June 25, 1957 J. L. GRATZMULLER 2,796,769

CRANK-SHAFT AND THE CORRESPONDING CRANK-CASE

Filed Feb. 3, 1954 3 Sheets-Sheet 1

Fig. 1

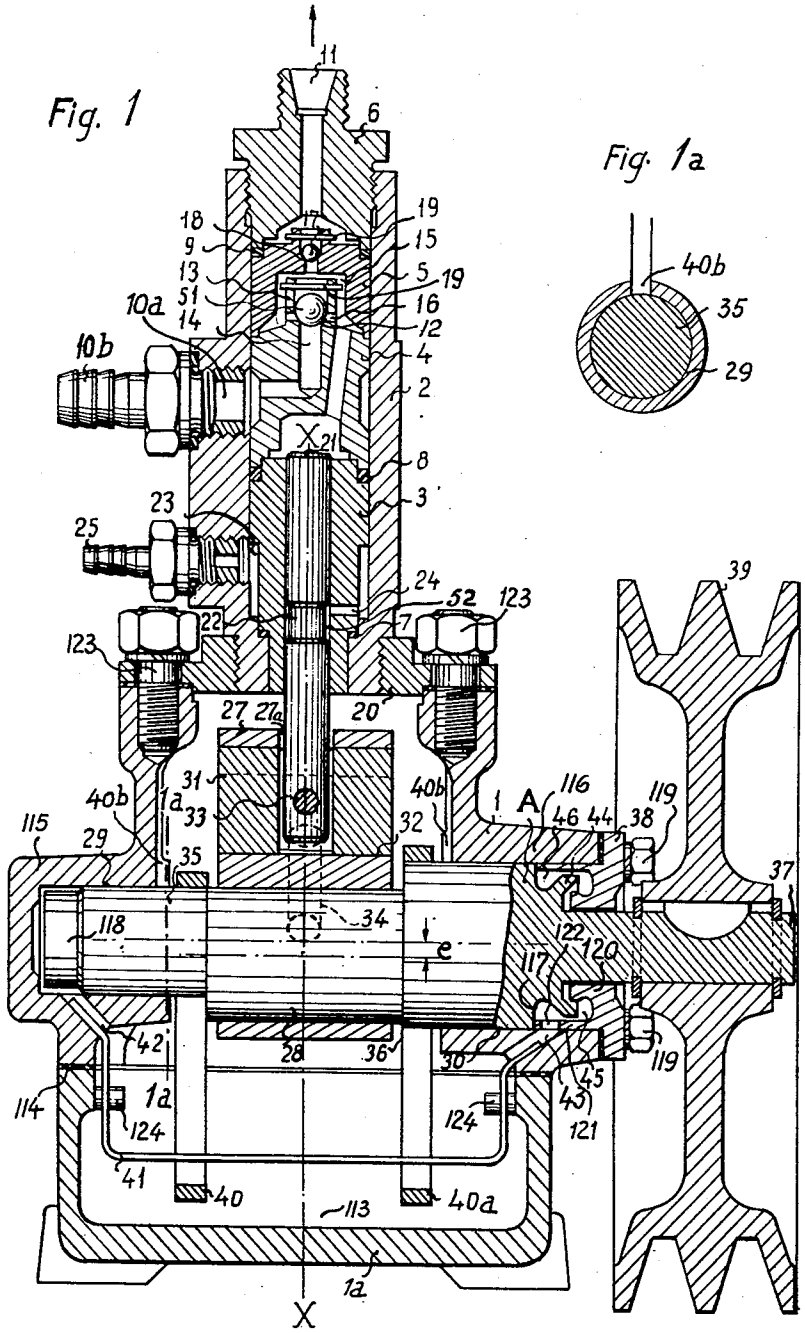


Fig. 1a

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Filed Feb. 3, 1954 3 Sheets-Sheet 2

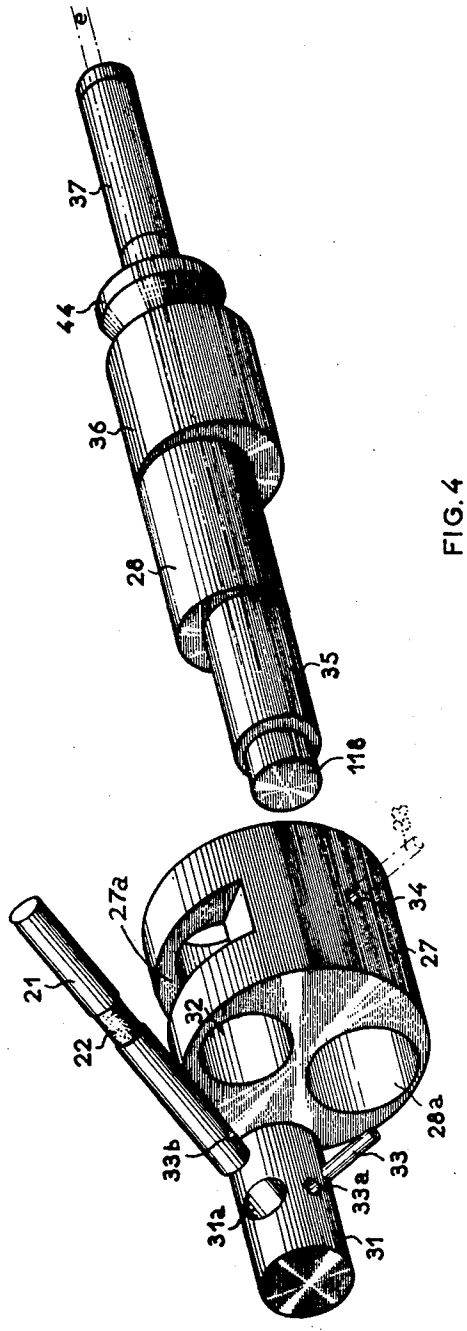


FIG. 4

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June 25, 1957 J. L. GRATZMULLER 2,796,769

CRANK-SHAFT AND THE CORRESPONDING CRANK-CASE

Filed Feb. 3, 1954 3 Sheets-Sheet 3

Fig. 2

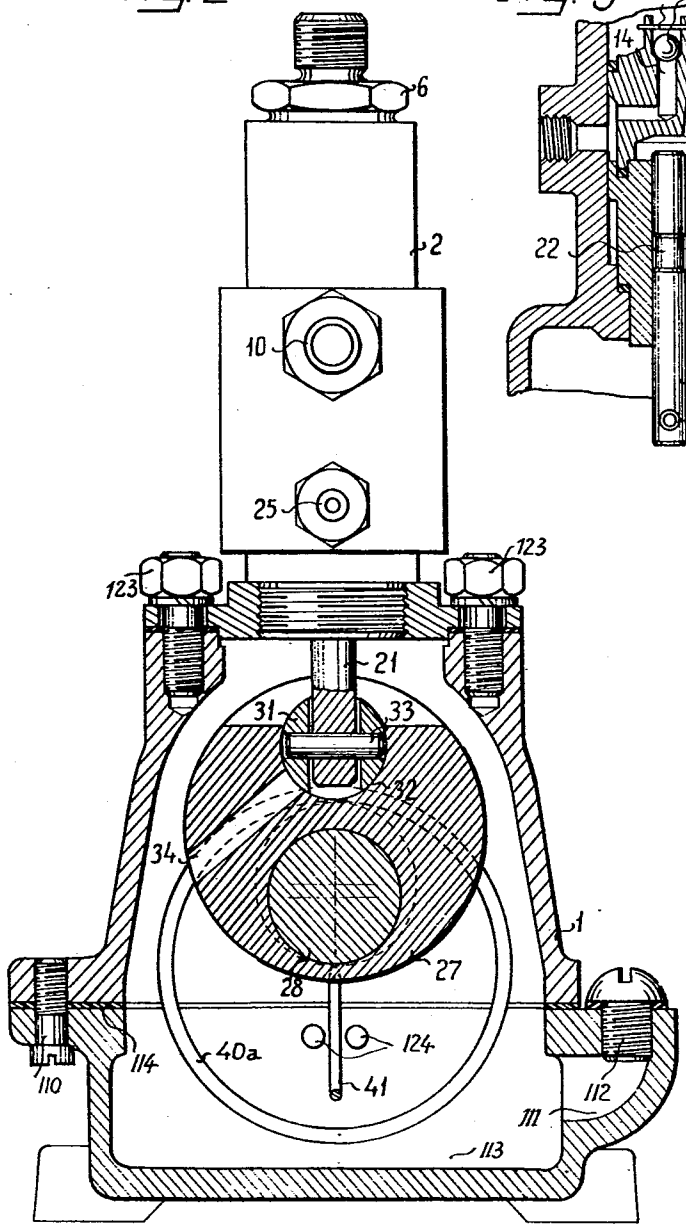


Fig. 3

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CRANK-SHAFT AND THE CORRESPONDING CRANK-CASE

Jean Louis Gratzmuller, Paris, France

Application February 3, 1954, Serial No. 408,009

Claims priority, application France February 5, 1953

6 Claims. (Cl. 74—49)

The present invention relates to reciprocating machines of the type comprising a crank-shaft mounted in a crank-case and a reciprocating member operatively connected with said crank-shaft.

In the existing machines of this type, the shaft is journalled in said crank-case by means of separate bearing structures provided with anti-friction means such as balls, rollers, needles, brass linings, graphite linings, etc. Said bearing structures have to be properly mounted in corresponding bores provided in the crank-case walls, the journal surfaces of the shaft being, in turn, so adjusted as to fit properly in said bearing structures.

It is obvious that such a way of mounting the shaft is time and work consuming and, hence, costly.

The present invention has for its purpose to simplify the mounting of the shaft in its crank-case without impairing the desired alignment of the shaft and even improving the same.

The present invention permits such a simplification of the mounting of the crank-shaft in the crank-case by completely eliminating the intermediate bearing structures and by having recourse to the natural properties of different metals to obtain ultimately a direct journalling of the crank-shaft in the crank-case walls.

It is an object of the invention to make the crank-case or, at least, the part of the same which has to receive the crank-shaft, of a metal having a high coefficient of thermal expansion and to journal the crank-shaft made of a metal having a lower coefficient of thermal expansion directly in opposite walls of said crank-case.

This direct journalling of a crank-shaft in the walls of a crank-case permits machining the two journals of said shaft on a lathe without removing the workpiece from said lathe, which naturally permits an absolute axial alignment of the two journals and also the boring of the two bearing surfaces provided in two opposite walls of the crank-case on a lathe, equally without removing the workpiece from said lathe.

It is to be understood that by having such perfectly aligned journals and bearing surfaces, it becomes easy to put the crank-shaft in place in its crank-case without any adjustment whatsoever. It even permits a non-selective assembly between crank-shafts and crank-cases, which means that a series of standardized crank-shafts and a series of corresponding standardized crank-cases can be interchangeably assembled between themselves.

Another object of the invention is to make the crank-case, or at least the part of the same receiving the shaft, in an aluminium alloy and to make the shaft in steel. Experience has shown that this particular combination of metals gives excellent results. In fact, if the fit between the journals of the shaft and the bearing surfaces of the crank-case walls is too tight, the rotation of the shaft develops friction and, hence, heating of the parts, the high coefficient of expansion of the metal forming the crank-case walls resulting in differential expansion, thus automatically reducing friction and limiting heating.

Another object of the invention is to give to one of the

journals of the crank-shaft and the corresponding bearing surface bored in a wall of the crank-case a greater diameter than those of the other journals of the crank-shaft and, hence, the other bearing surfaces intended to cooperate with said journals, which permits installing the crank-shaft by an axial displacement of the same, said crank-shaft being introduced in the crank-case with its smaller journal ahead.

A more particular object of the invention is to give to the smaller bearing surface bored in a wall of the crank-case the shape of an axial thrust bearing, which permits holding the crank-shaft in place after mounting, as described above, by mere locking of its end opposite to that which is journalled in said axial thrust bearing.

A still more particular object of the invention is to provide a crank-shaft designed and journalled in the manner described comprising, at one end, a journal the cross-section of which is comprised within that of an excentered mid-portion which is to be used as an eccentric sheave to be operatively connected with the reciprocating member of the machine, the cross-section of said eccentric sheave being, in turn, comprised within that of the other journal of the crank-shaft, the large end of the crank-shaft passing through the corresponding casing wall and being provided with an external extension adapted to receive suitable driving means.

A still more particular object of the invention is to combine the crank-shaft-crank-case combination just described with a connecting member of the type described in co-pending application Ser. No. 408,008, filed February 3, 1954, by same applicant for "Crank Pin-Piston Connecting Means" interposed between said eccentric sheave and a reciprocating member.

A still more particular object of the invention is to combine such a crank-shaft-crank-case combination and such connecting member with the plunger piston of a hydraulic pump of the type described in co-pending applications Ser. Nos. 408,006 and 408,007, filed February 3, 1954, by same applicant for "Hydraulic Pumps" and "Improvements in Hydraulic Pumping Units," respectively.

A further object of the invention is to provide in a crank-shaft-crank-case combination of the type described particularly simple and efficient lubricating means fed from the crank-case oil sump from which oil is conducted to the bearings to pass therethrough, whereafter it is returned by gravity to said sump for re-distribution through said lubricating means.

Other objects and advantages of the invention will be apparent from the following detailed description together with the accompanying drawings submitted for purposes of illustration only and not intended to define the scope of the invention, reference being had, for this purpose, to the subjoined claims.

In these drawings:

Fig. 1 is a sectional view of a hydraulic pump provided with a crank-shaft and a crank-case according to the invention.

Fig. 1*a* is a detail vertical section taken on the line 1*a*—*a* of Fig. 1.

Fig. 2 is a partly elevational, partly cross-sectional view along axis X—X of Fig. 1.

Fig. 3 is a partly axial sectional view showing an alternative embodiment of the pump barrel.

Fig. 4 is an exploded view of the crank-shaft according to the invention and a device to interconnect the same with a plunger piston, or the like.

Referring to the drawings, and more particularly to Figs. 1 and 2, there are shown at 1 the crank-case and at 2 the barrel of the pump screwed in the top wall 20 of said crank-case.

Inside the barrel 2 are stacked a member 3 constituting

the cylinder of the pump, a member 4 in which is formed the intake valve, a member 5 in whch is formed a delivery valve and a plug member 6, which, in the example shown, is screwed in the threaded end of barrel 2 and holds in place the whole assembly of the above described members, suitable packing rings such as 7, 8 and 9 being interposed between the relevant members of the stack.

It is to be noted that the packing rings 8 and 9 ensure tightness both between members 3 and 4 and members 5 and 6, respectively, and between said members and the inner wall of barrel 2. Members 3, 4, 5 and 6 are preferably made of a metal having the same coefficient of thermal expansion as barrel 2, so as to avoid any leakage or destruction of the packing rings, as the temperature of the pump varies in operation.

10*a* is the inlet of the pump to which the liquid is fed through a suitable pipe 10*b*. 11 is the outlet provided through plug 6. The intake valve essentially comprises a ball 51 cooperating with a seat 12 and guided and centered by a tubular extension 13 of member 4. The liquid is sucked into the pump through inlet 10*a*, a passage 14 and lateral holes 16 drilled through the wall of the tubular extension 13 in the near vicinity of seat 12.

The delivery valve which is formed in member 5 comprises a ball 17 cooperating with a seat 18. This last valve, of a more conventional type, offers between ball 17 and its cylindrical housing, sufficient annular clearance to permit flowing of the liquid towards outlet 11. Both valves are provided with abutment means to limit the lifting stroke of their respective ball, said abutment means being each constituted by a gudgeon pin 19.

It is to be noted that the delivery valve is located directly above the intake valve, said valves being both so designed that the air which could be accumulated in the pump cylinder before the pump is started will tend naturally to escape through outlet 11.

A complete separation is provided between barrel 2 and crank-case 1, said separation being ensured by an annular space formed between the plunger piston 21 and cylinder 3, said space freely communicating with a liquid tank, not shown.

In the example shown in Fig. 1, the annular space 52 is formed by a portion 22 of reduced diameter of piston 21, said portion extending over an axial length of the piston 21 at least equal to the stroke of said piston, so as to establish a permanent communication through at least one passage 24 with an annular chamber 23 constantly communicating in turn through a fitting 25 and an individual pipe (connected to said fitting 25) with the above mentioned liquid tank.

The long piston part extending between the pump chamber and the portion 22 of reduced diameter already ensures a good tightness. However, leakages can still occur, particularly when the pump delivers liquid under a very high pressure.

It will be readily understood that these leakages will return to the liquid tank through the free communication offered by the above mentioned individual pipe rather than forcing their way between the lower part of the piston and cylinder towards the crank-case 1.

Another important advantage of maintaining the annular space 52 in permanent and free communication with said liquid tank is to ensure in said space a constant liquid pressure slightly superior to the pressure in the crank-case 1. Due to this liquid pressure "seal," air cannot be sucked into the pump chamber during the suction stroke.

Still another advantage of the complete separation between barrel 2 and crank-case 1 is that of permitting the use in the latter of any desired lubricant, whatever the nature of the liquid delivered by the pumping unit.

As shown in Fig. 3, it is possible, in certain cases, to avoid the above mentioned individual pipe and to establish a permanent communication between the annular chamber 23 and, hence, the annular space 52 and a space upstream of the intake valve, the inlet port 14 of which is at the same pressure as the feeding tank, by means of passages 26. This simplified arrangement may be adopted, in particular, when the feeding tank is located in the near vicinity of the pump, so that no objectionable loss of pressure is to be feared.

On the contrary, when such losses of pressure could happen in the main feeding pipe 10*b*, e. g. in the case when the feeding tank is located at a considerable distance from the pump, it will be preferred to adopt the embodiment described with reference to Figs. 1 and 2 in which the presence of the independent duct 58 through which no forced circulation of liquid takes place maintains with safety in the annular space 52 the slight above mentioned over-pressure.

Referring again to Figs. 1 and 2, piston 21 is reciprocated by means of an eccentric sheave 28 integral with a crank-shaft A.

According to the invention, crank-shaft A is journalled into cylindrical bearing surfaces 29 and 30 directly bored in two opposed walls of crank-case 1.

In the example shown, according to another feature of the invention, said walls are relatively thin to ensure a certain flexibility, but they are provided with two integral embossings 115 and 116 which ensure to the bearing surfaces 29 and 30 the desired axial length.

Said crank-case is made of a metal having a high coefficient of thermal expansion and a low modulus of elasticity, such as an aluminium alloy. Thanks to this arrangement, it is possible to journal shaft A directly in the above described bearing surfaces bored in crank-case 1 without any risk of jamming.

Thus, a certain flexibility of the crank-case walls and the high coefficient of thermal expansion of the metal of said walls ensure a good operation of the pump without providing any special bearings to journal shaft A.

As shown in Fig. 4, crank-shaft A is connected with the plunger piston 21 of the pump through connecting member 27, which in the example shown has the shape of a disc.

Two parallel bores 28*a* and 32 are formed in body 27. The first one 28*a* has for its purpose to ensure journalling of body 27 around the eccentric sheave 28 of crank-shaft A. In the second bore 32 is freely engaged a pivot pin 31, the axis of which constitutes the usual axis of articulation of the body 27, which acts as a connecting rod, on piston 21.

The piston 21 is itself articulated to said pivot pin 31, said articulation ensuring the second degree of freedom to be provided by the connecting member according to the invention and proper to take care of possible disalignment between piston 21 and crank-shaft A. Pivot-pin 31 is provided for this purpose with a hole 31*a* into which is engaged the end of piston 21. This end, before being engaged in said hole 31*a* passes through a slot 27*a* formed in the mid-plane of the disc 27, the width of said slot being greater than the diameter of the piston 21. The articulation of the piston 21 in the hole 31*a* of the pivot pin 32 is ensured by a cylindrical gudgeon-pin 33 which is engaged through diametral holes 33*a* drilled through the pivot pin 31 and a corresponding hole 33*b* drilled in the end of piston 21. The diameter of the hole 31*a* is also greater than the diameter of the piston 21, to permit the pivoting of the same.

It will be readily understood that the assembling of the parts of such a connecting device is practically instantaneous, the operations of assembling consisting simply in introducing pivot pin 31 in the bore 32, then engaging the end of piston 21 in the hole 31*a* through the slot 27*a* and, finally, driving in the holes 33*a*, 33*b* and 33*a* the gudgeon pin 33.

The shape of the slot 27*a* and its location, are such that, when the pivot pin 31 with the end of piston 21 engaged therein is brought in an angular position in which said piston abuts against one end of said slot, one

of the holes 33*a* is apparent near the other end of said slot, so that the gudgeon-pin 33 can be easily engaged in the three corresponding holes 33*a*, 33*b*, 33*a*. In this position of the pivot pin 31, these three holes are brought into alignment with a hole 34 drilled in the disc 27 from the periphery of the same and which does not intersect bore 28*a*, so that it does not interrupt the bearing surface of the latter.

It will be easily understood that in this position of piston 21, the gudgeon pin 33 can be easily removed through said hole 34 to ensure dismantling of the whole assembly.

However, since in said extreme angular position of piston 21, hole 33*a* is in the immediate vicinity of the terminal edge of slot 27*a*, as soon as piston 21 leaves said terminal angular position, the gudgeon-pin 33 will be imprisoned inside body 27. In particular, this is the case when the connecting member according to the invention is mounted between the eccentric sheave 27 of crank-shaft A and piston 21, when said imprisoned gudgeon pin 33 will ensure interlocking of all parts of the driving assembly thus obtained.

In the example shown in the drawings (see Fig. 1), as already mentioned above, the bearing surfaces 29 and 30 for shaft A have different diameters, while shaft A proper offers an end 35 of reduced diameter adapted to be journalled in bearing surface 29, the eccentric sheave 28 of greater diameter and, finally, a portion 36 of still greater diameter adapted to be journalled in the bearing surface 30 of the crank-case 1.

Moreover, the circumference defining the cross-section of journal 35 is comprised within that which defines the cross-section of the eccentric sheave 28, while the latter is, in turn, comprised within the circumference which defines the cross-section of journal 36. This arrangement permits mounting the shaft A by introducing the same with its reduced end 35 ahead, first into the bearing surface 30, then through the bore 28*a* of the disc 27 and, finally, into the bearing surface 29. Once shaft A is mounted as just described, it is secured by means of a plug 38 provided with a hole through which passes the end 37 of shaft A on which a suitable driving member, such as a pulley 39, is keyed.

It is a particular feature of the invention to combine the improved direct crank-shaft mounting in the crank-case walls with connecting means between the crank-shaft and the reciprocating member as just described, due to the fact the perfect alignment of the crank-shaft by machining in one lathe operation of both bearing surfaces of the crank-case walls and also in one lathe operation of the crank-shaft journals can be obtained without taking care of precise right angularity between the shaft and the reciprocating member. This combination permits, in fact, mounting the pump barrel 2 on the crank-case 1 by screwing said barrel into a threaded hole of a plate 20, the same being secured on the crank-case 1 by means of stud-bolts 123.

In the example shown, in order to facilitate the assembling, the bottom of the crank-case, forming the sump 113, is constituted by a separate piece 1*a* assembled with the crank-case proper 1 by bolts 110 with interposition of a packing washer 114. The lubricating oil is introduced in the sump 113 through a passage 111 provided with a plug 112. This passage 111 is so arranged as to permit observing the oil level in the sump.

The lubrication of shaft A is ensured from the sump 113 by rings 40—40*a* freely suspended on shaft A and prevented from escaping by a piano wire 41 held in place by studs 124.

Rings 40 and 40*a*, the lower end of which is immersed in the oil contained in sump 113, are continuously rotated by friction under their own weight on shaft A. Thus, they continuously raise oil from the sump and bring it above the shaft A. Now, the internal walls of the crank-case 1 are provided, in registration with the vertical diametral plane of the shaft, with vertical grooves 40*b* (see Figs. 1 and 1*a*) which collect oil from rings 40 and 40*a* and direct said oil into the annular clearances provided between the bearing surfaces 29 and 30 and the corresponding crank-shaft journals 35 and 36. The oil flows axially between the bearing surfaces and the corresponding journals and is continuously returned to the sump through the passages 42 and 43.

At the smaller end of shaft A, journalled in embossing 115, which is formed as an axial-thrust bearing to provide lubrication of the very end of shaft A, the latter is provided with a portion of reduced diameter 118.

At the opposite, larger, end of shaft A, there is provided a turbine-like device to prevent oil from leaking out crank-shaft A. The frustro-conical rotating member 44 of said device is integral with shaft A, while its stationary member is constituted by a plug 38 tightly secured on the outer end of embossing 116 by means of screws 119 and which comprises an inner skirt 120 which has for its function to prevent oil from leaking around the reduced end 37 of shaft A and with an outer skirt 121 which has for its function to hold shaft A in place by cooperating with an abutment shouldering 117 provided on said shaft. The annular groove 45 comprised between both skirts 120 and 121 of plug 38 collects oil projected by the rotating member 44. A hole 122 is provided through the lower wall of skirt 121 to permit oil from the annular collecting groove 45 to return into sump 113 through the above-mentioned oblique passage 43.

While the invention has been described with particular reference to a preferred embodiment, it is not intended to limit the scope of the invention to the embodiment illustrated, nor otherwise than by the terms of the subjoined claims.

What is claimed is:

1. A casing structure for supporting a metallic rotary shaft, comprising a main section, two coaxial cylindrical bearings for said shaft each formed integral with one of two opposite side walls of said main section, said main section being made of a metal having a greater coefficient of expansion than that of the metal of which said shaft is made whereby frictional heat due to a tight fit of said shaft in said bearings will cause greater expansion of said main section than of said shaft so as to create clearance spaces between said shaft and said bearings, and mechanical means to circulate lubricant through said clearance spaces.

2. In a reciprocating mechanism, a crank-case comprising two opposite walls made of a metal having a high coefficient of thermal expansion, a crankshaft made of a metal having a lower coefficient of thermal expansion and having inner and outer end portions, two axially aligned bores of different diameter provided each in one of said opposite walls to constitute bearing surfaces for said crankshaft, the diameter of the larger bore being at least equal to the diameter of the circumference described by the crank of said shaft when the latter is rotating, and two journals of different diameter on said crankshaft, each journal fitting in a corresponding bore and the journal of smaller diameter being formed on said inner end portion of said shaft, the arrangement being such that said crankshaft may be introduced in said casing and journaled in said bores by passing its inner end portion axially through the bore of larger diameter.

3. A crankshaft-crank-case assembly according to claim 2, in which said walls are each formed with an integral embossing, said bearing surface being bored in said embossings.

4. A crankshaft-crank-case assembly according to claim 3, in which the embossing which receives the journal of smaller diameter also forms an axial thrust bearing for said crankshaft.

5. A casing for a horizontal metallic rotary shaft having two opposite journal-forming end portions of different diameter and an eccentric or cam intermediate

said end portions, comprising a socket formed integral with one of two opposite side walls of said casing and a boss formed integral with the other of said two opposite side walls, said casing being made of a metal having a greater coefficient of expansion than that of the metal of which said shaft is made, a cylindrical blind bore in said socket constituting a bearing surface for the end portion of smaller diameter of the shaft, a cylindrical bore in said boss coaxial with said blind bore and constituting a bearing surface for the end portion of larger diameter of said shaft, the diameter of said cylindrical bore being at least equal to the diameter of the circumference described by said eccentric or cam as said shaft is rotated, and means associated with said boss to hold said shaft against longitudinal displacement.

6. A casing according to claim 5, in which said shaft is made of steel and said casing is made of aluminium.

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