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TORPEDO

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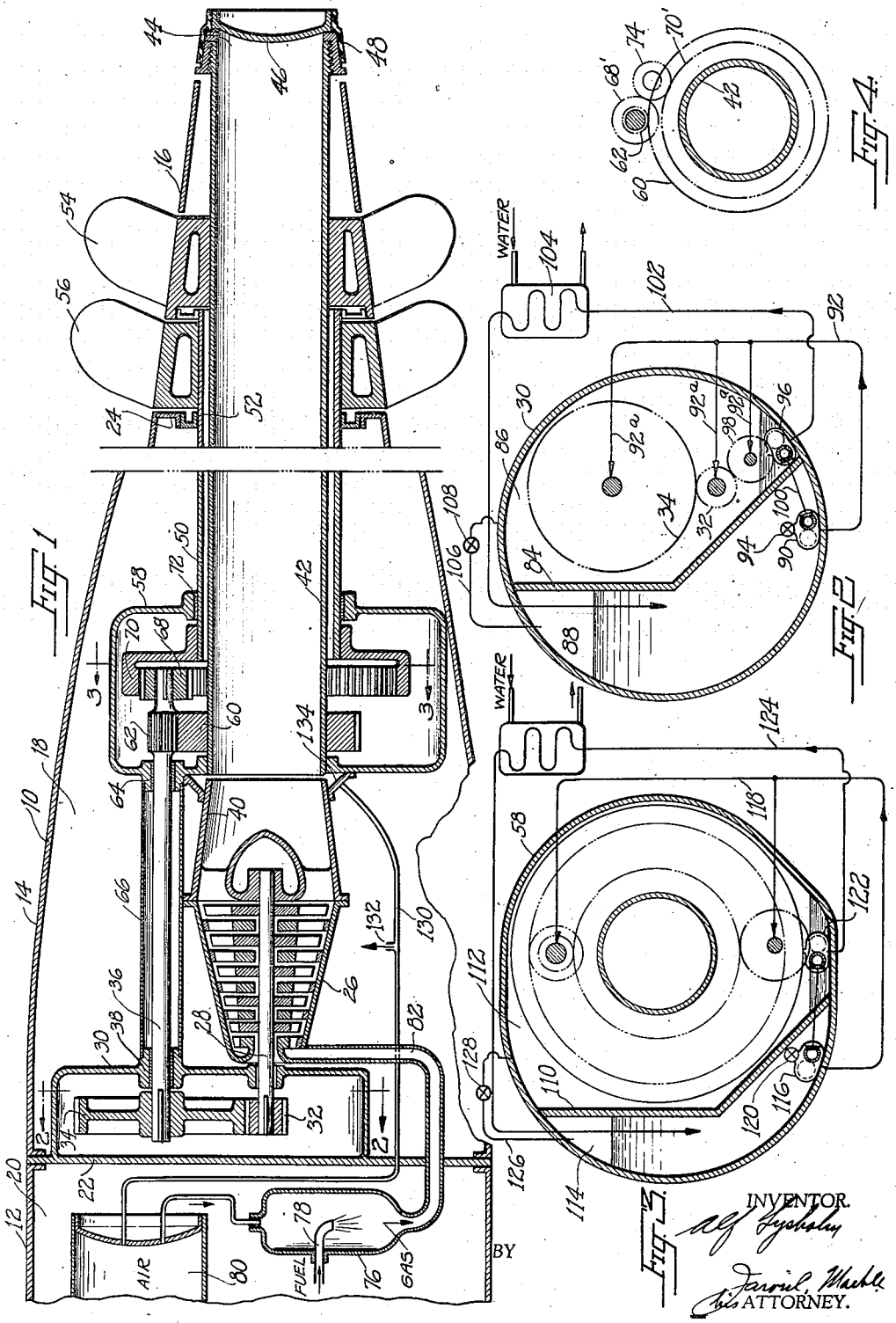

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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TORPEDO

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The present invention relates to self-propelled torpedoes and has particular reference to torpedoes driven by an elastic fluid turbine, such for example as a gas turbine.

On account of the high speed of operation of turbines suitable for torpedo drive, as compared with the maximum permissible propeller speed, gearing having a relatively very high overall speed reduction must be employed and a principal object of the present invention is to provide an improved arrangement of turbine and gearing for effecting the required drive to the propellers of the torpedo.

Another object of the invention is provision of an improved reduction gear and turbine arrangement which will permit among other things of substantially free and unrestricted flow of exhaust gas from the turbine through a hollow propeller shaft to the stern outlet of the torpedo. Still another object of the invention is to provide improved gearing which will enable the turbine to attain its designed maximum operating speed in the minimum of time.

The manner in which the above objects and other and more detailed objects of the invention are attained and the advantages to be derived from their use will best be understood from a consideration of the ensuing portion of this specification descriptive of suitable apparatus for carrying the invention into effect, which apparatus is illustrated in the accompanying drawing forming a part hereof, in which:

Fig. 1 is a diagrammatic longitudinal sectional view of the after portion of a torpedo embodying the invention;

Fig. 2 is a diagrammatic transverse section taken generally along the line 2—2 of Fig. 1 and showing some additional parts omitted from Fig. 1 for the sake of clearness;

Fig. 3 is a diagrammatic view like Fig. 2, taken generally along the line 3—3 of Fig. 1 and also showing parts omitted from Fig. 1 for the sake of clearness; and

Fig. 4 is a diagrammatic view showing an alternative arrangement of a part of the gearing.

Referring now to the drawing, the shell of the torpedo is indicated generally at 10 and this shell is advantageously subdivided into sections of which the fore section is indicated at 12, the after section at 14, and the stern section at 16. The after section 14 provides a space 18 in what may be termed the power section of the torpedo and this space is separated from the space 20 in the fore section by a bulkhead 22. The power section is separated from the stern section by a suitable bulkhead 24. The power source comprises a turbine 26 mounted longitudinally of the axis of the torpedo and preferably, as shown, coaxially with the longitudinal central axis of the torpedo. The shaft 28 of the turbine rotor projects forwardly from the inlet end of the turbine into casing 30 of a primary reduction gear which consists of a pinion 32 mounted on the turbine shaft and a reduction gear 34 fixed to shaft 36, the forward end of which is suitably journaled at 38 in the gear casing 30. The gear casing 30 and turbine may advantageously be constructed as a unit supported and formed in part by the bulkhead at the forward end of the power section.

The exhaust end 40 of the turbine casing communicates with the forward end of a hollow propeller shaft 42 which terminates at the stern of the torpedo in an exhaust outlet 44 which is advantageously closed by a cover plate 46 removably secured over the end of the propeller shaft by means of friction or by a rubber or other elastic sheath 48 serving to provide a water-tight cap for the end of the shaft. A second hollow propeller shaft 50 is mounted concentrically around shaft 42, shaft 50 passing through bulkhead 24, there advantageously being some form of packed bearing, not shown in detail, at 52. Shaft 42 carries propeller 54 and shaft 50 carries propeller 56.

At its forward end shaft 42 projects into the gear case 58 of a secondary reduction gear and at its forward end has fixed thereto a reduction gear 60 meshing with pinion 62. Pinion 62 is carried by the after end of shaft 36 which is journaled at this end in the secondary gear case 58 as indicated at 64. Advantageously, a tube 66 enclosing shaft 36 is fixed at its ends to the primary and secondary gear cases.

Shaft 36 also carries at its after end a pinion 68 meshing with an internal gear 70 which is fixed to the forward end of the propeller shaft 50, the latter shaft passing through a suitable journal 72 in the secondary gear case.

Alternatively, the internal gear 70 may be replaced as shown in Fig. 4 by a spur gear 70' connected to a pinion 68' by means of an intermediate idler gear 74.

The turbine 26 is operated by any suitable source of motive fluid under pressure, stored or generated in the fore part of the torpedo. In the present instance the apparatus for supplying gaseous motive fluid is indicated diagrammatically as comprising a combustion chamber 76

to which fuel is admitted through the supply pipe 78 for combustion with compressed air supplied from the bottle 80. The gas for operating the turbine is delivered from the combustion chamber through the supply conduit 82 passing through the bulkhead 22. Obviously, any other system for supplying fluid under pressure may be employed.

Referring now more particularly to Figs. 2 and 3, the gear casings forming the primary and secondary reduction gears are advantageously provided with special lubricating systems which will now be described. As will be observed from Fig. 2, the primary casing 30 is advantageously divided by a partition 84 to provide a gear compartment 86 and a lubricant compartment 88. Oil is withdrawn from the compartment 88 by means of any suitable form of pump operated from the turbine and delivering the oil to the several bearings and gears requiring lubrication. By way of diagrammatic illustration, there is illustrated a submerged pump 90 delivering through conduit 92 from which the several branches 92a serve to distribute the oil to the several places requiring lubrication. A valve 94 is advantageously provided to prevent leakage of lubricant through the pump line from the lubricant storage compartment to the gear compartment, when the torpedo is not in operation.

Lubricant delivered to the gear compartment is removed continuously therefrom by means of a suitable pump which returns excess lubricant to the storage compartment. The gear compartment may be said to operate as a dry compartment. In the embodiment illustrated a submerged pump 96 driven from the turbine pinion gear 32 through an intermediate gear 98 serves to keep the gear compartment dry. For purposes of illustration, pump 90 is shown as having a bevel gear driving connection indicated generally at 100 so that both pumps operate whenever the gearing operates. Obviously, any form of power connection and pump arrangement may be employed.

Pump 96 returns lubricant to the storage compartment through the delivery pipe 102 which may advantageously pass through an oil cooler 104 through which water is circulated by means of suitable connections leading to the exterior of the torpedo.

In order to equalize pressures between the two compartments, a connection 106 is provided which is further advantageously provided with an automatic check valve 108 for preventing flow of oil from the storage compartment to the gear compartment in case the former should be overfilled.

An arrangement generally similar to that just described with respect to the primary gear is also employed with the secondary gear, the case 58 of which is divided by partition 110 into a dry gear compartment 112 and a lubricant storage compartment 114. Pump 116 delivers oil from the storage compartment through the conduit 118 controlled by valve 120 while pump 122 returns excess oil through conduit 124 to the storage compartment in order to keep the gear compartment dry. These pumps may be operated from the turbine through any suitable driving connection and the two compartments in the casing are connected by means of a pressure balancing connection 126 provided with a valve 128 for checking reverse flow of oil.

The space 18 in the power section of the turbine is advantageously maintained under superatmospheric pressure by pressure fluid which is advantageously derived from the compressed air supply for forming the motive fluid for the turbine. In the embodiment illustrated this is accomplished by supplying compressed air through pipe 130 leading from the source of supply and having opening 132 for discharging air under pressure into the space 18.

The stationary turbine casing 40 and the secondary gear casing 58 are advantageously connected to provide a small chamber 134 encircling the joint between the casing and the propeller shaft 42 and this chamber is connected with the source of pressure fluid, advantageously by an extension of pipe 130, to maintain the chamber under pressure.

The packing at the inlet end of the turbine and the joint with which the chamber 134 communicates constitute the only points of egress of the air under pressure supplied through pipe 130.

The operation of the gearing will be largely evident from the drawing, the primary reduction gear at the forward end of the turbine serving to effect a substantial initial speed reduction. This speed reduction is further reduced by the secondary gearing and as will be evident from Fig. 1, with the gearing employing an external reduction gear 60 and an internal gear 70, both driven by pinions on shaft 36, opposite directions of rotation of the propellers 54 and 56 will be obtained in very simple manner.

By driving from the forward end of the turbine it is possible to locate the turbine advantageously in the torpedo so that direct and unobstructed flow of exhaust gas to the stern outlet of the torpedo is obtained.

Before the apparatus is operated, the lubricant storage compartments in the gear cases are filled with a sufficient quantity of oil to serve the gearing for the maximum period the torpedo is capable of operating and as soon as operation of the turbine is commenced, this lubricant is supplied to the gears. However, when starting the gear compartments are dry which eliminates a substantial amount of resistance to operation of the high speed gears which would be presented by operation of the gars in the usual wet case. This contributes materially to the ability of the turbine to reach its normal maximum operating speed in the minimum of time. Also, during the run of the torpedo, the circulating oil system with the dry gear compartments maintains the gear loss at a minimum, thus increasing the range of the torpedo with a giv n potential supply of motive fluid.

As soon as the turbine is started, exhaust pressure builds up within the hollow shaft 42 until the back pressure is sufficient to blow the stern cap off to permit the exhaust gases to escape. This arrangement prevents inflow of water to the turbine until sufficient exhaust gas pressure has been built up to prevent such inflow.

The tube 66 around shaft 36 serves to prevent leakage of lubricant into the main space of the power section through the journals 38 and 64 and the pressure maintained in the space 18 by compressed air admitted through opening 132 prevents leakage of hot motive fluid from the inlet end of the turbine into this space. This latter assures against overheating of the gears due to the gear cases being in a hot atmosphere of leaking motive fluid. By supplying air under pressure directly to the joint at the forward end of the propeller shaft 42, the escape of lubricant from the secondary reduction gear through the

journal at the forward end of shaft 42 is prevented. This is important since any lubricant escaping at this point would become mixed with the exhaust gases and be discharged therewith from the torpedo. Any such oil so discharged from the torpedo would leave a tell-tale slick on the surface of the water which it is obviously desirable to avoid.

It will be evident that the structure just described by way of example may be modified in many ways without departing from the principles of the invention as defined in the appended claims.

What is claimed is:

1. A self-propelled torpedo including two hollow concentric propeller shafts terminating at their forward ends within a power section of the torpedo, an elastic fluid turbine having a rotor shaft and located in the power section longitudinally of the torpedo, the inlet end of the turbine being disposed forwardly of the torpedo and the outlet being located to deliver exhaust gases without abrupt change in direction of flow to the forward end of the inner of said hollow propeller shafts, a primary reduction gear located at the forward end of the turbine and connected to the inlet end of said rotor shaft, a secondary reduction gear comprising a gear case encircling the forward ends of the propeller shafts, and a single power shaft for transmitting power from the primary gear to the secondary gear, said secondary reduction gear including gears for transmitting drive from said single power shaft to each of said propeller shafts and in respectively opposite directions.

2. A self-propelled torpedo including two propeller shafts, an elastic fluid turbine, mechanical reduction gearing for transmitting power from the turbine shaft, said gearing including a gear case having a partition dividing the case into a dry gear compartment and a lubricant reservoir compartment, means driven from the turbine for supplying lubricant from the reservoir compartment to the gearing, means driven from the turbine for removing excess oil from the gear compartment and returning it to the reservoir compartment, and a connection leading from the upper portion of the reservoir compartment to the gear compartment for equalizing pressure between the two compartments.

3. A self-propelled torpedo including two propeller shafts, an elastic fluid turbine, mechanical reduction gearing for transmitting power from the turbine shaft, said gearing including a gear case having a partition dividing the case into a dry gear compartment and a lubricant reservoir compartment, means driven from the turbine for supplying lubricant from the reservoir compartment to the gearing, means driven from the turbine for removing excess oil from the gear compartment and returning it to the reservoir compartment, a connection leading from the upper portion of the reservoir compartment to the gear compartment for equalizing pressure between the two compartments, and means in said connection for preventing flow of lubricant therethrough from the reservoir compartment to the gear compartment.

4. A self-propelled torpedo comprising a shell providing a fore section, a power section, and a stern section, bulkheads separating said sections, two propeller shafts extending through the stern section bulkhead into the power section, an elastic fluid turbine located in the power section, a storage reservoir in said fore section for high pressure motive fluid to be used for driving said turbine, mechanical reduction gearing located in the power section transmitting power from the turbine to said shafts, and a conduit leading from said reservoir to said power section and having an opening located in said power section for delivering fluid directly from said reservoir to the interior of said power section, whereby to prevent leakage of motive fluid from around the shaft packing of the turbine into the space in the power section occupied by said gearing.

5. A self-propelled torpedo having a power section, a hollow propeller shaft extending into said section, an elastic fluid turbine having an exhaust gas outlet adjacent to the inner end of said hollow propeller shaft for exhaust of gases through said shaft, mechanical gearing for connecting said turbine and said shaft, said gearing including a gear casing around the end of said shaft adjacent to the turbine outlet, means providing an annular chamber between the gear casing and the turbine outlet structure, and means for introducing compressed gaseous fluid into said chamber to prevent leakage of lubricant from the gear casing around the forward end of said shaft and into the stream of exhaust gases passing from the turbine outlet into said shaft.

6. A self-propelled torpedo providing a power section and a stern section, a stern bulkhead separating said sections, two hollow concentric propeller shafts extending through the stern bulkhead into the power section, an elastic fluid turbine mounted forwardly of said shafts in alignment therewith and with the outlet of the turbine in direct communication with the forward end of the inner shaft, a primary reduction gear comprising a gear casing located forwardly of the turbine and enclosing reduction gears driven from the inlet end of the turbine shaft, a secondary reduction gear including a gear casing encircling the propeller shafts and enclosing reduction gears for transmitting power in opposite directions of rotation to the two propeller shafts from a single power shaft, a power shaft journaled in each of said gear casings and connecting said primary and secondary reduction gears, a sleeve fixed at its opposite ends to the respective casings and enclosing said power shaft, and means for maintaining the space in said power section surrounding the aforementioned parts under super-atmospheric pressure.

7. A self-propelled torpedo including two propeller shafts, an elastic fluid turbine having a rotor shaft and arranged longitudinally of the torpedo ahead of said propeller shafts and with its inlet end disposed forwardly of the torpedo, a primary reduction gear located at the forward end of said turbine and connected to the inlet end of said rotor shaft, a secondary reduction gear located behind the turbine and around said propeller shafts, and a shaft providing a driving connection from said primary gear to said secondary gear, said secondary gear including an external gear on one propeller shaft, an internal gear on the other propeller shaft and pinions mounted on said connecting shaft, one of said pinions meshing with said external gear and the other of said pinions meshing with the internal gear.

8. A self-propelled torpedo including two hollow coaxial propeller shafts, the inner one of said shafts providing a conduit leading from the interior to the exterior of the torpedo, an elastic fluid turbine located in line with and ahead of said propeller shafts and with the outlet end of

the turbine adjacent to the inner end of said inner propeller shaft, said turbine exhausting into said inner shaft, a primary reduction gear located adjacent to the inlet end of the turbine and including a gear mounted on the inlet end of the turbine rotor, a secondary reduction gear including gears mounted on said propeller shafts for driving the propeller shafts in opposed directions from a uni-directional power delivering element, and a driving connection extending exteriorly of the turbine and to one side thereof for transmitting power from the driven element of said primary reduction gear to said secondary reduction gear.

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