METHOD OF MANUFACTURING AN ENGINE CYLINDER

Filed Jan. 11, 1929
UNITED STATES PATENT OFFICE

HERBERT T. HERR, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNEE TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

METHOD OF MANUFACTURING AN ENGINE CYLINDER

Application filed January 11, 1929. Serial No. 331,809.

My invention relates to engine cylinders and particularly to cylinders for engines of the internal combustion type and it has for an object to provide a novel method or process of manufacture or construction which may be readily and inexpensively accomplished and which shall at the same time be capable of producing an engine cylinder of extraordinary light weight consistent with the power it develops, a cylinder which shall incorporate adequate means for dissipating the heat it generates and a cylinder which shall possess the requisite strength to withstand the stresses to which it may be subjected.

This and other objects is effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a view, in sectional elevation of one form of engine cylinder constructed in accordance with my invention;

Figs. 2, 3, 4, 5 and 6 are transverse sectional views taken on the lines II—II, III—III, IV—IV, V—V and VI—VI of Fig. 1, respectively;

Fig. 7 is an enlarged partial view, in section, illustrating the method of securing the water jacket to the cylinder in the vicinity of the cylinder ports;

Fig. 8 is a partial plan view of the cylinder structure in the vicinity of the fuel inlet port;

Fig. 9 is an enlarged partial view, in section, illustrating the method of securing the end portions of the water jacket to the cylinder.

Referring to the drawings, I show my improved cylinder structure including a cylinder indicated at 10 having disposed therein a pair of opposed pistons indicated diagrammatically at 11 and 12. While in the present embodiment, I illustrate a cylinder of the opposed piston type, nevertheless it is to be understood that my invention is equally applicable to cylinders of other than the opposed piston type. Assuming that the cylinder is to be utilized in an engine operating on the Diesel cycle, I may provide, at a central portion of the cylinder, one or more inlet ports 13 for the injection of fuel, the fuel inlet ports 13 being provided with suitable bosses 14 formed integrally with the cylinder body 10. Spaced longitudinally on one side of the fuel inlet ports 13 is a series of scavenging fluid inlet ports 15 which spaced longitudinally on the opposite side of the fuel inlet ports 13 is a series of exhaust ports 16.

As shown in Fig. 3, the scavenging fluid inlet ports are spaced circumferentially from each other and each port is provided with a projecting flange portion 17, the flange portions 17 being spaced from each other circumferentially so as to permit the cylinder cooling fluid to pass between adjacent ports or through passages 18.

As shown particularly in Fig. 3, the scavenging fluid inlet ports 15 may be so arranged that their respective axes 20 are tangential to a circle 90° drawn about the cylinder axis. In this way, the scavenging fluid is so delivered into the engine cylinder that it is given a swirling or rotary motion within the cylinder and more thorough scavenging of the exhaust gases is thereby effected.

Upon reference to Fig. 3, it will also be noted that the wall portions 19 intermediate of adjacent flange portions 17 are made thicker than the normal thickness of the cylinder, these thickened wall portions as well as the projecting flange portions 17 cooperating to give the required strength to the cylinder in a region which would otherwise be weakened because of the several port openings.

Like the scavenging inlet ports 15, it will be seen from Fig. 5 that the exhaust ports 16 are also provided with projecting flange portions 21 spaced circumferentially from each other so as to provide intervening cooling fluid passageways 22. The cylinder wall portions 23 intervening between adjacent flanges 21 are also preferably made thicker than the normal cylinder wall thickness in order to strengthen the cylinder in the vicinity of the exhaust ports. As shown particularly in Fig. 5, the exhaust ports are preferably arranged with their axes disposed radi
ally so as to provide a direct outward passage for the exhaust gases.

Disposed on each side of the scavenging fluid inlet ports 15, as well as on each side of the exhaust ports 16, are projecting flanges 24 and 25, the flanges 24 and 25 associated with each series of ports being utilized to support the cylinder inlet manifold 26 and the cylinder exhaust manifold 27, respectively. Interposed between the fuel inlet connections 13 and the flanges 25 are reinforcing ribs 28 formed integrally upon the outer wall of the cylinder. In addition, the thickness of the cylinder wall may be increased from the vicinity of the inlet and exhaust ports to the central portion of the cylinder, as shown, in order that the cylinder may have the requisite structural strength in that portion where combustion of the fuel takes place and where maximum working pressures are created. The reinforcing ribs, as well as the thickened wall portions, cooperate to provide this required strength.

Spaced outwardly from the inlet and exhaust ports are jacket flanges 31 and 32, which flanges define the longitudinal extent of the cylinder cooling jacket. Located outwardly of these flanges are additional reinforcing ribs 33 and 34 while the end portions of the cylinders are provided with suitable screw threads 35 and 36 to which flanges 37 and 38 are secured. As disclosed and claimed in my copending application, Serial No. 370,606 filed June 13, 1929, entitled Internal combustion engine and assigned to the Westinghouse Electric & Mfg. Co., I show a form of engine wherein a cylinder of the character heretofore described may be utilized and it will be noted by referring to that application that the cylinders 10 are arranged in closed polygonal sets and that the cylinders themselves are so connected that they serve as stress members to resist engine working forces tending to distort the polygon. Accordingly, the cylinders 10 must be capable of not only withstanding the internal radial pressures created by the ignition of the fuel mixture, but they must also have the requisite strength longitudinally in both tension and compression so as to resist any engine working forces acting upon the flanges 37 and 38 and tending to move them either apart from each other or toward each other. I have found that a cylinder of the character heretofore described, although relatively light in weight, has the requisite structural strength so as to make it adaptable for use in engines of the type disclosed in my aforesaid copending application.

Disposed about the cylinder 10 is a suitable jacket sleeve 41, which jacket sleeve extends between the jacket flanges 31 and 32 and defines with the outer walls of the cylinder an annular jacket space 42. The jacket space 42 extends continuously from the flange 31 to the flange 32, a restricted number of openings 43 being provided in the flanges 24, as shown in Fig. 2, and a relatively large number of openings 49 being provided in the flanges 25, as shown in Fig. 6. A cooling fluid inlet connection 44 is preferably located at the lower end of the cylinder while a cooling fluid outlet connection 45 is located at the upper end of the cylinder, the arrangement being such that the cooling fluid passes throughout the entire length of the jacket. By properly restricting the flow area of the openings 43 in the flanges 24, the entire jacket space is always filled with cooling liquid, irrespective of how the cylinder may be inclined.

The jacket sleeve 41 is provided with suitable openings 46, 47 and 48 registering with the scavenging fluid inlet ports 15, the fuel inlet ports 13 and the exhaust port 16, respectively. The jacket sleeve 47 is also provided with thickened wall portions 49 and 51 in the vicinity of the inlet and exhaust ports. The end portions of the jacket sleeve are also provided with suitable reinforcing flanges 52 while disposed on each side of the inlet ports 15 and the exhaust port 16 are annular connections 53 and 54 for securing the inlet manifold 26 and the exhaust manifold 27, respectively. For a detailed description of the construction of the aforesaid manifolds and their attachment to the cylinder, reference may be had to my copending application, Serial No. 383,810, of even date, entitled Manifold for internal combustion engine and assigned to the Westinghouse Electric & Mfg. Co.

Referring to the operation of the above described cylinder, it will be apparent that the fuel injected into the engine cylinder through the inlet ports 15 is ignited between the opposed pistons 11 and 12 and the opposed pistons are forced apart and moved toward the ends of the cylinder upon their power or working strokes. Upon the piston 12 uncovering the exhaust port 16, the exhaust gases within the cylinder are liberated, and upon the piston 11 uncovering the scavenging fluid inlet ports 15, scavenging fluid enters the cylinder and sweeps out the burnt gases containing therein through the exhaust port 16 until such time as the piston 12 again closes the exhaust ports 16. Thereafter, scavenging fluid is admitted through the inlet ports 15 until such time as the piston 11 closes the scavenging ports at which time the cylinder has been properly supercharged. The pistons 11 and 12 thereafter continue to move toward each other upon their compression stroke after which fuel is again injected through the inlet ports 13 and the working cycle is repeated. Cooling water is admitted to the cylinder jacket through the inlet connection 44 and is discharged through the outlet connection 45, the water circulating
throughout the entire length of the jacket and absorbing the required amount of heat to maintain the cylinder at its proper operating temperature.

While I have described an engine working cycle of the Diesel, two-cycle type, nevertheless it is to be understood that the method of construction which I have evolved may be utilized to produce cylinders for use in engines of other than the Diesel type and operating upon other than the two-cycle principle.

Referring now to the method of manufacturing the aforesaid cylinder, it is submitted that the cylinder 10 and the jacket sleeve 41 are first of all separately formed. Preferably, both the jacket sleeve 41, as well as the cylinder 10, are each machined from a single piece of seamless steel tubing, thereby eliminating all longitudinal joints. Referring now to the cylinder, it is noted that first of all the outer and inner diameters of the cylinder is rough machined and the fuel inlet ports 13, as well as the scavenging fluid inlet ports 15 and the exhaust ports 16, are cut in the cylinder. Preferably, the scavenging fluid inlet ports 15 and the exhaust ports 16 are only roughly cut at this time. After the cylinder is rough machined, it is annealed so as to relieve all internal stresses and after annealing, the outer and inner diameters are finally machined, sufficient stock being left on the inner diameter or bore so as to permit final grinding of the same. In the final machining operation of the cylinder, the outer diameters of the jacket flanges 31 and 32, the manifold flanges 24 and 25, the projecting flange portions 17 and 21 of the inlet and exhaust ports, as well as the bosses 14 associated with the fuel inlet ports 13 are all preferably turned to the same diameter.

Like the cylinder, the jacket sleeve 41 is also machined from a single piece of seamless steel tubing, the outer and inner diameters of the jacket sleeve being finish-turned. Thereafter, the jacket sleeve is heated and is telescoped over the cylinder 10, the bore of the jacket sleeve 41 being such that heating will enlarge it sufficiently to permit it to be telescoped about the cylinder. Subsequent cooling of the jacket sleeve effects the necessary contractual effort so that the jacket sleeve engages the various flanges and bosses provided on the cylinder by radial tension and hence may be said to be shrunk upon the cylinder. Thereafter, openings are cut in the jacket sleeve registering with the inlet ports 13 and 15 and the exhaust ports 16, the inlet and exhaust ports in both the jacket sleeve and the cylinder being finally machined as a single unit. While I prefer to cut the scavenging and exhaust port openings in the jacket sleeve before assembly of the latter upon the cylinder, nevertheless it is obvious that I may provide these openings in the jacket sleeve before assembly. Thereafter, the outer edges of the scavenging fluid inlet ports 15 and the exhaust ports 16 are preferably counter-sunk, as at 61, in Fig. 7, after which the edges of the openings in the jacket are welded to the flanges of their associated ports, as at 62. The fuel inlet port flanges are also preferably welded to the jacket sleeve as at 63. The end portions of the jacket are preferably turned, as at 64 in Fig. 8, and the end portions of the jacket sleeve are welded to their respective jacket flanges as 65. The assembled cylinder and jacket sleeve is then finally annealed to relieve any internal strains or stresses after which the bore of the cylinder is ground to its final diameter and the manufacturing operation is thus completed.

From the foregoing, it will be apparent that, by means of such a method of construction, the entire cylinder structure is formed from only two pieces, which two pieces are welded and shrunk together so that they produce, in effect, a one-piece cylinder structure. Inasmuch as the edges of the jacket sleeve are all welded to the cylinder, an absolutely fluid tight cooling jacket is provided. Inasmuch as the cylinder and the jacket sleeve are first of all separately formed, they may both be made very light in weight consistent with the required strength and by means of my novel process of manufacture and assembly, a cylinder structure is finally produced having an extraordinary light weight consistent with its capacity and its strength, such a form of cylinder being especially adapted for use in engines employed in the propulsion of aircraft wherein lightness in weight is a very important consideration.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The method of manufacturing an engine cylinder structure which comprises forming a cylinder and a jacket sleeve separately; telescoping the jacket sleeve about the cylinder and in spaced relation to portions of the cylinder; shrinking the jacket sleeve against other portions of the cylinder; welding portions of the jacket sleeve to the cylinder so as to provide a fluid-tight cooling jacket; and annealing the assembled cylinder and jacket sleeve.

2. The method of manufacturing an engine cylinder structure which comprises rough machining a cylinder; annealing the cylinder; finish machining the outer surfaces of the cylinder; forming a jacket sleeve;
1,820,069

telescoping the jacket sleeve about the cylinder and in spaced relation to portions of the cylinder; shrinking the jacket sleeve against other portions of the cylinder; welding the jacket sleeve to portions of the cylinder; annealing the assembled cylinder and jacket sleeve, and finish grinding the bore of the cylinder.

3. The method of manufacturing an engine cylinder structure which comprises rough machining a cylinder having radial protuberances from a single, unitary piece of material; annealing the cylinder; finish machining the inner and outer surfaces of the cylinder; machining a jacket sleeve from a single, unitary piece of material; telescoping the jacket sleeve about the cylinder and shrinking the jacket sleeve against the protuberances on the cylinder; welding the jacket sleeve to the protuberances; and annealing the assembled jacket sleeve and cylinder.

4. The method of manufacturing an engine cylinder structure which comprises rough machining a cylinder having exterior protuberances from a single, unitary piece of material; annealing the cylinder; finish machining the inner and outer diameters of the cylinder; forming a jacket sleeve from a single, unitary piece of material; telescoping the jacket sleeve about the cylinder and shrinking the jacket sleeve against the protuberances on the cylinder; welding the jacket sleeve to the protuberances; annealing the assembled jacket sleeve and cylinder; and finish grinding the bore of the cylinder.

5. The method of manufacturing an engine cylinder structure which comprises rough machining a cylinder having ports and exterior protuberances disposed about the ports; annealing the cylinder; finish machining the outer and inner diameters of the cylinder; forming a jacket sleeve and finish machining the same; telescoping the jacket sleeve about the cylinder; shrinking the jacket sleeve against the protuberances on the cylinder; cutting openings in the jacket sleeve registering with the ports in the cylinder; finish machining the openings in the jacket sleeve and their associated ports in the cylinder; welding the jacket sleeve to the protuberances; welding the end portions of the jacket sleeve to the cylinder; annealing the assembled cylinder and jacket sleeve; and finish grinding the bore of the cylinder.

In testimony whereof, I have hereunto subscribed my name this 3rd day of January, 1929.

HERBERT T. HERR.