Aug. 10, 1943. W. VAN AMERONGEN ET AL 2,326,418

METHOD OF FINNING

Filed Feb. 28, 1941 2 Sheets-Sheet 1

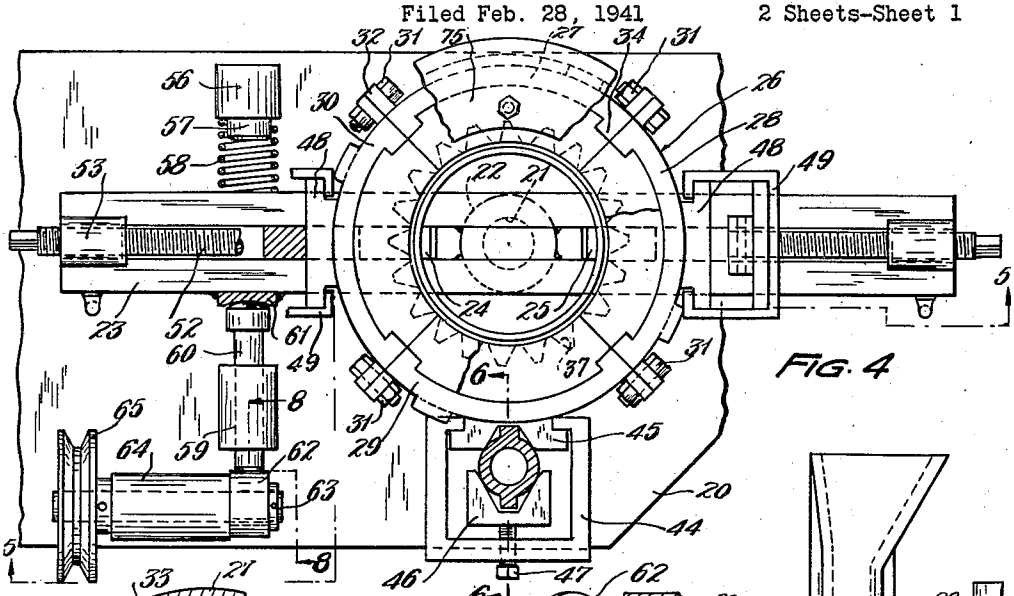

FIG. 4

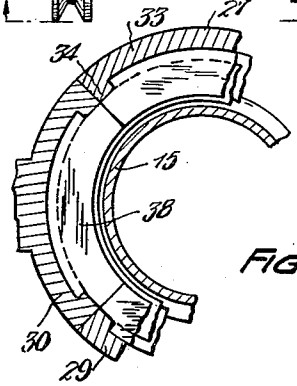

FIG. 7

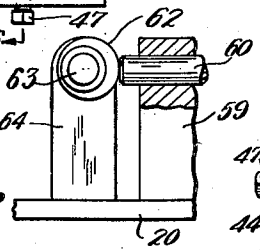

FIG. 8

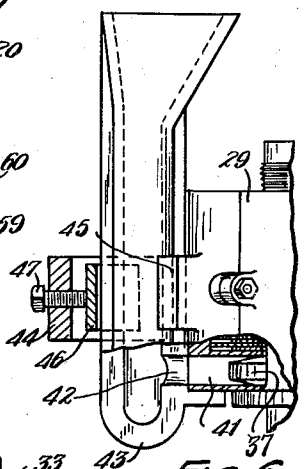

FIG. 6

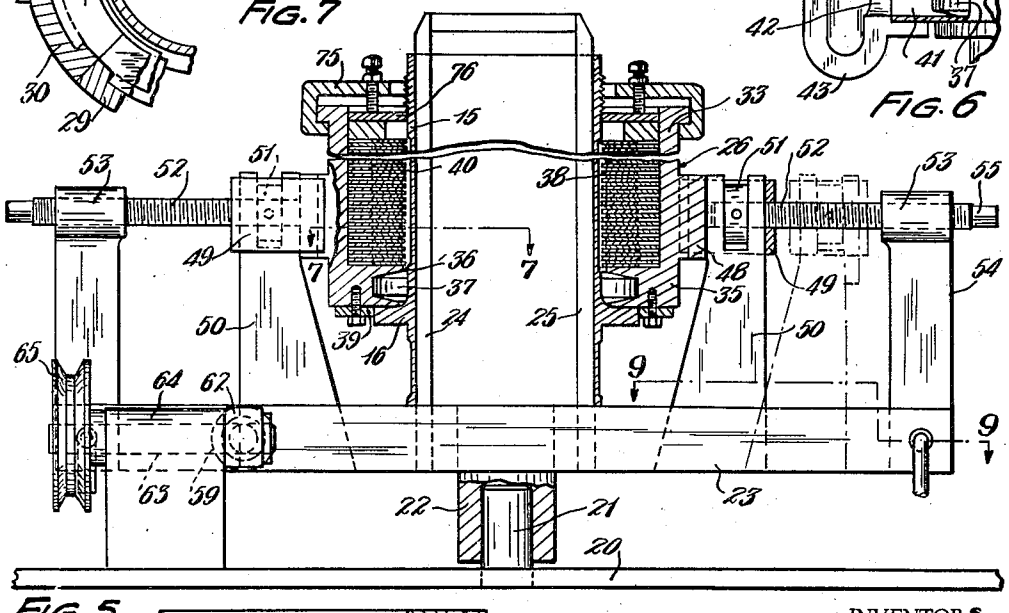

FIG. 5

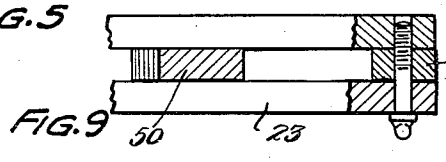

FIG. 9

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METHOD OF FINNING

Filed Feb. 28, 1941 2 Sheets-Sheet 2

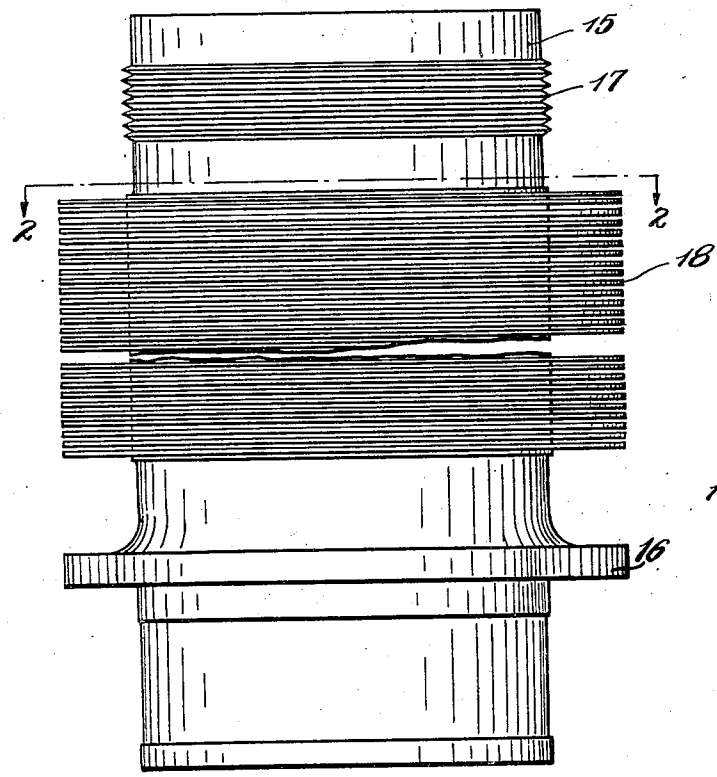

FIG. 1

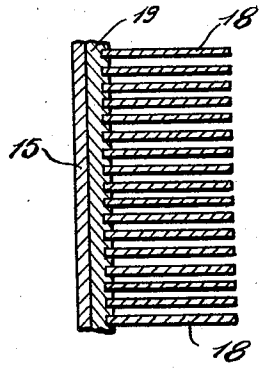

FIG. 3

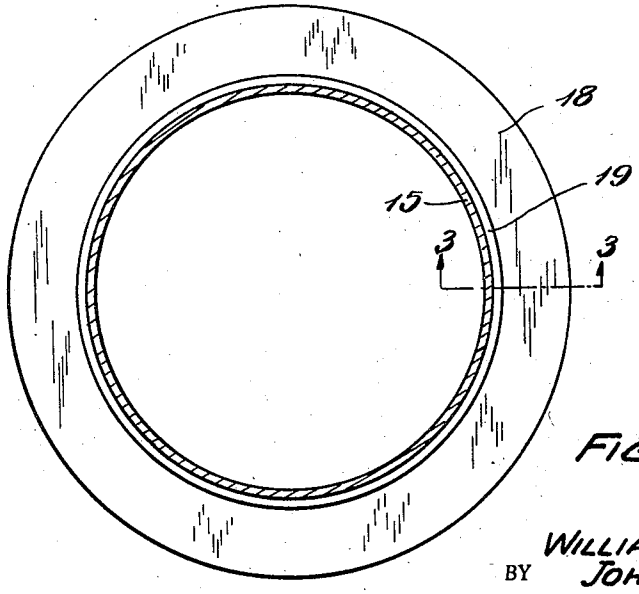

FIG. 2

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UNITED STATES PATENT OFFICE

2,326,418

METHOD OF FINNING

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Application February 28, 1941, Serial No. 381,064

9 Claims. (Cl. 22—204)

This invention relates to heat radiating finning for use in heat interchangers and more particularly to a new and improved method of providing cylinder barrels of internal combustion engines with cooling fins, and to the article produced thereby.

It is among the objects of the present invention to provide a new and improved method of providing a cylinder barrel with finning wherein the joint or union between the cylinder wall and the fins are of such a character as to provide for an effective and efficient flow of heat from the wall of the cylinder barrel to the surrounding atmosphere.

A further object of the invention is to provide a method of securing preformed fins made of a high heat conducting material, such as aluminum, to a cylinder barrel composed of a high strength material, such as steel, with a joint which is substantially free of any insulating mediums which would preclude the free flow of heat from the wall of the cylinder barrel to the fins.

A still further object of the invention is to provide a cylinder barrel having substantially increased heat dissipating surface area without unduly increasing the weight of the engine member.

Other objects of the invention, not at this time more particularly enumerated, will become more apparent as the nature of the invention is better understood from the following detailed description taken in conjunction with the accompanying drawings, wherein,

Figure 1 is a fragmentary side elevational view of a cylinder barrel having a plurality of preformed cooling fins mounted on the exterior wall thereof,

Figure 2 is a sectional view, taken on the line 2—2 of Figure 1,

Figure 3 is an enlarged fragmentary sectional view, taken on the line 3—3 of Figure 2,

Figure 4 is a top plan view of apparatus which may be employed in practicing the subject invention,

Figure 5 is a fragmentary elevational view, partly in section, taken on the line 5—5 of Figure 4,

Figure 6 is a fragmentary detail, partly in section, taken on the line 6—6 of Figure 4,

Figure 7 is a fragmentary sectional detail, taken on the line 7—7 of Figure 5,

Figure 8 is a detail, taken on the line 8—8 of Figure 4,

Figure 9 is a sectional view, taken on the line 9—9 of Figure 5.

With reference to Figures 1 to 3, inclusive, of the drawings, the numeral 15 designates a cylinder barrel of an air-cooled internal combustion engine, having the usual hold down flange 16, and the usual threads 17 on to which the cylinder head (not shown) is threaded and shrunk in the usual manner. The outer surface of the barrel is provided with a plurality of preformed, relatively thin, cooling fins 18, the inner edge portions of which are embedded in a cast muff 19, which is bonded to the exterior wall of the cylinder. The joint between the wall of the cylinder 15 and the muff 19 is characterized by having high thermal conductivity thereacross. The number, size, and distribution of the fins mounted on the exterior of the barrel wall can be varied to provide sufficient heat dissipating surface area to meet the desired cooling requirements of the particular cylinder barrel. In providing cooling fins on a cylinder barrel having a diameter of six inches, we have found with fin members twenty-five thousandths of an inch in thickness and extending outwardly from the barrel about one and one-fourth inch and spaced apart a distance of fifty thousandths of an inch along the barrel wall, a fifty per cent increase in cooling efficiency over prior types of finned barrels was obtained. Although the fin members may be made of any suitable metal having high thermal conductivity, we have found that where the combination of lightness and rapid heat dissipation is an essential element in the finished article, aluminum has proven to be most acceptable for the fins 18 and the muff 19.

More particularly, the new and improved method of the present invention for providing cylinder barrels with preformed cooling fins mounted on the exterior surface thereof, consists of first cleaning and then pickling that portion of the exterior surface of the barrel which is to receive the fins. Such cleaning and pickling is confined to a predetermined portion of the surface of the barrel by suitably masking the remaining surface. In cleaning, the barrel is immersed in an electrolytic bath containing caustic soda, then into a solution of sodium cyanide following which it is washed in clear water. Following the cleaning operation, the barrel is pickled in a solution of hydrochloric acid and then washed in clear water.

The cleaned wall portion of the barrel is then provided with a coating of a cadmium alloy. In applying this coating, the barrel wall is coated with a flux consisting of a solution containing three parts of zinc chloride and one part of sodium chloride and then the thus treated barrel

is immersed in a cadmiumizing bath. The coating bath may be formed by providing molten cadmium in a suitable container under a surface blanket of fluxing material which is preferably zinc chloride. After the bath has been so prepared, sheet nickel is introduced therein through the flux in amounts sufficient to yield a cadmium alloy containing approximately 0.1% to 10% of nickel, although from 1.3% to 1.75% has been found to be most desirable. Zinc in an amount approximately .05% of the total is added to the bath which serves to eliminate the tendency of the cadmium to vaporize. The cadmiumizing bath is formed substantially as disclosed in the patent to Carl E. Swartz, No. 2,040,282, issued May 12, 1936. It has also been found that the addition of tin not exceeding five percent to the cadmiumizing bath is helpful to prevent subsequent oxidation of coating on the cylinder barrel during the casting operation.

While the barrel is immersed in the cadmium bath, it is preferably rotated to insure a sufficient and uniform coating of cadmium alloy on the surface thereof. This rotation is continued as the barrel is withdrawn from the bath and thereafter while the coating is cooling, to provide a thin and uniform coating, free from dross or other extraneous matter.

The preformed fins, which may or may not have their inner edge portion provided with a thin coating of zinc, are assembled in a suitable mold and the mold and fins heated to a predetermined temperature, preferably between 1000° F. and 1060° F. During the time that the mold and fins are being heated, the barrel is also heated preferably to a temperature of between 450° F. and 600° F. When the barrel and the mold have been heated to the predetermined temperatures, the barrel is inserted within the mold and the assembly prepared for casting the muff. When the barrel is so disposed within the mold, the fins carried by the mold are positioned in proper spaced relation along the coated portion of the barrel wall. Immediately after the barrel has been inserted in the mold, molten aluminum at a temperature of between 1300° F. and 1450° F. is cast into the cavity defined by the inner edge portions of the fins and the barrel wall, completely filling the same. The molten metal may be cast under pressure with certain types of apparatus, or it may be cast under gravity feed and the mold assembly vibrated or rapidly rotated as in centrifugal casting practice, to insure a solid porosity free muff.

The cadmium alloy coating on the wall serves to bond the thus formed aluminum muff to the barrel, and the edge portions of the fins being secured within the muff, a substantially unitary structure is provided. The barrel is then removed from the mold and permitted to cool, after which it is finished and ready for use.

With reference to Figures 4 to 9, inclusive, of the drawings, there is illustrated a form of apparatus which may be used in conjunction with the practice of the present invention. This apparatus includes a base 20 having an upstanding cylindrical bearing post 21. The bearing post 21 is adapted to rotatably receive a hollow housing member 22 secured to the lower surface of the spaced frame members 23. Extending upwardly from between the frame members 23 are spaced supporting members 24 and 25 which are adapted to receive thereover the barrel 15 with the lower edge resting upon the upper surface of the frame members 23. The mold, generally indicated by the number 26, is adapted to encase the barrel and be supported in proper relative position to the outer surface of the barrel wall by the hold down flange 16 of the barrel.

The mold 26 is preferably made in quadrants 27, 28, 29, and 30, which are secured in assembled relation by means of bolts 31 extending through outwardly extending ears 32 formed on adjacent portions of the assembled quadrants. Each of the quadrants comprises a vertical arcuate wall 33 terminating in inwardly extending flanges 34. The lower portion of the arcuate wall 33 is formed with a bottom wall portion 35 which terminates in an arcuate wall 36. Extending outwardly from the wall 36 and formed in the bottom wall portion 35 is a recess 37. Each of the quadrants are adapted to receive in stacked relation on the upper surface of the bottom wall portion 35 a plurality of spacer members 38 which are provided with notched peripheral corners adapted to engage the inwardly extending flanges 34 of the wall portion 33. The fin members are adapted to be positioned or spaced relative to each other by the spacers 38, the thickness thereof defining the distance between adjacent fins when the same are secured to the barrel wall.

The quadrants are adapted to be supported upon the hold down flange 16 of the cylinder barrel. Each of the quadrants is provided with a plate 39 positioned to engage with the peripheral surface of the member 16 and serving to align or position the assembled mold 26 with respect to the barrel. When the mold 26 with the spacers and fins disposed therein is assembled about the barrel 15, there is provided a mold cavity 40 about that portion of the barrel wall which has been previously coated with the wetting metal, the bottom of this mold cavity 40 is in communication with the recess 37, the latter serving as a gate or runner for supplying molten metal to the mold cavity 40. Extending through the quadrant 29 is an orifice 41 which effects communication between the runner 37 and the discharge orifice 42 of the sprue 43.

The sprue 43 is maintained in proper pouring position with respect to the quadrant 29 by means of a C-clamp 44, the ends of which engage opposite ends of lug 45 formed integrally with the side wall of the quadrant 29. Cooperating with the C-clamp 44 is a shoe 46 engaging the sprue 43 and a set screw 47 for adjusting the relative position of the clamp 44 and shoe 46. Any suitable clamping means may be employed to hold the cylinder barrel, mold and fins together during the casting of the muff; for example, a plurality of clamping members 75 which bear upon the ring 76 disposed on the top of the mold quadrants may be employed.

Although we have illustrated apparatus wherein the metal may be poured into the mold cavity 40 to form the muff 19 through the sprue 43 by gravity feed, where it is preferable, the sprue may be dispensed with and the orifice 41 connected to the discharge port of any suitable type of pressure casting device.

For removing the mold 26 from the barrel, the opposed quadrants 28 and 30 are provided with outwardly extending lugs 48 which are adapted to receive the free ends of C-shaped bracket members 49 which are mounted upon the upper end of guiding members 50. The upper end of the members are bifurcated to receive the blocks 51 which are pinned on the ends of adjusting

screws 52. The adjusting screws 52 are threadedly received in the threaded ends 53 of posts 54 extending upwardly from the frame member 23. Adjustment of the screws 52 is effected by means of any suitable wrench adapted to engage the ends 55 thereof. The guiding members 50 serve to maintain the mold quadrants in a substantially horizontal position.

Where gravity pouring is employed, we have found that it may be preferable to vibrate or rapidly rotate the mold and barrel during the casting of the muff to insure a solid porosity-free muff. For this purpose there is illustrated, mounted on the base 20, adjacent one end of the frame 23, mechanism for oscillating or vibrating the frame 23 and the assembled mold and barrel carried thereby. Such mechanism comprises an upstanding post 56 carrying a cylindrical lug 57 which serves to receive one end of a spring 58, the opposing end of which is adapted to engage the side wall of the frame 23. On the opposite side of the frame 23 and in alignment with the post 56 is a bearing member 59 which slidably receives a horizontally extending shaft 60, one end of which seats against a bearing plate 61 carried on the frame 23. The opposite end of the shaft 60 is adapted to engage an eccentric 62 pinned to a shaft 63 rotatably supported in a bearing member 64. The shaft 63 is adapted to be rotated by means of a sheave 65 connected to any suitable source of power, not shown.

Having thus described our invention so that those skilled in the art may be able to understand and practice the same, what we desire to obtain by Letters Patent is defined in the appended claims.

What we claim is:

1. The method of producing a ferrous metal alloy cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof which includes the steps of providing that portion of the exterior surface of the barrel which is to receive the cooling fins with a coating of an alloy consisting of cadmium containing from 0.1% to 10% nickel, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, and then securing the fin members to the barrel by casting an aluminum sleeve about the barrel of sufficient thickness to embody the inner edge portions of the fin members.

2. The method of producing a ferrous metal alloy cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof which includes the steps of treating that portion of the barrel wall which is to receive the fins with an alloy consisting of cadmium containing from 0.1% to 10% nickel, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, securing the fin members to the barrel by casting an aluminum sleeve about said barrel, and vibrating the mold during the casting of the metal, said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

3. The method of producing a ferrous metal cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof which includes the steps of providing that portion of the exterior surface of the barrel which is to receive the fins with a coating of an alloy consisting of from 1.3% to 1.75% nickel, approximately .05% zinc and the balance cadmium, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, and then securing the fin members to the barrel by casting a sleeve about said barrel, said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

4. The method of producing a cylinder barrel for an air-cooled internal combustion engine with cooling fins on the exterior surface thereof, which includes the steps of treating that portion of the barrel wall which is to receive the fins with a pickling solution and then an alloy consisting of cadmium containing from 0.1% to 10% nickel, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said barrel and said mold and fins to different predetermined temperatures, and then inserting the heated barrel into the mold assembly and securing the fin members to the barrel by casting an aluminum sleeve about said barrel, said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

5. The method of producing a ferrous metal alloy cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof which includes the steps of treating that portion of the barrel wall which is to receive the fins with a pickling solution and then an alloy consisting of cadmium containing from 0.1% to 10% nickel, heating said barrel to a predetermined temperature, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, securing the fin members to the barrel by casting an aluminum sleeve about said barrel, and vibrating the mold during the casting of the sleeve, said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

6. The method of producing a ferrous metal alloy cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on a portion of the exterior surface thereof, which includes the steps of pickling that portion of the exterior surface of the barrel which is to receive the fins, coating said portion with an alloy consisting of from 1.3% to 1.75% nickel, approximately .05% zinc and the balance cadmium, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, securing the fin members to the barrel by casting an aluminum sleeve about said barrel, and vibrating the mold during the casting of the sleeve,

said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

7. The method of producing a ferrous metal alloy cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof, which includes the steps of pickling that portion of the exterior surface of the barrel which is to receive the fins, coating said portion with an alloy consisting of from 1.3% to 1.75% nickel, approximately .05% zinc and the balance cadmium, heating said barrel to a predetermined temperature, assembling preformed ring-like aluminum fin members in spaced relation with their openings in coaxial alignment within a permanent mold, heating said mold to a predetermined different temperature, inserting said barrel into the mold cavity defined by the opening in said fin members, and then securing the fin members to the barrel by casting an aluminum sleeve about said barrel, said sleeve being bonded to the wall of the cylinder barrel and having the inner edge portions of the fin members embedded therein.

8. A method of producing a ferrous metal cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof, which includes the steps of providing that portion of the exterior surface of the barrel which is to receive the cooling fins with a coating of an alloy consisting of cadmium containing from 0.1% to 10% nickel, heatin said barrel to a predetermined temperature, assembling preformed ring-like aluminum fin members with their openings in coaxial alignment in a permanent mold and heating the assembled mold and fins to a temperature of between 1000° F. and 1060° F., assembling said barrel within said mold, securing the fin members to the barrel by casting molten aluminum into the cavity defined by the barrel wall and the inner edge portions of the fins, and vibrating the mold during the casting of the metal.

9. The method of producing a ferrous metal cylinder barrel for an air-cooled internal combustion engine with aluminum cooling fins on the exterior surface thereof, which includes the steps of providing that portion of the exterior surface of the barrel which is to receive the cooling fins with a coating of an alloy consisting of cadmium containing from 0.1% to 10% nickel, heating said coated barrel to a temperature of between 450° F. and 600° F., assembling preformed ring-like aluminum fin members with their openings in coaxial alignment in a permanent mold and heating the assembled mold and fins to a temperature of between 1000° F. and 1060° F., assembling said barrel within said mold while at said temperatures, and then casting molten aluminum into the cavity defined by the barrel wall and the inner edge portions of the fin members, and vibrating the mold during the casting of the metal, thereby bonding the preformed fins to the wall of the cylinder barrel.

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