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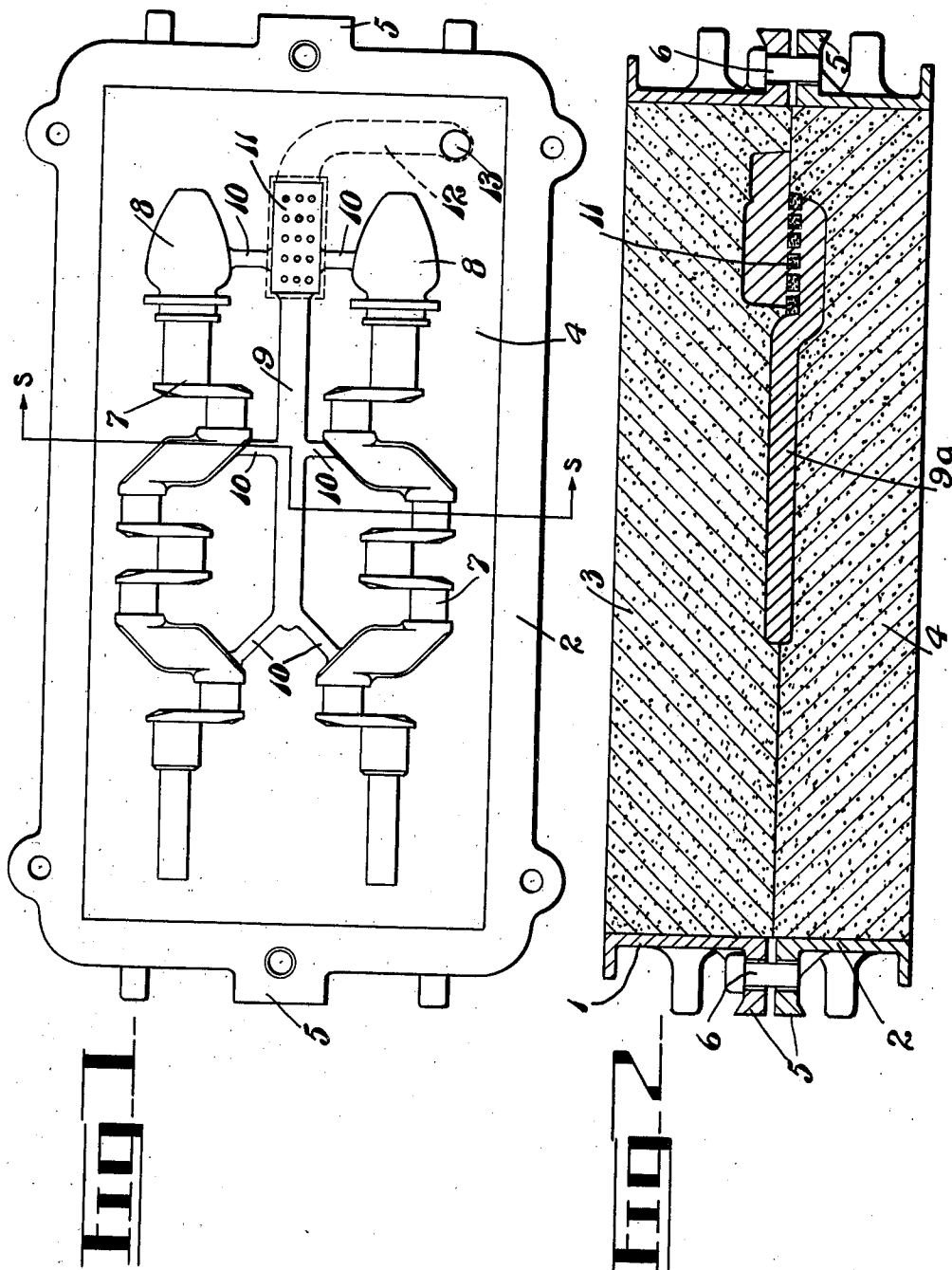
D. J. CAMPBELL

2,014,224

METHOD OF CASTING CRANK SHAFTS

Filed April 10, 1933

5 Sheets-Sheet 1



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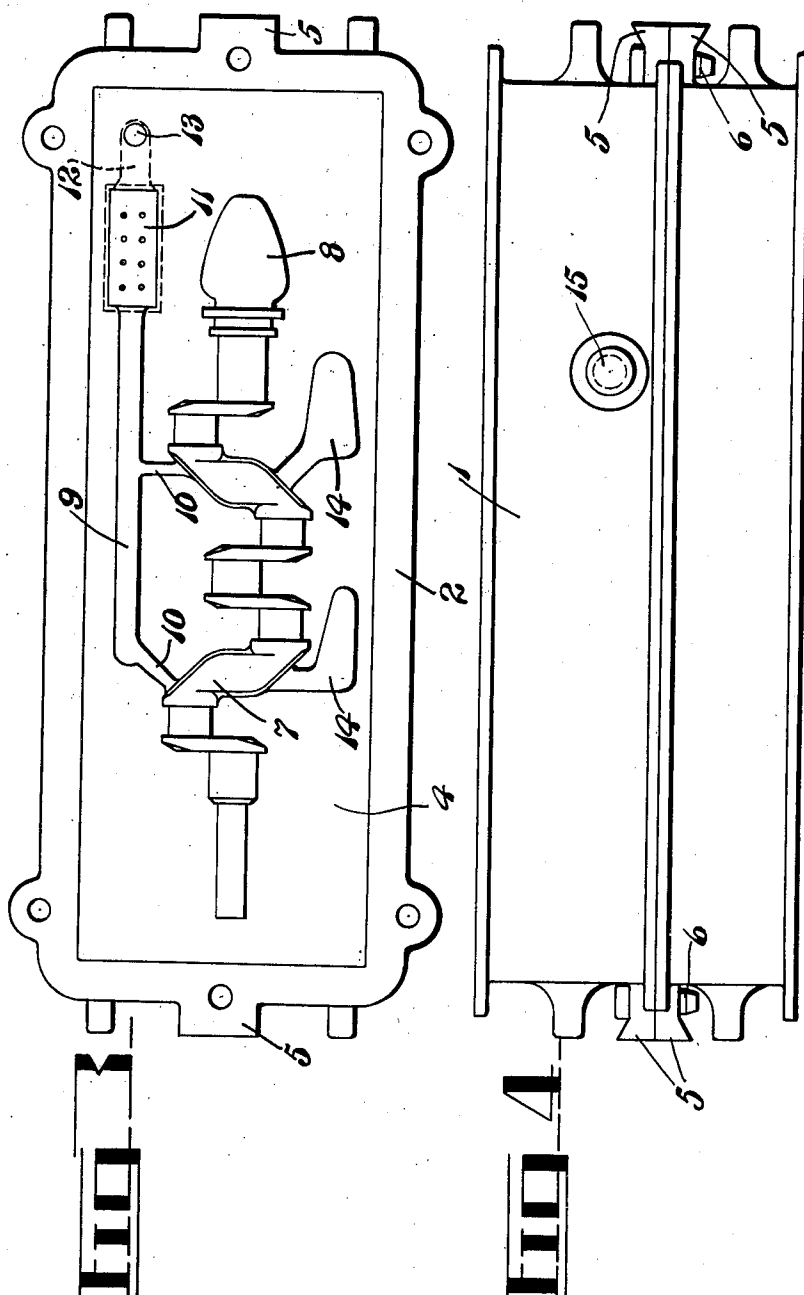
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5 Sheets-Sheet 2



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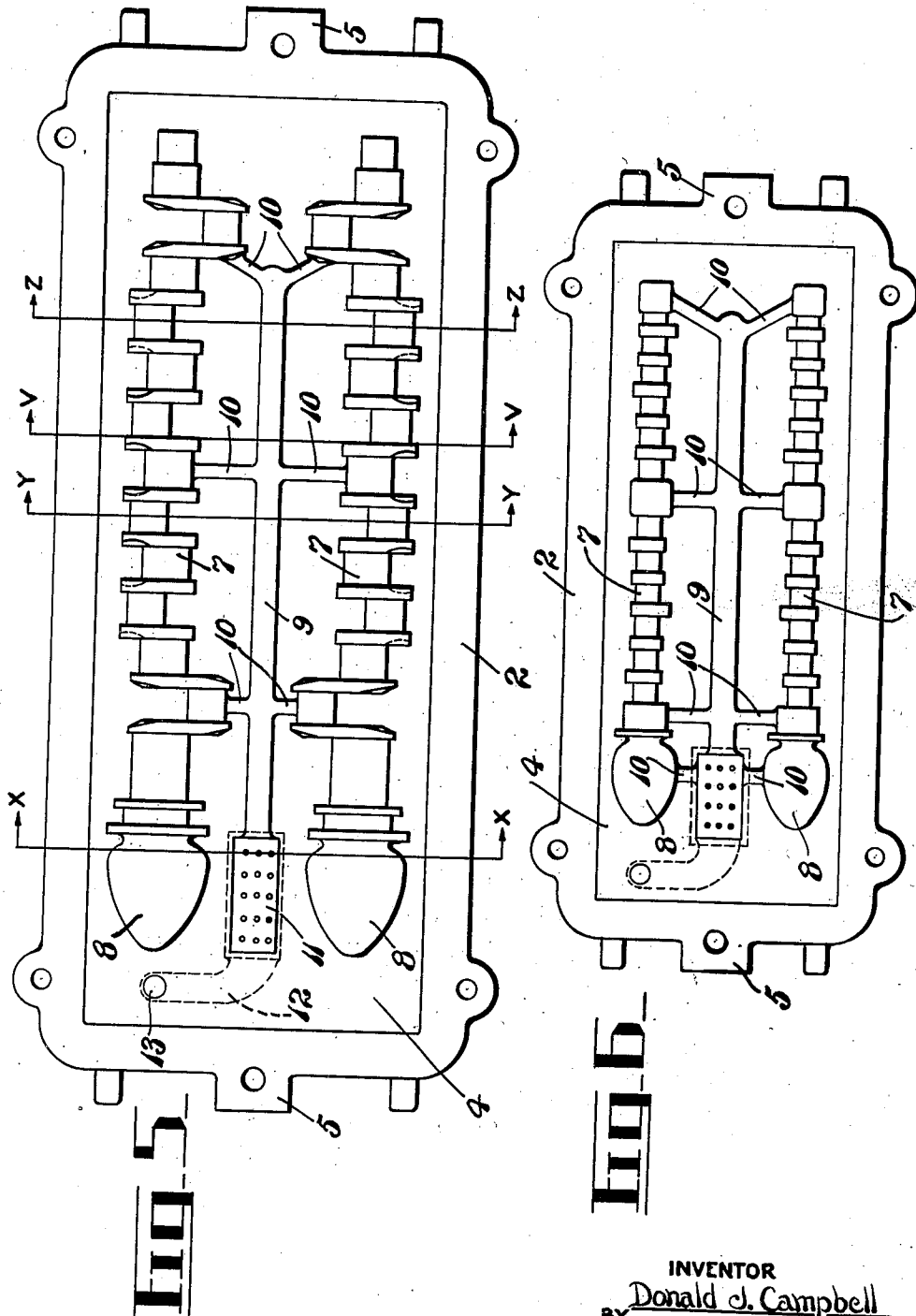
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5 Sheets-Sheet 3



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**Fig 7**

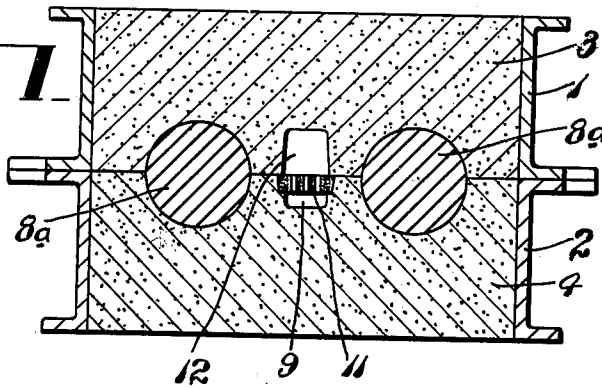


**Fig 8**

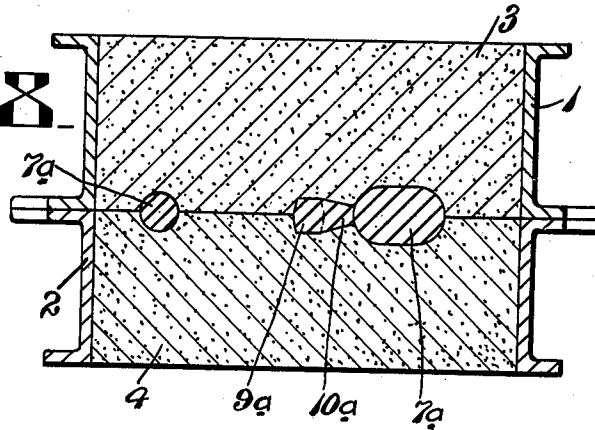
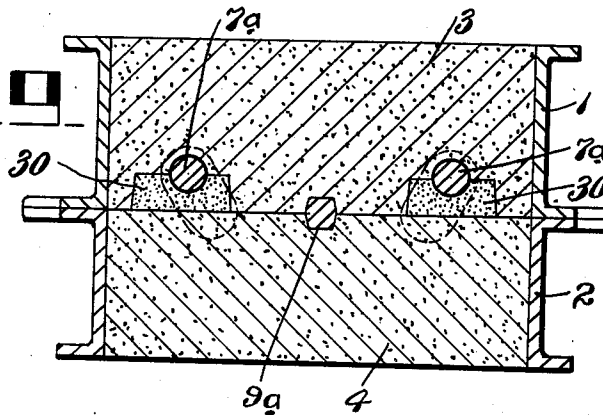


**Fig 9**



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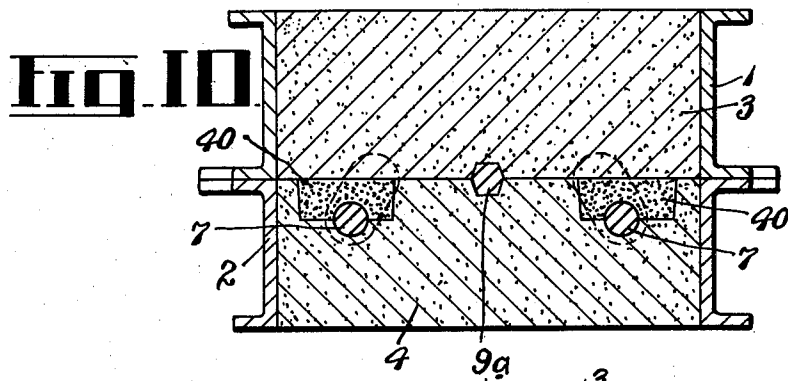
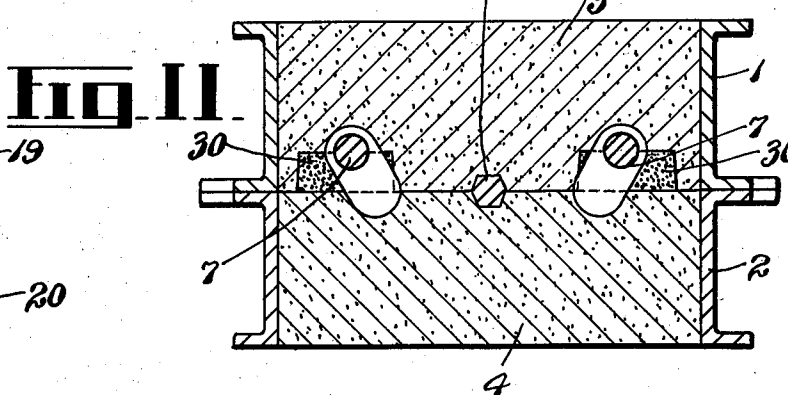
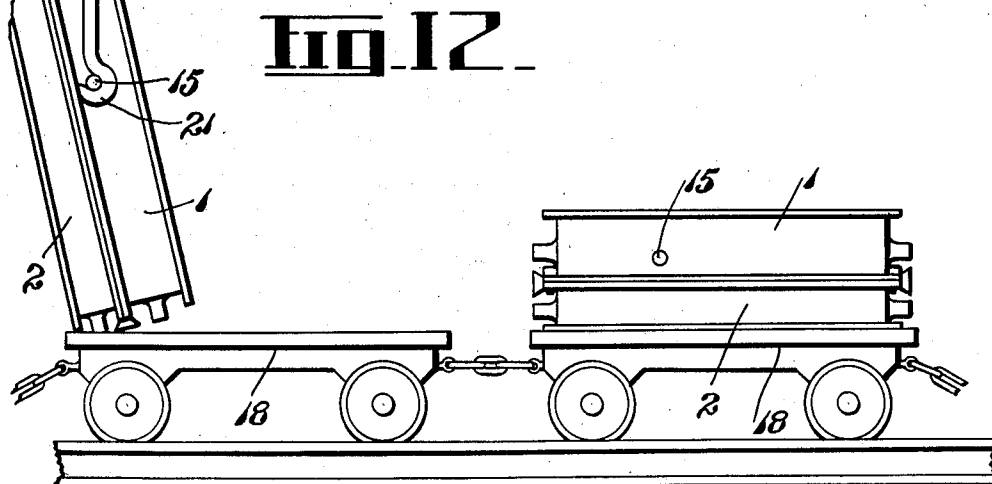
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**2,014,224**

## METHOD OF CASTING CRANK SHAFTS

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5 Sheets-Sheet 5



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## UNITED STATES PATENT OFFICE

2,014,224

## METHOD OF CASTING CRANK SHAFTS

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of Michigan

Application April 10, 1933, Serial No. 665,391

2 Claims. (Cl. 22—209)

This invention relates to a method of casting irregular shapes, particularly crank shafts, cam shafts and the like, and is primarily concerned with a practical method whereby cam shafts or crank shafts, having a sound, uniform, homogeneous structure, free from shrinks and draws, may be produced, and with which method the same may be very economically and rapidly produced.

10 The method which I have invented includes as one very essential step the feeding of molten metal from a reservoir therefor to the mold during the period of solidification of the molten metal. And it is an object and purpose of the invention to produce shafts of the character noted wherein the normal effects of shrinking and drawing, which would be very considerable in elongated articles of this kind, are compensated by such feeding of the molten metal there-  
15 to. Accordingly, by use of my invention cam shafts or crank shafts for internal combustion engines of a uniform structure throughout from one end to the other may be readily produced.

20 A further object and purpose of the invention is to pour the molten metal into a mold positioned substantially horizontal, whereby the pouring may be performed as rapidly as in any casting operation, and then immediately turning the mold to a substantially vertical position, with the feeder reservoir of molten metal thereupon located at the upper portion of the mold, so that, with solidification of the shaft, feeding of molten metal thereto to obviate shrinkage which takes place with the mold vertically positioned and with the elongated shafts in a substantially vertical position.  
25

30 It is well known that in casting articles such as crank shafts or cam shafts, the same being of elongated dimensions compared to their transverse dimensions, longitudinal shrinkage will take place after the pouring of the metal in the mold on cooling, resulting in a somewhat coarse grain of the iron; and also in articles of this class, which have irregular shapes, shrinks and draws are caused at places where a relatively heavy section of metal joins a lighter section. Such shrinks and draws cause weaknesses in the shaft at such sections. With my invention I obviate these faults and produce a cast cam or crank shaft  
35 which is sound and of a uniform, homogeneous structure throughout.

40 An understanding of the invention for the attainment of the objects stated, as well as many others not at this time enumerated, may be had from the following description, taken in connec-

tion with the accompanying drawings, in which,

Fig. 1 is a plan view of a drag section of a mold for the casting of two crank shafts.

Fig. 2 is a vertical longitudinal section through the complete mold, taken midway between its sides.

Fig. 3 is a plan view of the drag section of a mold shown for casting one shaft having exceptionally heavy crank flank portions.

Fig. 4 is a side elevation of the molding flask used.

Fig. 5 is a plan view of a drag section of a mold for casting crank shafts having throws in different angular relations to each other.

Fig. 6 is a similar plan view of a drag portion of a mold for casting cam shafts.

Fig. 7 is a vertical cross section taken on the line  $x-x$  of Fig. 5.

Fig. 8 is a vertical cross section on the irregular line  $s-s$  of Fig. 1.

Fig. 9 is a traverse vertical section on the line  $y-y$  of Fig. 5.

Figs. 10 and 11 are similar vertical sections taken respectively on the lines  $z-z$  and  $v-v$  of Fig. 5, and

Fig. 12 is a side elevation illustrating a lifting mechanism by means of which the mold is raised from its pouring position into a substantially vertical position immediately after pouring.

Like reference characters refer to like parts in the different figures of the drawing.

The mold used is an ordinary green sand mold, the sand being rammed or tamped into the flasks, the cope flask 1 being located over the drag 2 and the same supplied with molding sand, the mold cavities being formed at the lower side of the sand 3 in the cope and at the upper side of the sand 4 in the drag. The flasks have projecting ears 5 with aligned openings therethrough to receive pins 6 for properly locating the flasks with respect to each other, said pins passing through the aligned openings.

The mold cavities 7, as shown in Figs. 1, 3, 5 and 6, are provided in the usual manner by using suitable patterns and at one end an enlarged cavity 8 is made which serves as a reservoir for an excess of molten iron of the shaft. The gates 9, with branches 10 therefrom to different parts in the length of the mold cavities, receive the molten iron, which is drained through a skim gate 11 to eliminate dirt and slag, the molten iron passing through a passage 12 leading to the upper side of the skim gate and the iron being poured into a riser opening at 13 in the usual manner. It will be noted that the passage 12 is turned sub-

stantially at right angles to the length of the gate 9 for a distance and then joins with the riser 13.

For regular constructions of crank shafts or cam shafts, what has been described applies in Figs. 1, 5 and 6. But with respect to crank shafts which have very heavy crank flank portions, additional mold cavities 14 are provided by suitable parts on the patterns so as to provide reservoirs for molten iron to feed to said extra heavy flank portions, as shown in Fig. 3; and it will be noted that when the mold is turned to a vertical position, by gravity molten iron will feed not only from the reservoir at 8 but also from the cavities at 14 to the shaft, that supplied at 14 going directly to the heavy flank portions.

With crank shafts which have throws at an angular relation to each other the mold is merely changed to provide therefor, using cores 30 and 40 as shown in Figs. 10 and 11 for parts of the crank shaft above and below the division line between the drag and cope.

The mold is rammed, the pattern drawn and the flasks with the mold sections therein brought together after the pattern has been removed in the usual manner and thereafter placed horizontally on a suitable truck such as indicated in Fig. 12. A number of these trucks may be connected together and pulled over a track to the pouring station, one after another, and the metal poured into the mold in the usual manner. The cope section of the flask is provided with outwardly extending pins or trunnions 15 located to one side of a plane midway between the ends of the flasks, with which pins an elevating apparatus is adapted to detachably connect as soon as the mold has been drawn away from the pouring station.

This elevating apparatus may be of any desired character but, as shown in Fig. 12, consists preferably of a pneumatic cylinder 19 having the usual piston (not shown) from which a piston rod 20 extends, and at the lower end of which a fork is suspended, the arms of which have hooks 21 at their lower ends to engage with the pins 15. The piston may be lowered to hook the hooks 21 with the pins 15 and then elevated to lift the mold from the horizontal position shown on the truck 18 at the right in Fig. 12 to the position shown at the left in Fig. 12, that is, with the mold in a vertical or nearly vertical position.

Such change of position of the mold occurs immediately after pouring and before the molten metal has solidified, particularly before it has solidified at the central portions of the iron which has been poured into the mold cavities. The reservoirs 8 will then be at the upper ends of the molten iron poured into the cavities and furnish a body of melted iron to feed to a shaft as the same begin to solidify, cool and shrink at their outer sides, it of course being understood that the castings cool and solidify first at the walls of the mold cavities. This counteracts the shrinking which would otherwise take place if there were no feeders at 8 to supply molten metal against shrinkage; and likewise the feeding from the molten metal in the cavities 14 will feed the heavier flank portions, as in crank shafts.

When the casting operation is completed and the casting has been solidified the crank shafts 7a will be continuous in length and of the irregular shape shown, will be uniform in structure without shrinks or draws. The gates 9 and 10, having been filled with metal, will provide connecting pieces 9a and 10a which may be readily separated from the finished shafts and the feeder cavities at 8 and 14 will provide additions to the shafts which will be cut away therefrom.

It will be noted that the angular position of the part 12 of the pouring passage to the length of the main gate 9 precludes the spilling out of any molten metal other than what may be in the riser 13 and the adjacent passage 12 in the lifting of the mold from horizontal to vertical position.

It is to be understood that it is not necessary for the mold to be positioned horizontally. It can be positioned at a slight angle to the horizontal quite as well, and the invention should not in any sense be limited to the locating of the mold in the first place in an absolutely horizontal position. With this invention cam shafts or crank shafts for internal combustion engines are readily and economically produced. The pouring is not checked in any way but may take place as rapidly as in any molding. The feeding of metal to the cooling casting from the upper end or at points in the length thereof by gravity eliminates undesirable shrinking and draws in the casting, and permits a control of the casting operation such that very close limits in sizes and dimensions may be observed. The casting produced even in such irregular shapes as engine crank shafts is sound and is produced in much closer correspondence to the length of the pattern used than heretofore, and with the use of my invention rapid quantity production may be attained.

I claim:

1. The method of producing cast shafts which consists, in providing a mold cavity in which to cast the shaft and further providing a cojoining feeder cavity of substantially the same size at one end of the mold cavity, locating said mold in a substantially horizontal position and pouring molten metal into said mold cavity to fill the same and the feeder cavity, and then changing the position of the mold to substantially vertical position with the molten metal in the feeder cavity at the upper end of the molten metal filling said cavities to feed to the mold cavity while solidification is taking place.

2. The method of producing cast shafts which consists, in providing a mold having a cavity corresponding to the shaft, and further providing the mold with an enlarged feeding cavity at one end of the shaft cavity, locating the mold in a substantially horizontal position and pouring molten metal therein to fill the same while in said position, and then immediately changing the mold to a position such that the molten metal in the feeder cavity is at the upper end of and feeds to the metal in the shaft cavity during cooling and solidification of the metal.

DONALD J. CAMPBELL.