

Feb. 26, 1935.

C. E. SORENSEN

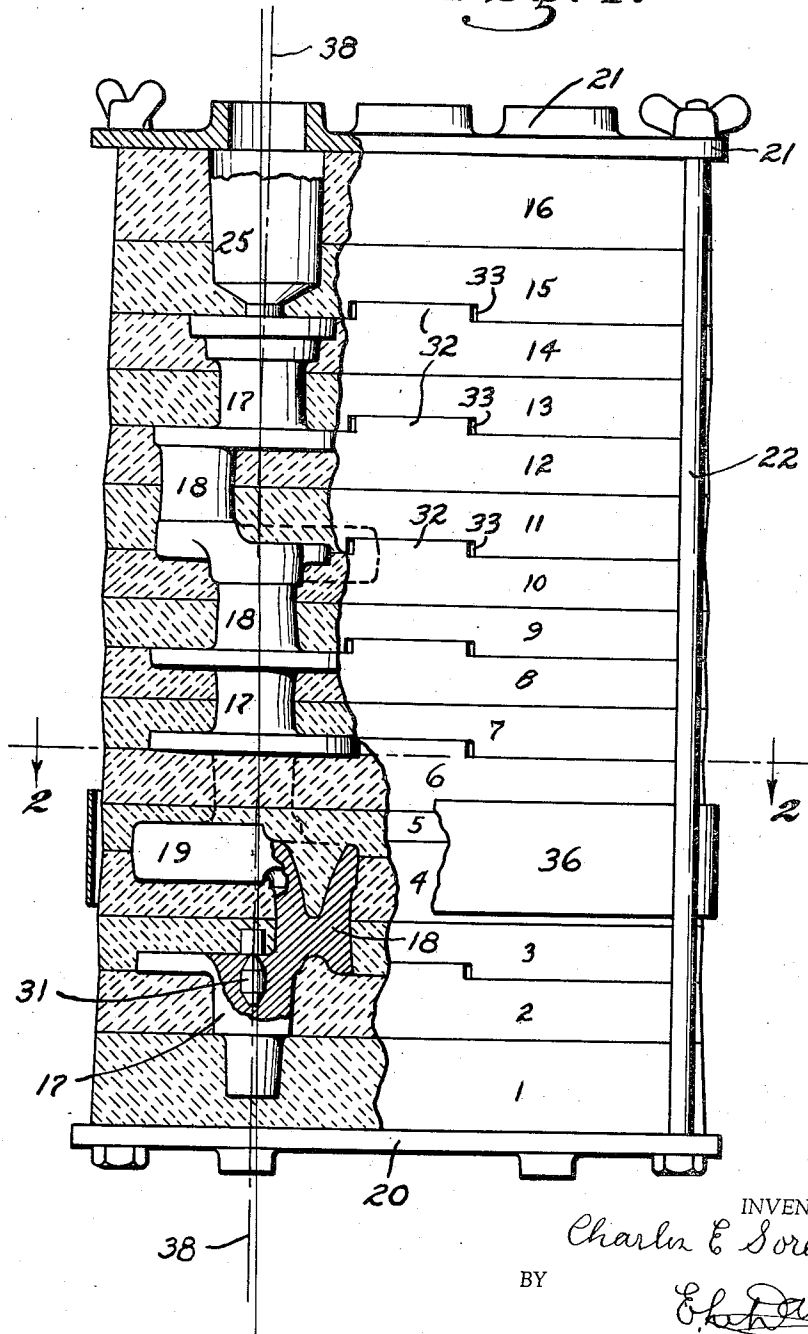
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MOLD FOR CASTING INTERNAL COMBUSTION ENGINE CRANK SHAFTS

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2 Sheets-Sheet 1

Fig. 1.



INVENTOR.
Charles E. Sorensen
BY
E. H. Davis.
ATTORNEY.

Feb. 26, 1935.

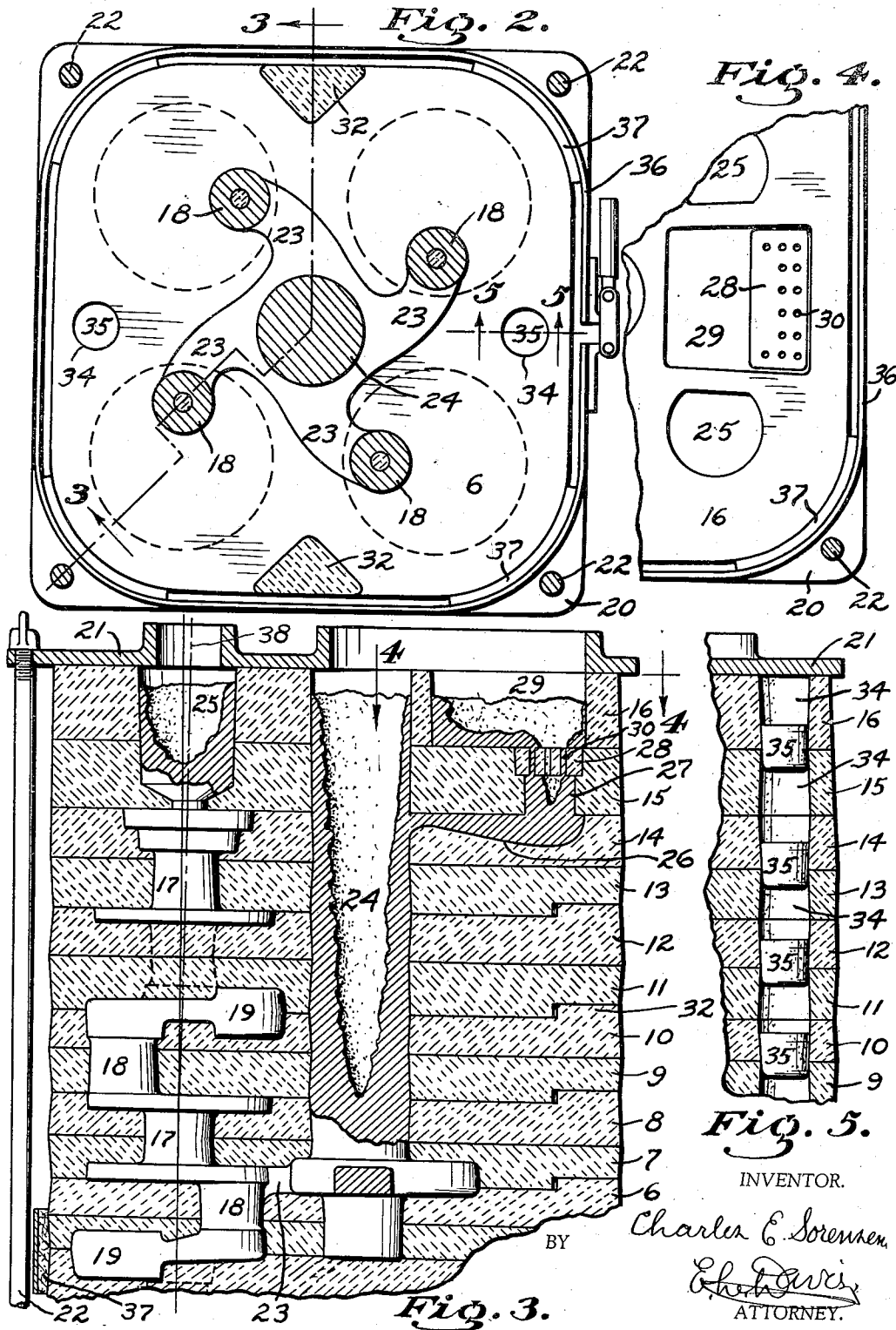
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UNITED STATES PATENT OFFICE

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MOLD FOR CASTING INTERNAL COMBUSTION ENGINE CRANK SHAFTS

Charles E. Sorensen, Detroit, Mich., assignor to Ford Motor Company, Dearborn, Mich., a corporation of Delaware

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7 Claims. (Cl. 22—129)

The object of my invention is to provide a crank shaft especially suitable for use in multi-cylinder internal combustion engines, particularly V-type eight cylinder motors wherein a 90 degree four-throw crank shaft is employed.

An important feature of my improved crank shaft is that it need be machined only at its bearings, in contrast to the conventional shaft which is usually machined all over. This advantage results for the reason that the conventional shaft is formed as a forging whereas my improved shaft is formed as a casting. The device or casting mold used maintains an accuracy not obtainable in forgings so that balancing alone is required after the bearings have been machined.

A further feature of great importance in connection with this device is that my improved crank shaft is cast with the axes of its three main bearings not aligned with each other so that the casting when poured is definitely bowed. This bowed shape compensates for shrinkage upon cooling and allows the casting to assume a normal straight shape after it has cooled.

A further object of this invention is to provide a novel mold arrangement, particularly the means for aligning the several parts of the mold, whereby an accuracy in casting may be maintained much higher than heretofore available.

With these and other objects in view, my invention consists in the arrangement, construction and combination of the various parts of my improved device, as described in the specifications, claimed in my claims, and illustrated in the accompanying drawings, in which:

Figure 1 is a plan view of one of my improved mold assemblies, a portion thereof being broken away to better illustrate the construction of a crank shaft which is cast thereby.

Figure 2 shows a sectional view, taken on the line 2—2 of Figure 1, illustrating particularly the gate construction whereby iron is conducted simultaneously to form the four crank shafts in the mold.

Figure 3 is a sectional view, taken on the line 3—3 of Figure 2.

Figure 4 is a fragmentary sectional view, taken on the line 4—4 of Figure 3, and

Figure 5 is a sectional view, taken on the line 5—5 of Figure 2.

Referring to the accompanying drawings, I have used the reference numeral 17 to indicate the three main bearings of an internal combustion engine crank shaft, especially suitable for use in a V-type eight cylinder engine. The shaft

is provided with four crank pins 18, each of these pins being spaced at 90 degree intervals around the axis of the main bearings to provide what is known as a four-throw 90 degree crank shaft. A plurality of counterweights 19 are provided, these counterweights being located opposite to each crank pin bearing. The counterweights are designed to dynamically counterbalance the crank pins and associated heavy ends of the connecting rods which are secured thereto.

Heretofore, somewhat similar shafts have been formed by the forging process, however, the crank shaft shown herein is formed by the casting process. The casting of crank shafts of this character has been attempted in the past but due to the irregular parting line invariably required in casting a 90 degree crank shaft, no commercial application of this method was made. The method of casting herein disclosed differs from the conventional practice in that the mold is made entirely of a plurality of super-imposed plates, each formed of core sand, these plates being accurately located one above the other in a predetermined relationship.

Two of such core plates are required for each bearing of the shaft and two of such plates are required for the risers. Consequently, a total of sixteen core plates are required to form the mold for casting the shaft shown. These plates have been given the reference numerals 1 through 16, respectively, beginning with the lowermost plate. The number of plates provided depends upon the number of bearings on the shaft and will, of course, vary with shafts of other design.

Referring to the drawings, particularly Figures 1 and 2, it will be noted that I have provided a metal bottom plate 20 upon which the core plates comprising my mold rest. A metal top plate 21 is provided and four tie rods 22 secure the metal plates 20 and 21 together thereby firmly securing the core plates, 1 through 16, in position one above the other.

It will be noted that four crank shaft castings are formed in each mold assembly, the shafts being cast simultaneously from a single runner or sprue which extends down through the center of the group of core plates.

Each of the core plates 14 is formed of core sand in a suitable die or mold, which plate is then baked in the conventional manner. Referring to Figure 1, it will be noted that the bottom or number one core plate is provided with four depressions, formed one in each corner thereof, which

depressions form the ends of the crank shaft castings. The number two core plate has four aligned openings therein which form the front end bearing of the crank shaft. Plate number 3 is also provided with openings therein which form the first crank pin and opposite counterweight. In each succeeding core plate suitable openings are provided to form one half of each balance weight and half of the adjacent bearing. It will be noted that from the fifth core plate on through the sixteenth, each plate is provided with a central opening to form a sprue or runner 24 through which iron is poured. The sixth and seventh core plates are provided with four branch runners 23 whereby the iron is conducted to the four crank shaft molds. It will be noted that the point at which the iron is conducted to the molds is well above the bottom of each mold but still slightly below the center of the crank shaft. It is very important that the iron be conducted in at this point as otherwise a porous casting at the center bearing is believed unavoidable. An important feature of this device is that the runners 23 are disposed several inches above the bottom of the sprue 24, whereby the iron is cushioned as it is poured into the runner so as to prevent washing away of the sand of the cores. When the iron is poured into the runner, it forms a well four or five inches deep in plates 5 and 6 and consequently the iron which flows through the runners 23 does not sour away the sand in the bottom of the well.

Each of the plates 15 and 16 is provided with openings for risers 25 which form continuations of the crank shaft castings. The core plate 14 is provided with a transverse passageway 26 therein which communicates with a vertical opening 27 in the core plate 15, this vertical opening having a strainer block 28 fixed therein. The upper face of the strainer block 28 is in communication with a relatively large chamber 29 which is formed in the plate 16. The top plate 21 is provided with suitable openings therein which expose the chamber 29 together with each riser 25 and the central runner 24.

In pouring the casting, the molten metal is poured directly into the chamber 29 from which it flows through a plurality of openings 30 in the strainer block 28 down through the opening 27 and into the passageway 26. The metal then flows to the aligned central openings in the core plates and drops to the bottom of this passageway, or to core plate 4, filling the well up level with the branch runners 23 from which it flows radially therethrough into the molds proper. The iron fills up the four molds level with the passageways 23 and the pouring is continued until the iron level nears the top of all four of the risers 25 and the runner 24. The unit is then allowed to slowly cool, it requiring between three or four hours for the castings to solidify. During this solidification period the iron shrinks and liquid metal in the risers 25 supplies the metal to compensate for the shrinkage in the upper several bearings of the shaft. However, the majority of the metal which is supplied to take up the shrinkage comes from the runner 24 which, as shown in Figure 3, resembles only a shell at the time the castings have become solid. It is very important that the runner 24 is placed in the center between the four castings, because if such runner is disposed next to one of the walls of the mold then it would cool practically as rapid as the castings. Inasmuch as practically all of the heat radiation required to solidify the castings

must radiate laterally through the core plates it may readily be seen that the runner, being disposed at the center of the four castings, will remain liquid much longer than the castings themselves. Thus, liquid metal is supplied to the castings while cooling to take up the unavoidable shrinkage.

It will be seen from Figures 1 and 3 that the axial center of the openings in the core plates which form each individual crank shaft are not exactly aligned with each other but on the contrary are located with the ends offset from the center, or bowed, as shown by the dot-and-dash line 38. This novel departure from the conventional practice is made in order to compensate for the further shrinkage of the metal in the crank pin bearings as the shaft cools from its temperature of solidification down to the atmospheric temperature. The core plates, being formed of dry sand, are quite rigid and quite incompressible. The crank pins are, of course, radially offset from the shaft center so that when the pins contract in length, the shaft will become bowed unless the two opposite flanges or counterbalance weights also close in toward each other. The rigidity of the dry sand core plates is sufficient to prevent such closing in at the counterbalance portions but this rigidity is not sufficient to prevent the crank cheek portions adjacent to the crank pins from contracting. Consequently the shaft, if cast originally straight, would be considerably bowed when cooled down to room temperature. To overcome this the shaft is cast with its axis bowed in a direction opposite to its normal distorting movement so that when the shaft is cold the axis of the main bearings will be aligned with each other. This amounts to forming the mold so that the portions of the counterweights and flange opposite each crank pin are slightly closer together than the length of the pin so that when the pin shrinks the crank cheeks will be parallel and the shaft main bearings aligned with each other.

Referring to Figure 1, it will be noted that the lowermost main bearing of the crank shaft has a cylindrical metal slug 31 cast therein, the purpose of which is to solidify the metal in this lower main bearing before the crank pin bearings directly above have time to solidify. This main bearing will therefore draw liquid metal from the crank pin bearings as it shrinks upon cooling and thereby prevent a porous main bearing. The slug 31 is not inserted to form a chill but rather to speed up the cooling of the lower bearing before the upper crank pin bearings solidify to thereby assure a supply of liquid metal from the runner 24, through the crank pin bearings.

A very important feature in connection with my improved mold is the means for aligning the core plates one above the other. It will be noted that a pair of triangularly shaped keys 32 are formed in each evenly numbered core plate with the exception of the top plate 16. These keys are placed into correspondingly shaped keyways 33 which are molded in the odd numbered core plates. These keys and keyways are triangularly shaped so as to accurately pilot the core plates one upon the other. It will be noted that core plates 2 and 3, 4 and 5, etc., are thus secured in alignment but that no keys extend between plates 1 and 2, 3 and 4, etc. While such keys might be desirable it is not commercially practical to form a locator on both sides of each plate because in forming one surface of the plate much be slicked

off flush with the core mold face. Consequently, in order to pilot the slicked off faces of the molds upon each other, I have provided a pair of openings 34 in each core plate, these openings being located on a line transverse to the line adjoining the keys 32. Core sand tapered dowels 35 are adapted to be inserted in these openings, as shown in Figure 5, to align the coating faces of plates 1 and 2, 3 and 4, 5 and 6, etc.

From Figures 1 and 2 it will be seen that a metal band 36 is clamped around the numbers 4 and 5 core plates, this band having a pad 37 at each corner thereof. The purpose of these pads is to reinforce these core plates at the corners. This reinforcing is desirable with these two plates because in the particular arrangement shown the heavy section of the lower counterbalancing weight 19 is so orientated that the thin adjacent section of the core might be washed out by the flow of metal therein. Of course, the core plates could be made larger to overcome this; however, it is commercially desirable to keep the core plates as small as possible and inasmuch as the counterweights weaken only two of the core plates the reinforcing band is desirable as it reduces the overall size of all sixteen of the plates an appreciable amount.

Among the many advantages arising from the use of my improved device, it may be well to mention that with the arrangement shown herein I am able to commercially cast a four-throw 90° crank shaft from alloy steel, which shaft is believed to be commercially impossible to cast by the conventional foundry practice. Further, by locating the main running in the center of a group of castings, the runner is prevented from solidifying until after the castings solidify to thereby allow the metal in the runner to compensate for shrinkage in the castings. A further important feature of the device is that the well at the bottom of the runner cushions the iron therein and thereby prevents the molten iron from scouring off sand of the cores and conducting them into the casting.

Perhaps the most important feature of my device is that only a plurality of dry sand plates are used, there being no flasks or green sand employed. For this reason alloy steel having a relatively high melting point may be used without danger of excessive scrap due to failure of the mold.

Some changes may be made in the arrangement, construction and combination of the various parts of my improved device without departing from the spirit of my invention and it is my intention to cover by my claims such changes as may reasonably be included within the scope thereof.

I claim as my invention:

1. A device for casting engine crank shafts having a plurality of axially aligned main bearing sections spaced therealong with an axially offset crank section connecting said main bearing sections, comprising, a mold formed from baked core sand having a metal receiving cavity therein which is similar in shape to the shape to be formed but which differs therefrom in that the portions of said cavity which cast the main bearing sections of the shaft are sufficiently out of axial alignment that lengthwise contraction of the crank pin section, due to cooling, stresses

said crank pin and causes the shaft to warp to a position where the main bearing sections are in axial alignment.

2. A device, as claimed in claim 1, wherein counterbalancing weight cavities are formed in the mold, these cavities being disposed diametrically opposite to the crank pin section.

3. A device, as claimed in claim 1, wherein said mold is formed from a plurality of superimposed core sand discs, said discs having depressions therein which form the crank arms of the shaft and having openings therethrough which form the main and crank pin bearings of the shaft being cast.

4. A mold for casting engine crank shafts having a plurality of axially aligned main bearing sections spaced therealong and having axially offset crank pin bearing sections and counterweights integral therewith, comprising, a plurality of superimposed baked core sand discs each of which is provided with communicating depressions therein and openings therethrough, the walls of said depressions and openings forming a casting chamber of a shape similar to the shaft to be cast but differing therefrom in that the axes of the main bearing portions of the chamber are out of axial alignment sufficiently that the lengthwise contraction of said crank pin portions due to the cooling of the shaft will warp the casting sufficiently to cause axially alignment of the main bearing portions when the shaft is cold.

5. A self aligning mold for casting internal combustion engine crank shafts comprising, a plurality of baked core sand discs disposed one above the other, each of said discs when properly aligned having communicating depressions therein and openings therethrough which form a plurality of casting chambers, each of said chambers being similar in shape to the shaft being cast, and each of said discs being characterized in that one of its faces is raked flat with said depressions formed entirely in the opposite face, and said discs being located one above the other with their raked faces adjacent and with the depression containing faces adjacent, the joint formed between each pair of depressions containing faces being angularly positioned by means of integral keys and keyways formed on said faces while the joint formed between each pair of raked faces is angularly positioned by means of detachable core sand dowels.

6. A self aligning mold comprising, a plurality of baked core sand discs disposed one above the other, said discs when properly aligned having communicating depressions therein and openings therethrough which form the casting chamber, and each of said discs being characterized in that one of its faces is raked flat with said depressions being formed entirely in its opposite face, and said discs being located one above the other with their raked faces adjacent and with their depression containing faces adjacent, the joint formed between each pair of depression containing faces being angularly positioned by means of integral keys and keyways formed in said adjacent faces respectively, and detachable means for angularly positioning each of said raked faces with respect to its adjacent raked face.

7. A mold, as claimed in claim 6, wherein the means for positioning said raked faces comprises a plurality of baked sand dowels.

CHAS. E. SORENSSEN.