Nov. 2, 1954 P. H. RAU 2,693,079

STEERING APPARATUS FOR JET PROPELLED CRAFT

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Fig. 1.

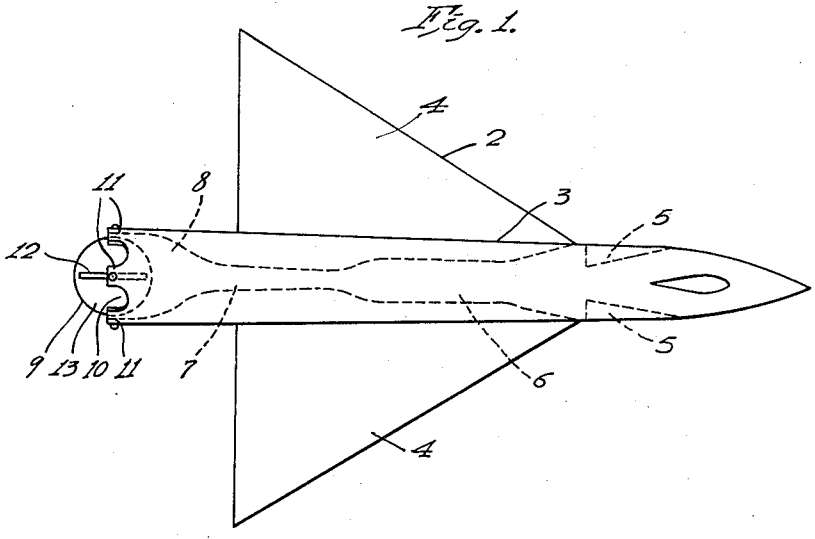
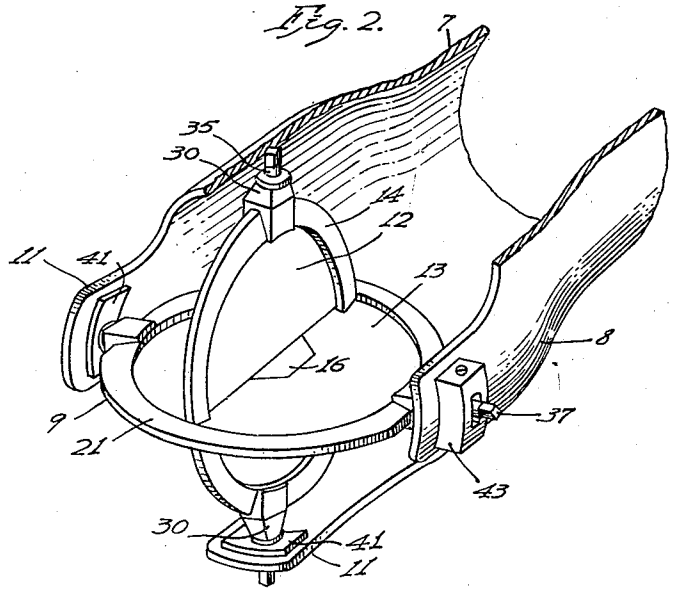


Fig. 2.



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Fig. 3.

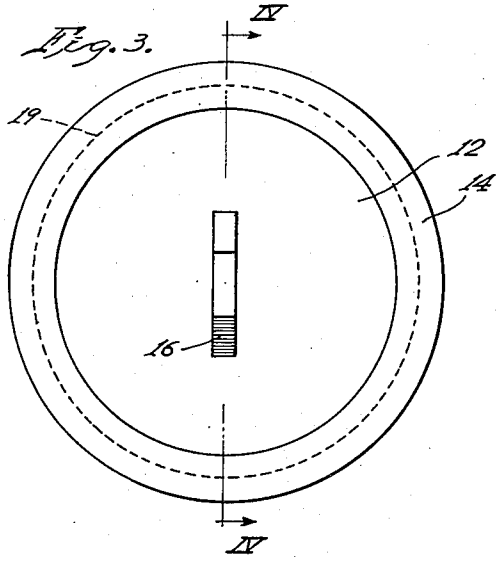


Fig. 4.

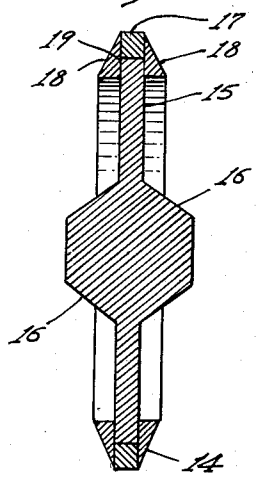


Fig. 5.

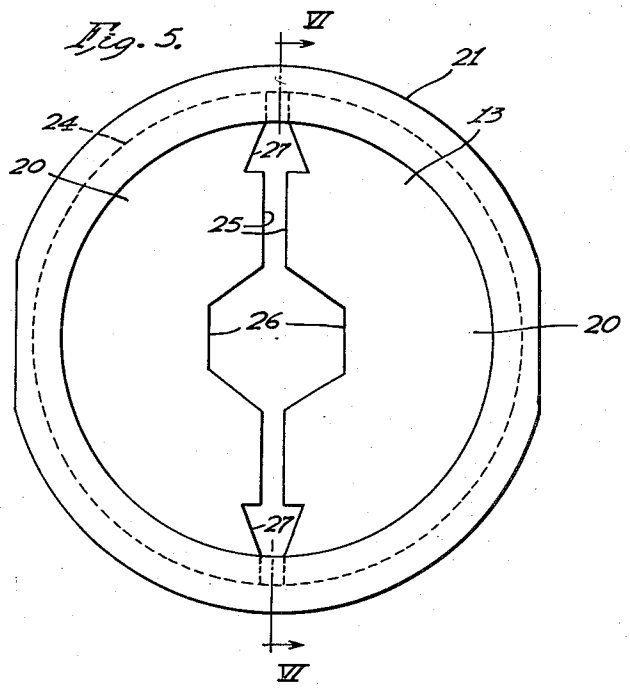
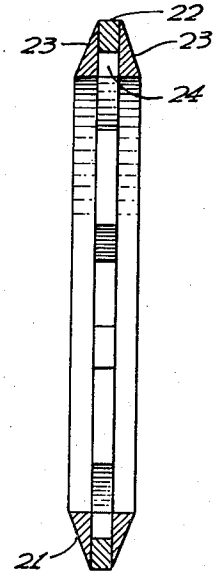


Fig. 6.



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Fig. 7.

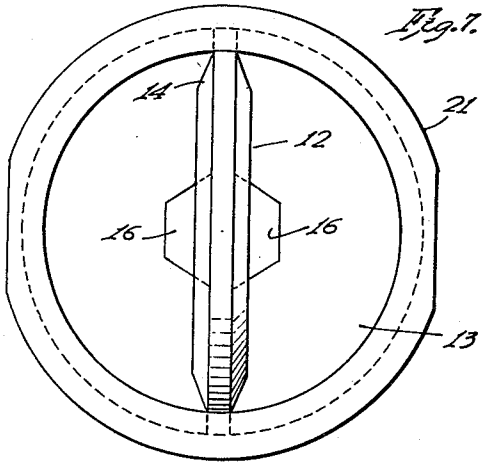


Fig. 8.

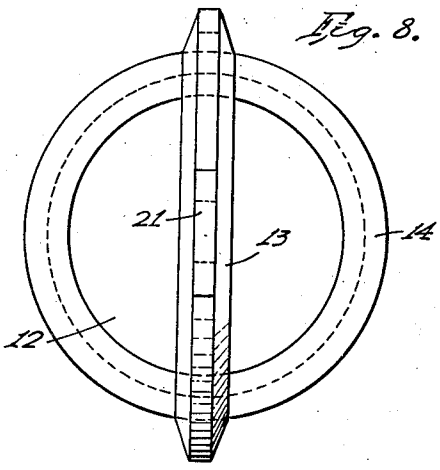


Fig. 9.

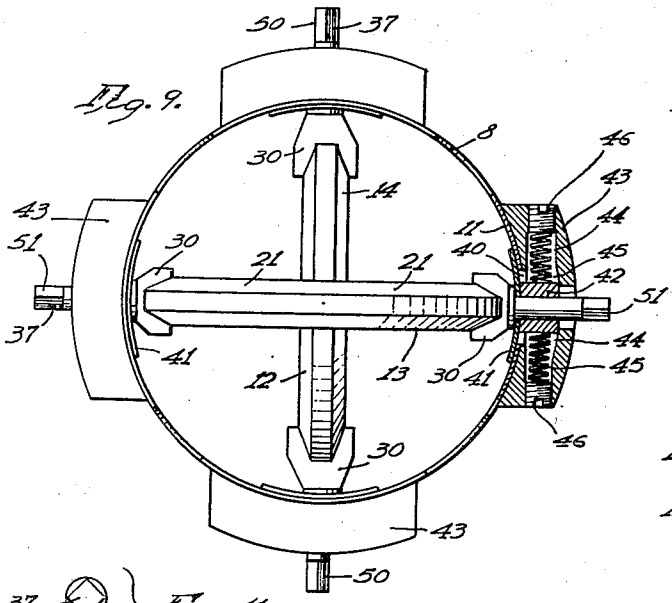


Fig. 10.

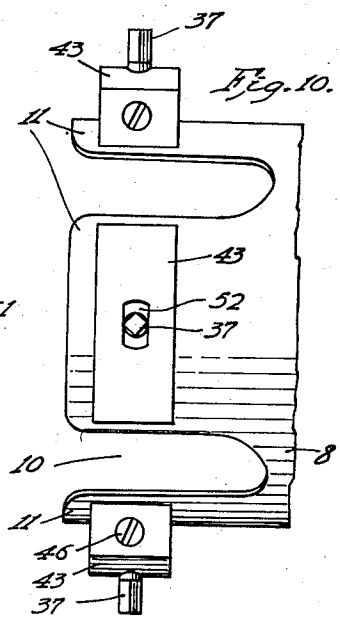
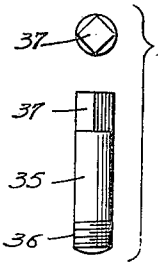
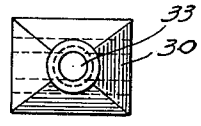


Fig. 11.





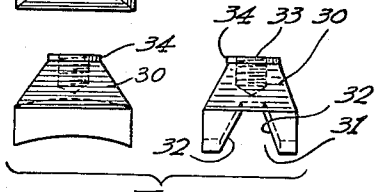


Fig. 12.

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United States Patent Office 2,693,079
Patented Nov. 2, 1954

2,693,079

STEERING APPARATUS FOR JET PROPELLED CRAFT

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Application February 7, 1950, Serial No. 142,764

7 Claims. (Cl. 60—35.54)

This invention relates to steering apparatus which is particularly adapted for use in aircraft having a so-called jet or turbo-jet as its propulsion means. Although the invention is primarily adaptable for use in jet propelled aircraft, it will be understood that its principles are applicable to any water or land craft operating in a fluid medium, and having propulsion mechanism operating on a reactive principle with respect to the fluid medium through which the craft is moving. For example, the principle of the invention is applicable whether the fluid medium in which the reactive propulsion mechanism is operating is air or water.

In reaction type propulsion mechanism of the character with which this invention is concerned, such as jet or rocket propelled aircraft, a fluid medium has a high velocity imparted to it by the propulsion mechanism. In producing the high velocity of the fluid medium, a reaction force is created which is effective to impart movement to the craft being propelled by the propulsion mechanism. The fluid medium which has a high velocity imparted to it by the propulsion mechanism in the production of a driving thrust will be the gaseous products of combustion in the case of a rocket, will be gaseous products of combustion and air in the case of a jet or turbo-jet, or will be a mixture of gas and water in the case of a reactive propulsion device operating under water. Regardless of the fluid medium, the relatively high velocity imparted thereto by the propulsion mechanism is employed, in accordance with the principles of this invention, to produce a yawing or steering movement on the craft in which the propulsion mechanism is mounted.

In applying the principles of this invention to reactive propelled craft, this invention has as one of its principal objects the provision of an improved form of control mechanism which will be effective to deflect the fluid medium emerging at high velocity from the propulsion mechanism universally so as to exert both vertical and horizontal steering control efforts in varying amounts.

A further object of the invention is to provide steering control mechanism which will be effective to eliminate the vertical and horizontal control rudders customarily employed for steering craft operating in a fluid medium.

A further object of the invention is to provide control mechanism of the character referred to with control members rigidly mounted at right angles to each other to provide intersecting control surfaces for deflecting engagement with the high velocity fluid medium.

A still further object of the invention is to provide a control mechanism of the character described having control members mounted in positions at right angles to each other with a novel form of actuating mechanism by which the angular position of either of the control members with respect to one reference plane may be regulated without changing the angular position of the other of the control members with respect to another reference plane.

Other objects and advantages of the invention will become apparent from the following description.

In the drawings, there is shown a preferred embodiment of the invention. In this showing:

Fig. 1 is a diagrammatic bottom plan view of an aircraft provided with steering control mechanism constructed in accordance with the principles of this invention;

Fig. 2 is an enlarged and fragmentary perspective view

showing and illustrating in detail the structure of the steering control mechanism provided in the craft shown in Fig. 1;

Fig. 3 is a plan view of one of the parts of the control mechanism;

Fig. 4 is a sectional view taken substantially along the line IV—IV of Fig. 3;

Fig. 5 is a plan view of another of the parts of the control mechanism which cooperates with the part illustrated in Fig. 3;

Fig. 6 is a sectional view taken substantially along the line VI—VI of Fig. 5;

Fig. 7 is a top plan view of the control mechanism illustrating the parts of Figs. 3 and 5 assembled together;

Fig. 8 is a view similar to Fig. 7 with the parts illustrated rotated through an angle of 90°;

Fig. 9 is an end view looking into the exhaust of the propulsion mechanism and showing the control mechanism of Figs. 7 and 8 mounted in operative position therein;

Fig. 10 is a fragmentary view in side elevation of the structure shown in Fig. 9;

Fig. 11 is a group view illustrating in top plan and side elevation the structure of one of the mounting pins; and

Fig. 12 is a group view illustrating respectively in top plan, side elevation, and end elevation a mounting part employed in connection with the mounting pin shown in Fig. 11.

Referring to Fig. 1 of the drawings, there is shown an aircraft 2 of the jet or turbo-jet type. The craft 2 comprises a body portion 3 having wings 4 projecting laterally from the sides thereof. The propulsion mechanism and its arrangements are illustrated diagrammatically by the dotted lines and includes air scoops 5 through which air for supporting combustion is delivered to an engine 6 of the jet or turbo-jet type. The products of combustion are delivered rearwardly through an exhaust conduit 7, and, as is well-known, the products of combustion travel through the conduit 7 at extremely high velocity. The conduit 7 is enlarged at its exit end 8 and has steering control mechanism indicated as a whole by the numeral 9 mounted therein. The tail of the body 3 is shaped to conform to the exhaust 8 and has portions cut out as at 10 to provide supporting arms 11, four in number, for mounting the steering control mechanism in position in the path of the gaseous products of combustion emerging from the exhaust end 8. The fluid medium emerging from the exhaust 8, will, as pointed out above, be dependent upon the craft, the type propulsion mechanism, and whether the craft is operating in air or submerged in water.

As best shown in Figs. 2 and 9, the control mechanism comprises a pair of discs 12 and 13 which intersect along a common diameter and are rigidly and permanently secured together. In a manner to be described, the angular position of the disc 12 is changed to control movement of the craft in azimuth and the angular position of the disc 13 is changed to control movement of the craft in elevation. In the position of the discs 12 and 13 with respect to the exhaust 8 as shown in Figs. 2 and 9, the craft will move straight ahead without having any steering movement imparted thereto by the discs 12 and 13. As the discs 12 and 13 are moved angularly from the position shown in Figs. 2 and 9, the fluid emerging through the exhaust 8 will be deflected vertically or in an azimuthal direction to effect a corresponding steering control on the craft.

The structure of the discs 12 and 13 and their mounting by which the angular position of one may be varied without changing the angular position of the other will be best understood by referring to Figs. 3 through 6. In Figs. 3 and 4, to which reference is now made, the disc 12 and its mounting ring 14 are shown. As illustrated, the disc 12 comprises a solid circular plate 15 having semi-hexagonally shaped plates 16 projecting from opposite sides thereof. The ring 14 comprises a ring 17 of the same thickness as the plate 15 and side rings 18 having an inner diameter smaller than the inner diameter of the ring 17. The ring 17 and plates 18 cooperate to provide an annular groove 19 in which

the outer edge of the circular plate or disc **15** is receivable. In this manner, ring-shaped structure **14** provides an annular mounting for the disc **12** in which the disc **12** may rotate with respect to the ring **14**.

Referring now to Figs. 5 and 6, the disc **13** is shown as comprised of two substantially semi-circular plates **20** mounted in a ring-shaped structure **21** similar to the ring-shaped structure **14** in which the disc **12** is mounted. The mounting ring **21** comprises a ring **22** of the same thickness as the plates **20** and side discs **23** cooperating therewith to provide an annular groove **24** in which the circular edges of the plates **20** are receivable and in which the plates **20** may rotate in unison. The facing edges **25** of the plates **20** are spaced apart a distance equal to the thickness of the plate **15**. In addition, the edges **25** have central indentations **26** in which the plates **16** are snugly receivable to keep the discs **12** against rotation with respect to the disc **13**. The ends of the surfaces **25** are provided with angularly shaped recesses **27** to provide a space for the reception of the mounting rings **14**.

The structure is assembled by first constructing the disc **12** as shown in Figs. 3 and 4. The next step is to place the semi-circular plates **20** on opposite sides of the plate **15** with the semi-octagonal shaped plates **16** fitted snugly in the recesses **26**. The parts **20** and **15** may be secured rigidly together against movement relative to each other as by welding. When thus mounted in position, the facing surfaces **25—25** and **27—27** of the plates **20** will have abutting engagement with opposite surfaces of the plate **15** and ring **14**. With the plates **20** thus secured in position with respect to the discs **15**, the mounting ring **21** may then be applied to the outer edge of the plates **20** to provide a rotatable mounting for the disc **13** which in effect is comprised of the plates **20**.

When the parts **12** and **13** are assembled into a unit as described above, the control as shown in Figs. 7 and 8 is provided. In the unit as there shown, it will be noted that the entire structure is rotatable within the ring **21**. In other words, the ring **21** may be rotated about the disc **13** in a plane angularly related to the disc **12** without imparting movement to either disc **12** or **13**. The ring **14** may be rotated similarly through the spaces provided by the indentations **27—27** without imparting movement to the disc **12**.

The unit shown in Figs. 7 and 8 is mounted in position with respect to the exhaust **8** as shown in Fig. 9. This is accomplished by securing a pair of similar mounting parts **30** to each of the rings **14** and **21** at diametrically opposite points thereof. Each of the mounting parts **30** has a groove **31**, as shown in Fig. 12, having a V-shape in transverse section and arcuately shaped longitudinally with a curvature matching that of the ring **14** or **21** to which it is to be secured. The surfaces **32** defining the groove **31** have an inclination corresponding to that of the lateral surfaces of the side rings **18** or **23** against which they are to abut. The parts **30** are placed in position on the rings **14** and **21** and are rigidly secured thereto as by welding.

The outer end of each mounting part **30** is provided with a threaded opening **33** having a collar **34** thereabout. The opening **33** is provided for the reception of the end of an actuating stud or pin **35** having threads at its end **36** for threaded engagement in the opening **33** to secure the pin in position. The outer end **37** is square in shape for connection to an operating member (not shown).

In mounting the unit in position, it is placed in position as shown in Fig. 9 with each of the members **30** positioned centrally of one of the arms **11**. Each of the arms **11** has an elongated slot **40**, as illustrated in the arm **11** and associated structure shown in section at the right of Fig. 9, immediately opposite the mounting part **30**. With the mounting parts in position, a bearing plate **41** of arcuate shape is placed against the inner surface of the arm **11** to prevent movement of the mounting part **30** outwardly through the slot **40**. Each of the plates **41** has a central opening through which the end of a pin **35** may be passed, and the pins are inserted through such opening and rotated to provide a threaded connection with the part **30**. A bearing **42** is then slipped over the pin **35**, and a housing **43** is placed over the bearing **42**. The housing **43** has abutting engagement with the bearing **42** to hold it against the bearing plate **41**. Openings **44** with springs **45** therein for centering the bearings **42** are provided in the housing **43**. Plugs **46** provide removable closures for the openings **44** by which access may be had to the springs **45**. The housings **43** are secured to the outer surface of the arms **11** on which they are mounted as by welding and serve to mount the steering control unit in position on the exhaust **8**. With the unit thus positioned, it is ready for operation and may be actuated by the controls (not shown) connected to the ends **37** of the studs or pins **35**.

The vertically spaced ends **37**, as viewed in Fig. 9, provide a control **50** by which rotational movement of the plate **12** and azimuthal movement of the craft **2** may be controlled. Similarly, the horizontally spaced ends **37**, as viewed in Fig. 9, provide a control **51** by which the elevational movement of the craft **2** may be controlled. These movements are controlled by changing the relative angular positions of one of the discs **12** or **13** with respect to the tail exhaust **8** without varying the position of the other of the discs.

The operation of the structure will be better understood by considering the action that takes place upon rotation of either of the control parts **50** or **51**. When the part **50** is rotated, the mounting member **30** and ring **14** are rotated about the axis of the vertical pins **35**. This changes the angular position of the vertical plate **12** and the fluid moving through the exhaust conduit **8** is deflected to either the right or left according to the angular direction in which the plate **12** is moved to give the desired steering motion in azimuth. This angular movement or positioning adjustment of the vertical plate **12** is accomplished without changing the angular position of the plate **13**. The plate **13** is rotated by the angular movement of the plate **12** without any change in its angular position, the rotation of the plate **13** being permitted by its rotatable mounting in the ring **21**.

In a similar manner, rotation of the controls **51** is effective to change the angular position of the horizontal plate **13** without changing the angular position of the vertical plate **12**. When the controls **51** are rotated, the ring **21** and plate **13** rotate about the axis of the horizontal pins **35** to change the angular position of the plate **13** to deflect the fluid flowing through the conduit **8** vertically to impart a steering movement in elevation to the craft. The rotation of the plate **13** causes a rotation of the vertical plate **12** in its mounting ring without changing its angular position.

When one of the plates **12** or **13** is out of its neutral position, as shown in Fig. 9, rotation of the other of such plates cannot be made without allowing its actuating pins **35** to shift slightly. The shifting movement of the actuating pins **35** is provided for by the resilient mounting of such pins in the blocks **43**, such mounting being the resilient mounting of the bearings **42** carrying the pins **35**. It will be noted that the openings in the housings **43** through which the pins **35** project are elongated as at **52** to provide for shifting movement of the pins **35**.

From the foregoing, it will be apparent that the control unit of this invention provides improved structure for utilizing the velocity of a fluid stream for controlling the movement of aircraft and the like. Attention is particularly directed to the fact that the steering control is effected by two plates which intersect each other centrally thereof and extend at right angles to each other. It will also be noted that the mounting of the plates **12** and **13** in the exhaust **8** enables the independent or simultaneous adjustment of their respective angular positions relative to the exhaust **8** so as to effect selected or combined steering controls in elevation and azimuth.

While I have illustrated and described one specific embodiment of my invention, it will be understood that this is merely by way of illustration, and that various changes and modifications may be made therein within the contemplation of my invention and under the scope of the following claims.

I claim:

1. Steering apparatus for craft moving in a fluid medium comprising a conduit through which fluid is discharged at relatively high velocity into said fluid medium, and a control device comprising a pair of discs connected together along a common diameter and at right angles to each other mounted in said conduit for deflecting the fluid passing therethrough to thereby steer the craft through said fluid medium.

2. Steering apparatus for craft moving in a fluid medium comprising a conduit through which fluid is discharged at relatively high velocity into said fluid medium,

a control device comprising a pair of discs connected together along a common diameter and at right angles to each other, and means mounting said device for limited universal movement in said conduit to different angular positions with respect thereto to vary the angular deflection of the fluid being discharged therefrom and to thereby steer the movement of the craft through said fluid medium.

3. Steering apparatus for craft moving in a fluid medium comprising a conduit through which fluid is discharged at relatively high velocity into said fluid medium, a control device comprising a pair of discs connected together along a common diameter and at right angles to each other, and means mounting said device for limited universal movement in said conduit comprising a pair of rings respectively mounted adjacent an end of said conduit for rotational movement about an axis extending transversely thereof, the axes about which said rings rotate intersecting with each other, each of said discs being mounted for rotational movement in one of said rings.

4. The invention claimed in claim 3 characterized by each of said rings having a pair of diametrically opposed pivots providing a rotational mounting therefor in said conduit.

5. The invention claimed in claim 3 characterized by each of said rings having a pair of diametrically opposed pivots providing a rotational mounting therefor in said conduit, and a housing supporting each of said pivots for limited movement with respect to said conduit.

6. The combination with the discharge conduit of a reactive type motor, of a steering apparatus comprising

a pair of discs connected together along a common diameter and at right angles to each other, and means mounting said discs adjacent the discharge end of said conduit comprising a pair of rings respectively mounted for rotation about an axis extending transversely thereof, the axes about which said rings rotate intersecting with each other, each of said rings including structure mounting one of said discs for rotation therein.

7. Steering apparatus for craft moving in a fluid medium comprising a conduit through which fluid is discharged at relatively high velocity into said fluid medium, and a steering control unit at the discharge end of said conduit comprising a first annulus mounted for rotation about a diameter thereof extending vertically of said conduit, a second annulus mounted for rotation about a diameter thereof extending horizontally of said conduit, and a pair of discs connected together along a common diameter and at right angles to each other, said annuli respectively including parts engageable with the periphery of and mounting one of said discs for rotation about the rotational axis of the annulus mounting the other of said discs.

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