Nov. 5, 1968 H. H. HAMLIN 3,408,898

BARREL ENGINE HAVING COOLING SYSTEM

Original Filed April 26, 1966 2 Sheets-Sheet 1

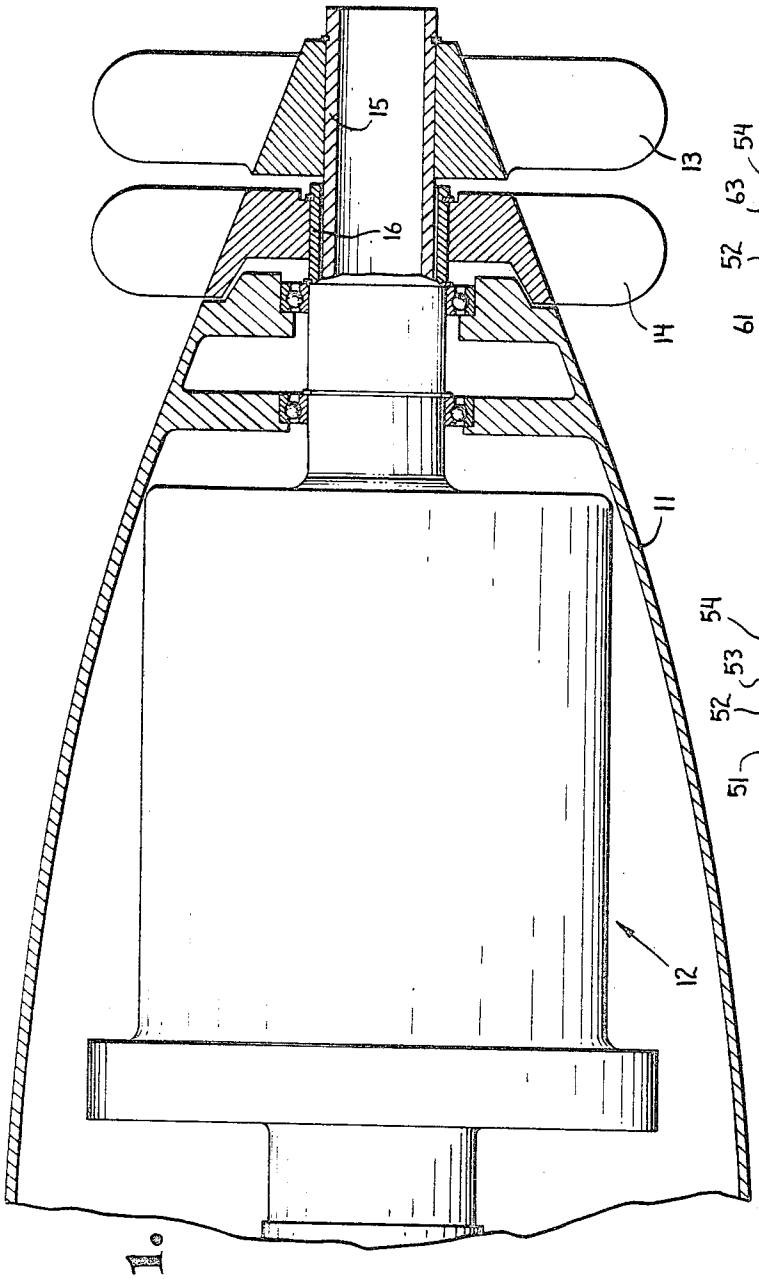

Fig. 1.

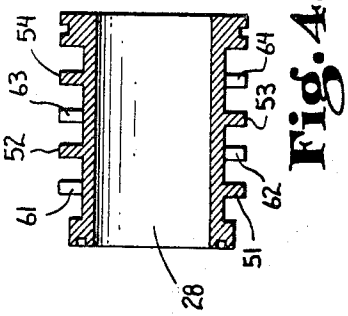

Fig. 4.

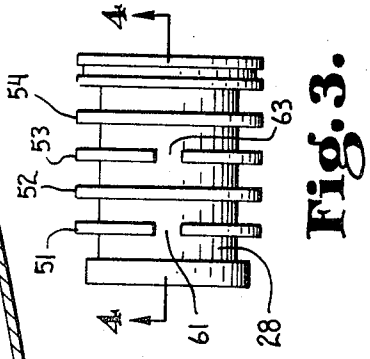

Fig. 3.

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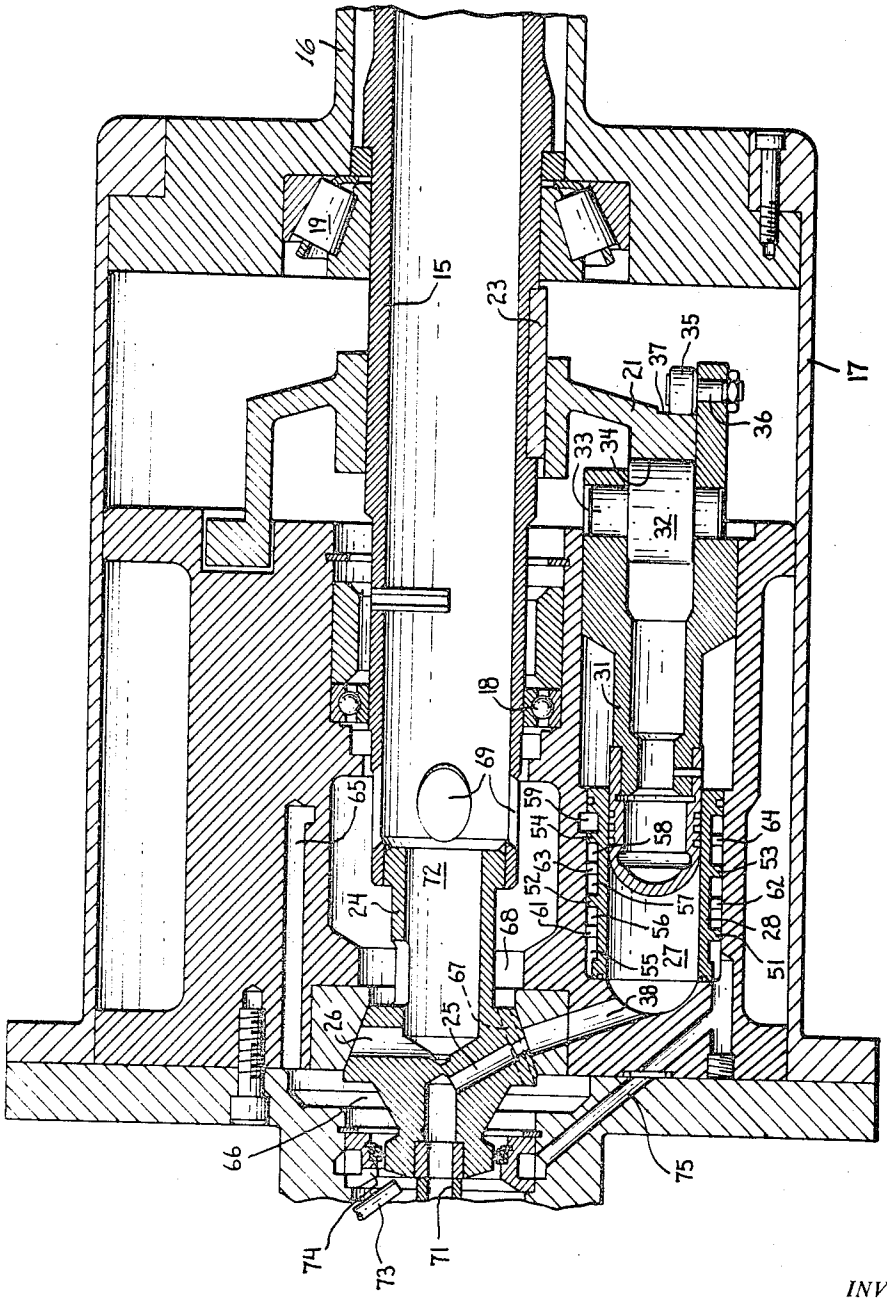

Fig. 2.

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BARREL ENGINE HAVING COOLING SYSTEM

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Continuation of application Ser. No. 546,150, Apr. 26, 1966. This application Feb. 8, 1968, Ser. No. 704,178
2 Claims. (Cl. 91—175)

ABSTRACT OF THE DISCLOSURE

A barrel engine having a plurality of cylinders and pistons whose stroke axes are parallel to a power output shaft and having a cooling jacket surrounding each of said cylinders, each said cooling jacket having grooves around the outer periphery that provide for passage of cooling water in both clockwise and counterclockwise direction around the cooling jacket. The cooling water flows from the last groove into the engine exhaust.

This application is a continuation of my earlier application Ser. No. 546,150 filed Apr. 26, 1966, now abandoned.

The present invention relates to a barrel engine and more particularly to a barrel engine having improved means for cooling the various internal parts.

A barrel engine is an engine that has a plurality of pistons and cylinder assemblies having their stroke axes parallel to and symmetrically disposed to a power output shaft. The pistons coact with a wobble plate on the output shaft so as to impart rotary motion to the shaft in response to staggered linear reciprocation of pistons in their respective cylinders.

Barrel engine may find application in many fields, both commercial and military, and one important military application for a barrel engine is that of a propulsion unit for Naval torpedoes. One heretofore known barrel engine specifically adaptable for use as a prime mover for Naval torpedoes is disclosed in the present inventor's U.S. Patent 3,151,527, entitled "Barrel Engine," which issued Oct. 6, 1964.

The barrel engine of the above-mentioned patent provides torque balanced contra-rotating propellers for propelling a torpedo through water. Torque balance is required since a lack of it would impose a resisting torque on the torpedo body and cause the torpedo to roll to one side. A permanent inclination of the torpedo is very undesirable as it will interfere with the steering controls. An outer housing and a hollow inner shaft are coaxially mounted relative to each other and adapted to establish relative rotation. A fluid pressure inlet, through which hot gas flows, is positioned coaxially with respect to the inner shaft. The motive power assembly includes a plurality of pistons reciprocally mounted in the housing with their stroke axes parallel to the axial center of rotation. The motive power assembly is constructed and arranged to translate the fluid pressure into an axial force component. A wobble plate conversion assembly is mounted to the inner shaft for converting the reciprocatory substantially linear motion of the pistons into rotary motion. The outer housing is rotated in an opposite direction to the inner shaft solely by virtue of the reaction to the rotation of the inner shaft.

Cooling of the engine of the above-mentioned patent is accomplished by a coolant, such as water, which is introduced into the engine through an annular space surrounding the tubular hot gas nozzle. The coolant then flows from the annular space through channels and slots into a cooling jacket which surrounds each cylinder. The coolant is then fed through additional passageways into the inner power take-off shaft and there the coolant joins the exhaust gas where it serves the function of cooling the exhaust for the protection of engine components along the exhaust path.

As the size of torpedoes increase, larger size engines are required which dissipate huge quantities of heat into the engine structure. Accordingly, improved means for cooling must be provided to protect the various engine parts. In the present invention, a liquid coolant, such as water, is delivered under pressure through an annular space surrounding a hot gas nozzle. A plurality of coolant passages are provided which lead to a plurality of cylinder liners that surround each cylinder. Each cylinder liner is provided with grooves around the outer periphery that provide passages for cooling water. A quantity of water entering these grooves divides and flows in both clockwise and counterclockwise direction around the cylinder liner. The two streams then join and flow into an adjacent groove where the quantity of water again divides and flows in two directions. This flow path is repeated from groove to groove until the entire cylinder circumference has been encompassed. From the last groove, the cooling water leaves the cylinder liner and is discharged into the engine exhaust.

It is therefore a general object of the present invention to provide improved cooling means for a barrel engine.

Another object of the present invention is to provide a turbulent stream of coolant flowing at a high velocity around the external surface of an engine cylinder.

Other objects and advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIGURE 1 is a longitudinal partial sectional view of the aft section of a torpedo;

FIGURE 2 is a partial sectional view of a barrel engine used to propel a torpedo;

FIGURE 3 is a top plan view of a cylinder liner; and

FIGURE 4 is a sectional view taken on line 4—4 of FIGURE 3.

Referring now to the drawings, and particularly to FIGURE 1, there is shown an aft-section of a torpedo housing **11** in which a barrel engine **12** drives a pair of contra-rotating propellers **13** and **14**. Hot gas, or other suitable fluid, flows from a combustion chamber into barrel engine **12** where it is distributed to a plurality of cylinders by a rotary valve assembly. The gas drives pistons in the cylinders and the reciprocating motion of the pistons is converted into rotary motion by means of a cam that is attached to and drives a hollow shaft **15**. Propeller **13** is provided on the end of hollow shaft **15** and is driven thereby, and a second hollow shaft **16** is concentrically mounted around hollow shaft **15** and is driven in a contra-rotating direction relative to the direction of rotation of hollow shaft **15**. Propeller **14** is attached to the outer end of hollow shaft **16**.

Referring now to FIGURE 2 of the drawings, hollow shaft **15** is rotatably mounted within engine housing **17** by means of radial bearing **18** and thrust bearing **19**. A cam **21** is attached to shaft **15** by key **23** and is rotatable therewith. A rotary valve **24**, having an inlet port **25** and an exhaust port **26**, is rotatably mounted within housing **17** and is attached to the inner end of hollow shaft **15**. Exhaust port **26** communicates with the bore of hollow shaft **15** and exhaust products passing through port **26** pass into hollow shaft **15** and then are expelled into the air, or into the sea.

Six hollow cylinders **27** are positioned in a circular array about the central axis of housing **17**, and the central axis of each cylinder is substantially parallel to the central

axis of housing 17. A cylinder liner 28 is provided in each cylinder, and each cylinder liner 28 is positioned in the end of the cylinder 27 through which hot gases enter. A piston 31 is provided in each cylinder 27 and a first roller 32 is attached to one end of piston 31 by means of a shaft 33. Rollers 32 engage the top surface 34 of cam 21 and a second roller 35 is attached to each piston 31 by means of shaft 36 and engages the bottom surface 37 of cam 21. When hot gases enter into each cylinder 27 through passageway 38, these hot gases move pistons 31 outwardly and rollers 32 apply a driving force against cam 21 thereby causing cam 21 to be rotated. As cam 21 is keyed to hollow shaft 15, rotation of cam 21 causes hollow shaft 15 to be rotated. Shaft 16 rotates in a contra-rotation direction relative to the direction of rotation of shaft 15.

Referring now particularly to FIGURES 2, 3, and 4 of the drawings, cylinder liner 28 is provided with a plura'ity of flanges 51, 52, 53, and 54 that encompass the circumference of cylinder liner 28. When cylinder liner 28 is positioned within a cylinder 27, the plurality of flanges in conjunction with the cylinder wall provide a plurality of annular passageways 55, 56, 57, 58 and 59, for the flow of a coolant, such as water. Flange 51 is provided with a slot 61 whereby passageways 55 and 56 are connected. Likewise, flange 52 is provided with a slot 62 whereby passageways 56 and 57 are connected. Slot 62 is displaced approximately 180 degrees from an in line position from slot 61. Flange 53 is provided with a slot 63 that joins passageways 57 and 58, and likewise, flange 54 is provided with a slot 64 that joins passageways 58 and 59. Slot 63 is in line with slot 61 and slot 64 is in line with slot 62. An aperture is provided in each cylinder wall adjacent passageway 59 and connects with one of a plurality of passageways 65 which are provided one each adjacent each cylinder wall. Each passageway 65 connects with an annular space 66 which surrounds the forward end of rotary valve 24. A plurality of holes 67 are provided in rotary valve 24 and connect annular space 66 with space 68. A plurality of holes 69 are provided in hollow shaft 15 and water entering space 68 passes through holes 69 and into the engine exhaust.

In operation, hot gases enter rotary valve 24 from stationary nozzle 71 and these hot gases are selectively distributed to cylinders 27 at an appropriate time when pistons 31 are in position to make a stroke. Outward movement of pistons 31 causes cam 21 to be rotated, and as cam 21 is keyed to hollow shaft 15, shaft 15 is rotated and also shaft 16 is rotated in a contra-rotation direction. During the exhaust stroke of each piston 31, exhaust products are expelled from the respective cylinder being exhausted through passageway 38, exhaust port 26, and into the bore 72 of rotary valve 24, which communicates with the bore of hollow shaft 15.

Cooling water is supplied through conduit 73 into annular space 74 which surrounds nozzle 71 and, from annular space 74, the cooling water flows through passageway 75 into passageway 55 which is provided by cylinder liner 28 and the inside surface of cylinder 27. The cooling water flows in both a clockwise stream and a counterclockwise stream in passageway 55 and the two streams join and then pass through slot 61 into passageway 56. The cooling water then flows in both a clockwise stream and a counterclockwise stream in passageway 56 and the two streams join and then pass through slot 62 into passageway 57. The same pattern of flow takes place in passageways 57, 58, and 59, and from passageway 59, the cooling water flows through passageway 65 into annular space 66. The cooling water then passes through holes 67, space 68, and holes 69 into hollow shaft 15 where the cooling water is exhausted along with the exhaust products from the cylinders.

It can thus be seen that the present invention provides improved cooling means for a barrel engine whereby said engine can be driven by gases which are at an extremely high temperature. Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that wthin the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A barrel engine comprising:
a housing,
a hollow shaft rotatably mounted within said housing,
a plurality of cylinder bores machined integral in said housing and extending in circular array about said hollow shaft with their axes being parallel thereto,
a plurality of pistons each having an inner end slidably disposed one each in each said cylinder bore and each having first and second rollers attached to an outer end,
a double-end cam fixedly attached to said hollow shaft and having first and second cam surfaces thereon, said first and second rollers of each said piston being engaged, respectively, with said first and second cam surfaces whereby said hollow shaft is rotated upon slidable motion of said pistons,
a valve rotatably mounted in said housing having an inlet port and an exhaust port, said inlet port selectively providing a passageway between a fluid source and said cylinder bores, and said exhaust port selectively providing a passageway between said cylinder bores and said hollow shaft,
a plurality of cylinder liners mounted one each in each said cylinder bore, each said cylinder liner having a plurality of outwardly extending flanges each having a slot therein whereby said inner surface of said cylinder bore and said outwardly extending flanges provide a plurality of connected fluid passageways,
a quantity of cooling fluid,
means in said housing for channeling said cooling fluid to said passageways in said cylinder liner, and
means in said housing for channeling said cooling fluid between said cylinder liners and said hollow shaft.

2. A barrel engine as set forth in claim 1 wherein said housing is rotatably mounted whereby rotation of said hollow shaft in one direction causes said housing to rotate in an opposite direction.

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