Jan. 24, 1939. V. I. MONCRIEFF 2,144,928

METHOD OF MAKING INTERNAL COMBUSTION ENGINES

Filed April 19, 1935

Fig. 1

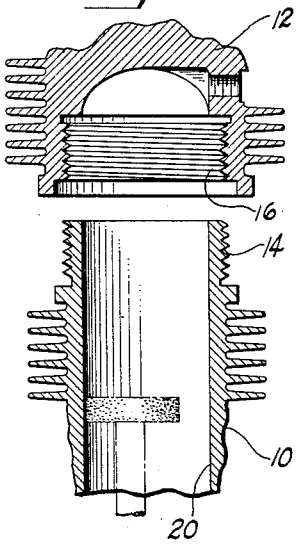


Fig. 2

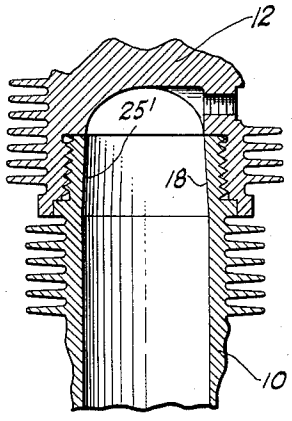


Fig. 3

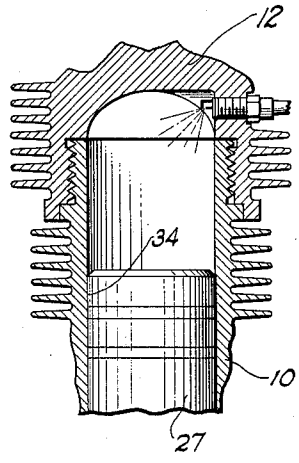


Fig. 4

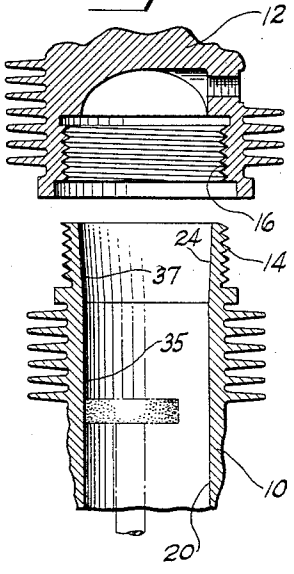


Fig. 5

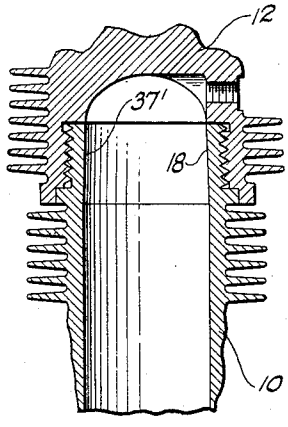
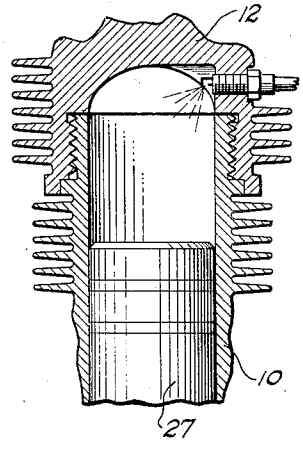


Fig. 6



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METHOD OF MAKING INTERNAL COMBUSTION ENGINES

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Application April 19, 1935, Serial No. 17,222

22 Claims. (Cl. 29—156.4)

This invention relates to improvements in internal combustion engines and has for an object the production of a cylinder for an air-cooled internal combustion engine so constructed that the diameter of the bore thereof at different positions along the cylinder axis will be substantially uniform under the temperature attained by the various parts of the cylinder during operation of the engine.

Another object of this invention is to simplify the finishing of the cylinder and improve the finished product.

In the accompanying drawing I have shown by way of illustration the usual method employed at present in the construction of engine cylinders of the type referred to and what is now considered the preferred form of my improved method of producing such cylinders to overcome certain disadvantages heretofore encountered, and a somewhat modified form of my improved process.

The drawing, however, is to be taken for the purpose of illustration only and not as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

Figures 1, 2, and 3 are vertical cross sectional views of an engine cylinder and cylinder head illustrating the various steps under my improved method for producing cylinders for an air-cooled internal combustion engine, and

Figures 4, 5, and 6 are vertical cross sectional views of an engine cylinder and cylinder head showing the various steps, in a somewhat modified form, of my improved method of producing cylinders for an air-cooled internal combustion engine.

According to present practice the barrel portion of the cylinder is ordinarily formed of steel and is provided with a series of cooling fins machined onto the outer surface of the barrel. This series of cooling fins terminates at the upper or outer extent thereof in an annular ledge or shoulder and the portion of the exterior surface of the cylinder barrel beyond the ledge from the series of cooling fins is provided with annular screw threads.

The cylinder head is ordinarily cast of some light strong material such as an aluminum alloy which, as is well known, has a heat expansion coefficient somewhat greater than the heat expansion coefficient of steel, and has cast upon the exterior surface thereof a plurality of cooling fins for dissipating heat from the cylinder head and valve ports. This cylinder head is a generally cup-shaped member and is provided interiorly thereof adjacent to the open end with a series of annular screw threads which cooperate with the screw threads on the cylinder barrel to secure the cylinder head and cylinder barrel together to form a complete cylinder. In practice the diameter of the threaded portion of the cylinder head is less than the diameter of the threaded portion of the cylinder barrel when the head and barrel are both at the same temperature by an amount sufficient to insure a tight fit at all times and make up for any differences in the expansion of the head and the barrel due to any difference in the heat expansion coefficients of the head and barrel. In order to assemble the two parts together the temperature of the head is raised or the temperature of the barrel is lowered, or both of these expedients are employed to alter the respective diameters of the head and barrel so that the head may be screwed upon the barrel. When the head and barrel are so assembled and reach the same temperature, the head will then have a shrunk fit upon the barrel and will be immovably secured thereto. In the old method the bore of the barrel portion of the cylinder is rough machined straight before the head and barrel are assembled together. This machining is done by a boring tool and no attempt is made to obtain a finished surface. Sufficient stock is left on the cylinder walls to permit subsequent grinding to finished size. After the head and barrel are assembled together the shrinking of the head upon the head end of the barrel will cause the adjacent end of the cylinder bore to taper inwardly to provide a slight original choke condition in the bore of the cylinder. The bore of the cylinder is then ground straight so that it has, when cold, a uniform diameter from one end to the other, this operation necessarily thinning out the wall section of the head portion of the cylinder. In this old method, when the cylinder is cold, the cylinder bore is straight and the piston fits accurately therein from one end to the other. During operation of the engine, however, it is a well known fact that the head portion of the cylinder heats up to a much greater extent than the base portion thereof owing to the repeated firing of explosive charges in the head portion. As the temperature variation between the base portion and the head portion of the cylinder increases and reaches its fixed differential value, the head portion of the cylinder will expand more than the base portion thereof, thereby producing the condition in which the head end of the bore has a diameter greater than the base end thereof. This condition is commonly referred to as a bell-mouthed cylinder,

and introduces serious disadvantages in the operation of the engine, in that the piston rings on the piston reciprocating in the cylinder are allowed to move relative to their grooves thereby causing an undue flexing of the rings which may ultimately result in fatigue of the material thereof and possible breakage and also causes the lower edges of the rings to scrape or score the surface of the cylinder wall. This bell-mouthed condition also renders it difficult to maintain proper lubrication in the head end of the cylinder and adversely affects the compression seal provided by the piston rings.

In the method of production contemplated by this invention and illustrated in Figures 1, 2, and 3, the bore of the cylinder barrel 10 is machined and ground straight and to the finished size before the head is assembled on the barrel. After the head is assembled on the barrel the shrinking thereof results in a slight inward taper of the head end of the cylinder bore which I have designated a choked bore, as illustrated at 25' in Figure 2. In this method of production the choke is not removed and the result is that when the engine is heated up to operating temperatures the bore is substantially straight as illustrated in Figure 3. This method of construction not only provides a substantially straight bore for the cylinders when the engine is at operating temperature so that the difficulties mentioned above in connection with the conventional method of construction are substantially eliminated, but also renders it possible to provide a much better finish on the interior surface of the cylinder barrel at an actual decrease in production cost, as it will be evident to one skilled in the art that it is much easier to machine the cylinder when both ends are open than when one end is closed by the cylinder head. The upper portion or head of the piston 27 must, of course, be shaped to fit into the choked portion of the cylinder bore when the engine is operated cold as during the starting and warming up period. It has been found, however, in actual tests that the piston head expands at substantially the same rate as the cylinder head as the engine warms up so that, when the engine has reached its normal operating temperature and the cylinder bore has become substantially straight, the piston head will have also expanded to take up any undue slack and preserve the working fit between the relatively movable parts.

The modified form of the invention is carried out by machining and grinding the cylinder bore straight as indicated at 35 in Figure 4 leaving the bore straight up to the threaded portion of the cylinder barrel but tapering the portion of the bore within the threaded portion of the barrel slightly outwardly as indicated at 37 in Figure 4, to provide a slight outward flare, before the head is assembled to the barrel, the flare indicated at 37 being preferably somewhat less than the shrinking effect of the cylinder head. When the cylinder barrel and cylinder head have reached the same temperature in their assembled position, in the modified form of the invention illustrated in Figure 5, the shrinking effect of the cylinder head will produce a choke condition in the head end of the cylinder bore as is indicated at 37' on Figure 5, but not as great a choke as that illustrated in Figure 2 described above. This choke effect is preferably designed so that the expansion of the cylinder head is just sufficient to remove the choke 37' and straighten the cylinder bore as illustrated in Figure 6. Obviously the taper may be altered to fit the expansion characteristics of cylinder heads.

My improved method of producing cylinders for air-cooled internal combustion engines results in the operating condition illustrated in Figures 3 and 6 in which, when the engine is operating at its normal temperature, both the cylinder bore and the piston are substantially straight and the fit between the piston and the bore is within the limits of best operating conditions.

While I have illustrated and described specifically my improved method for producing cylinders for air-cooled internal combustion engines, it is to be understood that the invention is not limited to the specific method illustrated and described, but that such changes therein may be resorted to as come within the scope of the appended claims.

Having now described my invention so that others skilled in the art may clearly understand the same, what I claim and desire to secure by Letters Patent is as follows:

1. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately and finishing the bore of the barrel to finished size before assembling the head on the barrel, inserting one end of the barrel into the head and securing the head on the barrel by contraction of the head.

2. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately with the interior diameter of the cylinder head slightly less than the exterior diameter of the cylinder barrel, grinding the bore of the cylinder barrel straight and to finished size and then shrinking the head onto the barrel to produce a slight choke in the head end of the cylinder bore when the cylinder head contracts.

3. The method of finishing cylinders for internal combustion engines in which the cylinder heads and cylinder barrels are formed separately and then secured together by a shrunk fit which comprises, forming the cylinder head with an interior diameter less than the exterior diameter of the head receiving portion of the cylinder barrel, machining and grinding the bore of the cylinder barrel to a straight finished condition and then heating the cylinder head and placing it upon the cylinder barrel so that the pressure exerted by the head will cause the head end of the barrel to have a slight inward taper when the head and barrel are at the same temperature.

4. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately with the interior diameter of the head slightly less than the exterior diameter of the barrel, grinding the bore of the barrel straight, tapering the portion of the bore within the head receiving portion of the cylinder barrel to provide an outward flare and then assembling the head on the barrel by heating the head and allowing it to shrink upon the head receiving portion of the barrel.

5. The method of producing cylinders for internal combustion engines in which the cylinder barrels and cylinder heads are formed separately and secured together by a shrink fit which comprises, grinding the bore of the cylinder barrel straight, finishing the bore by providing the portion of the bore within the head receiving portion of the barrel with a flare before assembling the head on the barrel and then shrinking the cylinder head onto the cylinder barrel.

6. The method of producing cylinders for internal combustion engines in which the cylinder barrels and cylinder heads are made separately and secured together by a shrunk fit which comprises, providing the cylinder barrel with a straight bore of uniform diameter throughout, and then tapering a portion of the bore within the head receiving portion of the cylinder barrel to provide an outward flare, and then assembling the head and barrel the dimensions of said flare being such that the head end of the cylinder bore is slightly choked when the head is assembled on the barrel and both head and barrel are at the same temperature.

7. The method of manufacturing cylinders for internal combustion engines in which the cylinder head and cylinder barrel are manufactured separately and the head shrunk onto the head receiving portion of the barrel which comprises, providing the barrel with a straight smooth bore of final dimensions before the head is assembled thereon, providing the head with an internal diameter less than the external diameter of the head receiving portion of the barrel, and shrinking the head onto the barrel so that the head will contract the head receiving portion of the barrel to provide a finished cylinder having normally an inward taper at the head end thereof.

8. The method of manufacturing cylinders for internal combustion engines in which individual cylinder heads and cylinder barrels are manufactured separately and the head is shrunk onto the barrel to provide the completed cylinder which comprises, providing the barrel with a straight smooth bore of uniform diameter and of substantially finished size before the head is assembled thereon, providing the head with an internal diameter less than the external diameter of the head receiving portion of the barrel, and then assembling the head and the barrel to contract the head receiving portion of the barrel and provide a choked bore condition in the head end of the cylinder, the amount of contraction of said barrel being substantially equal to the amount of expansion of said head from atmospheric temperature to engine operating temperature.

9. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately, completing all machining and finishing operations upon said parts while separate, and then securing the head upon the barrel by a shrunk fit whereby the head contracts the head end of the barrel.

10. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately, and securing the head upon the barrel by a shrunk fit as the final operation of the cylinder production method.

11. The method of producing cylinders for internal combustion engines which comprises, forming the cylinder head and cylinder barrel separately to a completely finished condition of the bore of the cylinder barrel, providing the cylinder head with a barrel receiving portion slightly smaller than the head receiving portion of the barrel, and securing the head on the barrel by a shrunk fit.

12. In the process of making engine cylinders having heads shrunk onto the cylinder barrels, the step of bringing the bore of the cylinder to substantially final size before shrinking the head on the barrel.

13. The method of making engine cylinders comprising, the steps of finishing the bore of a cylinder barrel to finished size and then contracting one end of said barrel by placing a ring thereon which has a barrel receiving portion smaller than the ring receiving portion of the barrel when both ring and barrel are at atmospheric temperature.

14. In the method of making engine cylinders, the steps of finishing the bore of a cylinder barrel substantially straight and to finished size at approximately atmospheric temperature, and then contracting one end of said barrel relative to other portions of the barrel.

15. In the method of making engine cylinders, the steps of finishing the bore of a cylinder barrel substantially straight and to finished size and then contracting one end of said cylinder barrel by encircling said end in a member having a barrel receiving portion of smaller diameter than the member receiving portion of the barrel when both the member and barrel are at atmospheric temperature.

16. The method of making engine cylinders comprising, the steps of finishing the bore of a cylinder barrel to finished size and then contracting one end of said barrel by encircling said end with a member having a greater coefficient of expansion than said barrel and having a barrel receiving portion smaller than the member receiving portion of the barrel when both the member and barrel are at atmospheric temperature.

17. In the method of making engine cylinders providing a cylinder barrel with a bore having an outward flare at one end, finishing said bore to finished size retaining said flare when the barrel is at approximately atmospheric temperature, and then contracting the said end of the barrel relative to other portions of said barrel.

18. The method of manufacturing engine cylinders having a cylinder barrel with a head shrunk thereon which comprises providing the cylinder barrel with a cylindrical bore of substantially final dimensions before assembling the head on the barrel and then producing a choke in said cylindrical bore by assembling the head and barrel.

19. The method of manufacturing engine cylinders which comprises forming the cylinder head and cylinder barrel separately and bringing the bore of the barrel to substantially finished size before assembling the head on the barrel, providing the head with a barrel receiving portion smaller than the head receiving portion of the barrel when both the barrel and the head are at the same temperature, changing the relative temperatures of the head and barrel to render the barrel receiving potion of the head larger than the head receiving portion of the barrel, inserting said portion of the barrel into the head and restoring the head and barrel to the same temperature to permanently secure the head on the barrel and to contract the head end of the barrel relative to the remainder thereof.

20. The improvement in the manufacture of engine cylinders having a cylinder barrel with a head shrunk thereon which comprises providing the bore of the barrel with an outwardly flared portion adjacent the head end and with substantially cylindrical portions, before the barrel is assembled with the head, and then contracting the head end of the barrel to produce a choked bore in the cylinder barrel.

21. The improvement in the manufacture of engine cylinders having a cylinder barrel with a

head shrunk thereon which comprises providing the bore of the barrel with an outwardly flared portion, adjacent the head end and with substantially cylindrical portions before the barrel is assembled with the head, and then assembling the barrel and head and thereby contracting the head end of the barrel and producing a barrel having a substantially straight bore at operating temperatures.

22. The method of producing engine cylinders comprising the steps of finishing the bore of a cylinder barrel to finished size at approximately the same temperature throughout and then contracting one end of said barrel relative to the remainder of the barrel during the assembly of the barrel and head.

VEON I. MONCRIEFF.