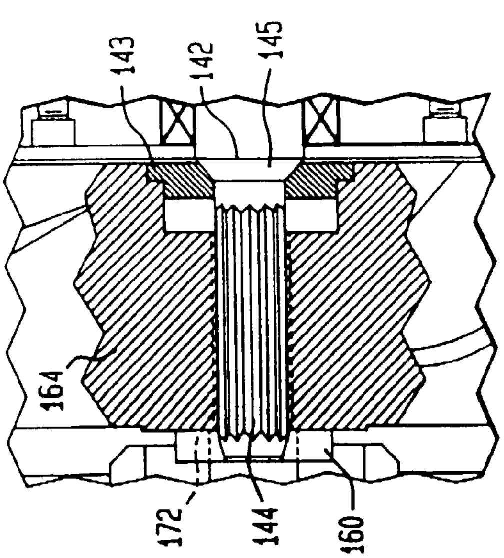



FIG. 5B

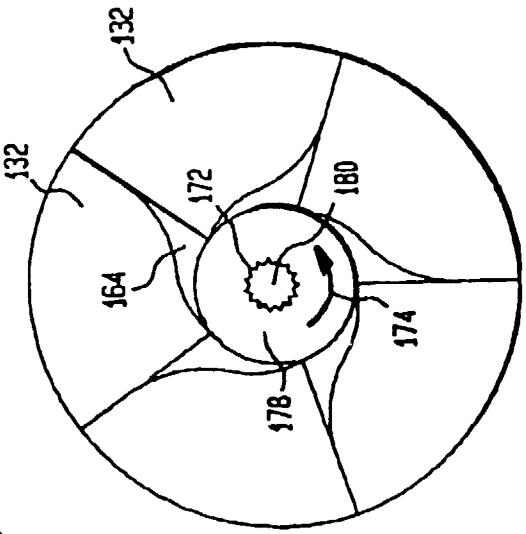



FIG. 6D

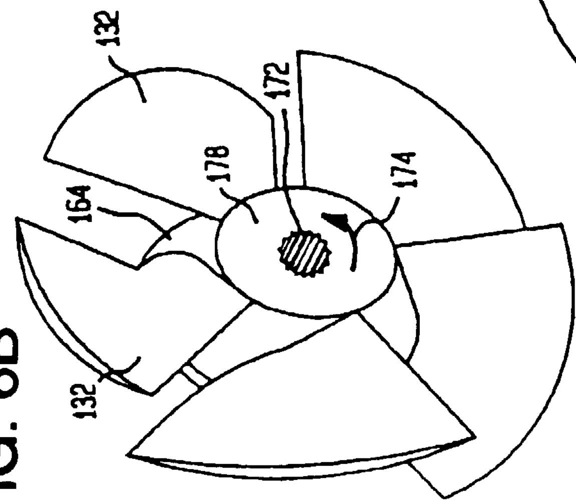



FIG. 6B

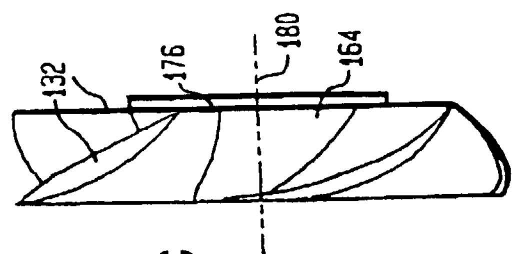



FIG. 6C

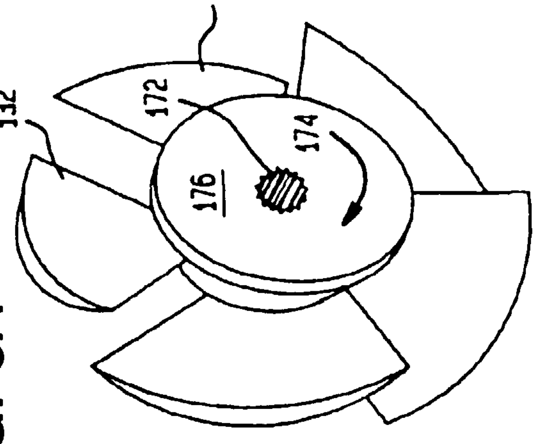



FIG. 6A

FIG. 7A

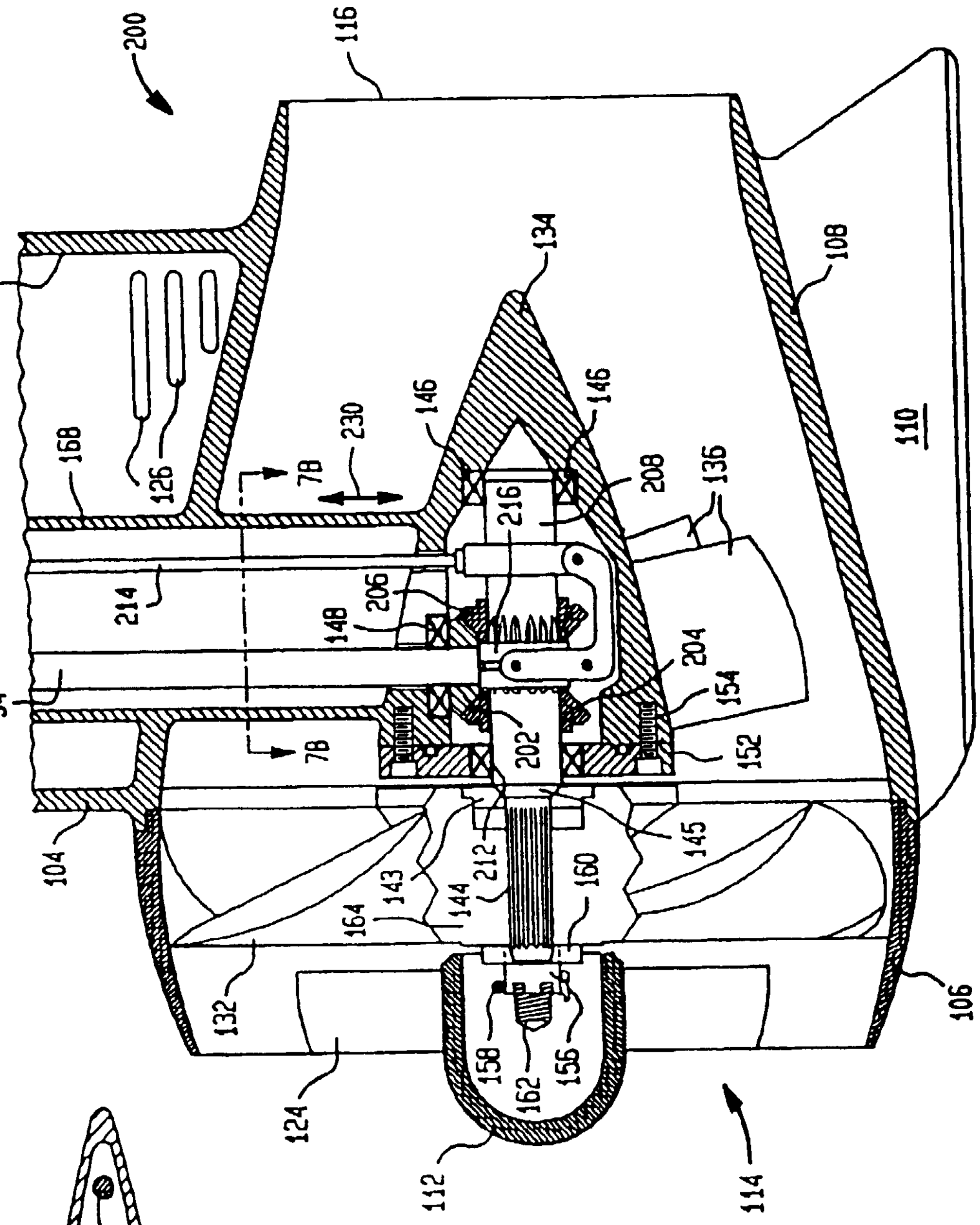
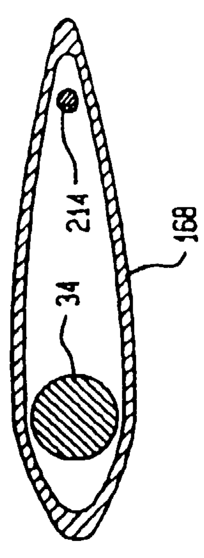

200
116
128
168
126
230
7B
146
134
108
146
110
216
208
136
214
206
148
204
154
34
202
152
7B
104
212
145
143
144
164
160
132
158
162
156
106
124
112
114

FIG. 7B


34
214
168

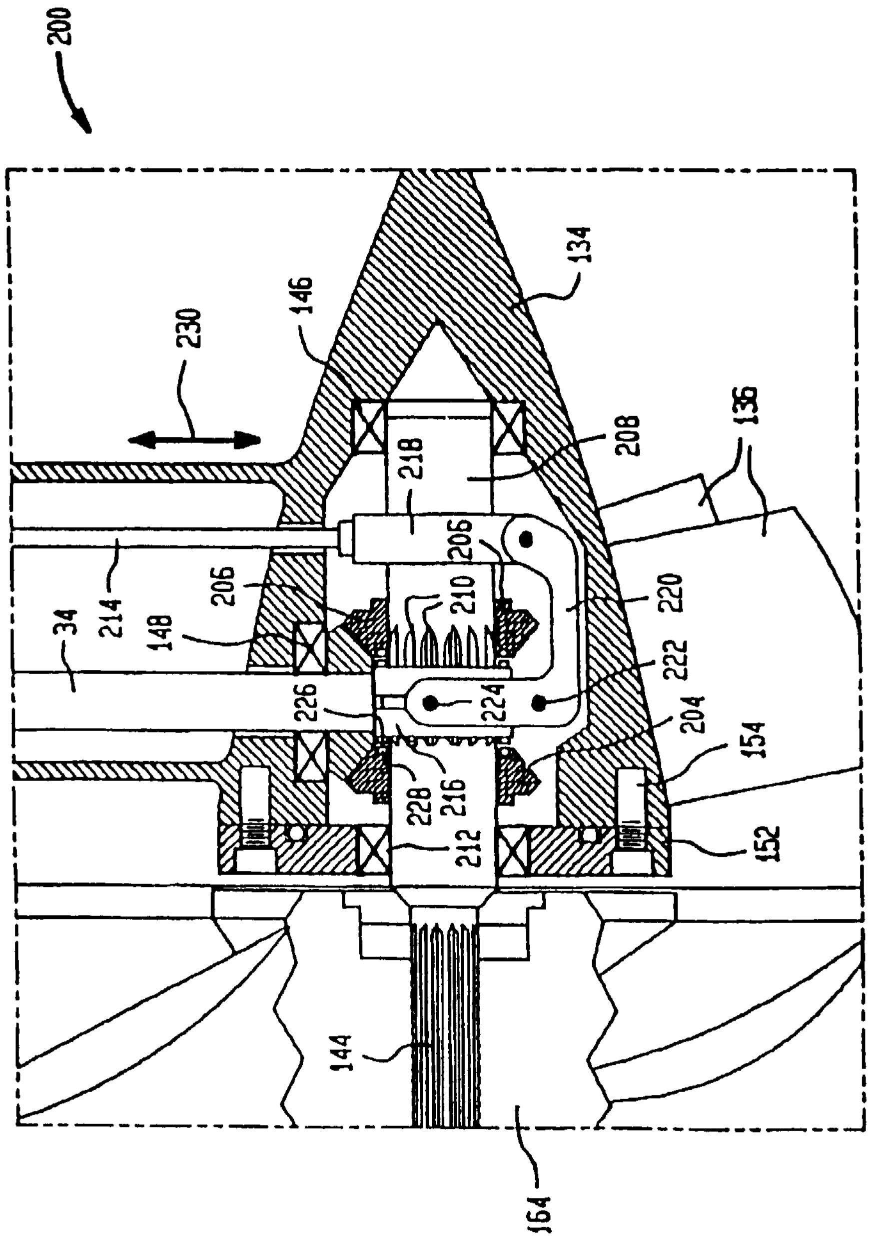

200
230
146
134
136
208
218
206
214
148
34
210
220
222
224
226
228
216
212
204
154
152
144
164

FIG. 7C

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 96 30 5950

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X<br>Y | FR-A-2 416 162 (M.MOURARET)<br>* page 2, line 20 - line 27; figures * | 1-4<br>5-7 | B63H11/08<br>B63H20/00<br>B63H20/20<br>B63H20/24 |
| X<br>Y | US-A-2 965 065 (W.TINKER)<br>* column 5, line 54 - line 75; figures 5,6 * | 1<br>5-7 | |
| Y | US-A-3 249 083 (F.IRGENS)<br>* figure 9 * | 7 | |
| X | AU-B-442 063 (M.FOUNTAIN)<br>* figures * | 1 | |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B63H

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 19 November 1996 | Stierman, E |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)