May 14, 1963 K. E. MANN 3,089,735

RECIPROCABLE COMBUSTION ENGINE

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FIG. 1

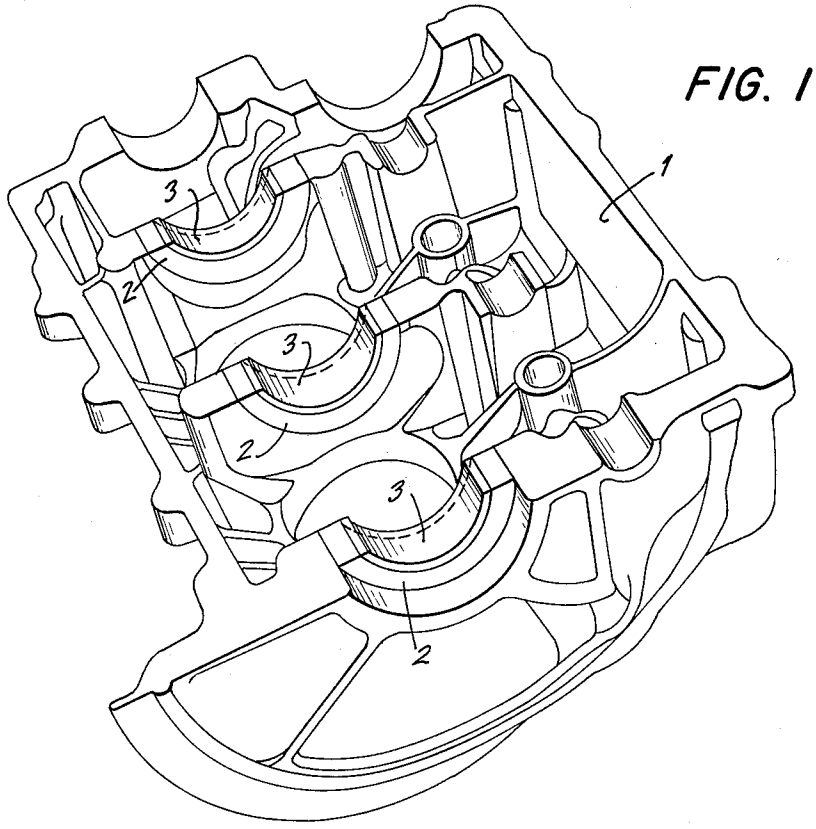
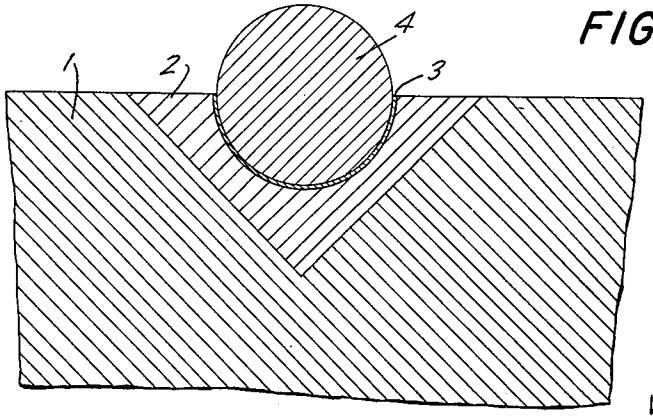


FIG. 2



INVENTOR.
Karl Ernst Mann

BY
Michael S. Striker
Attorney

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FIG. 3

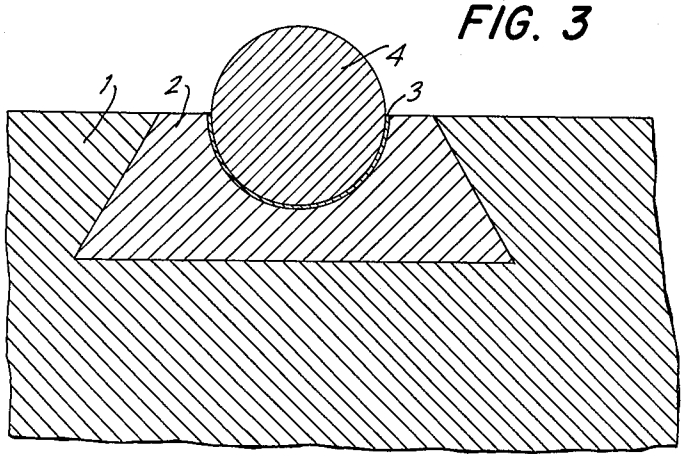


FIG. 4

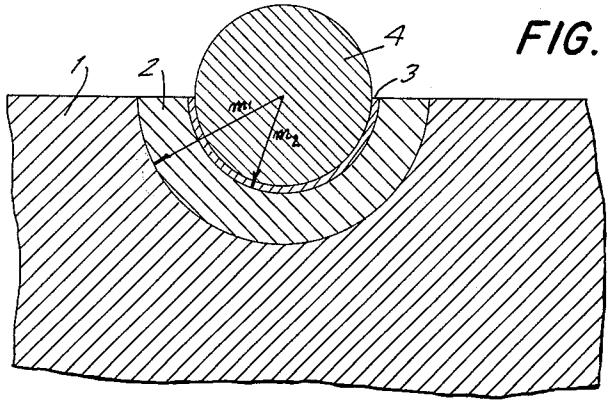
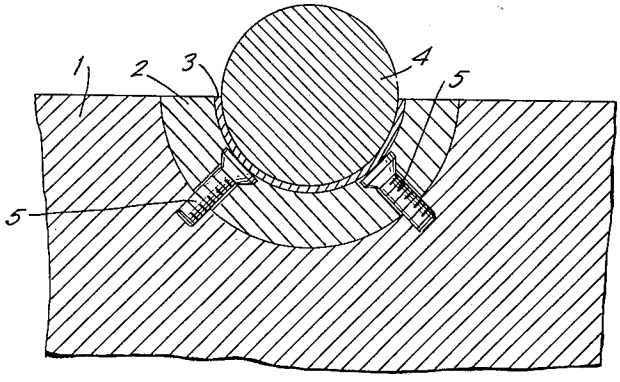


FIG. 5



INVENTOR.
Karl Ernst Mann

BY
Michael S. Striker
Attorney

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FIG. 6

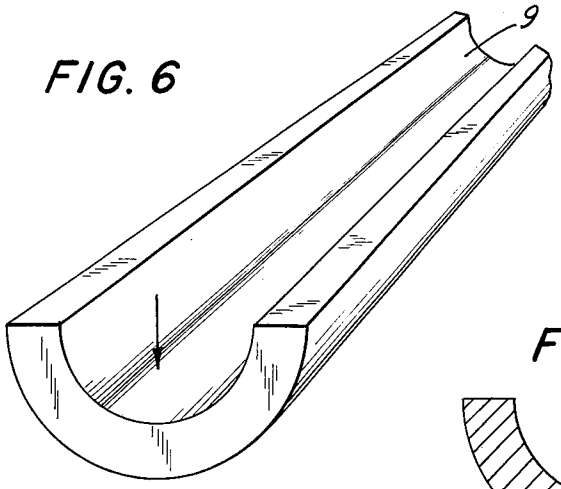


FIG. 7

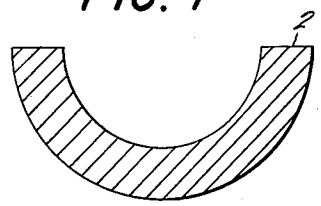


FIG. 8

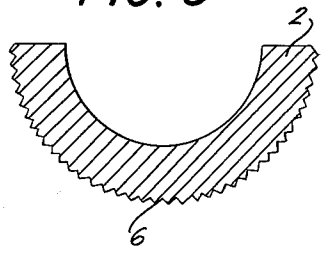


FIG. 9

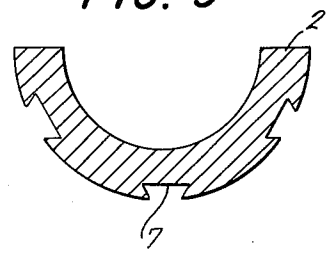
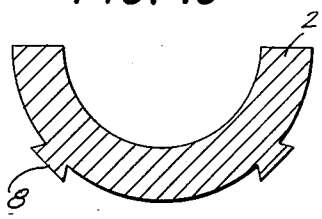


FIG. 10



INVENTOR.
Karl Ernst Mann
BY
Michael S. Striker
Attorney

United States Patent Office

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RECIPROCABLE COMBUSTION ENGINE

Karl Ernst Mann, Meinerzhagen, Westphalia, Germany, assignor to Otto Fuchs Kommandit Gesellschaft, Meinerzhagen, Westphalia, Germany

Filed May 31, 1961, Ser. No. 113,892
Claims priority, application Germany June 2, 1960
19 Claims. (Cl. 308—23)

The present invention relates to reciprocable combustion engines, and particularly to engines having a motor block cast of light metal alloys.

Motor blocks produced of light metal alloys possess several advantages such as low specific gravity, high heat conductivity and others known in the art.

However, particularly after prolonged use, such light metal engines will not operate at the desired low noise level. It has been found that the fit between the crank shaft and the bearings supporting the same will be subject to progressive deterioration, the play between crank shaft and bearing will increase and the bearing will become out-of-round.

It has been attempted to reduce the noise caused by the above described conditions by forming in the bearing a relatively thick film of oil. However, the results obtained in this manner were not satisfactory, partly due to the fact that the viscosity of the lubricating oil decreases with increasing temperatures.

Recently attempts have been made to cope with this problem by considering the difference in the heat expansion coefficients of the metals and alloys involved. Within the temperature range relevant for the operation of combustion engines, the light metal alloy of the motor block might expand at a greater rate than the bearing shell or the crank shaft. The thus caused change in the degree of play depends on variations of the prevalent temperature and thus is reversible. In this connection it has been suggested to machine the bearing to the lower limit and the bearing contacting crank shaft portions to the upper limit of the permissible tolerance. It has also been suggested to solve the problem of different heat expansion coefficients of the various metal parts involved by providing a bimetallic bearing cap capable of compensating for the heat expansion of the bearing.

However, all of these attempts met only with limited success.

It is therefore an object of the present invention to overcome the above discussed difficulties and disadvantages connected with the use of light metal motor blocks in reciprocable combustion engines.

It is another object of the present invention to provide a reciprocable combustion engine having a light metal motor block, wherein even upon prolonged use the play in the crank shaft bearings will not exceed tolerable limits.

It is a further object of the present invention to provide a light metal reciprocable combustion engine which may be operated for prolonged periods of time without substantial increase in engine noise.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention contemplates in a reciprocable combustion engine, in combination, a motor block of cast light metal having in one face thereof an elongated recess having in a transverse direction parallel to the face a predetermined maximum transversal extension, an elongated bearing insert consisting essentially of an alloy selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys located in the recess fitting into the same and formed with a substantially elongated part cylindrical recess in its outer face, the recess having in the plane of the outer face a maximum transverse extension smaller than the predetermined maximum transversal extension and the compression yield strength of the alloy being greater than that of the motor block, and a bearing shell adapted to support a crankshaft fitting into the cylindrical recess in the bearing insert, whereby pressure exerted by a crankshaft on the bearing shell will be distributed upon a surface area of the cast motor block which is greater than the area of contact between the bearing insert and the bearing shell.

According to a preferred embodiment of the present invention, the bearing support structure for reciprocable combustion engines and the like comprises, in combination, a motor block of cast light metal, a crank shaft, bearing means for supporting the crank shaft, extruded first support means of magnesium alloy directly carrying the bearing means and having a bearing contacting surface of predetermined area, the magnesium alloy of the extruded first support means having an anisotropic grain structure, and second support means forming part of the motor block for carrying the first support means, the first support means having a downwardly directed face in contact with the second support means and having a square area which measured in horizontal direction equals at least twice the cross-sectional area of the bearing supported portion of the crank shaft taken in horizontal direction and through the center thereof so that pressure exerted by the crank shaft on the bearing will be distributed upon a surface area of the second support means which is greater than the predetermined contact surface area between the bearing and the first support means, the compression yield strength of the first support means being greater than the compression yield strength of the second support means and the anisotropic grain orientation in the firstt support means being such that the same possesses maximum compression yield strength in a direction perpendicular to the downwardly directed face of the first support means contacting the second support means.

I have found that the increase in play and the progressive increase in the out-of-round condition of the crank shaft bearing is caused only to a relatively small degree by the differences between the heat expansion coefficients of the various coacting metal parts. Consequently, any attempts to equalize heat expansion or to make allowance for the differences in heat expansion of the various parts will, at most, meet only with limited success.

The present invention is based on the surprising finding that the major reason of the above discussed difficulties are not so much due to the differential heat expansion but to the stress exerted during operation of the engine on the bearing shell and by the bearing shell on the supporting portion of the light metal motor block. It is the ability or inability of the affected parts to withstand the impact stress which mainly controls the play and the degree of out-of-round condition of the bearing, and thus the noise level.

Due to the impact stress exerted by the crank shaft on the bearing shell and the supporting portion of the light metal motor block, an irreversible increase in the play between crank shaft and bearing shell will be created, and this in turn will be due to the fact that due to such stress during prolonged operation of the engine a plastic deformation of the bearing shell supporting portion of the light metal motor block occurs.

The compression yield strength of light metal casting alloys is relatively low. Such compression yield strength ($\sigma_{0.2}$) is the pressure expressed in kilograms per square millimeter by which a permanent deformation of 0.2% is obtained. Thus, for instance, the compression yield

strength of the magnesium alloy AZ91, containing about 9% aluminum, 1% zinc and 0.15% manganese, is about 11 kg./mm.^{2}. The compression yield strength of a eutectic aluminum-silicon alloy is about 5 kg./mm.^{2}. The above values were determined on specially cast testing rods and thus are better than the actual values of cast bodies such as motor blocks wherein irregularities such as pipings hardly can be avoided.

Other light metal casting alloys also have a relatively low compression yield strength. Thus, an aluminum alloy containing between 5 and 13% silicon and at least one of the metals copper, magnesium and manganese in quantities of up to 4% copper, up to 1% magnesium and up to 1% manganese, will have a compression yield strength of about 6.5 kg./mm.^{2}. The compression yield strength of magnesium casting alloys containing between 5–10% aluminum, up to 4% zinc and between 0.1 and 0.5% manganese will hardly exceed 13 kg./mm.^{2}.

According to the present invention it is now proposed to eliminate or at least substantially reduce crank shaft bearing deformation and increase in play between crank shaft and bearing by interposing an insert between the bearing shell and the light metal motor block, which insert or first support means according to certain preferred embodiments of the present invention will consist of an alloy the density of which has been increased by kneading deformation. In any event, the insert according to the present invention must possess a greater compression yield strength than the light metal alloy of the motor block, and the shape of the insert will be thus that the stress exerted by the crank shaft will be distributed over a greater area of the motor block than would be the case if the bearing shell would be directly supported by the motor block.

For instance, the insert may be formed of wrought aluminum alloys of the Al-Cu-Mg type which possess compression yield strengths of between about 30 and 38 kg./mm.^{2}, or of extruded magnesium alloy AZ855 containing about 8% aluminum, 0.5% zinc and 0.15% manganese which in longitudinal and lateral direction has a compression yield strength of about 18 kg./mm.^{2} and in a direction perpendicular to the direction of extrusion reaches a compression yield strength value of 26.5 kg./mm.^{2}. Such extruded inserts are also preferred because of the greater uniformity of their mechanical strength and lack of pipings and pores.

Thus, according to the present invention, an insert is interposed between motor block and bearing shell, which insert consists of a wrought light metal alloy member or of a copper alloy having a greater compression yield strength than the light metal casting of the motor block, and the stress exerted by the crank shaft is distributed over a larger area of the cast light metal motor block.

In addition to wrought magnesium and aluminum alloys, it is also possible to form the insert of a cast or wrought copper alloy of relatively high compression yield strengths having, for instance, a composition such as described in Examples I–VII.

Example I

57% Cu, up to 3.0% Ni, up to a combined total of 7.5% of Al, Si, Mn, Fe, Sn, the balance being Zn.

Example II

10% Al, 4% Fe, 4.5% Ni, up to 3.0% Mn, up to 0.5% Zn, up to a combined total of 0.5% Pb, Sn, Si, the balance being Cu.

Example III

Between 57.0 and 59.5% Cu, between 1.0 and 3.0% Pb, the balance being Zn and the permissible quantities of Fe, Sn, Al, Mn, Ni, Sb.

Example IV

Between 62.0 and 65.0% Cu, the balance being Zn and the permissible quantities of Fe, Sn, Al, Mn, Ni, Pb, Sb.

Example V

Between 56.0 and 61.0% Cu, between 0.2 and 3.0% Mn, between 0.4 and 1.3% Al, up to 2.0% Ni, up to 1.5% Fe, up to 0.5% Sn, up to 0.8% Si, up to 1.0% Pb, the balance being Zn.

Example VI

Between 56.0 and 61.0% Cu, between 0.2 and 3.0% Mn, between 1.3 and 2.5% Al, up to 2.0% Ni, up to 1.5% Fe, up to 0.5% Sn, up to 0.8% Si, up to 1.0% Pb, the balance being Zn.

Example VII

Between 1.8 and 2.2% Ni, between 0.5 and 0.8% Si, the balance being Cu.

Generally, copper alloys with between 1.8 and 2.2% nickel and between 0.5 and 0.8% silicon will have a compression yield strength of between 35 and 55 kg./mm.^{2}; wrought aluminum alloys with between 2.5 and 5% copper, 0.2 and 2.0% magnesium, 0.3 and 1.5% manganese and up to 1% silicon will have a compression yield strength of between 26 and 38 kg./mm.^{2}; and the compression yield strength of wrought magnesium alloys with between 3 and 9% aluminum, 0.1 and 1.5% zinc and 0.1 and 0.3% manganese will be between 16 and 24 kg./mm.^{2}.

Preferably, inserts of the casting alloys according to Examples I and II are formed from continuously cast profiled rods by saw cuts perpendicular to the axis of the rod, while inserts of the wrought alloys of Examples III–VII are cut from extruded profiles. Inserts or rods formed of the alloy of Example VII may also be heat tempered.

The bearing insert or first support means according to the present invention will receive and carry the crank shaft bearing shell and also will contact the cast light metal motor block, whereby the geometrical configuration of the area of contact between insert and motor block will be such that the stress exerted by the crank shaft will be received by a larger area of the motor block than would be the case if the bearing shell would be in direct contact with the motor block.

In view of the relatively high temperature in the operating combustion engine, the insert-forming alloy preferably will be an alloy possessing a relatively great compression yield strength at such elevated temperatures.

Thus, inserts according to the present invention must consist of an alloy having a compression yield strength which is considerably higher, preferably at least 50% higher than the compression yield strength of the light metal motor block, and preferably the insert will be formed of a wrought magnesium alloy or a wrought aluminum alloy, or a copper alloy which may be a cast or a wrought copper alloy which possesses such relatively great compression yield strength.

In the case of magnesium alloys, it is possible to take advantage of the anisotropic grain structure by forming the insert by extrusion in such a manner that maximum compression yield strengths will be achieved in the direction in which the insert is exposed to maximum stress.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a motor block including crank shaft bearings in accordance with the present invention;

FIGS. 2, 3 and 4 are fragmentary elevational views in

cross-section illustrating several embodiments of the present invention.

FIG. 5 illustrates in the embodiment of FIG. 4 another manner of fastening the insert to the motor block;

FIG. 6 is a perspective view of a profiled rod from which inserts according to the present invention may be cut; and

FIGS. 7, 8, 9 and 10 are cross-sectional views of several embodiments of inserts according to the present invention.

Referring now to the drawings, and particularly to FIG. 1, motor block **1** is shown consisting of a cast light metal alloy having a relatively low compression yield strength. Inserts **2** are interposed between motor block **1** and bearing shells **3**. Inserts **2** consist of a wrought magnesium or aluminum alloy, or of a copper alloy of relatively great compression yield strength. It can readily be seen that the stress exerted by the crank shaft on bearing shell **3** will be absorbed by a lesser upwardly directed surface area of insert **2**, than the surface area of motor block **1** to which the stress is transmitted from a downwardly directed surface area of insert **2**.

FIGS. 2, 3 and 4 illustrate different cross-sectional configurations of insert **2**, whereby FIG. 4 corresponds to the insert shown in FIG. 1. In FIGS. 2–4, reference numeral **1** again denotes the motor block, reference numeral **2** the insert of high compression yield strength and reference numeral **3** the bearing shell. In addition, the crank shaft is indicated by reference numeral **4**. It will be seen in each of FIGS. 2–4 that the stress exerted by crank shaft **4** against bearing shell **3** will be transmitted to a surface area of insert **2** which is considerably smaller than the area of contact between insert **2** and motor block **1**.

As can be seen in FIG. 1 and easily deduced from FIGS. 2–4, the motor block is formed in one face thereof with an elongated recess having in a transverse direction parallel to said face a predetermined maximum transversal extension. Elongated bearing insert **2** fits into the recess in motor block **1** and is formed with an elongated part cylindrical recess in its outer face. The recess in insert **2** has in the plane of its outer face a maximum transversal extension which is smaller than the predetermined transversal extension of the recess in the motor block. Bearing shell **3** fits into the part cylindrical recess in the outer face of bearing insert **2**, and crank shaft **4** is supported by bearing shell **3**.

Radii m_1 and m_2 in FIG. 3 serve to indicate the difference between the size of the two opposite faces of insert **2** which, respectively, contact motor block **1** and bearing shell **3**; and also to show that the stress originating from crank shaft **1** will be transmitted from insert **2** over a greater surface area of motor block **1** than the surface area of insert **2** at which such stress is received from bearing shell **3**.

Insert **2** may be fixed to motor block **1** in various ways, for instance by shrinking, by casting the motor block in a mold in which inserts **2** had been previously positioned, or by threaded connection.

FIG. 5 corresponds to FIG. 4 but shows in addition screws **5**, preferably of light metal, which serve for firmly connecting insert **2** with motor block **1**.

Shrinking may be carried out by heating the motor block so as to expand the recess which is to receive the insert, introducing the insert into the recess and allowing the motor block to cool whereby, due to contraction, the motor block will firmly grip the insert.

The same effect may be achieved by severely cooling the insert, for instance with liquid air, so as to cause contraction of the insert, and to introduce the thus contracted insert into the recess of a motor block which is maintained either at ambient or at elevated temperature. Upon return of insert and motor block to ambient temperature, it will be found that the insert is firmly held in the recess.

The insert may also be arranged in the mold in which the motor block is to be cast and upon subsequent pouring of the molten light metal alloy for the motor block into the mold, the insert will be embedded in the molten alloy and after solidification of the alloy, the insert will firmly adhere thereto.

FIGS. 8, 9 and 10 are cross-sectional views of different embodiments of inserts **2** formed at their face engaging motor block **1** with a plurality of closely spaced axially extending grooves **6**, or dove-tailed grooves **7**, or dove-tailed projections **8** which will serve for firmly anchoring the respective insert in the motor block alloy cast about the same.

According to a preferred embodiment, the face of the insert which eventually will engage the motor block is coated with a layer of low melting or fusing metal, in the case of inserts made of wrought magnesium alloys, for instance, with a layer of lead, cadmium, tin or preferably zinc. Upon pouring the molten alloy of the motor block into the mold in which the thus coated insert is arranged, the coating metal, at least partially, will form an alloy with the molten motor block-forming light metal alloy.

Thus, when casting the motor block in a mold in which the inserts are positioned, firm anchoring of the insert in the motor block can be enhanced by forming the engaging surface of the insert for instance in accordance with FIGS. 8–10, and/or by arranging on the engaging surface of the insert a coating or layer of a metal adapted to form an alloy with the molten light metal alloy which is poured into the mold for forming the motor block.

FIG. 6 illustrates an extruded profiled rod consisting of an anisotropic magnesium alloy as AZ855 which due to its anisotropic grain orientation possesses in a direction perpendicular to the direction in which rod **9** had been extruded, as indicated by the arrow, a particularly great compression yield strength of about 26.5 kg./mm.^{2}.

FIG. 7 is a cross-sectional view of the profiled rod illustrated in FIG. 6 in a direction perpendicular to the axis of the rod and corresponding to an end face of an insert cut from rod **9**.

Thus, according to the present invention, it is essential that the compression yield strength of the insert is considerably greater than that of the material of the motor block, preferably at least 50% greater; and that the insert has a downwardly directed face in contact with the motor block having a square area which measured in horizontal direction is considerably greater, preferably at least twice as great as the square area measured in horizontal direction of the upwardly directed face of the insert which contacts the bearing shell.

An economical advantage with respect to the scrap value of the motor block is achieved by using for the insert an alloy of a qualitative compositive which is substantially similar to that of the motor block-forming alloy, so that motor block rejects and cuttings accruing during machining of the cast motor block may be remelted and used for forming the alloy employed for subsequent casting of motor blocks.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of reciprocable engines differing from the types described above.

While the invention has been illustrated and described as embodied in a reciprocable combustion engine, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are in-

tended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a reciprocable combustion engine, in combination, a motor block of cast light metal having in one face thereof an elongated recess having in a transverse direction parallel to said face a predetermined maximum transversal extension and including an elognated insert consisting essentially of an alloy selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys located in said recess fitting into the same and formed with a substantially elongated part cylindrical recess in its outer face, said recess having in the plane of said outer face a maximum transverse extension smaller than said predetermined maximum transversal extension and the compression yield strength of said alloy being greater than that of the cast light metal of said motor block; and a bearing shell adapted to support a crankshaft fitting into said cylindrical recess in said insert, whereby pressure exerted by a crankshaft on said bearing shell will be distributed upon a surface area of said cast light metal of said cast motor block which is greater than the area of contact between said insert and said bearing shell.

2. In a reciprocable combustion engine, in combination, a motor block of cast light metal having in one face thereof an elongated recess having in a transverse direction parallel to said face a predetermined maximum transversal extension and including an elongated insert consisting essentially of an alloy selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys located in said recess fitting into the same and formed with a substantially elongated part cylindrical recess in its outer face, said recess having in the plane of said outer face a maximum transverse extension smaller than said predetermined maximum transversal extension and the compression yield strength of said alloy being at least 50% greater than that of the cast light metal of said motor block; and a bearing shell adapted to support a crankshaft fitting into said cylindrical recess in said insert, whereby pressure exerted by a crankshaft on said bearing shell will be distributed upon a surface area of said cast light metal of said cast motor block which is greater than the area of contact between said insert and said bearing shell.

3. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a material selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; and first support means firmly attached to said motor block and in contact with said bearing means, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

4. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a material selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; first support means located between said bearing means and said cast motor block; threaded means fixing said first support means to said cast motor block, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing means and having a bearing contacting surface of predetermined area, and also having a surface portion larger than said predetermined area and adjacent said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

5. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a material selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; first support means located between said bearing means and said cast motor block; said first support means being shrunk onto said cast motor block, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion larger than said predetermined area and adjacent said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

6. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a light metal alloy selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; first support means contacting said bearing means and partially embedded in said cast motor block; a layer of fusing metal interposed between and adhering said first support means and said cast motor block to each other, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion larger than said predetermined area and adjacent said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

7. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a material selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; first support means carrying said bearing means; a layer of fusing metal on said first support means said motor block being cast about said first support means with said layer of fusing metal thereon, said layer of fusing metal adhering said first support means and said motor block to each other and at least a portion of said layer of fusing metal forming an alloy with adjacent portions of said cast motor block so as to make said first support means integral with said motor block, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion larger than said predetermined area and adjacent said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

8. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a magnesium alloy; a crank shaft; bearing means for supporting said crank shaft; first support means located between

said bearing means and said cast motor block, said first support means being formed of a wrought magnesium alloy having a compression yield strength superior to that of the magnesium alloy forming said cast motor block and including a coating of a fusing metal selected from the group consisting of lead, tin, cadmium and zinc, and being adapted to form an alloy with the magnesium alloy of said cast motor block said coating being interposed between and adhering said first support means and said cast motor block to each other so as to make said first support means integral with said motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion facing said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

9. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a material selected from the group consisting of aluminum and magnesium alloys; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block; means forming part of said cast motor block and of said first support means for interlocking the same, said first support means being formed of a material selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys, and having a compression yield strength superior to that of said cast motor block, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion contacting said cast motor block and so formed that the stress of the said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

10. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a magnesium alloy; a crank shaft; bearing means for supporting said crank shaft; first support means located between said bearing means and said cast motor block; means forming part of said cast motor block and of said first support means for interlocking the same, said first support means being formed of a wrought magnesium alloy having a compression yield strength superior to that of the magnesium alloy forming said cast motor block; and a coating of a fusing metal selected from the group consisting of lead, tin, cadmium and zinc, and being adapted to form an alloy with the magnesium alloy of said cast motor block interposed between and adhering said first support means and said cast motor block to each other, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion facing said cast motor block and so formed that the stress of said crank shaft is distributed upon surface area of said cast motor block which is larger than said predetermined area.

11. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of an aluminum alloy containing between 5 and 13% silicon and at least one of the metals copper, magnesium and manganese in a proportion of up to 4% copper, up to 1% magnesium and up to 1% manganese, and having a compression yield strength of up to 6.5 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing and said cast motor block, said first support means being formed of a wrought aluminum alloy containing between 2.5 and 5% copper, between 0.2 and 2% magnesium, between 0.3 and 1.5% manganese and up to 1% silicon, and having a compression yield strength of between about 26 and 38 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

12. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of an aluminum alloy containing between 5 and 13% silicon and at least one of the metals copper, magnesium and manganese in a proportion of up to 4% copper, up to 1% magnesium and up to 1% manganese, and having a compression yield strength of up to 6.5 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block, said first support means being formed of a wrought magnesium alloy containing between 3 and 9% aluminum, between 0.1 and 1.5% zinc and between 0.1 and 0.3% manganese, and having a compression yield strength of between about 16 and 24 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

13. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of an aluminum alloy containing between 5 and 13% silicon and at least one of the metals copper, magnesium and manganese in a proportion of up to 4% copper, up to 1% magnesium and up to 1% manganese, and having a compression yield strength of up to 6.5 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block, said first support means being formed of a copper alloy containing between 1.8% and 2.2% nickel and between 0.5 and 0.8% silicon, and having a compression yield strength of between about 35 and 55 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

14. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a magnesium alloy containing between 5 and 10% aluminum, between 0 and 4% zinc, and between 0.1 and 0.5% manganese, and having a compression yield strength of up to 13 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block, said first support means being formed of a wrought magnesium alloy containing between 3 and 9% aluminum, between 0.1 and 1.5% zinc and between 0.1 and 0.3% manganese, and having a compression yield strength of between about 16 and 24 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

15. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a magnesium alloy containing between 5 and 10% aluminum, between 0 and 4% zinc, and between 0.1 and 0.5% manganese, and having a compression yield strength of up to 13 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block, said first support means being formed of a wrought aluminum alloy containing between 2.5 and 5% copper, between 0.2 and 2% magnesium, between 0.3 and 1.5% manganese, and up to 1% silicon, and having a compres-

sion yield strength of between about 26 and 38 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

16. In a reciprocable combustion engine and the like, in combination, a cast motor block formed of a magnesium alloy containing between 5 and 10% aluminum, between 0 and 4% zinc, and between 0.1 and 0.5% manganese, and having a compression yield strength of up to 13 kg./mm.^{2}; a crank shaft; bearing means for supporting said crank shaft; and first support means located between said bearing means and said cast motor block, said first support means being formed of a copper alloy containing between 1.8% and 2.2% nickel and between 0.5 and 0.8% silicon, and having a compression yield strength of between about 35 and 55 kg./mm.^{2}, said first support means directly carrying said bearing and having a bearing contacting surface of predetermined area, and also having a surface portion fixed to and contacting said cast motor block and so formed that the stress of said crank shaft is distributed upon a surface area of said cast motor block which is larger than said predetermined area.

17. A bearing support structure for reciprocable combustion engines and the like, comprising, in combination, a motor block of cast light metal; a crank shaft; bearing means for supporting said crank shaft; extruded first support means of magnesium alloy directly carrying said bearing means and having a bearing contacting surface of predetermined area, said magnesium alloy of said extruded first support means having an anisotropic grain structure; and second support means forming part of said motor block for carrying said first support means, said first support means having a downwardly directed face fixed to and in contact with said second support means and having a square area which measured in horizontal direction equals at least twice the cross-sectional area of the bearing supported portion of said crank shaft taken in horizontal direction and through the center thereof so that pressure exerted by said crank shaft on said bearing will be distributed upon a surface area of said second support means which is greater than the predetermined contact surface area between said bearing and said first support means, the compression yield strength of said first support means being greater than the compression yield strength of said second support means and the anisotropic grain orientation in said first support means being such that the same possesses maximum compression yield strength in a direction perpendicular to said downwardly directed face of said first support means contacting said second support means.

18. A bearing support structure for reciprocable combustion engines and the like, comprising, in combination, a motor block of cast light metal; a crank shaft; bearing means for supporting said crank shaft; extruded first support means directly carrying said bearing means and having a bearing contacting surface of predetermined area and consisting essentially of an alloy selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys; and second support means forming part of said motor block for carrying said first support means, said first support means having a downwardly directed face fixed to and in contact with said second support means and having a square area which measured in horizontal direction equals at least twice the cross-sectional area of the bearing supported portion of said crank shaft taken in horizontal direction and through the center thereof so that pressure exerted by said crank shaft on said bearing will be distributed upon a surface area of said second support means which is greater than the predetermined contact surface area between said bearing and said first support means, the compression yield strength of said first support means being at least 50% greater than the compression yield strength of said second support means.

19. A bearing support structure for reciprocable combustion engines and the like, comprising, in combination, a motor block of cast light metal; a crank shaft; bearing means for supporting said crank shaft; first support means directly carrying said bearing means and having a bearing contacting surface of predetermined area and consisting essentially of an alloy selected from the group consisting of wrought aluminum alloys, wrought magnesium alloys and copper alloys; and second support means forming part of said motor block for carrying said first support means, said first support means having a downwardly directed face fixed to and in contact with said second support means and having a square area which measured in horizontal direction equals at least twice the cross-sectional area of the bearing supported portion of said crank shaft taken in horizontal direction and through the center thereof so that pressure exerted by said crank shaft on said bearing will be distributed upon a surface area of said second support means which is greater than the predetermined contact surface area between said bearing and said first support means, the compression yield strength of said first support means being greater than the compression yield strength of said second support means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,324,676 Butterfield ---------- July 20, 1943