

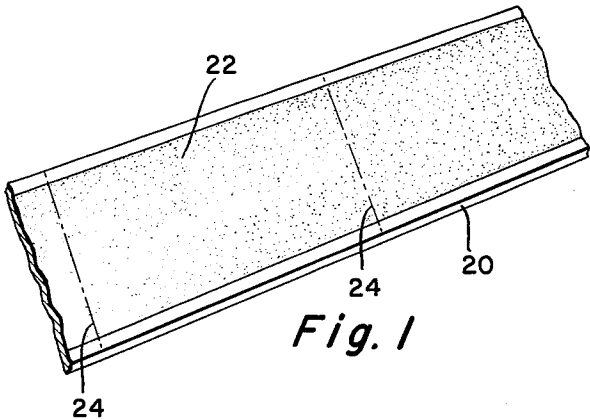
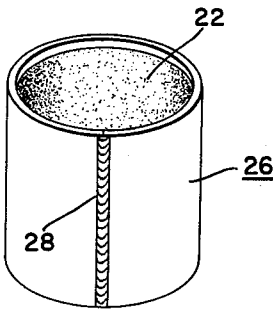
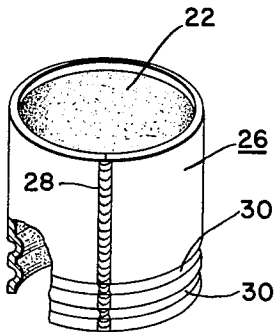
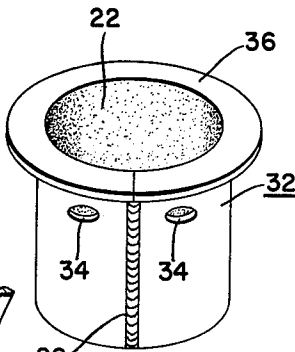
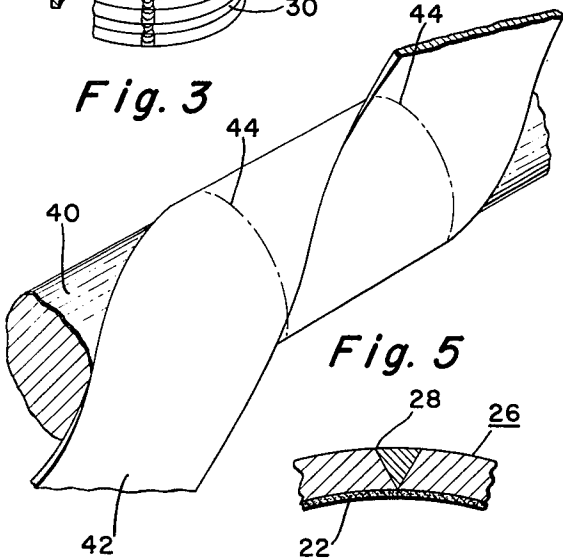
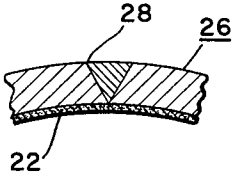
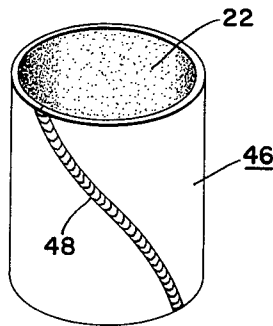
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3,153,990

INTERNAL COMBUSTION ENGINE

Filed Jan. 26, 1962



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1

3,153,990

INTERNAL COMBUSTION ENGINE

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6 Claims. (Cl. 92-169)

This invention relates to internal combustion engines and other devices using reciprocating pistons and is particularly concerned with cylinder liners of various types for use in such engines.

In many types of internal combustion engines, and particularly small horsepower engines and two cycle engines, the engine is air cooled by fins cast directly on a cylinder block. Engines of this type frequently use cylinder liners for the block since the material thereof is aluminum or some suitable diecasting metal. The liners may be cast directly in place or the liners may be removable and replaceable.

One type of liner for engines of this character is disclosed in my Patent 3,000,370, granted September 19, 1961. In this patent a porous metal line is shown which includes an interfitting portion for carrying valve seats and valve guides so that all of the parts are pre-determinately arranged prior to the time that the block is cast therearound. In this instance the liner is not replaceable.

In application 109,959, filed in the name of Anton F. Erickson on May 15, 1961, now Patent No. 3,033,183, granted May 8, 1962, and assigned to the assignee of the present invention, a short cylinder liner is disclosed and claimed which may be removably positioned within any of the usual types of cylinder blocks where a liner is desired. The basis for the invention is the specific length of the liner which only encompasses that portion of the cylinder wall which is traversed by the piston rings.

The present invention is directed to improvements over both of these inventions and wherein the cylinder liners may be cast in place or may be made removable with respect to the block as desired. It is to be understood that while these liners are particularly adapted for air cooled engines and the like that this is not a limitation and that the liners as disclosed herein may be used in connection with many types of internal combustion engines, pumps and similar devices which use reciprocating pistons.

It is, therefore, an object of this invention to provide an improved cylinder liner for an internal combustion engine and the like, comprising a cylindrical metal sleeve of a strong sheet metal material and having a porous metal surface thereon.

A further object of the invention is to provide a method for making such a liner wherein long lengths of sintered strip material are formed, which strip is then wound around a mandrel to form a tube having a spiral seam which is welded to form a continuous tube and thereafter liners of the desired lengths are cut from the tube by separating the tube in a plane perpendicular to the longitudinal axis thereof.

A still further object of this invention is to provide a liner and method for making same from a flat strip of sheet metal having sintered metal powder at one surface thereof wherein the strip is formed to a cylindrical form and includes a flange at one end thereof and wherein ports may be punched directly in the flat sheet prior to the formation of the cylindrical liner for

2

valving when the liner is to be used in connection with two cycle engines.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIG. 1 shows a section of a strip of strong metal having a sintered metal liner on one surface thereof.

FIG. 2 is a cylinder liner made from a segment of the strip shown in FIG. 1 with the abutting edges thereof welded together to form a cylindrical sleeve. FIG. 2A shows a preferred V-cut seam.

FIG. 3 is a modification of the liner shown in FIG. 1 wherein circumferential grooves are formed directly in the liner for increasing the surface thereof which grooves may be used for cooling and/or for positioning the liner when the same is to be cast directly in a block.

FIG. 4 is a variation of the liner shown in FIG. 2 wherein a flange is provided at one end thereof and wherein ports are shown in the wall of the liner.

FIG. 5 is a diagrammatic view showing another method of making the liner wherein the strip with the porous metal surface at the inside surface thereof is wound spirally to form a continuous tube.

FIG. 6 is a view of a liner cut from the tube formed in FIG. 5 at the dot-dash line portions thereof.

Strip stock from which the liner may be made can be produced by any of several well known processes. For example, Koehring et al. Patent 2,158,461 discloses a method for producing composite strip material including a steel strip having a pressed and sintered layer thereon of porous metal. In Koehring Patent 2,198,253 another method is disclosed for sintering metal powder onto a strong metal support. In this instance the porous metal layer produced may be sized to a desired thickness after sintering. Koehring Patent 2,289,658 discloses still another method for producing a composite strip material utilizing a steel base with a compacted porous metal layer thereon.

In some instances it may be desirable to make the strip entirely of porous metal without the steel backing. This is particularly true if the liner is to be cast in place since the porosity of the liner offers anchoring points for the cast metal. One method of producing a porous metal strip stock without a supporting backing is shown in Marvin Patent 2,341,732 wherein the metal powder is pressed directly into a strip and is sintered. All of these and many more patents disclose methods for making a strip stock comprising a porous metal either bonded directly to steel or without a steel backing.

Specifically, I prefer to use iron powder as the porous metal layer. This may be mixed with small quantities of copper powder, for example up to 5% as a supplemental bonding agent or with ferro-phosphorus powder. The ferro-phosphorus acts as a bonding agent and also hardens the resulting porous metal layer. Lenel Patent 2,291,732 discloses use of ferro-phosphorus as a bonding agent. Similarly, graphite may be added to the iron powder. It may be added up to 2% to form materials as desired. Again the specific composition of the layer forms no part of my invention since it is well known in the art that sintered layers of metal may be made by a number of processes and using a variety of suitable alloying agents, although the use of these agents is not always necessary nor desired. In any event, after the strip has been formed either with a steel backing or

without, it may be cut transversely thereof as shown in FIG. 1 wherein a steel strip 20 is shown having a porous metal layer 22 on one or both surfaces thereof. Layer 22 is preferable in the order of .020" to .030" thick and has been compacted in the flat condition to relatively high density. The strip is cut along the dot-dash lines 24 which produce a developed length desired for the cylinder. The strip is then formed into a cylinder 26 and is butt welded along the abutting edges 28. The butt weld is machined off so that a smooth surface is provided. In some instances it may be desirable to form annular grooves in the strip either for cooling or keying purposes. Grooves are shown at 30 in FIG. 3 wherein a liner similar to the liner of FIG. 2 is shown except for the addition of the grooves. In FIG. 4 another type of liner is shown that may be used specifically in two cycle engines. In this instance ports 34 are punched in the developed lengths of the material prior to forming the cylinder 32. Similarly, a flange 36 may be applied to the cylinder liner either by welding or by forming, if the flange is to be of relatively minor extent. This flange aids in positioning the liner in the block.

In all of these embodiments the liner has been formed from flat stock. Referring also to FIG. 5, another method of forming is shown wherein a mandrel 40 having a desired diameter is used. A strip 42 of undetermined length, and either formed from a porous metal or from steel strip having porous metal at one surface thereof, is spirally wound around the mandrel so that the edges thereof are in tight abutting relation. The strip is wound so that the porous metal is in contact with the mandrel. This provides a continuous process for forming a spirally wound tube. The seam thereof may be progressively welded if desired, as the tube is formed and may be progressively machined to form a smooth outer surface on the tube. Suitable lengths of the tube are cut off for ease of handling and cylinder liners may be severed therefrom by cutting the tube into the desired lengths, for example, on dot-dash line 44 to form a cylinder liner 46, as shown in FIG. 6 wherein the seam 48 thereof runs spirally of the liner.

Of course, operations involving formation of a continuous tube are usually carried out on a relatively large scale operation since it is apparent that the equipment is more costly, although once provided, the ultimate cost of the liner is reduced.

A specific example, stock used for a liner is as follows. Strip stock .060" thick S.A.E. 1020 steel was prepared with a porous metal layer thereon having a finished thickness of .040" thick. This layer was made from reduced oxide iron powder and had a relatively low porosity wherein the density in the finished state was in the order of 6.25-6.5 gm./cc. and contained 4% carbon. The strip was cut to size and rolled into a liner 4" long and 2½" inside diameter. It is apparent that these figures may vary widely in accordance with the liner desired and the purpose for which the liner is to be used.

It is to be understood that in some instances the seam does not require welding. If the edges are ground mere abutment is sufficient, particularly when the sleeve is to be cast in place. It may be desirable to spot weld the seam at the top and bottom and outside of that portion where the piston rings will slide. This maintains the cylinder with its edges in abutting relation during placement thereof. In general, the porous metal portion will absorb oil, some of which will carbonize and then any oil leakage through the seam will quickly be stopped. I prefer to test liners in a particular application to determine whether the seam requires welding.

In this connection FIG. 2A shows V-cut seam wherein the abutting edges are cut at an angle of about 30°-45° from the vertical, this offers space for welding metal when required.

Liners of this character, whether porous metal and steel or plain porous metal, are highly useful since they tend to take up some oil which has a lubricating effect on cylinder walls. Further, the porosity of the liner is limited since in use, carbon formed in the cylinder is picked up by the pores of the liner and tends to seal the same. In some instances it may be desirable to lubricate the porous metal with MoS₂. This yields excellent lubrication while being capable of withstanding the temperatures within a cylinder.

When the liner is to be cast in place, I prefer to use a fully porous metal liner since this aids in keying the liner to the cast material. Of course, a steel liner having porous metal on both sides thereof may also be used but is more expensive to fabricate.

It is apparent from the foregoing that the liner disclosed overcomes many of the past manufacturing difficulties apparent in patents and applications mentioned herein. These difficulties are mainly found in the manufacturing of porous metal liners of any substantial length. Briquetting operations on any such liners are difficult to control in order to obtain a uniform density throughout the length of the liner. By following the teachings of my invention it is possible to produce such a liner at the lowest possible cost. Furthermore, since the liner is initially formed from strip material, expensive briquetting dies are not required, it merely being necessary to use different mandrels. This also reduces the cost of the liner. One additional advantage of the present liner is that the porous metal may be made extremely thin particularly if it is supported on steel and this reduces the cost of the material used wherein the strip material may be manufactured by following the teachings found in the aforementioned patents.

Since the liner is formed from strip stock it is a simple matter to finish the surface either by boring, grinding, or any other suitable and well known machine operation. This can be done on automatic equipment which further reduces the cost.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a method for making cylinder liners for internal combustion engines and the like, the steps comprising; providing a length of sheet metal having a porous ferrous metal layer coextensively bonded metallurgically to one surface thereof said layer having a density above about 6.25 grams per cc., forming the strip into a cylindrical shape with the porous metal layer on the inside of the cylindrical shape, welding the seam on one side only of said shape for permanently joining the sheet metal and then finishing the porous metal inner surface to a precision dimension.

2. In a method for making cylinder liners for internal combustion engines and the like, the steps comprising; providing an indeterminate length of sheet metal having a porous ferrous metal layer coextensively bonded metallurgical to one surface thereof said layer having a density above about 6.25 grams per cc., forming the strip with the porous metal layer on the inside surface thereof into a long cylindrical shape having a spiral abutment, welding the abutment on the outside surface only thereof for forming a long length of cylindrical tubing, progressively cutting the tubing perpendicularly of its longitudinal axis for forming a plurality of cylindrical liners of the desired length, and then individually finishing the internal surfaces of each of said liners.

3. The process as claimed in claim 1 wherein annular cooling grooves are rolled into the cylinder above and/or below the working surface thereof.

4. The process as claimed in claim 2 wherein annular cooling grooves are rolled into the individual cylinder liners above and/or below the working surface thereof during said finishing step.

5

5. The method claimed in claim 1 including the added step of punching port holes in the strips prior to forming the same into cylindrical shape.

6. A cylinder liner having an internal combustion engine comprising in combination a cylindrical sheet steel sleeve including an abutted seam extending generally longitudinally thereof and throughout the length of the sleeve, said seam being welded on the outer surface only of the sleeve, and a coextensive inner layer of porous ferrous metal bonded coextensively and metallurgically to the sleeve and comprising sintered ferrous metal having a density of above about 6.24 grams per cc., said porous metal lining including up to 4% carbon.

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