

Oct. 28, 1969

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3,474,709

CYLINDER LINER FOR BARREL ENGINE

Filed Sept. 28, 1967

2 Sheets-Sheet 1

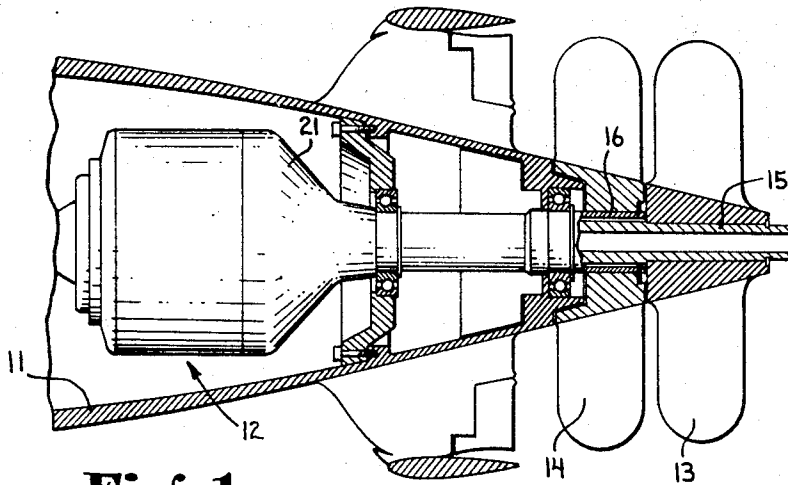


Fig. 1.

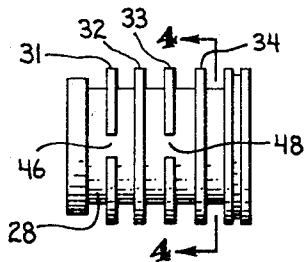


Fig. 3.

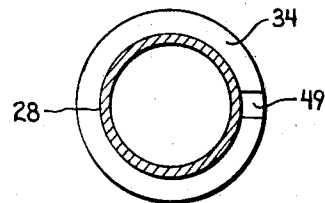


Fig. 4.

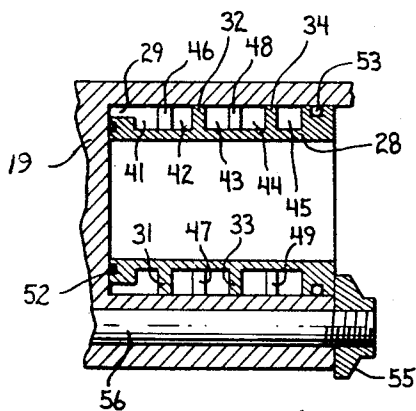


Fig. 5.

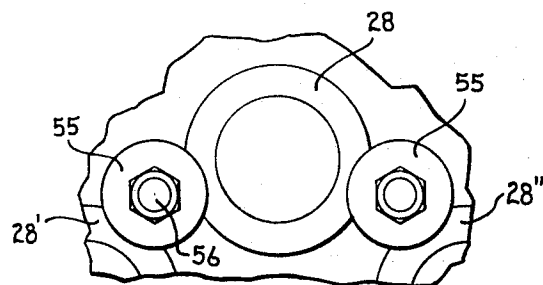


Fig. 6.

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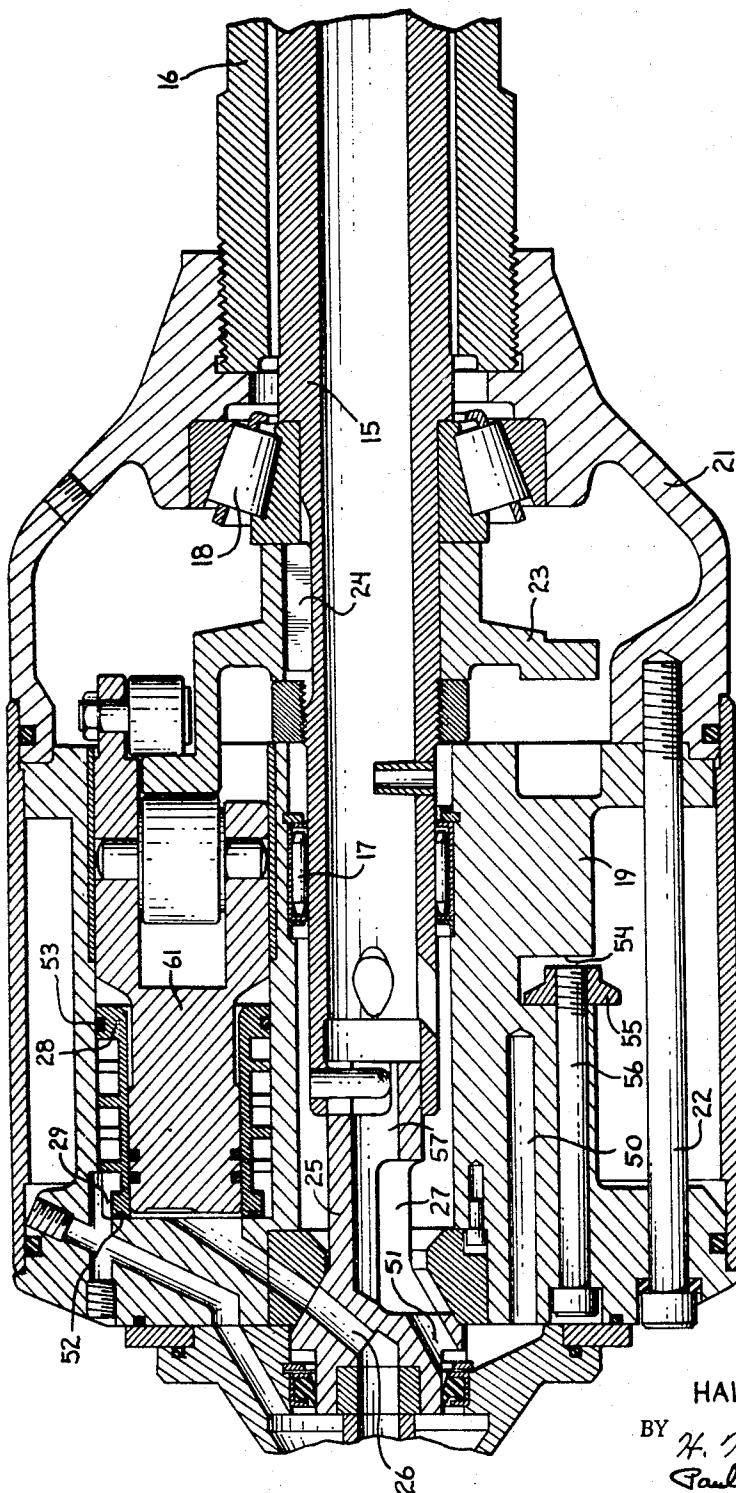


Fig. 2.

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3,474,709

CYLINDER LINER FOR BARREL ENGINE

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U.S. Cl. 92-71

1 Claim

ABSTRACT OF THE DISCLOSURE

An improved cylinder liner for a barrel engine having a plurality of annular fins surrounding the outer periphery which forms a plurality of water passageways when said cylinder liner is seated in a cylinder bore. Each said annular fin having a slot therein which provides communication between adjacent water spaces. A first sealing means is provided on one end face of said cylinder liner and compressive means are provided to seat said cylinder liner in said cylinder bore.

CROSS-REFERENCES TO RELATED APPLICATIONS

The following pending applications of applicant are related to the present disclosure:

(a) Application Ser. No. 538,162, filed Mar. 22, 1966, for "Sealing Device For High Temperature Input Nozzle"; which issued as U.S. Patent 3,411,795;

(b) Application Ser. No. 546,150, filed Apr. 26, 1966, for "Barrel Engine Having Cooling System"; now abandoned and the parent application of application Ser. No. 704,178, filed Feb. 6, 1968, which issued as U.S. Patent 3,408,898; and

(c) Application Ser. No. 547,080, filed Apr. 29, 1966, for "Barrel Engine Having Forced Lubrication" which issued as U.S. Patent 3,359,864.

BACKGROUND OF THE INVENTION

The present invention relates to improved cylinder liners for a barrel engine. 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 coast with cam means on the output shaft so as to convert the reciprocating motion of the pistons into rotary motion which rotates the output shaft. Barrel engines 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. In this patent, there is disclosed a barrel engine having 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.

In applicant's above-identified patent, a spider member is formed with six openings positioned in circular array about the central axis of the spider. Each spider opening is adapted to rigidly receive a hollow cylindrical casing, one end of which is mounted to the spider member and the other end of which is secured to a housing section. To seal each cylindrical casing into position, an O-ring is secured into an annular groove of the engine head, and another O-ring is secured into an annular groove in the spider member.

SUMMARY OF THE INVENTION

The present invention relates to an improvement in barrel engines of the type shown in the inventor's U.S. Patent 3,151,527, and while the principle of operation is essentially identical, there are some structural differences. For example, the swashplate cam of the patent, which serves to convert the reciprocating motion of the pistons to rotary motion which turns the inner tubular power take-off shaft, has been replaced by a harmonic cam.

The specific improvement for a barrel engine to which this disclosure relates is that of the cylinder liners which are provided in cylinder bores formed in a monolithic cast aluminum block. Each cylinder liner has a plurality of annular fins surrounding the outer periphery, and when the liner is seated in the cylinder bores in the aluminum block, a plurality of channels are formed which are used for the flow of coolant, such as water, for cooling the engine. Each annular fin is provided with a slot that permits communication between adjacent channels, and the slots are staggered so that the coolant flows around the channels. Coolant admitted at one end of the cylinder liner must flow around the liner to the opening cut in the first fin and, upon transfer to the next channel, the coolant again circulates around the cylinder liner to reach the slot in the next fin. The transfer of coolant from one channel to the next causes a turbulent flow of relatively high velocity which encompasses the entire exterior surface of the cylinder liner.

A groove is provided in the forward end of each liner and bolts and threaded washers are provided to provide axial pressure which serves to compress a packing member which is provided in the groove.

It is therefore a general object of the present invention to provide in a barrel engine a cylinder liner which is economical to manufacture and easy to install, and which will provide better cooling of the barrel engine.

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.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a partial longitudinal sectional view showing an aft section of a torpedo which embodies the present invention;

FIGURE 2 is a partial longitudinal sectional view of a barrel engine embodying the present invention;

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

FIGURE 4 is a sectional view taken on line 4-4 of FIGURE 3;

FIGURE 5 is a partial sectional view showing a cylinder liner in a cylinder bore; and

FIGURE 6 is an end view of a cylinder liner in a pocket.

DESCRIPTION OF THE PREFERRED EMBODIMENT

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. By way of example, the hot gas, or other suitable fluid, may flow from a combustion chamber into a tubular conduit and a hot gas seal assembly, as shown in applicant's co-pending patent application entitled, "Sealing Device For High Temperature Input Nozzle," which was filed Mar. 22, 1966, Ser. No. 538,162. The hot gas enters into a rotary valve assembly which distributes the hot gas to the various cylinders.

The hot gas, or other suitable fluid, which is distributed by the rotary valve assembly to the various cylinders, 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 attached to the end of hollow shaft 15 and is rotated 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. The reciprocating linear motion of the pistons is converted, by the cam, into rotary motion which rotates the inner hollow shaft 15 and, simultaneously, torque reaction causes the outer hollow shaft 16 to be contra-rotated as shaft 16 is substantially integral with the housing of barrel engine 12. Propeller 14 is attached to the outer end of hollow shaft 16 and thus rotates in a contra-rotating direction relative to the direction of rotation of propeller 13.

Referring now to FIGURE 2 of the drawings, hollow shaft 15 is rotatably mounted within a housing by means of radial bearing 17 and thrust bearing 18. The housing is comprised of a front section 19 which is attached to an aft section 21 by means of bolts 22. By way of example, front section 19 might be comprised of a monolithic block of cast aluminum. A cam 23 is attached to hollow shaft 15 by key 24, and rotation of cam 23 causes a corresponding rotation of hollow shaft 15. A rotary valve 25, having an inlet port 26 and an exhaust port 27, is rotatably mounted in front housing section 19 and is attached to the inner end of hollow shaft 15. Exhaust port 27 communicates with the bore of hollow shaft 15 and exhaust products passing through port 27 pass into hollow shaft 15 and then are expelled into the air, or into the sea.

Referring now particularly to FIGURES 2 through 6 of the drawings, a plurality of cylinder liners 28 are seated one each in a plurality of cylinder bores 29 that are provided in front housing section 19. Each cylinder liner 28 is provided with a plurality of flanges 31, 32, 33, and 34 that encompass the circumference of cylinder liner 28. When cylinder liner 28 is positioned within a cylinder bore 29, the plurality of flanges, in conjunction with the cylinder wall, provide a plurality of annular passageways 41, 42, 43, 44, and 45, for the flow of a coolant such as water. Flange 31 is provided with a slot 46 whereby passageways 41 and 42 are connected. Likewise, flange 32 is provided with a slot 47 whereby passageways 42 and 43 are connected. Slot 47 is displaced approximately 180 degrees from an in line position from slot 46. Flange 33 is provided with a slot 48 that joins passageways 43 and 44, and likewise, flange 34 is provided with a slot 49 that joins passageways 44 and 45. Slot 48 is in line with slot 46 and slot 49 is in line with slot 47. After the coolant enters into passage 45 in cylinder liner 28, it then passes through passage 50 and then through hole 51 in valve 25. The coolant then passes through the center hole 57 in valve 25 and then into

hollow shaft 15 where the coolant is exhausted along with the exhaust products from the cylinders. There is a passage 50 situated close to each of the cylinder bores and each passage 50 communicates, as by a hole or a slot, with a separate passage 45.

The front face of each cylinder liner 28 is provided with an annular groove in which a sealing material 52 is seated to prevent leakage of hot gas that enters the cylinders. By way of example, sealing material 52 might be a crushable packing member and, upon the application of axial pressure, material 52 is crushed whereby the annular groove is completely filled to provide a seal between cylinder liner 28 and the end or bottom of cylinder bore 29. Another groove is provided in the outer circumference of each aft end of liners 28, and a packing member 53 is provided therein for sealing the coolant that flows within the various passageways.

The front housing section 19 is provided with slots 54 at a level even with the aft end of the cylinder liners and a threaded washer 55 is provided in each slot 54. A bolt 56 threadedly engages each washer 55 and upon tightening of washer 55 onto bolt 56 a compressive force is applied axially to cylinder liner 28 thereby compressing or crushing sealing material 52. As best seen in FIGURE 6 of the drawings, each threaded washer 55 engages adjacent cylinder liners 28 and thus each liner 28 is firmly held at two points which are nearly diametrically opposite one another.

A piston 61 is provided in each cylinder and pistons 61 drive cam 23. As cam 23 is keyed to hollow shaft 15, rotation of cam 23 causes hollow shaft 15 to be rotated, and shaft 16 rotates in a contra-rotation direction relative to the direction of rotation of shaft 15 due to torque reaction.

It can thus be seen that the present invention relates to an improved cylinder liner for a barrel engine with the cylinder liner being economical to manufacture and easy to install. Each cylinder liner is separately clamped with axial pressure being applied to crush a packing member confined in an annular groove in the front end of the liner against an opposing face of a cylinder bore. By crushing the packing member, the annular groove is completely filled to provide a seal for hot gases entering the cylinder. Also the confinement of each liner in a cylinder bore provides a plurality of passageways for a liquid coolant, such as water. Coolant entering at one end of the liner flows around the periphery of the liner to the slot in the first fin and is then transferred to the adjacent passageway. It then circulates around the periphery of the liner to the next slot which is displaced from the first slot by approximately one hundred and eighty degrees. The transfer of coolant from one passageway to another causes a turbulent flow of relatively high velocity which provides improved cooling of the barrel engine.

I claim:

1. In a barrel engine having a housing a hollow shaft rotatably mounted within said housing, a plurality of cylinder bores in said housing extending in circular array about said hollow shaft with their axes parallel thereto, a plurality of pistons slidably disposed one each in each said cylinder bore, and a harmonic cam attached to said hollow shaft and in engagement with said pistons, the improvement comprising:

a plurality of cylinder liners mounted one each between the outer diameter of said pistons and the walls of said cylinder bores, each said cylinder liner having a plurality of outwardly extending flanges wherein the cylinder walls and said outwardly extending flanges provide a plurality of closed fluid passageways, each said cylinder liner having an annular groove on one end thereof,

sealing material positioned in said annular groove, and a plurality of bolts equal in number to the number of cylinder bores, said bolts being attached to said

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housing in a circular array, each bolt having thread-
edly attached thereto a threaded washer which en-
gages adjacent cylinder liners for applying axial forces
to said cylinder liners at the end opposite said end
having said annular groove whereby said sealing
material is compressed to provide a gas seal between
the end of said cylinder liner and the bottom of said
cylinder bore.

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U.S. Cl. X.R.

91—175, 180; 92—171