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METHOD OF AND MEANS FOR PROVIDING A HARD WEARING SURFACE IN THE
CYLINDER BORES OF INTERNAL COMBUSTION ENGINES AND THE LIKE

Filed Feb. 13, 1934

2 Sheets-Sheet 1

Fig. 1

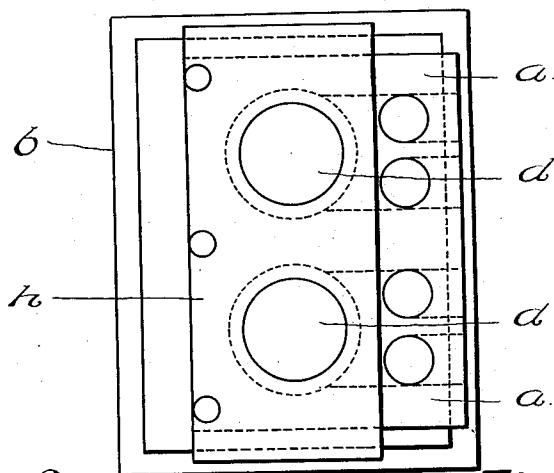


Fig. 2

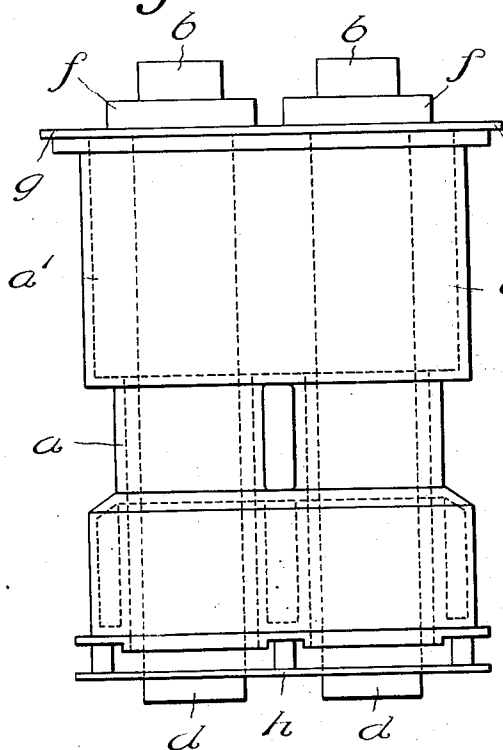
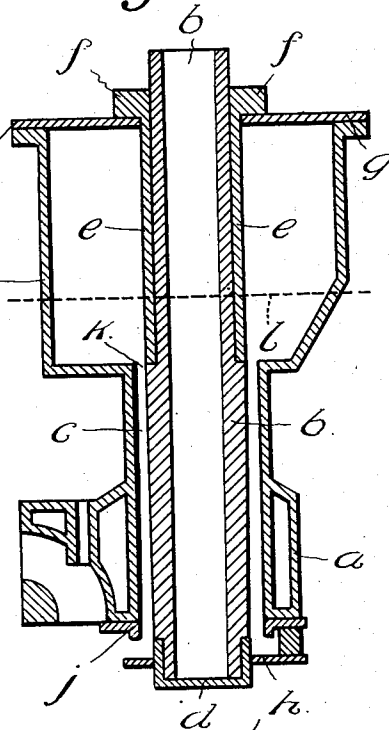


Fig. 3



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Fig. 4

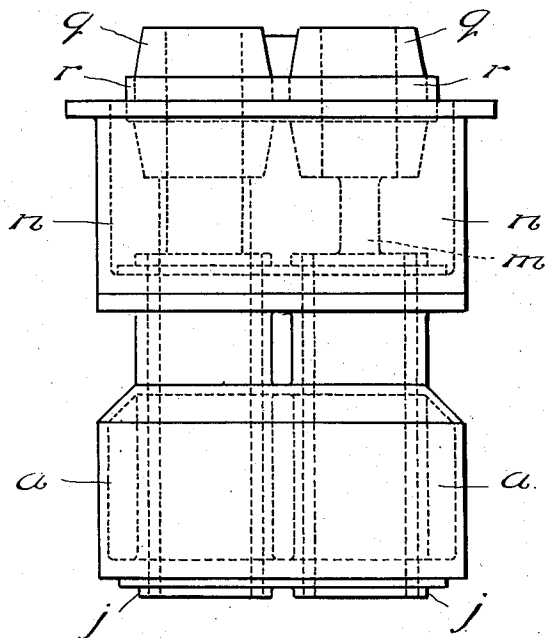
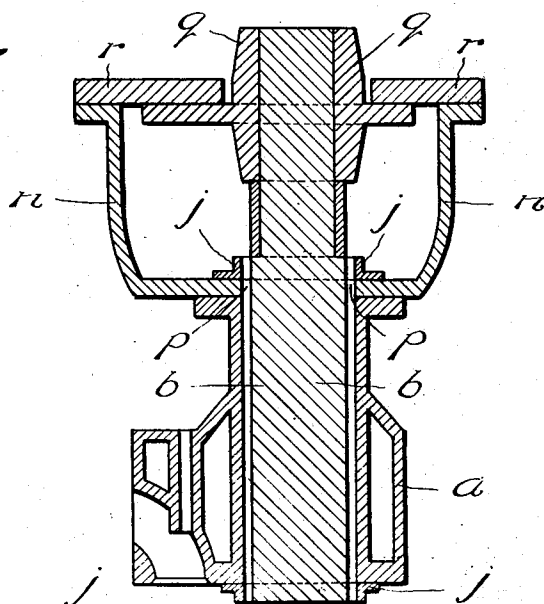


Fig. 5



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UNITED STATES PATENT OFFICE

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METHOD OF AND MEANS FOR PROVIDING
A HARD WEARING SURFACE IN THE
CYLINDER BORES OF INTERNAL COM-
BUSTION ENGINES AND THE LIKE

Henderik van der Horst, Hilversum, Netherlands

Application February 13, 1934, Serial No. 711,060
In Great Britain February 21, 1933

2 Claims. (Cl. 204—8)

This invention relates to a new or improved method of providing a hard wearing surface in the cylinder bores of internal combustion engines and the like by the application to the bores of a surface coating of chromium.

One of the chief troubles experienced with modern internal combustion engines is the high rate of cylinder wear on account of which it is often necessary to rebore the cylinders and fit oversize pistons two or three times before the bearings are sufficiently worn to necessitate a complete engine overhaul. The rapid wear of the cylinder bores is partly due to the high piston speeds now employed with aluminium or aluminium alloy pistons, but recent research indicates that the chief cause of wear is corrosion of the cylinder walls by acid condensates from the burning fuel mixture, the iron being readily attacked by formic acid and nitric acid which are present in the condensates.

Various methods of reducing cylinder wear have been proposed including the use of special iron for the cylinder block and the use of cylinder liners made from special alloys suitably heat-treated, but while these reduce wear due to abrasion they do not reduce wear due to corrosion, whereas the application of a coating of chromium to a cylinder bore effectively reduces wear from all causes as chromium is extremely hard, has a very low co-efficient of friction, and is entirely unaffected by formic or nitric acids.

The object of my invention is to permit the application to the whole of the wearing surface of a cylinder bore of a coating of chromium of uniform thickness and free from any bare or weak patches, a result which, so far as I am aware, has not hitherto been achieved in practice.

According to my invention a coating of chromium is deposited electrolytically on the inner surface of the cylinder bore of an internal combustion engine or the like in a plating bath employing a substantially cylindrical anode accurately centred in the bore and having a diameter only slightly less than that of the bore, and the anode or the cylinder block is so arranged or protected that the flow of current is confined strictly to the cylinder bore and the part of the anode within it to reduce electrical losses to a minimum and ensure uniformity of the flow of current and hence uniformity in the deposition of chromium.

For this purpose a temporary covering of insulating material may be secured over the part or parts of the cylinder block adjacent to but outside the cylinder bore, or the parts of the anode outside the bore may be reduced in diameter

and/or may be covered with insulating material.

Before depositing the coating of chromium the surface of the cylinder bore is first finished to as high a degree of smoothness as possible, and preferably a coating of chromium of a slightly greater thickness than is required is deposited, the chromium coating being subsequently honed or otherwise treated to remove any roughness and provide a wearing surface having a very high degree of smoothness.

The anode is conveniently of hard lead and has a diameter of from two-thirds to seven-eighths that of the cylinder bore, which means that with the usual diameters of cylinders the anode will be from three-eighths to five-eighths of an inch less in diameter than the bore.

To ensure a uniform thickness of deposit it is essential that the anode should be accurately centred in the cylinder bore and this can be ensured by the use of suitable jigs or carriers for the cylinder block and anode.

Further, to ensure that the full thickness of the chromium deposit shall extend without interruption to the ends of the cylinder bore a false or temporary extension of the bore is preferably provided in the known manner at the upper or both ends of the cylinder block.

For cylinders which are relatively short in length in comparison with the diameter of the bore a truly cylindrical anode can be employed but with cylinders of considerable length there is a tendency with a cylindrical anode for a greater thickness of chromium to be deposited on the lower part of the cylinder bore than on the upper. It is therefore preferable to employ an anode of which the part within the cylinder bore is tapered off in diameter towards its lower end.

The deposition of the chromium is carried out in a plating bath of normal constitution, a suitable bath consisting of 350 grammes of chromic acid per litre of water with the addition of a sulphate which may be provided by the addition to the solution of approximately 1% of sulphuric acid.

Two practical methods of carrying my invention into practice are illustrated diagrammatically in the accompanying drawings in which:

Figure 1 is an inverted plan of an inverted twin-cylinder block with the anodes mounted ready for immersion in the plating bath.

Figure 2 is a side elevation of the cylinder block.

Figure 3 is a transverse vertical section on the axis of one cylinder bore.

Figure 4 is a side elevation of another cylinder

block illustrating a modified method of mounting the anodes.

Figure 5 is a transverse vertical section on the axis of one cylinder bore.

5 In the arrangement illustrated in Figures 1 to 3 a is a cylinder block having two cylinders integral with the upper half of the crank case a' , but it will be understood that these figures are diagrammatic only and that the arrangement
10 illustrated is equally applicable to a block having any number of cylinders.

Each of the anodes b is a hollow cylinder of hard lead and is of a diameter slightly less than that of the cylinder bore, the anode being accurately mounted concentrically within the cylinder
15 bore so as to leave between it and the surface of the bore a comparatively narrow annular space c .

The part of the anode outside the bore at each end is reduced in diameter and over these reduced parts are fitted sleeves d e of insulating material such as glass, porcelain or any other material having suitable mechanical strength and being unaffected by the chromium solution. The
20 lower sleeve d may be in the form of a flanged cap completely enclosing the end of the anode as shown in Figure 3, while the upper sleeve e is of considerable length and is provided with a shoulder or enlargement f by which the anode is supported. This shoulder rests on a narrow steel
30 or other plate g having apertures through which the anodes pass and provided with means for attaching it temporarily to the bottom end of the crankcase b which is uppermost during the plating operation, the means of attachment also serving to locate the plate accurately with the anodes accurately centred in the cylinder bores. The lower ends of the anodes are similarly centred by a plate h temporarily secured to the cylinder
35 block and apertured to receive the insulating sleeves d .

There is also secured to the upper end of the cylinder block in alignment with each bore a temporary extension of the bore in the form of a flanged ring j of which the internal diameter is the same as that of the bore. The part of the anode of full diameter terminates in the same plane as the free edge of the ring as shown in Figure 3 for a reason which will be explained
45 more fully hereinafter. A similar ring may be fitted at the other end of the bore at the point k but this is not so essential at the crankcase end of the bore.

The assembly as illustrated is immersed in a chromium plating bath to a suitable depth such as that indicated by the dotted line l , and preferably the block is first subjected to an anodic treatment by making it the anode in the bath for a period of, say, one minute to ensure complete
50 de-gassing of the surface of the bore. The current is then reversed and chromium deposited on the surface of the bore. The evolution of hydrogen from the solution in the annular space c between the anode and the bore ensures a very rapid upward circulation of the solution through that space so that no other means for circulating the electrolyte are required.

The current density is chosen to give a deposit of the greatest possible hardness and in practice I have found the most suitable current density to be from 30 to 70 amperes per square decimetre, the pressure being from 3 to 5 volts. For this current density a suitable temperature for the bath is approximately 55° to 65° C.

70 It will be observed in Figure 3 that the part of

the anode within the cylinder bore is tapered in diameter from the top to the bottom. The object of this is to ensure a uniform thickness of the chromium deposit throughout the length of the cylinder bore as with long bores there is a tendency with a cylindrical anode for the thickness of the deposited layer of chromium to increase gradually towards the lower end of the bore. The reason for this appears to be that the hydrogen generated in the process rises up in the annular space between the anode and the cylinder bore and becomes more and more concentrated towards the upper end of the space and so reduces the efficiency of the deposition, and this effect is counteracted by reducing the effective diameter of the anode towards its lower end.

The tapering of the anode need only be very slight, a suitable taper being a reduction in the diameter of the anode of one part in each hundred parts of the length of the anode. For very long cylinders the degree of taper may be slightly increased or alternatively a uniform degree of taper can be employed and an absolutely uniform deposit of chromium can be ensured by controlling the current density since the volume of hydrogen generated varies with the current density.

The object of the insulating sleeves d e is to confine the flow of current strictly to the cylinder bore and the part of the anode within it so that electrical losses are reduced to a minimum and uniformity of the flow of current over the whole surface of the bore and hence uniformity in the deposition of chromium are ensured. I have found in practice that any flow of current between the anode and parts of the cylinder block other than the surface of the bore tends to upset the whole process and results in a patchy deposition of chromium or even no deposition at all.

In the plating bath an electrical pressure of two volts is normally required to overcome polarization and owing to the small distance between the anode and the surface of the cylinder bore only a small voltage is required to give a high current density. The plating bath may have a current pressure of from three to five volts and a current density of from thirty to seventy amperes per square decimeter. In practice a total pressure of 3 to 4 volts is sufficient to give the highest desirable current density and as 2 volts are required to overcome polarization it will be obvious if the current is allowed to stray to comparatively large areas of other parts of the cylinder block as well as to pass to the surface of the cylinder bore only a relatively small and unknown amount of current will be available for the deposition of chromium. To attempt to overcome this difficulty by an increase of current does not produce the desired result as it only increases the flow of current to greater areas of the cylinder block outside the bores.

Instead of providing a sleeve of insulating material over a reduced part of the anode outside the cylinder bore I may employ a steel or other sleeve coated with an insulating enamel resistant to the chromium solution or I may apply an insulating enamel to the anode itself.

Alternatively the part of the anode outside the cylinder bore may be very much reduced in diameter as shown at m in Figure 4, and this reduced part may be left uncovered as the electrical path between its surface and that of the nearest part of the block is too long for any appreciable leakage of current to take place. If desired, however, this reduced part may be coated with in-
75

insulating enamel or covered with a sleeve of insulating material or of enamelled metal.

The object of the ring *j* forming a temporary extension of the cylinder bore is to ensure that the full thickness of the deposited coating of chromium shall extend to the extreme end of the bore. In depositing chromium electrolytically on the inside of cylinder bores I have found that there is a tendency for the thickness of the deposited layer to taper off at the ends of the bore, which is a serious disadvantage, particularly at the upper end of the bore. By providing a temporary extension of the bore any tapering off or failure of the deposit takes place on the surface of the extension and the deposit on the bore is of the full thickness to the extreme end.

Instead of the extension being formed by a flanged ring it may be formed by an aperture in a plate of substantial thickness secured against the end of the block, the internal diameter of the aperture being the same as that of the cylinder bore.

The extension will usually be made of metal and preferably of the same metal as the cylinder block so that chromium will be deposited on it but it is possible to use an extension made of insulating material as the flow of current from the anode will then be kept to the bore and a layer of chromium of full thickness will be deposited right up to the end of the bore.

Figures 4 and 5 of the drawings illustrate an assembly suitable for dealing with a cylinder block which is separate from the crank-case.

In this case the inverted cylinder block *a* is bolted or otherwise secured to the underside of a frame *n* having apertures *p* corresponding to each cylinder bore. The anodes *b* are mounted in and accurately located by a cast iron or other block *q* which is mounted on the frame by means of a plate *r* of insulating material such as hard wood or ebonite. This arrangement is suitable for use in a works when numbers of identical cylinder blocks are to be treated.

The thickness of the layer of chromium deposited on the surface of the cylinder bore will depend on requirements. In coating the bores of new cylinder blocks a coating of from 3 to 6 thousandths of an inch is sufficient to allow for a finish grinding or honing of the chromium surface to remove any roughness and to provide a wearing surface which will have a life equal to that of the engine.

In the case of old cylinder blocks a coating of any desired thickness within reason can be applied to restore the cylinder bores to their original diameter and permit standard pistons to be refitted.

After the chromium has been deposited on the cylinder bores it may be desirable to heat the cylinder block to a temperature of 150° to 300° cent. for a period of one half to two hours in order to get rid of hydrogen occluded in the chromium deposit and in the iron of the cylinder block as occluded hydrogen tends to make the chromium brittle. This treatment prevents any risk of fracturing the chromium deposit in the final grinding and polishing operations.

In cases where a cylinder bore has to be stripped and re-plated heating of the block is essential as it is impossible to deposit chromium on iron containing occluded hydrogen.

I claim:

1. A process for depositing a uniform layer of chromium on the inner surface of a cylinder consisting in depositing the chromium electrolytically in a plating bath employing an anode which is vertically arranged axially of a cylindrical bore and which is of circular cross-section tapering in diameter from the upper to the lower end, the said taper being thus sufficient to effect a uniform deposit throughout the cylinder, and in which the anode is accurately centred in the cylinder bore, and is of a diameter only slightly less than that of the bore, and in so arranging the anode or cylinder block that the flow of current is confined strictly to the cylinder bore and the part of the anode within it.

2. A process of depositing a uniform layer of chromium on the inner surface of a cylinder consisting in depositing the chromium electrolytically in a plating bath employing an anode of circular cross section arranged with its axis vertical and tapering in diameter from the upper to the lower end with a degree of taper such as to ensure a deposit of chromium of uniform thickness throughout the length of the cylinder bore, the anode being accurately centred in the bore and its mean diameter being only slightly less than that of the bore, and the anode or cylinder block being so arranged that the flow of current is confined strictly to the cylinder bore and the part of the anode within it.

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