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CASING STRUCTURE FOR INTERNAL-COMBUSTION FREE PISTON ENGINES

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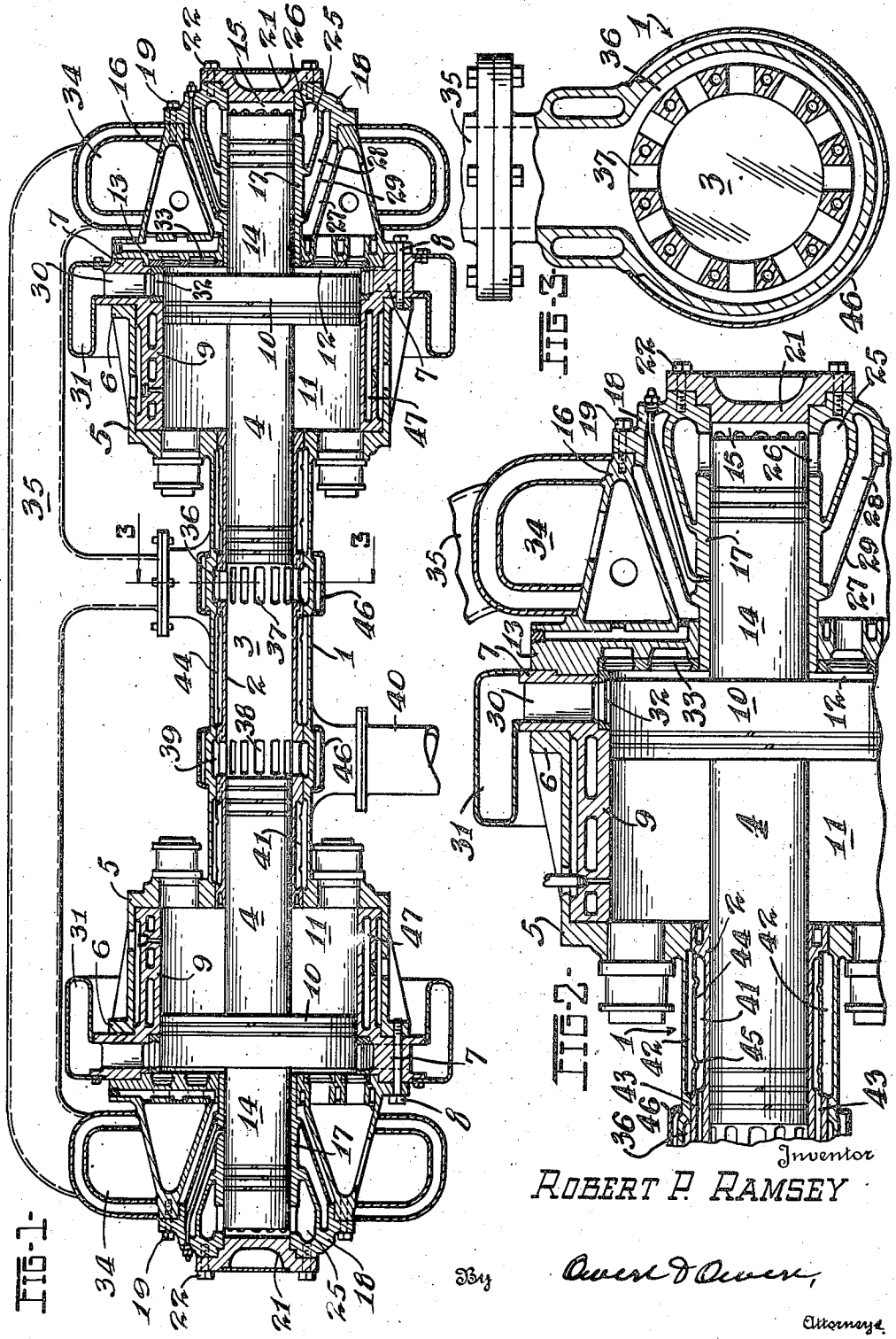


FIG-1-

FIG-2-

FIG-3-

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CASING STRUCTURE FOR INTERNAL-COMBUSTION FREE PISTON ENGINES

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14 Claims. (Cl. 123—46)

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This invention relates to free piston engines of the internal combustion type, and particularly to such an engine used in connection with turbines to supply gas under pressure thereto.

An object of the invention is the provision of an engine frame or casing construction composed of a plurality of sections which are separably connected to permit easy access to the internal parts for inspection, replacement and repair.

Another object of the invention is the provision of liner means for the cylinder forming the combustion chamber and in which the power pistons operate, which means is removably fitted into the cylinder in a manner to permit easy replacement, and which provides an efficient bearing surface for the pistons and also provides a water-jacketing feature.

Other objects and advantages of the invention will be apparent from the following detailed description and from the accompanying drawing illustrating one embodiment of the invention, in which—

Fig. 1 is a central longitudinal section of the engine frame with the parts thereof in assembled relation and with the customary free pistons at the outer ends of their strokes and in full; Fig. 2 is an enlarged fragmentary section the same as in Fig. 1, and of one end portion thereof, and Fig. 3 is an enlarged cross-section on the line 3—3 in Fig. 1.

Referring to the drawing, 1 designates the center frame of the engine, which frame is of cylindrical form and has a liner 2 forming the combustion chamber 3 in which a pair of opposing free pistons 4, 4, constituting the power pistons of the engine, operate. The frame 1 at each end terminates in a radially enlarged cylindrical extension 5 that is coaxial with the chamber 3 and is provided, in the present instance, at its outer end with an outwardly projecting radial flange 6.

A ring 7 abuts against the outer end of the extension 5, being secured to its flange 6 by stud bolts 8, and has a cylindrical liner part 9 projecting therefrom into the extension 5 to cooperate therewith and with the ring 7 to form the circumferential wall of a cylinder in which an air compressor piston 10 of the engine operates. This piston is attached to the outer end of the power piston 4 to move therewith and divides the interior of the compressor cylinder into a reverse bounce chamber 11 and an air compressor chamber 12.

Attached to the outer end of each ring 7 by the bolts 8 is a head 13 for the air compressor cylinder and this has a central cylindrical opening through which a bounce piston 14 projects outwardly from the piston 10 centrally thereof into a bounce chamber 15 formed as hereinafter described. The head 13 has a hollow outward extension 16 which is radially spaced from the chamber 15 and has its inner wall or that adjacent to said chamber of conical form which narrows the said spacing inwardly from the outer end of the extension.

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A liner 17, which constitutes the cylinder in which the piston 14 operates and which forms the chamber 15, is fitted into the central opening of the compressor cylinder head 13 and has its outer end portion radially enlarged as at 18 to abut against the outer end of the extension 16 and to be attached thereto by stud bolts 19. A bounce cylinder head 21 is removably attached to the outer end of the liner 17 by stud bolts 22. The liner 17, in surrounding relation to the bounce chamber 15, forms an annular chamber 25 which communicates with the outer end portion of the chamber 15 through one or more ports 26, thus forming an enlargement for the bounce chamber. The extension 16 and liner 17 cooperate to form a space therebetween which is divided into an air chamber 27 and a coolant circulating chamber 28 by a sheet metal sleeve 29 that is welded at its end edges to shouldered portions of the liner. A circulating coolant is introduced into the chamber 28 in any suitable manner.

Air to be compressed in each chamber 12 is admitted thereto through one or more inlet openings 30 in the ring 7, which openings communicate with the atmosphere through a supply chamber or manifold 31 and with the compressor chamber 12 through suitable inwardly opening valves 32. Outwardly opening discharge valve means 33 is provided in the compressor cylinder head 13 and open outwardly into the hollow of the head extension 16 and thence through a surrounding chamber or manifold 34 to a scavenging receiver 35. This receiver, as is customary with engines of this character, connects the chambers 34 at both ends of the engine and, in the present instance, has its sole discharge into the combustion chamber through a passage 36 surrounding the combustion chamber and in communication therewith through an annular series of ports 37. These ports are uncovered by one of the pistons 4 when near the outer end of its stroke. The exhaust from the combustion chamber 3 takes place through an annular series of ports 38 into an annular passage 39 in the frame part 1 and thence to the exhaust manifold 40 leading to the turbine or other device to which

the compressor gas is to be supplied. The ports 38 are uncovered by the other power piston 4 when near the outer end of its stroke and the length and arrangement of the scavenging ports 37 and exhaust ports 38 are such that the exhaust ports are opened in advance of the scavenging ports and remain open during the entire period that the latter ports are open.

The power cylinder liner 2 may be inserted into position within the frame part 1 from an end thereof and has a fluid tight connection therewith at spaced points lengthwise thereof so that a cooling fluid may be circulated in spaces 41 provided therebetween. These spaces are in communication lengthwise of the liner through passages 43. The outer sides of the spaces 41 may be, and in the present instance are shown as being, separated from outwardly registering space portions 42 of the frame part 1 by sheet metal strips 44 welded thereto at their ends and having expansion portions 45 therein to facilitate contraction and expansion of the sizes of the spaces 41 under changing temperature conditions. The walls of the passages 36 and 39 are jacketed, as shown at 46, to facilitate the circulation therearound of a cooling fluid.

The wall of the air compressor cylinder formed by the extension 5 and liner 9 may be cooled by the circulation of a cooling fluid through a passage 47 provided around the cylinder between such parts.

It is apparent from the foregoing that the frame or casing of the engine includes a plurality of separable parts joined together to form the cylinders for the working pistons 4, the compressor pistons 10 and the bounce pistons 14; that these parts may be easily and quickly assembled or disassembled; that by removal of the bounce cylinder head 21 the interior of the bounce chamber 15 may be inspected; that the liner 17 forming the bounce cylinder may be removed together with the head 21 by simply removing the bolts 19, thus exposing the sides as well as the ends of the bounce piston 14, that the compressor cylinder head 13 together with the parts carried thereby may be removed from the compressor cylinder by removal of the bolts 8 and that the ring 7 and its liner 9 may also be removed from the cylindrical extension 5 upon a removal of said bolts. The removal of the head 13 permits inspection of the operating parts carried thereby and also permits removal of the piston sets from the engine casing and after this the power cylinder liner 2 may be removed for inspection or replacement.

I wish it understood that my invention is not limited to any specific construction, arrangement or form of the parts, as it is capable of numerous modifications and changes without departing from the spirit of the claims.

Having thus described my invention, what I claim as new, and desire to secure by United States Letters Patent, is:

1. In an internal combustion free piston engine, a casing structure including a center frame part serving in part at least to form an open ended piston receiving power cylinder having an enlarged longitudinally extending cylindrical part at each end and a liner for said extending part to provide a cylinder for receiving an air compressor piston and a removable head for each of said latter parts forming a cylinder for receiving a bounce piston, a removal of said heads rendering access to the different cylinders.

2. In an internal combustion free piston engine, a casing structure including a center frame

forming a power cylinder and having at each end a longitudinally extending cylindrical enlargement with its outer end open, a head removably attached to said enlargement and having an extension projecting therein and forming a liner therefor to form an air compressor cylinder, said head also forming a bounce cylinder, said power, compressor and bounce cylinders being axially aligned and opening one into another and adapted to respectively receive the power, air compressor and bounce pistons of the engine.

3. In an internal combustion free piston engine, a casing structure including a center frame forming in part at least a power cylinder and having at each end a longitudinally extending cylindrical enlargement with its outer end open, said enlargement forming in part at least an air compressor cylinder, a head removably attached to the outer end of each of said enlargements and having a part removable therefrom and forming a bounce cylinder, said power, compressor and bounce cylinders being axially aligned and opening one into another and adapted to respectively receive the power, the air compressor and bounce pistons of the engine.

4. In an internal combustion free piston engine, a casing structure including a center frame forming a liner receiving cylinder open at each end and also having at each end a longitudinally extending cylindrical enlargement, a liner in said cylinder forming a power chamber, a head for said enlargement having a cylindrical extension projecting therefrom into said enlargement to cooperate therewith to form an air compressor cylinder, said head also forming a bounce cylinder, said several cylinders being axially aligned and adapted to successively receive the power, air compressor and bounce pistons of the engine.

5. In an internal combustion free piston engine, a casing structure including a cylindrical center frame part, a liner in said part forming a power cylinder, said part and liner having circulating passages therebetween for a cooling fluid, the outer ends of said frame part having radially enlarged axial extensions, and means removably attached to the end of each of said extensions and having a liner part projecting therefrom into the extension to cooperate therewith to form an air compressor cylinder, said latter part and extension having provision therebetween for the circulation of a cooling fluid, said means forming a head for the compressor cylinder and a bounce cylinder at the outer end of the compressor cylinder, said power, compressor and bounce cylinders being adapted to respectively receive the power, the air compressor and bounce pistons of the engine.

6. In an internal combustion free piston engine, a casing structure including a center frame, a liner removably cooperating therewith to form a power cylinder, said frame having at each end a longitudinally projecting radially enlarged extension, a ring removably attached to said extension and having a liner projecting therefrom into the extension and cooperating therewith to form the circumferential wall of an air compressor cylinder, said ring having air inlet openings therein to said cylinder and a head removably attached to said ring for closing the outer end of the compressor cylinder and having provision for the discharge of air therethrough from the cylinder, and means removably carried by said head and providing a liner projecting therein to form a bounce cylinder, said power, compressor and bounce cylinders being adapted to

respectively receive the power, compressor and bounce pistons of the engine.

7. In an internal combustion free piston engine, a casing structure including a central part of cylindrical form having at each end a longitudinally projecting radially enlarged extension, a liner removably mounted in said cylindrical frame part to form a power chamber, a liner removably mounted in said extension to cooperate therewith to form a compressor cylinder, a head removably attached to said extension and second liner to close the outer end of the compressor cylinder and having a central opening, said head having a hollow outward projection surrounding its center opening and having its inner wall substantially conical in form with its large end outward, and means attached to said head extension and forming a liner for projection into the center openings of said head and its extension to form a bounce cylinder, said power, compressor and bounce cylinders being adapted to respectively receive the power, compressor and bounce pistons of the engine.

8. In an internal combustion free piston engine, a casing structure including a central frame part forming power and air compressor cylinders, a head attached to said part at each end and closing the outer end of the compressor cylinder, said head having a central opening and an outer hollow extension around said opening and forming a compressed air receiving chamber having an outlet, said head having valved discharge passages between said compressor cylinder and chamber, and sleeve means removably attached to the outer end of said head extension and projecting within said extension and to the center opening of the head to form a bounce cylinder and an auxiliary chamber in communication with said bounce cylinder, said power, air compressor and bounce cylinders being adapted to respectively receive the power, air compressor and bounce pistons of the engine.

9. In an internal combustion free piston engine, a casing structure including a central frame part forming power and at each end an air compressor cylinder, a head attached to said part at each end and closing the outer end of the respective compressor cylinder, each of said heads having a central opening and an outer hollow extension around said opening and forming a compressed air receiving chamber having an outlet, said head having valved discharge passages between said compressor cylinder and chamber, and sleeve means removably attached to the outer end of said head extension and projecting within said extension and the center opening of the head to form a bounce cylinder and an auxiliary chamber in communication with said bounce cylinder, said power, air compressor and bounce cylinders being adapted to respectively receive the power, air compressor and bounce pistons of the engine, said head extension and liner means having provision therebetween for the circulation of a cooling fluid.

10. In an internal combustion free piston engine, a casing structure including center means forming a power cylinder and at each end thereof the circumferential and inner end walls of an air compressor cylinder which is enlarged relative to the power cylinder and is coaxial therewith, head means removably attached to each end of said center means and closing the outer ends of the respective air compressor cylinders, said head means having a central opening and a hollow outward extension surrounding said opening together with valved discharge passages from the compressor cylinder to the hollow of said extension and an outlet passage therefrom, and means removably attached to the outer end of said head extension and including a liner projecting within said extension and head opening to form a bounce cylinder in axial alignment with said other cylinders, said power, air compressor and bounce cylinders being adapted to receive the respective power, air compressor and bounce pistons of the engine.

11. In an internal combustion free piston engine wherein a set of connected power, air compressor and bounce pistons operate at each end, means forming a power cylinder for the power pistons and at each end thereof a portion at least of a cylinder for receiving the respective compressor piston, means at each end completing the respective compressor cylinder and forming a compressed air distributing chamber in check valve controlled communication with the compressor cylinder, said last means having an opening concentric to the compressor cylinder with its wall including said distributing chamber, and means mounted in said opening and forming a bounce chamber for the respective bounce piston.

12. A structure as called for in claim 11 wherein the last means is radially spaced from the wall of said distributing chamber to provide a cooling fluid circulating space therebetween.

13. A structure as called for in claim 11 wherein said last means includes a supplemental chamber which surrounds and is in communication with said bounce cylinder and is disposed partially at least within said opening.

14. A structure as called for in claim 11 wherein said last means includes a supplemental chamber which surrounds and is in communication with said bounce cylinder and is disposed partially at least within said opening and wherein a cooling fluid circulating space is provided between said distributing chamber and a considerable portion of said last means.

ROBERT P. RAMSEY.

Certificate of Correction

Patent No. 2,406,037. August 20, 1946.

ROBERT P. RAMSEY

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 3, lines 68, 69 and 70, claim 1, strike out the words "and a liner for said extending part to provide a cylinder for receiving an air compressor piston" and insert the same in line 72, same claim, after "piston" and before the comma; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of November, A. D. 1946.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.