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ENGINE CYLINDER LINER AND METHOD

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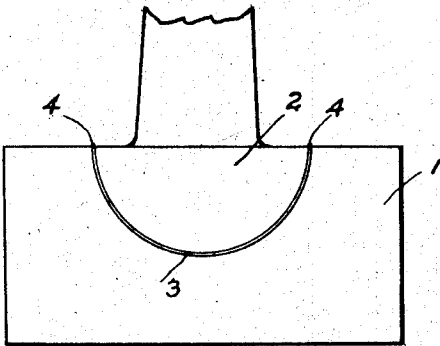


FIG. 1

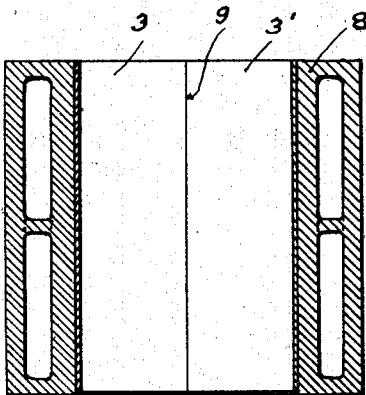


FIG. 3

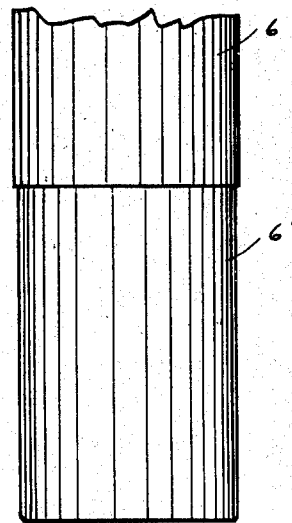
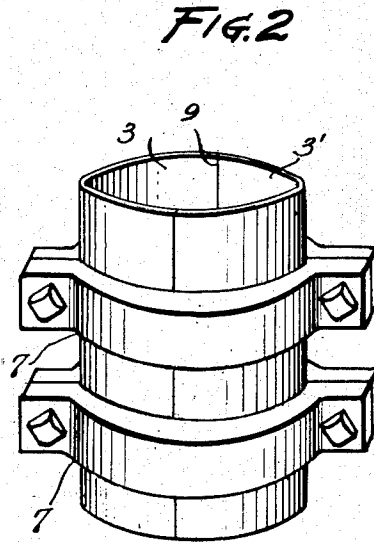


FIG. 4

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ENGINE CYLINDER LINER AND METHOD

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12 Claims. (Cl. 29—156.4)

This invention relates to internal combustion engines and has for its objects an improved liner for the cylinders of such engines as well as the method of carrying out the invention. This application forms a continuation in part of my co-pending application for patent filed under Serial No. 98,942 on September 1, 1936.

One of the objects of the invention is to provide a wear-resisting segmental cylindrical liner for internal combustion engine cylinders of relatively thin, flexible sheet metal for forcibly pressing into a true cylinder bore to fit tightly therein without requiring auxiliary fastening means, and which by reason of its flexibility will properly conform itself to the true bore so as to require, if anything, but very little grinding to finish the interior surface to the exact surface and dimensions required.

Another object is to produce a cylinder liner of the kind above described from rolled or drawn sheet metal thereby eliminating machine work in the preparation of the liners.

Another object is to provide a sheet metal liner of this kind which is formed in at least two segments of a cylinder and which, when placed in abutting relation, will tightly fit within the true bore of the cylinder to be lined.

Other objects and advantages of the invention will appear in the following description and accompanying drawing.

In the drawing:

Figure 1 is, an elevation of the forming die with a liner segment in place.

Figure 2 is a perspective view showing two segments or halves of the shaped liner placed with edges in abutting relation to form a complete cylindrical liner ready for press-forcing into a suitably bored out cylinder.

Figure 3 is a vertical cross section of a cylinder of an internal combustion engine with the segmented thin sheet metal liner tightly fitting in place.

Figure 4 shows the lower end of a press mandrel with reduced end to fit within the liner when forcing in place.

Before describing the invention in detail, it is desired to state that the lining of engine cylinders by inserting sleeves of various metals to form an interior lining for the cylinder is well known in the art, but such sleeves have generally been of two types; first, made of comparatively thick metal, such as castings of bronze or special iron which were carefully machined both inside and out and thereafter fitted into the engine cylinder, sometimes by first heating the cyl-

inder to expand the cylinder so that it would shrink tightly upon the sleeve liner after insertion,—secondly, sleeves have been made of thin metal and fitted into the cylinders by shrinking as above described, or by forcibly expanding the sleeve within the cylinder by rolling the sleeve internally until in tight contact with water channeled cylinder walls to form the inner wall of the water or steam jacket, as in Patent No. 240,708. However, for engine cylinders such thin metal liners were generally in the complete cylindrical form which is extremely difficult to produce accurately in a thin metal sleeve, and while in some cases it has been purposed to roll thin cylindrical liners to complete cylindrical form either with or without a welded joint, the making of such liners for use in engine cylinders entails such precise work to insure the exact dimensions required for both external as well as internal diameters while at the same time preserving proper curvature, that it has never come into any appreciable use in automotive engines, though hundreds of thousands of engine cylinders are bored out every year and over-size pistons must be put in to compensate for the metal removed.

As a practical automotive machinist doing a great deal of engine cylinder reboring, I have experimented with various types of liners in an endeavor to avoid the requirement for over-size pistons in the rebored cylinders, particularly with the rolling of complete cylindrical sleeves formed of a sheet of steel with welded or unwelded abutting ends and with the inner surface of the formed sleeve hardened as by the nitriding, or carburizing methods and as set out in my co-pending patent application above mentioned.

However, in practical application, I found that the work of forming the liners of sheet steel could be carried out with much greater accuracy and in a fraction of the time, if two half cylinders were formed separately, either by rolling, or preferably in a pair of dies, and then the two halves abutted on their longitudinal edges and forced into the rebored engine cylinder with a press, and greatly to my surprise, I found that such liners of thin sheet steel, though unsecured in place except by friction, have shown no tendency to become loose or displaced after many thousands of miles of use in automobile truck service, yet after prolonged usage when wear finally does take place they may be forcibly pushed or pulled out of the cylinder again and a new set pushed in.

At this point I wish to say that I am aware

of thick rigid split bushings as used in split and solid pulley bores and machine bores, also aware of thin sheet metal split bushings having been applied to shaft bearings, but in such bearings the shell or housing is itself split, and the two halves inserted and the housing cap clamped over the bushing, something which cannot be done with an internal combustion engine cylinder where the cylinders are always cast solid or integrally.

In carrying out my invention, I rebores the worn cylinder sufficiently to allow for the thickness of the sheet metal liner which is going to be inserted, so as to re-establish the original bore, to fit the original sized pistons, or to make it slightly less in diameter after lining if a slight cut is required off of the pistons to true them up. I then cut two sheets of the desired rolled or drawn thin sheet steel or other wear-resisting sheet metal, of a proper size each to form at least a full half cylinder for the required liner, and then shape them separately to half cylinder form with the rolled grain of the sheet running crosswise or rather circumferentially of the bore of the cylinder.

The forming or shaping of the sheet metal to half cylinders may be done by passing through forming rolls, but in which case the metal sheet should be somewhat longer than required to form a half cylinder to allow for the imperfectly rolled or curved end margins of the sheet to be cut off. Instead of rolling the sheets, I prefer to press them to shape between a pair of dies, 1, 2, as shown in Figure 1, and in which the half cylindrical sheet metal liner is indicated at 3.

The thin sheet metal, if of a springy nature, will tend to open out somewhat when released from the dies, but will assume the proper curve when forced into the cylinder, though if the metal is very springy and opens out too much, it may be given successive blows between a pair of dies of somewhat less than the desired curvature while successively arcuately advancing the sheet to bring the pressure of the dies at all points from end to end of the sheet, paying particular attention to the ends of the sheet which will abut, as the curvature should be substantially correct adjacent these ends as they do not flex so readily as the intermediate portions of the sheet.

As it is necessary that the longitudinal edges of the two halves meet in tightly abutting relation when the lining is in the cylinder, while at the same time the body of the liner must seat perfectly against the inner wall of the rebored engine cylinder, the precise circumference or length (arcuately) of the two segments is of greatest importance, for if too long the liner cannot seat against the wall of the cylinder, and if too short it will not stay in place. To therefore insure the arcuate length of each segment being correct, they may be made a trifle too long and clamped in the dies shown in Figure 1, either separately or placed end to end if the dies are long enough, and a slight finishing cut or grind taken off of the upper edge or edges 4 of the liner—the forming dies or a special set being made of a suitable depth to permit this.

When relining several duplicate cylinders, a pair of narrower strips of the same sheet of lining metal may be formed in the die and first finished on the edges as described and tried out in one of the cylinders to determine its fit before edge finishing of the full length segments.

Such a final edging or finishing also insures the edges being straight and true, and an abso-

lutely tight abutting joint when the lining is in place in the cylinder, as the sheet metal frequently stretches unequally in rolling or die shaping, and this feature of the method of forming thin sheet metal liners is important for perfect results whether the cylindrical shaping has previously been done by rolling or die pressing.

If any heat treating or hardening or toughening or other treatment of the inner surface of thin sheet steel liners is desired, or such treatment as nitriding, or carburizing followed by hardening the final edging to determine exact size of the shells and insure straight, true, meeting edges as above explained should be carried out after any hardening or heat treating of the shell, as some steel shrinks or expands in the treatment and might otherwise not fit in the bored cylinder.

Also, particularly if the shell segments are hardened by any process, or the sheet metal used is relatively hard, it is desirable that the outer surface be relatively soft or left in its normal unhardened condition to insure a better frictional and thermal contact with the bore of the cylinder to respectively prevent possible displacement and to dissipate heat. To better carry out the above the outer surface of the shells may first be plated or coated with a protective layer of a softer metal, such as copper, zinc, tin, or other soft metal. Such a plating is preferably applied to one side of the flat sheets of metal before shaping into cylindrical form, but any hardening if resorted to, is preferably carried out after shaping, for otherwise the shaping is made more difficult if not impossible to carry out without injury to the interior surface. In case of nitriding, or carburizing the sheets with subsequent hardening, such plating confines the action to the inner surface only of the sheets. Copper is preferred as the rear plating metal for the liner as its softness insures a good thermal contact with the bored cylinder walls, and its high thermal conductivity is important to pass the heat outward from the liner to the cylinder walls and water jacket or cooling fins.

In shaping the half shells or segments of the lining they normally tend to spring outward again to a somewhat larger radius curve than that of the cylinder, though if the extreme ends or abutting margins of the sheets are substantially to the curve of the cylinder, and the length is correct, a snug fit against the walls of the cylinder will be assured, as the sheet metal being flexible, the pressure of its abutting edges will force all portions in perfect contact with the cylinder bore.

In Figure 3 the two segments 3, 3' of my thin sheet metal liner are shown in place in a conventional engine cylinder 8, and is applicable to any kind of an internal combustion engine cylinder whether water or air cooled. One of the abutting joints of the liner ends is shown at 9 in this figure.

While I have mentioned my thin sheet metal liners as applied to rebored engine cylinders to compensate for the metal removed, the use of the invention goes far beyond this, and it is contemplated that all internal combustion engine cylinders in the future be originally bored out of a size to be initially fitted with such a thin flexible sheet metal split liner of definite thickness, say $\frac{1}{16}$, $\frac{1}{8}$, or $\frac{1}{4}$, of an inch in thickness, and after this becomes worn from long use, it may be pushed or pulled out and a new pair of shells pushed in, thus forever entirely avoiding any reboring of the cylinder, and giving the cylinder

unlimited life by repetition of this simple procedure.

In pressing the linings in place, the two shells 3, 3' are assembled as shown in Figure 2, and one or more external clamping straps 7 are clamped about them to hold them together for forcing into the cylinder. A lubricant is first wiped around the inside of the cylinder wall as well as on the interior surface of the clamps, and on the exterior of the lining. The upper edge of the cylinder may be rounded slightly to facilitate entry of the liner, and if the linings are of very thin metal, an internal supporting mandrel or reduced extension 6' of the press mandrel 6 (Figure 4) may be used to insure against inward buckling particularly at the abutting edges. After the lining shells are seated in place, a very light finishing grind may be taken off of the inner surface to remove slight inequalities on the surface of the liner, if desired, but which will not be required if properly surfaced sheet metal is used.

In applying the pressure on the assembled and clamped shells, the shells may be forced through the lubricated clamps or straps without releasing the straps until necessary to push the remaining portion of the shells into the cylinder, though if the press mandrel 6 be no larger than the outside diameter of the liner, the clamp or clamps will slide over it as the mandrel descends.

While my invention is principally directed to the use of thin sheet steel, inner surface hardened, or otherwise treated, liners to resist wear in engine cylinders, it should be noted that considerable experimentation is now being carried on by engine builders to determine whether or not the combined heat and chemical action of the exploding gases are equally or more responsible for destruction of the walls of engine cylinders, and if so what steels or other alloys will best resist such deleterious actions. Therefore, when the best resistant metal is finally decided by the result of all these experiments, my invention affords the best means of carrying the use of such metal into practice, especially if all engines are initially factory equipped with my liners made of thin corrosion-resisting metal, be it stainless steel or any other metal or alloy, so that they merely required renewal after long periods of use, thus doing away forever with the reborring of internal combustion engine cylinders.

While I have found by thousands of miles of tests of engines lined by my method above described that no positive securing of the liners in place in the cylinders is required, still the invention in its broader aspect does not preclude any desired fastening means being employed if desired, or the use of a slight shoulder at the lower or inner end of the cylinder to positively insure no possible creeping of the liner in that direction, as is positively insured in the opposite direction by the head of the cylinder when in place, though it may be stated that thin sheet metal linings applied according to my invention require considerable press force to remove them, and attempts to pry the upper end of one of the half shells inwardly with a chisel resulted in breaking the engine casting. If a slot be cut or ground in the worn liner almost through the metal, the strain will be relieved so that it may easily be removed.

Also to be noted is, that while I show and prefer my cylindrical liner to be made of two equal half segments, it is not limited to this as I have found it possible, especially in large bore cylinders, to use three segments pressed in as ex-

plained for the two segments, and they also remain firmly locked into place without securing means and do not become displaced in use. The use of three segments is an advantage if heat treating is used as it is easier to treat smaller areas without buckling.

In considering the above disclosure it should be noted that the preforming of the thin flexible sheet liner segments to exact size to secure the proper fit is one of the important features of the invention. That the invention is confined strictly to a flexible sheet metal liner for a cylinder of an internal combustion engine or similar piston working barrel, and the method of applying it, that the problem involved has no relation to bushings used in pulleys, bearings, or brake band linings of various kinds, as any and all of these have not reduced the daily reborring of many thousands of engine cylinders one bit, that by the use of my invention it is possible to gain the advantages of accurately rolled strip sheet steel or special alloys, with the greater homogeneity, toughness and density, together with accuracy of gage and finish of such sheet metal impossible to get in a cast liner, or any form of drawn or extruded metal tubing so far obtainable, and more than this, it permits placing the natural or rolled grain of the sheet metal transversely to the reciprocating movement of the engine piston, to thereby effectually overcome grooving due to possible minute striations in the metal—advantages not possible to obtain with drawn metal tubing.

In view of the above, I therefore feel entitled to patent coverage on my invention or any modification thereof when applied to the cylinders of an internal combustion engine, as may come within the scope of my appended claims.

I therefore claim:

1. The method of lining an internal combustion engine cylinder having a true bore, which comprises forming sheets of thin flexible metal of uniform thickness into a plurality of duplicate longitudinal straight-edged segments of a cylinder with all longitudinal edges parallel to the axis of the cylinder and of a size to form when assembled with longitudinal edges abutting a complete cylindrical sleeve of a size to form a press fit within the engine cylinder, assembling the segments into such cylindrical form with edges abutting substantially throughout their length and unattached, and thereafter simultaneously forcing the thus assembled unattached segments longitudinally and tightly into the cylinder.

2. The method of lining an internal combustion engine cylinder having a true bore, which comprises forming sheets of thin flexible metal of uniform thickness into a plurality of duplicate longitudinal straight-edged segments of a cylinder with all longitudinal edges parallel to the axis of the cylinder and of a size to form when assembled with longitudinal edges abutting a complete cylindrical sleeve of a size to form a press fit within the engine cylinder, assembling the segments into such cylindrical form with edges abutting substantially throughout their length and unattached, and thereafter simultaneously forcing the thus assembled unattached segments longitudinally and tightly into the cylinder while supporting the segments interiorly against inward buckling.

3. The method of lining an internal combustion engine cylinder having a true bore, which comprises forming sheets of thin flexible metal of uniform thickness into a plurality of dupli-

cate longitudinal straight-edged segments of a cylinder with all longitudinal edges parallel to the axis of the cylinder and of a size to form when assembled with longitudinal edges abutting a complete cylindrical sleeve of a size to form a press fit within the engine cylinder, assembling the segments into such cylindrical form with edges abutting substantially throughout their length and unattached, and thereafter simultaneously forcing the thus assembled unattached segments longitudinally and tightly into the cylinder while supporting the segments interiorly in a manner to assure alignment of their edges while entering the cylinder.

4. The method of lining an internal combustion engine cylinder having a true bore, which comprises forming sheets of thin flexible metal of uniform thickness into a plurality of duplicate longitudinal straight-edged segments of a cylinder with all longitudinal edges parallel to the axis of the cylinder and of a size to form when assembled with longitudinal edges abutting a complete cylindrical sleeve of a size to form a press fit within the engine cylinder, assembling the segments into such cylindrical form with edges abutting substantially throughout their length and unattached, clamping the assembled segments together to bring them to substantially true cylindrical form, and thereafter simultaneously forcing the thus assembled unattached segments longitudinally and tightly into the cylinder.

5. The method of lining an internal combustion engine cylinder having a true bore, which comprises forming sheets of thin flexible metal of uniform thickness into a plurality of duplicate longitudinal straight-edged segments of a cylinder with all longitudinal edges parallel to the axis of the cylinder and of a size to form when assembled with longitudinal edges abutting a complete cylindrical sleeve of a size to form a press fit within the engine cylinder, assembling the segments into such cylindrical form with edges abutting substantially throughout their length and unattached, clamping the assembled segments together to bring them to substantially true cylindrical form, and thereafter simultaneously forcing the thus assembled unattached segments longitudinally and tightly into the cylinder while sliding them through the clamping means.

6. An internal combustion engine cylinder provided with a true bore lined with a sheet metal liner composed of a plurality of duplicate and symmetrical longitudinal cylindrical segments of thin flexible sheet metal of uniform thickness longitudinally press fitted into place and with longitudinally straight edges in unattached abutting relation extending parallel to the longitudinal axis of the cylinder.

7. An internal combustion engine cylinder provided with a true bore lined with a sheet metal liner composed of a plurality of duplicate and symmetrical longitudinal cylindrical segments

of thin flexible sheet metal of uniform thickness longitudinally press fitted into place and with longitudinally straight edges in unattached abutting relation extending parallel to the longitudinal axis of the cylinder, said segments backed with a uniform thin coating of relatively soft metal providing increased frictional resistance against displacement in use.

8. An internal combustion engine cylinder provided with a true bore lined with a sheet metal liner composed of a plurality of duplicate and symmetrical longitudinal cylindrical segments of thin flexible sheet metal of uniform thickness longitudinally press fitted into place and with longitudinal straight edges in unattached abutting relation extending parallel to the longitudinal axis of the cylinder, said segments backed with a uniform thin coating of copper providing increased thermal transmission and frictional resistance against displacement in use.

9. A piston cylinder lined internally with a sheet metal liner formed of thin flexible sheet metal of uniform thickness with longitudinally straight edges in unattached abutting relation press fitted into place, the grain of said sheet metal extending circumferentially of the cylinder.

10. A sheet metal wearing liner for a piston cylinder comprising a plurality of duplicate longitudinal cylindrical segments of thin flexible sheet metal of uniform thickness with longitudinal edges straight and parallel to the axis of the cylinder, the segments being of such a size that when assembled in cylindrical form with edges abutting they form a complete cylindrical liner of a size adapted for longitudinal press fitting into the cylinder for tightly seating therein against displacement in use.

11. A sheet metal wearing liner for a piston cylinder comprising two half cylindrical segments of thin flexible sheet metal of uniform thickness with longitudinal edges straight and parallel to the axis of the cylinder, the segments being of such a size that when assembled in cylindrical form with edges abutting they form a complete cylindrical liner of a size adapted for longitudinal press fitting into the cylinder for tightly seating therein against displacement in use.

12. A sheet metal wearing liner for a piston cylinder comprising a plurality of duplicate longitudinal cylindrical segments of thin flexible sheet metal of uniform thickness with longitudinal edges straight and parallel to the axis of the cylinder, the segments being of such a size that when assembled in cylindrical form with edges abutting they form a complete cylindrical liner of a size adapted for longitudinal press fitting into the cylinder for tightly seating therein against displacement in use, the grain of said sheet metal extending circumferentially of the liner.

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