Dec. 11, 1934. H. J. HICK 1,983,758

APPARATUS FOR CASTING MASSIVE STRUCTURES

Filed July 11, 1932 4 Sheets-Sheet 1

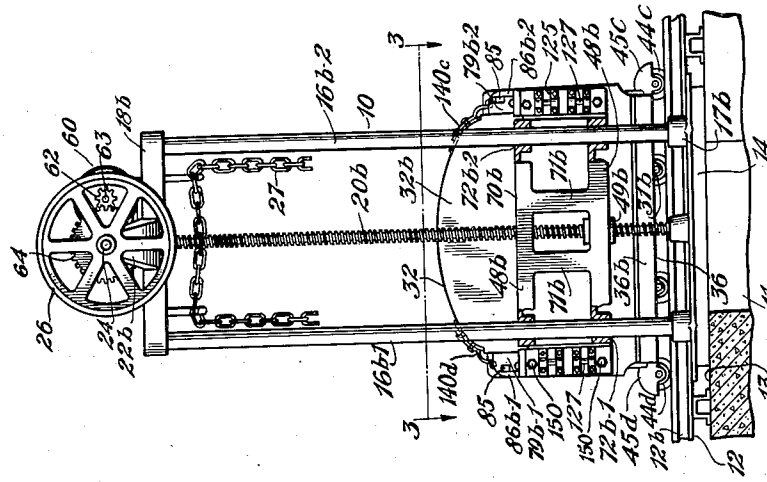

Fig. 2

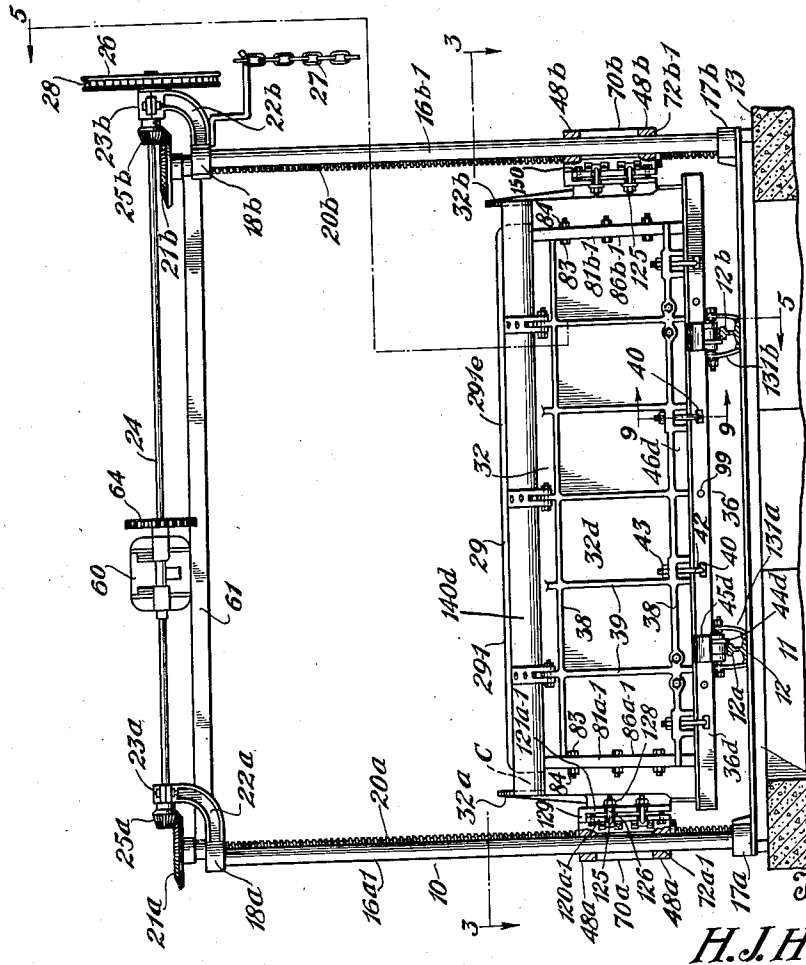

Fig. 1

Inventor
H. J. Hick
By Fraser and Bishop
Attorneys

Dec. 11, 1934. H. J. HICK 1,983,758

APPARATUS FOR CASTING MASSIVE STRUCTURES

Filed July 11, 1932 4 Sheets-Sheet 2

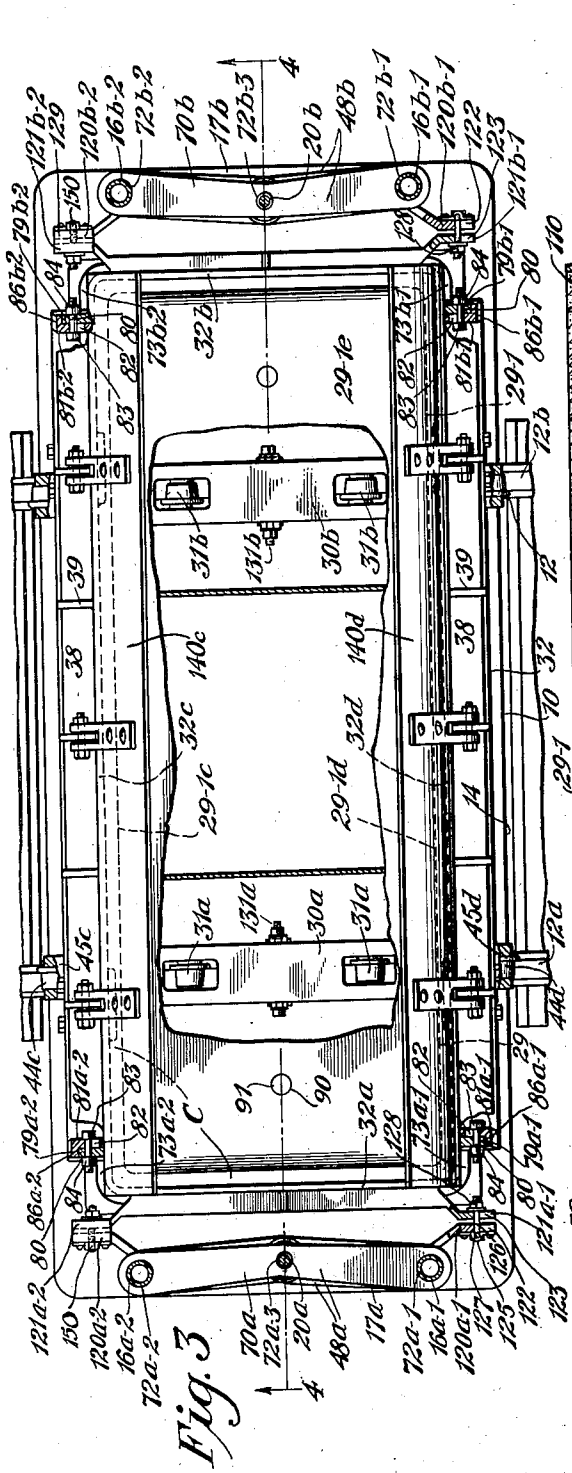

Fig. 3

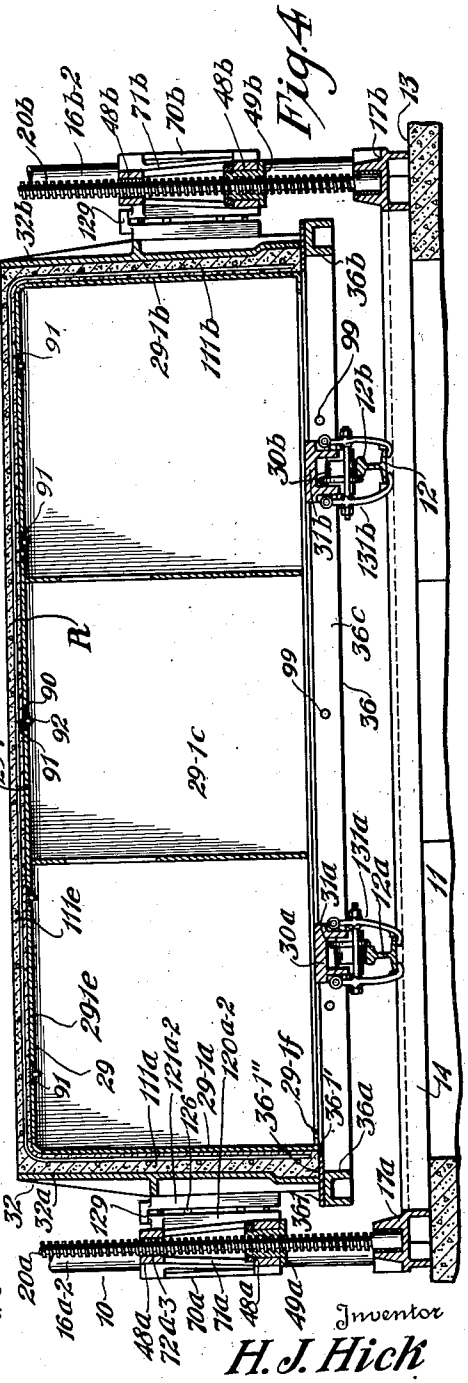

Fig. 4

Inventor
H. J. Hick

By Frean and Bishop

Attorneys

Dec. 11, 1934. H. J. HICK 1,983,758

APPARATUS FOR CASTING MASSIVE STRUCTURES

Filed July 11, 1932 4 Sheets-Sheet 3

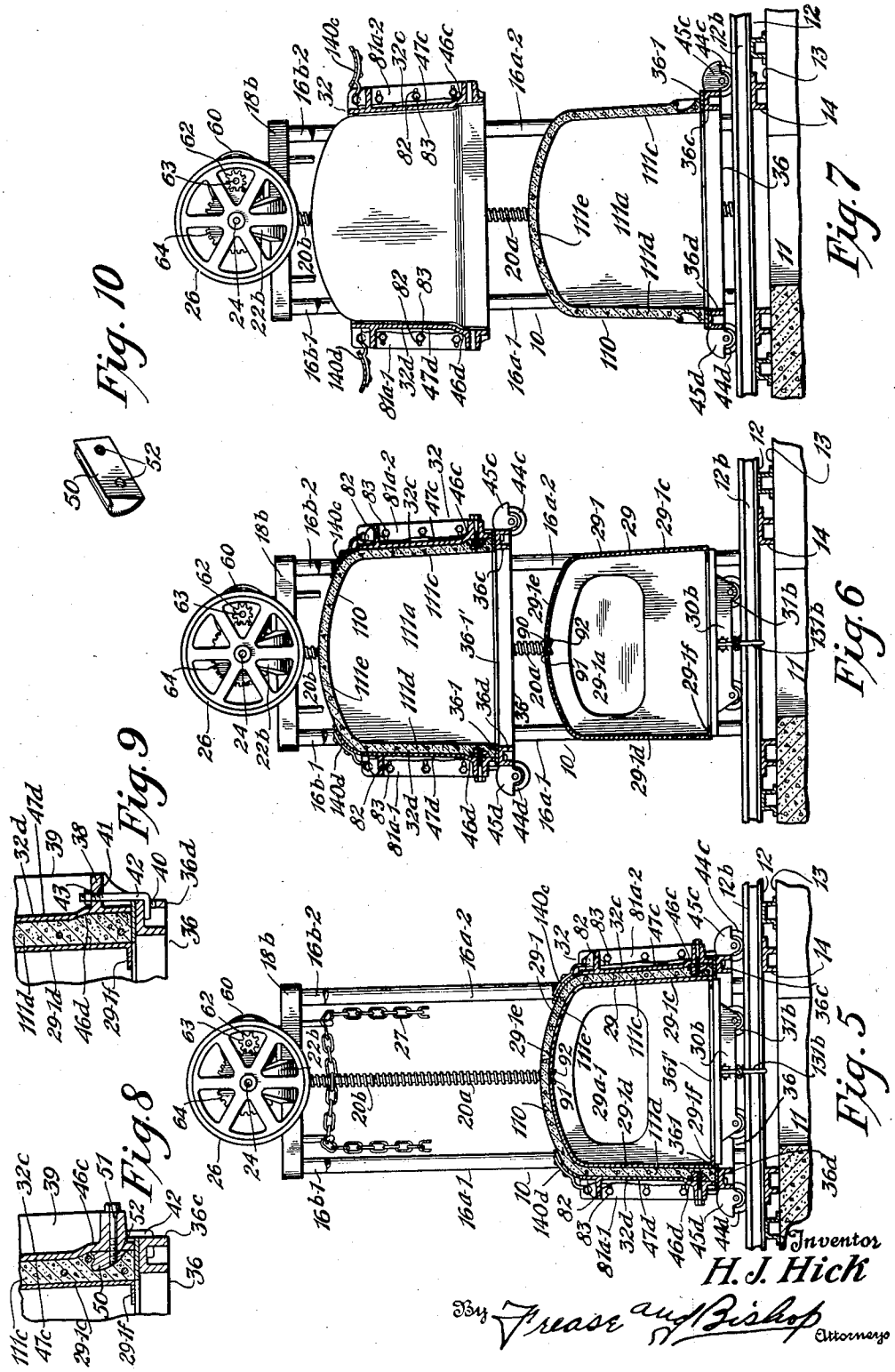

Fig. 10

Fig. 7

Fig. 6

Fig. 9

Fig. 5

Fig. 8

Inventor
H. J. Hick
By Frease and Bishop Attorneys

Dec. 11, 1934. H. J. HICK 1,983,758

APPARATUS FOR CASTING MASSIVE STRUCTURES

Filed July 11, 1932 4 Sheets-Sheet 4

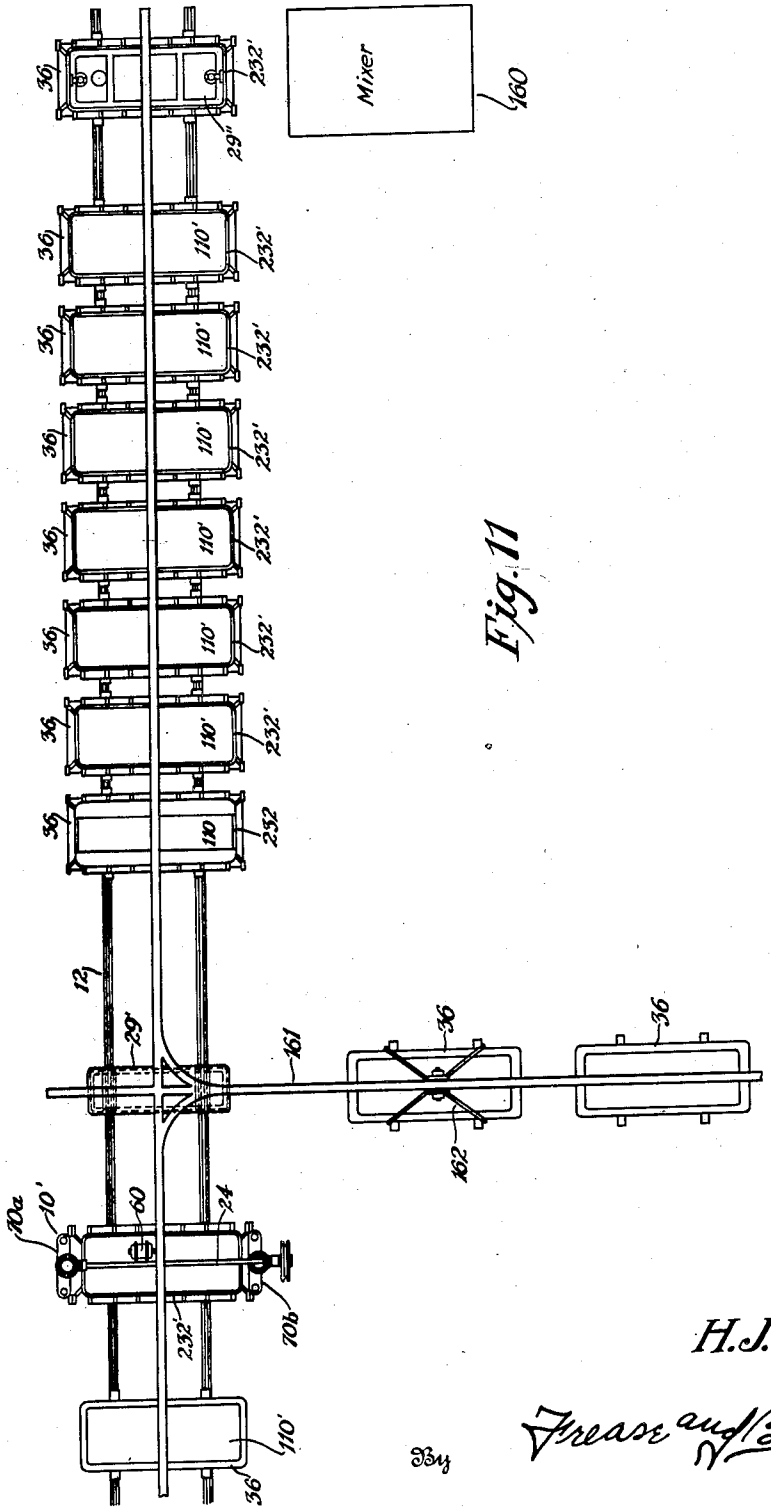

Fig. 11

Inventor
H. J. Hick

By Frease and Bishop
Attorneys

Patented Dec. 11, 1934 1,983,758

UNITED STATES PATENT OFFICE

1,983,758

APPARATUS FOR CASTING MASSIVE STRUCTURES

Harry J. Hick, Alliance, Ohio, assignor to The Machined Steel Casting Company, Alliance, Ohio, a corporation of Ohio

Application July 11, 1932, Serial No. 621,788

6 Claims. (Cl. 25—130)

My invention relates to methods and apparatus for casting massive structures, such as grave vaults, septic tanks, and the like, and which may be pre-cast preferably in permanent molds usually from plastic material such as concrete.

The present invention includes improvements of the inventions set forth in my prior application for United States Letters Patent for Methods and apparatus for casting massive structures, filed January 15, 1932, Serial No. 586,721, and in my prior application for United States Letters Patent for Methods and apparatus for casting massive structures, filed June 7, 1932, Serial No. 615,844, and the present application is also a continuation in part of common subject matter set forth in said prior applications.

Generally speaking, casting methods and apparatus available prior to the methods and apparatus of said prior applications, whether particularly adapted for casting structures from plastic material such as concrete, or whether adapted for casting structures from molten metallic material, are primarily designed for intermittent and irregular operation, are relatively slow in operation, and thus involve a relatively high cost in machine and man hours per unit of manufactured product.

Methods and apparatus adapted for use in continuous production lines must be capable of relatively rapid operation, and always result in a lower cost in machine and man hours per unit of manufactured product, than the cost in machine and man hours per unit of the same manufactured product when produced by slower intermittent and irregular methods.

On the other hand, the casting of massive structures as practiced by the use of the usual methods and apparatus, involves a relatively high cost in machine and man hours per unit of manufactured product, without considering reductions in cost attainable by the adoption of continuous manufacturing methods, due to the fact that casting single units under ordinary conditions is relatively slow, because excessive manipulation of the molds or forms is required in preparing the same for pouring and in removing the cast product or structure from the molds.

From another standpoint, in the casting of massive concrete or cement structures as heretofore practiced, particularly when said structures are relatively high or deep dome shells, such as grave vaults, half-sections of septic tanks, or the like, great difficulty has been experienced in avoiding cracking of the wall or walls of the dome shell during setting of the structure after pouring, and heretofore it has always been considered absolutely necessary to permit the cast dome shell structure to reach a final set after pouring before removing any of the molds, and despite which, losses due to wall cracking have been relatively high.

Accordingly, common objects of the inventions of said prior applications and of the present invention include the provision of improved methods and apparatus for casting massive structures, whereby a substantial reduction is attained in the machine and man hours required per unit of manufactured product, and by the use of which continuous manufacturing methods may be carried out for casting massive structures.

Further common objects of the inventions of said prior applications and of the present invention include the provision of improved methods and apparatus for casting massive structures, whereby the improved apparatus may be operated for carrying out the improved methods, with rapidity and with a high degree of facility.

Further common objects of the inventions of said prior applications and of the present invention include the provision of improved methods and apparatus for casting massive structures which are particularly adapted for use in connection with permanent molds, and by the use of which the cast structure may be removed from the molds in a minimum period of time after pouring the structure, and with the requirement of a minimum manipulation of the molds in preparation for pouring and during removal of the cast structure from the molds.

Further common objects of the inventions of said prior applications and of the present invention, include the provision of improved methods and apparatus for casting massive high or deep dome shell structures, whereby losses due to wall cracking are reduced to a minimum.

Further common objects of certain of the improvements of said prior applications and of the present invention, include the provision of improved methods and apparatus whereby manipulation of the molds is facilitated, both for assembling the molds for casting, and for stripping the molds from the cast product, and whereby stripping of the cast dome shell structure from its inner mold is facilitated, and whereby a number of different dome shell structures, such as grave vaults, half-sections of septic tanks and the like, may be made by the use of similar outer molds and by interchanging

inner molds, and whereby the interchanging of the inner molds is facilitated.

By the use only of the improved methods of said prior applications, in a production line equipped only with one of said improved apparatus of either of said prior applications, a production schedule of 5 completed cast massive structures per 24 hour day may be attained.

In low production plants, heretofore equipped with a relatively small number of old type molds which are assembled and stripped according to the usual old methods of hand manipulation, the use of a single apparatus of either of said prior applications and having as aforesaid a productive capacity of 5 cast structures per day, very greatly reduces the labor and handling costs per cast structure in such a low production plant, since by the usual old methods carried out by the use of hand manipulated molds, a production of only 1–2 cast structures per day, such as grave vaults, has been the usual production schedule in such a plant.

On the other hand, there are certain high production plants, already equipped with a relatively large number of hand manipulated molds, and other auxiliary pouring, drying, and curing apparatus, and the like, and which would greatly benefit by the use of the improved methods and the improved apparatus of said prior applications, but which would be required not only to scrap the already relatively large investments in the hand manipulated molds, but also would be required to make relatively large new investments in a relatively large number of the improved apparatus of either of said prior applications, each of which as aforesaid has a production capacity of substantially 5 cast structures per day, in order that such high production plants may use said improved methods and apparatus and maintain their high production schedules.

The objects of the present invention include the foregoing common objects together with additional objects including the provision of improvements in the methods and apparatus of said prior applications, said improvements being particularly directed to attaining a maximum productive capacity of a plant utilizing the present improved methods and apparatus, whereby a single apparatus including in general the improvements of said prior applications, together with the present improvements, and suitable improved auxiliary equipment, may be utilized to carry out the improved methods of said prior applications and of the present invention, whereby the productive capacity of such a single apparatus and auxiliary equipment may be increased to as much as 4 cast structures per hour, or even greater, thereby enabling the improved methods and apparatus to be used in high production plants at a relatively low additional investment cost, and at the same time the improved methods and apparatus hereof are adapted for use in low production plants, whereby all the benefits of the inventions of said prior applications are enhanced and made economically available for both low production and high production plants by the present invention.

Further particular objects of the present invention include the provision of improvements in the methods and apparatus of said prior applications, whereby cast structures of different sizes and designs may be produced by a single apparatus including in general the improvements of said prior applications, together with the present improvements, and suitable improved auxiliary equipment.

The foregoing and other objects are attained by the methods, apparatus, improvements, combinations, and sub-combinations, which comprise the present invention, and the nature of which is set forth in the following general statement, and preferred embodiments of which are set forth in the following description, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

In general terms, the method of making cast structures hereof includes improvements in the methods set forth in my said prior applications, Serial No. 586,721, and Serial No. 615,844, and more particularly includes the use of one or more laterally transportable inner molds, and a laterally transportable outer mold which is separable from the inner mold or molds, and which preferably includes separable members, and the inner and outer molds being preferably vertically movable into and out of position with respect to each other, so as to form a mold cavity or cavities in which the structure is cast with its material in engagement preferably with the outer mold, and after the material of the cast structure has attained an initial set, the outer mold and the cast structure engaged thereby are separated from the inner mold or molds, and some of the members of the outer mold being disengaged and separated from the cast structure, and the cast structure being permitted to attain a final set while being supported on one of the outer mold members, which is preferably a laterally transportable supporting and lifting member.

The casting apparatus of the present invention includes in general the improvements in casting apparatus set forth in my said prior applications, Serial No. 586,721 and Serial No. 615,844, and more particularly includes laterally transportable inner and outer molds, preferably in the form of mold cars, the mold cars being adapted for being selectively separated from and assembled with each other, each car including mold members, the mold members of the cars forming a mold cavity therebetween when the cars are in assembled position, the outer car preferably comprising a ring car or member engirdling the mold members of the inner car when in the assembled position, and the mold members of the outer mold car being preferably separable from each other and from the ring car, longitudinally spaced jack members or frames, means for simultaneously moving the jack members or frames selectively in either one of opposite directions, preferably upwards and downwards, preferably laterally extending guide or track means extending crosswise of and between the jack members or frames, each car preferably including separate flanged wheel means transportably supporting the car preferably on the guide or track means, means for releasably connecting the outer mold members with the jack members or frames, and preferably the ring car being adapted for supporting engagement with the material of a structure cast in the mold cavity formed when the outer and inner mold cars are in mold cavity forming or assembled position, and the foregoing elements being preferably provided with other improved details of construction as are hereinafter more fully set forth.

Preferred embodiments of the improved apparatus hereof, preferably adapted for carrying out

the improved methods, are illustrated in the accompanying drawings forming part hereof, in which

Figure 1 is a fragmentary side elevation of an embodiment of the improved apparatus, as arranged for making grave vaults, with portions broken away and illustrated in section;

Fig. 2, a fragmentary end elevation thereof, with portions broken away and illustrated in section;

Fig. 3, an enlarged plan sectional view thereof, as on line 3—3, Figs. 1 and 2, with portions broken away and illustrated in section, and the inner and outer mold cars being in their relative positions after assembly for having a grave vault cast between and on the mold and supporting members thereof, when the apparatus is being used on a relatively low production schedule;

Fig. 4, a fragmentary longitudinal vertical sectional view thereof as on line 4—4, Fig. 3, and with a grave vault cast between and on the mold and supporting members of the mold cars;

Fig. 5, an end elevation and transverse sectional view of the apparatus as on line 5—5, Fig. 1, illustrating the relative arrangements of the parts just after the grave vault has been cast;

Fig. 6, a view similar to Fig. 5, illustrating the outer mold car with the cast grave vault separated from the inner mold car by operation of the apparatus to elevate the outer mold car and cast grave vault, and the inner mold car being ready to be rolled laterally away from the remaining parts of the apparatus;

Fig. 7, a similar view illustrating the side and end members of the outer mold car bodily separated from the cast grave vault, the cast grave vault resting on the preferred separable lifting and engaging ring member or car, and the ring car and the grave vault carried thereon being ready to be rolled laterally away from the remaining parts of the casting apparatus;

Fig. 8, an enlarged fragmentary transverse sectional view of the apparatus, similar to Fig. 5;

Fig. 9, a similar fragmentary transverse sectional view thereof as on line 9—9, Fig. 1;

Fig. 10, a detached isometric view illustrating one of the preferred separable combined engaging and socket forming members, preferably for the outer mold members of the apparatus; and

Fig. 11, a diagrammatic view illustrating a preferred arrangement of the improved apparatus hereof together with suitable auxiliary equipment for carrying out the preferred improved continuous method thereof.

Similar numerals refer to similar parts throughout the drawings.

The improved casting apparatus is indicated generally by 10 and for most advantageously carrying out the improved methods, the lower portions of the casting apparatus 10 are preferably located above a pit 11 which is located beneath and spanned by a track 12 which is laid upon the ground or floor 13.

The casting apparatus 10 includes a base 14 which rests upon the floor 13 above the pit 11 and beneath the track 12. Laterally spaced corner posts 16*a*—1 and 16*a*—2 are secured at their lower ends to one end 17*a* of the base 14 and extend upwardly therefrom at one side of the track 12; and similarly, laterally spaced corner posts 16*b*—1 and 16*b*—2 are secured at their lower ends to the other end 17*b* of the base and extend upwardly therefrom at the other side of the track 12.

The upper ends of the posts 16*a*—1 and 16*a*—2 are secured to and support a gear mounting and bearing bracket 18*a*; and similarly, the upper ends of the posts 16*b*—1 and 16*b*—2 are secured to and support a gear mounting and bearing bracket 18*b*.

A jack screw shaft 20*a* is preferably located between the posts 16*a*—1 and 16*a*—2, and the shaft 20*a* is journalled at its lower end in the end 17*a* of the base 14, and the shaft 20*a* is journalled adjacent its upper end in the bracket 18*a*, and the shaft 20*a* preferably extends above the bracket 18*a*, and a bevel gear 21*a* is secured upon the upper end of the shaft 20*a*, above one side of the bracket 18*a*.

Similarly, a jack screw shaft 20*b* is preferably located between the posts 16*b*—1 and 16*b*—2, and the shaft 20*b* is journalled at its lower end in the end 17*b* of the base 14, and the shaft 20*a* is journalled adjacent its upper end in the bracket 18*b*, and the shaft 20*a* preferably extends above the bracket 18*b*, and a bevel gear 21*b* is secured upon the upper end of the shaft 20*b* above one side of the bracket 18*b*.

The bracket 18*a* includes an angled arm 22*a* extending laterally from one side of the bracket and upwardly at one side of the bevel gear 21*a*; and similarly the bracket 18*b* includes an angled arm 22*b* extending laterally from one side of the bracket and upwardly at one side of the bevel gear 21*b*.

The arms 22*a* and 22*b* are preferably arranged as illustrated, so that the arm 22*a* is located between the set of posts 16*a*—1 and 16*a*—2, and the set of posts 16*b*—1 and 16*b*—2, and the arm 22*b* is located on the other or outer side of the set of posts 16*b*—1 and 16*b*—2.

The arm 22*a* preferably terminates in a bearing block 23*a* which is preferably located above the bevel gear 21*a*; and similarly the arm 22*b* terminates in a bearing block 23*b* which is preferably located above the bevel gear 21*b*, and the bearing blocks 23*a* and 23*b* have journalled therein a drive shaft 24 which extends longitudinally between and through the bearing blocks, as illustrated.

A bevel pinion 25*a* is secured on the end of the shaft 24 adjacent the bevel gear 21*a*, and the pinion 25*a* is meshed with the gear 21*a*.

A bevel pinion 25*b* is secured on the shaft 24 between the bearing blocks 23*a* and 23*b*, and the pinion 25*b* is meshed with the gear 21*b*.

A chain drive wheel 26 is secured upon the end of the shaft 24 on the outer side of the bearing block 23*b*, and an endless pull chain 27 may be meshed with a suitably socketed peripheral groove 28 which as illustrated is provided for the chain drive wheel 26.

The chain 27 is preferably of sufficient length so that when applied to the wheel 26, the chain 27 will hang down substantially to the ground level 13, in order that the chain may be easily grasped by the operator of the apparatus; whereby a pull on the chain will cause rotation of the wheel 26 and of the shafts 20*a* and 20*b*, by reason of the above described gearing and drive shaft connection between the shafts 20*a* and 20*b* and the wheel 26.

Obviously the direction of rotation of the shafts 20*a* and 20*b* depends upon which side portion of the chain 27 is grasped and pulled by the operator.

Normal rotation of the drive shaft 24 is pref-

erably effected by means of a motor 60 which is mounted on a base channel 61 extending between and being supported on the brackets 18*a* and 18*b*.

The motor 60 is operatively connected with the shaft 24 as by means of a pinion 62 secured on one end of the motor shaft 63, and meshed with a gear 64 which is secured on the drive shaft 24.

The motor 60 is a reversing motor, and is supplied with power from any usual power line, not shown, and is controlled by any usual reversing switches and suitable auxiliary controlling apparatus, not shown.

The bevel pinions 25*a* and 25*b* are the same size and have the same number of teeth, and the bevel gears 21*a* and 21*b* are the same size and have the same number of teeth, and accordingly the jack screw shafts 20*a* and 20*b* rotate at the same speed.

The threads of the jack screw shafts 20*a* and 20*b* have the same pitch, and the shaft 20*a* is screw connected with a jack frame 70*a* which is slidably mounted on and thus guided by the posts 16*a*—1 and 16*a*—2.

Similarly, the jack screw shaft 20*b* is screw connected with a jack frame 70*b* which is slidably mounted on and thus guided by the posts 16*b*—1 and 16*b*—2.

Accordingly the jack frames 70*a* and 70*b* will be raised or lowered simultaneously, and at the same speed, depending upon the direction of rotation of the jack screw shafts 20*a* and 20*b*. In other words the improved apparatus 10 includes the longitudinally spaced jack frames 70*a* and 70*b*, and means for simultaneously raising and lowering the jack frames preferably at the same speed.

As illustrated, the jack frame 70*a* preferably includes longitudinally spaced and laterally and transversely extending web members 71*a*, and transversely spaced laterally extending upper and lower ribs 48*a* which are supported between the web members 71*a*; and the ribs 48*a* have formed therein guide bearing apertures 72*a*—1 and 72*a*—2 which slidably fit respectively on the posts 16*a*—1 and 16*a*—2; and the upper rib 48*a* of the jack frame 70*a* has formed therein an aperture 72*a*—3 through which the screw shaft 20*a* slidably extends; and the lower rib 48*a* of the jack frame 70*a* has secured therein a nut 49*a*, and the shaft 20*a* extends through and screws in the nut 49*a*.

Similarly as illustrated, the jack frame 70*b* preferably includes longitudinally spaced and laterally and transversely extending web members 71*b*, and transversely spaced laterally extending upper and lower ribs 48*b* which are supported between the web members 71*b*; and the ribs 48*b* have formed therein guide bearing apertures 72*b*—1 and 72*b*—2 which slidably fit respectively on the posts 16*b*—1 and 16*b*—2; and the upper rib 48*b* of the jack frame 70*b* has formed therein an aperture 72*b*—3 through which the screw shaft 20*b* slidably extends; and the lower rib 48*b* of the jack frame 70*b* has secured therein a nut 49*b*, and the shaft 20*b* extends through and screws in the nut 49*b*.

Members forming improved inner and outer transportable molds, preferably mold cars, indicated generally by 29 and 32, respectively, may be moved, preferably by rolling on the track 12, into location above the base 14 and between the posts 16*a*—1 and 16*a*—2, and the posts 16*b*—1 and 16*b*—2, and the height of these posts is such that the distance between the base 14 and the brackets 18*a* and 18*b* is preferably over twice the overall height of the mold forming members, for enabling the preferred operation of the apparatus for carrying out the improved method, as will be hereinafter set forth in greater detail.

As is hereinafter set forth in greater detail, the jack frames 70*a* and 70*b* provide a releasable supporting or elevator means for the outer transportable mold 32, whereby the outer mold 32 may be raised, lowered, or maintained at any desired elevation, during operation of the apparatus, after being moved with the inner transportable mold 29 into position between the jack frames 70*a* and 70*b*.

The improved transportable molds preferably mold cars 29 and 32 as illustrated are arranged for making grave vaults. The inner transportable mold 29 includes a dome-shaped mold shell 29—1.

The inner mold shell 29—1 includes longitudinally spaced laterally extending end walls 29—1*a* and 29—1*b* the side corners of which are connected by and merge with the end corners of longitudinally extending laterally spaced side walls 29—1*c* and 29—1*d* and the upper corners of the side and end walls are connected by and merge with the outer corners of a top wall 29—1*e*.

From the lower corners of the end and side walls there extends inwardly a peripheral flange 29—1*f* by which the dome-shaped inner shell member 29—1 is secured to the ends of trucks 30*a* and 30*b* which are longitudinally spaced from each other and extend laterally with respect to the mold shell 29—1. The truck 30*a* has journalled therein laterally spaced flanged wheels 31*a* which roll on the rail 12*a* of the track 12 and similarly the truck 30*b* has journalled therein flanged wheels 31*b* which roll on the rail 12*b* of the track 12.

In other words the trucks and wheels comprise separate means transportably supporting the preferred mold car 29 on the track 12.

The outer transportable mold preferably a mold car, is indicated generally by 32, and is preferably formed of separable members, and is adapted for being moved into and out of position with respect to the inner mold 29, so that when the molds are in mold cavity forming position, a mold cavity indicated generally by C is formed between the outer and inner molds.

As illustrated, the outer transportable mold 32 includes a laterally extending end wall member 32*a* whose inner face is longitudinally spaced from the outer face of the outer end wall 29—1*a* of the inner mold shell 29—1 when the molds are assembled in mold cavity forming position.

Similarly, the outer mold 32 also includes a laterally extending end wall member 32*b* whose inner face is longitudinally spaced from the outer face of the outer end wall 29—1*b* of the inner mold shell 29—1 when the molds are assembled in mold cavity forming position.

The outer mold 32 furthermore includes a longitudinally extending side wall member 32*c* whose inner face is laterally spaced from the outer faces of the side wall 29—1*c* of the inner mold shell 29—1, when the molds are assembled in mold cavity forming position.

Similarly, the outer mold 32 includes a longitudinally extending side wall member 32*d* whose inner face is laterally spaced from the outer

faces of the side wall 29—1*d* of the inner mold shell 29—1, when the molds are assembled in mold cavity forming position.

For permitting movement of the side wall members of the outer mold 32 away from the outer side surfaces of the product cast in the mold cavity C, after the product has set, and thereby facilitating stripping of the side and end wall members of the outer mold from the cast product, the outer mold side wall members 32*c* and 32*d* extend between and are adjustably mounted on opposite side portions of the outer mold end wall members 32*a* and 32*b*.

For the purpose of thus adjustably mounting the outer mold side wall member 32*d* on one set of similar side portions of the outer mold end wall members 32*a* and 32*b*, as illustrated, the outer mold end wall member 32*a* includes at one side thereof a side member 73*a*—1 which extends longitudinally from the inner face of the end wall member 32*a* towards the end wall member 32*b*. The side member 73*a*—1 is provided with a transversely and laterally extending flange 79*a*—1 which protrudes outwardly from the side member 73*a*—1, and which has formed therein a plurality of apertures 80.

The adjacent end of the outer mold side wall member 32*d* is provided with a transversely and laterally extending end flange 81*a*—1 which protrudes outwardly from the side wall member 32*d*, and which abuts against the flange 79*a*—1 of the side member 73*a*—1, and the flange 81*a*—1 is provided with a plurality of laterally extending slots 82 which register with the apertures 80 in the flange 79*a*—1.

The outer mold end wall member 32*b* includes, at its side similar to the side of the outer mold end wall member 32*a* having the side member 73*a*—1 thereon, a side member 73*b*—1 which is similarly provided with a flange 79*b*—1 having apertures 80 formed therein, and the end of the outer mold side wall member 32*d* adjacent the flange 79*b*—1 is similarly provided with an end flange 81*b*—1 abutting against the flange 79*b*—1, and the flange 81*b*—1 is similarly provided with a plurality of laterally extending slots 82 which register with the apertures 80 in the flange 79*b*—1.

Bolts 83 and nuts 84 are provided, as illustrated, for connecting the end flanges 81*a*—1 and 81*b*—1, respectively, with the flanges 79*a*—1 and 79 *b*—1, and the shank of one of the bolts 83 extends through each registering aperture 80 and slot 82, and the head of each bolt abuts against an outer face of one of the abutting flanges, and one of the nuts 84 is screwed on the threaded outer end of each bolt 83 and clamps against the outer face of the other abutting flange, thereby permitting clamping of the side wall member 32*d* in the normal position for casting as best illustrated in Fig. 3, with the shanks of the bolts 83 located in the outer ends of the slots 82.

When it is desired to displace the outer mold side wall member 32*d* away from the inner molds 29, it is only necessary to loosen the nuts 84, and to pry the side wall member 32*d* in the desired direction.

For the purpose of facilitating the desired displacement of the side wall member 32*d* by prying with a crow bar or the like, the side member flanges 79*a*—1 and 79*b*—1 are provided with notches 85, and a tongue flange 86*a*—1 is provided on the flange 81*a*—1 and overlaps the notches 85 of the flange 79*a*—1, and the flange 81*b*—1 is provided with a tongue flange 86*b*—1 overlapping the notches 85 of the flange 79*b*—1.

Accordingly, when the side wall member 32*d* is in the normal position for casting illustrated in Fig. 3, and after the nuts 84 have been loosened, the end of a crow bar may be inserted in each notch 85, and pried against the overlapping flange 86*a*—1 or 86*b*—1, whereby the outer mold side wall member 32*d* will be displaced away from the inner mold 29.

As illustrated, the outer mold side wall member 32*c* is adjustably mounted on the other set of similar side members 73*a*—2 and 73*b*—2 of the outer mold end wall members 32*a* and 32*b*, in a manner similar to the preferred adjustable mounting just described of the side wall member 32*d* on the side members 73*a*—1 and 73*b*—1, the end wall member 32*a* being provided with a flange 79*a*—2 protruding outwardly from the side members 73*a*—2, and the end wall member 32*b* being provided with a flange 79*b*—2 protruding outwardly from the side member 73*b*—2, and a plurality of apertures 80 being provided in each of the flanges 79*a*—2 and 79*b*—2, and the side wall member 32*c* being provided with end flanges 81*a*—2 and 81*b*—2, and the end flanges 81*a*—2 and 81*b*—2 being provided with a plurality of laterally extending slots 82 which register with the apertures 80 in the flanges 79*a*—2 and 79*b*—2, and bolts 83 and nuts 84 adjustably connecting the flanges 81*a*—2 and 81*b*—2, respectively, with the flanges 79*a*—2 and 79*b*—2.

The flanges 79*a*—2 and 79*b*—2 are likewise provided with notches 85, and the flanges 81*a*—2 and 81*b*—2 are likewise provided respectively with overlapping tongue flanges 86*a*—2 and 86*b*—2.

The outer mold 32 also includes a supporting and lifting ring member, preferably a car, indicated generally by 36 which includes longitudinally spaced laterally extending end sections 36*a* and 36*b* connected at their extremities with the extremities of laterally spaced longitudinally extending side sections 36*c* and 36*d*.

The ring ledge member 36 may be channel-shaped as illustrated, and is preferably removably secured to the outer mold side wall members 32*c* and 32*d*.

For this purpose, transversely spaced longitudinally extending ribs 38, and longitudinally spaced transversely extending ribs 39 preferably protrude from the outer face of each of the outer mold side wall members 32*c* and 32*d*, and the ring ledge member 36 is provided preferably in its outer channel legs with a plurality of apertures 40 each of which may be alined with one of a plurality of apertures 41 formed in the opposite lowermost ribs 38 of the side members, whereby the ring ledge member may be separably supported from the lower ends of the members of the outer mold 32, as by means of hook bolts 42 and nuts 43, the shank of each bolt extending through one of the apertures 41, and the hook head of each bolt as illustrated extending through one of the apertures 40 and abutting against the underside of the web of the channel-shaped ring ledge member, and one of the nuts 43 being screwed on the threaded end of each bolt against the opposed rib 38.

Oppositely flanged wheels 44*c* are longitudinally spaced with reference to the ring ledge member section 36*c*, and each wheel 44*c* is journalled in a bracket 45*c* which is secured to the outer side of the ring ledge member section 36*c*.

Similarly, oppositely flanged wheels 44*d* are longitudinally spaced with reference to the ring ledge member section 36*d*, and each wheel 44*d* is journalled in a bracket 45*d* which is secured to the outer side of the ring ledge member section 36*d*.

The spacing of the wheels is of the proper gauge so as to roll on the track 12, and the wheels comprise means transportably supporting the ring car, and thus the outer mold car on the track 12.

A relatively narrow lower longitudinally extending portion 46*c* of the side wall member 32*c* is laterally and outwardly offset with respect to the remaining upper longitudinally extending portion 47*c*.

Similarly, a relatively narrow lower longitudinally extending portion 46*d* of the side wall member 32d is laterally and outwardly offset with respect to the remaining upper longitudinally extending portion 47*d*.

Accordingly, the spacing of the inner faces of the lower portions 46*c* and 46*d* from the opposite portions respectively of the outer faces of the side walls of the inner molds is greater than the spacing of the inner faces of the upper portions 47*c* and 47*d* respectively from the outer faces of the side walls of the inner molds.

Longitudinally spaced combined socket forming and engaging members 50 may be separably secured upon the inner face of the lower portion 46*c* of the side wall member 32*c* and likewise upon the inner face of the lower portion 46*d* of the side wall member 32*d*, as by means of cap screws 51, the shanks of which extend through apertures provided in the side members 32*c* and 32*d* and the threaded ends of which screw into threaded apertures 52 provided in the socket forming and engaging members 50.

For facilitating stripping of the cast product from the inner mold shell, the top wall of the inner mold shell is preferably provided with a plurality of air valve openings 90, in the upper end of each of which valve disk 91 is seated, and means such as a spring yoke 92 is secured to the lower face of each valve disk 91 for limiting the displacement of each valve disk from its seat.

For enabling the production of different size vaults and the like, or in other words dome shell products having different internal and external dimensions, a standard size ring member 36 may be adopted, (and a ring plate 36—1 may be interposed between the ring member 36 and the lower portions of the side and end wall members of the outer mold 32, and the dimensions and form of the inner periphery 36—1′ of each ring plate 36—1 is such as to slidably fit around the side and end faces of the particular inner mold shell 29—1 being used, whereby the portions 36—1″ of the upper face of the ring plate 36—1 located between the outer faces of the side and end walls of the inner mold shell 29—1 and the inner faces of the side and end wall members of the outer mold 32, provides a supporting and lifting ledge for a cast structure 110 which may be cast between the inner and outer molds as hereinafter set forth in greater detail.

In order to permit lifting of any inner mold 29 by means of any ring member 36, preferably when the ring member is connected as aforesaid with the outer mold side and end wall members, the legs of each channel-shaped ring ledge member 36 are provided with apertures 99, whereby bolt shanks may be inserted through the apertures 99 so that the inner ends of the bolt shanks are located below the flange 29—1*f* of the inner mold shell 29—1, whereby the inner mold 29 may be lifted by elevating the ring member 36.

As hereinbefore set forth, the jack frames 70*a* and 70*b* provide a releasable supporting or elevator means for the outer transportable mold 32, whereby the outer mold may be raised, lowered, or maintained at any desired elevation, during operation of the apparatus after being moved into position, usually with the inner transportable mold 29, between the jack frames 70*a* and 70*b*.

Means for releasably connecting the outer mold 32 with the jack frames are preferably provided, and may include as illustrated, laterally spaced and vertically extending lifting and connector flanges 120*a*—1 and 120*a*—2 which are provided on the jack frame 70*a*, and which are adapted to register respectively with similarly arranged and positioned lifting and connecting flanges 121*a*—1 and 121*a*—2 which are provided on the outer corners of the outer mold end wall member 32*a*.

Similarly, laterally spaced and vertically extending lifting and connector flanges 120*b*—1 and 120*b*—2 are provided on the jack frame 70*b*, and are adapted to register respectively with similarly arranged and positioned lifting and connecting flanges 121*b*—1 and 121*b*—2 which are provided on the outer corners of the outer mold end wall member 32*b*.

Each of the flanges 120*a*—1 and 120*a*—2 has preferably formed therein a plurality of notches 122, and each of the flanges 121*a*—1 and 121*a*—2 has formed therein a plurality of notches 123, each of which registers with one of the notches 122. The flanges 120*b*—1 and 120*b*—2 are similarly provided with notches 122, and the flanges 121*b*—1 and 121*b*—2 are likewise similarly provided with notches 123 registering with the notches 122 of the flanges 120*b*—1 and 120*b*—2.

Each set of registering notches 122 and 123 is adapted for receiving preferably swinging bolt means indicated generally by 125, whereby each set of registering lifting and connector flanges may be connected with each other.

Each bolt means 125 preferably includes a swinging bolt 126 having a pivot head 127 which is pivotally mounted on one of the lifting and connecting flanges of one of the jack frames, and the shank of each bolt 126 being adapted to be swung through one of the notches 122 and into and out of the notch 123 registered therewith. Each bolt 126 has a threaded outer end, whereby a nut 128 may be screwed thereon.

For facilitating lateral movement preferably by rolling on the track 12 of each outer transportable mold 32 into and out of position for being connected with the jack frames 70*a* and 70*b*, a clearance is preferably provided between the jack frame connecting flanges 120*a*—1 and 120*a*—2 and the outer mold connecting flanges 121*a*—1 and 121*a*—2, and between the jack frame connecting flanges 120*b*—1 and 120*b*—2 and the outer mold connecting flanges 121*b*—1 and 121*b*—2.

Preferably a plurality of wedge screws 150 are screwed in suitable threaded apertures in each of the jack frame flanges 120*a*—1, 120*a*—2, 120*b*—1, and 120*b*—2, whereby when the molds are positioned between the jack frames so that the notches 122 and 123 are registering with each other, the wedge screws 150 may be ad-

justed so as to wedge their inner ends against the outer faces of the connecting flanges of the outer mold 32.

Accordingly the nuts 128 screwed on the swinging bolts 126 provide a further clamping action tending to clamp the outer mold lifting and connecting flanges against the inner ends of the wedge screws 150, and with the shanks of the swinging bolts 126 being then positioned to transmit the entire load of the outer mold 32 and any structure cast in engagement therewith, to the jack frames 70*a* and 70*b*.

For further facilitating lifting of the outer mold by the jack frames, the upper end of each lifting and connecting flange of each of the outer mold end wall members, is preferably provided with a hook flange 129 which overlaps the registering upper end of one of the lifting and connecting flanges of one of the jack frames, when the outer mold is rolled into position so that the lifting and connecting flanges register with each other.

For securing the inner transportable mold 29 in position to permit stripping operations of the apparatus, releasable clamp means indicated generally by 131*a* are provided on the truck 30*a* for releasably securing the truck 30*a* to the rail 12*a*, and similar releasable clamp means 131*b* are provided on the truck 30*b* for releasably securing the same to the rail 12*b*.

Operation of the clamping means 131*a* and 131*b* may be effected from the pit 11.

As illustrated in the drawings, the apparatus is arranged for making cast concrete grave vaults, each of which is indicated generally by 110, and each of which comprises a relatively high dome shell having laterally extending longitudinally spaced end walls 111*a* and 111*b*, the sides of which are connected by and merge with the ends of longitudinally extending laterally spaced side walls 111*c* and 111*d*, and the upper ends of the side and end walls are connected by and merge with the outer portions of a top wall 111*e*.

All the walls are preferably formed of reinforced concrete, as illustrated.

The grave vault 110 is a bottom seal vault, and the top wall 111*e* is transversely arched, its inner arch surface being formed by suitably arching the top wall 29—1*e* of the inner mold shell 29—1, and the outer arch surface of the vault top wall 111*e* being preferably determined by the contour of the top faces of the outer mold end wall members 32*a* and 32*b*, which may be used as striking off faces during casting of a vault 110.

For facilitating forming the heel portions at each side of the arch top wall 111*e*, a curved heel plate 140*c* is preferably removably hinge mounted at the upper end of the outer mold side wall member 32*c*, and similarly a curved heel plate 140*d* is preferably removably hinge mounted at the upper end of the outer mold side wall member 32*d*.

The improved apparatus 10 may be operated on a relatively low production schedule or on a high production schedule.

In using the improved apparatus 10 for operation under a relatively low production schedule, the several parts may be arranged as illustrated in Figs. 1, 2, and 3, the heel plates 140*c* and 140*d* may be swung back from the normal heel forming position illustrated in Figs. 1, 2, and 3, to the position illustrated in Fig. 7, the socket forming members 50 are removably secured on the outer mold side wall members as aforesaid, reinforcing R is applied about the inner molds and between the inner and outer molds, and concrete is poured first between the sides of the inner and outer molds, with a vibrator preferably being operated against one or more of the outer mold members.

After the side walls of the vault 110 have been poured, the heel plates 140*c* and 140*d* are swung to the forming positions illustrated in Figs. 1, 2, and 3, and more concrete is applied over the top wall of the inner mold for forming the complete dome shell vault structure 110, as illustrated in Figs. 4 to 7 inclusive.

The material of the dome shell structure 110 thus cast has its lower ends in engagement with the upper portions 36—1′ of the ring plate 36—1 which is as aforesaid laid upon the ring member 36, and the side walls of the cast structure 110 are also in engagement with the socket forming members 50.

After the cast structure has set for substantially 3½ hours, the drive shaft 24 is rotated in the proper direction either by the motor 60 or the chain 27, so as to rotate the shafts 20*a* and 20*b* in the direction to separate the outer mold 32 and the cast structure engaged thereby from the inner molds 29, by elevating the outer mold 32 and the cast structure engaged thereby from the casting position, illustrated in Figs. 1, 2, 3, 4, and 5, to the intermediate position, illustrated in Fig. 6.

Stripping of the cast structure from the inner molds is facilitated by the air valve openings 90 each provided as aforesaid with a valve disk 91, the operation of which to admit air beneath the inner faces of the top of the cast structure prevents formation of a vacuum between the cast structure and the inner molds.

The clamping means 131*a* and 131*b* on the inner transportable mold 29 are then released from engagement with the rails 12*a* and 12*b*, respectively, and the inner transportable mold 29 is rolled on the track 12 laterally away from the apparatus 10.

The drive shaft 24 is then reversely rotated so as to lower the outer mold 32, the ring 36, and the cast structure 110 back to its lowermost position, with the wheels of the ring 36 resting on the rails of the track 12.

The nuts 43 are then unscrewed from the bolts 42, and the bolts 42 are removed from the registering apertures 40 and 41, whereby the lifting ring member 36 and ring plate 36—1 are disengaged from the side and end wall members of the outer mold 32.

The cap screws 51 are also unscrewed and removed, whereby the socket forming members 50 are disengaged from the side members 32*c* and 32*d* of the outer mold 32.

Also, the side members of the outer mold 32 are preferably displaced away from the inner molds and the cast structure, as heretofore described.

The drive shaft 24 is then again rotated so as to again elevate the displaced side and end members of the outer mold 32 to the position illustrated in Fig. 7, wherein the side and end members are separated from the ring member 36, and the ring member 36 with its green cast structure 110 supported and engaged thereon may then be rolled on the track 12 laterally away from the apparatus, so that the cast structure 110 may attain a final set away from the apparatus.

The side members of the outer mold 32 are then repositioned in their relative locations for casting, and another ring member 36 is then connected to the outer mold side and end members, together with another set of handle members 50, and the reassembled transportable mold 32 is then positioned about another transportable inner mold 29 which is laterally rolled into position beneath the reassembled outer mold 32, and the parts of the casting apparatus are then in the proper arrangement, so that another structure can be immediately poured, as aforesaid.

Each structure thus cast and removed from the apparatus, with its material in the condition of initial set, is rolled on its own ring member 36 to any desired location for seasoning and final hardening.

In the method of using the apparatus as thus described, for low production operation, the pouring of the concrete is effected when the mold members are in position between the jack frames or members and connected therewith, as aforesaid.

Low production operation of the apparatus, requires a minimum investment in the apparatus.

High or mass production operation of the apparatus may be carried out as illustrated diagrammatically in Fig. 11, by the use of a concrete mixer 160, located along the track 12 at one side of the jack frame parts and elevating means therefor of the apparatus indicated generally by 10', and by the use of a plurality of ring members or cars 36, a plurality of inner transportable molds or mold cars 29, 29', and 29'', a plurality of sets of outer mold side and end members, each indicated generally by 232 and 232', and preferably an overhead conveyer track system indicated generally by 161, which operatively mounts in a usual manner a traveling crane hoist 162.

The bottom seal vault structure 110 as aforesaid has an arched top wall 111*e*.

The bottom seal vault 110 may be cast by the use of a set of outer mold side and end members 232, a ring member or ring car 36, and a transportable inner mold car 29 as aforesaid.

Top seal vaults 110', each of which is generally similar to the bottom seal vault 110, but which includes a flat wall corresponding to the wall 111*e* of the vault 110, may be made by the use of a set of outer mold side and end members 232' associated with a ring car 36 and an inner mold car 29', in a manner generally similar to the mold arrangements for the bottom seal vault 110, with the exception that arch heel plates are eliminated from the outer mold members 232', and the top of each inner mold car 29' is flat.

Similarly, septic tank half-sections as set forth in greater detail in my prior application, Serial No. 615,844, may be made by the use of a set of outer mold members 232', a ring car 36, and an inner mold car 29'', which generally function with respect to each other in a manner similar to that described for the mold cars for the vault 110.

It has been found that the inner mold car, and the side and end members of the outer mold cars, may be removed from each cast structure 3½ hours after pouring.

It has also been found that by the use of one mixer, each structure may be poured in substantially ½ hour.

It has also been found that by the use of the jack frame and elevator apparatus 10', purely for stripping and assembling the mold cars, there is required substantially ½ hour for each stripping and assembling operation.

Accordingly substantially continuous production may be effected by the use of 9 complete assembled units of mold cars, and a plurality of additional ring cars for the outer mold cars, whereby 7 cast structures may be attaining initial set in a row of the units between the jack frame and elevator apparatus 10' and the mixer 160, and during each half hour, at one end of the row of units, one assembled unit of mold cars may be arranged for having a structure cast therein from the mixer 160, and during each half hour, at the other end of the row of units, the jack frame and elevator apparatus 10' first strips a cast structure 110, and then reassembles another unit of the mold cars.

The reassembling of each unit of mold cars is effected preferably by the use of the traveling crane 162, by which a ring member 36 may be brought to and lowered about each disassembled inner mold car, which as illustrated is a car 29' which has preferably been rolled towards the mixer 160 from the apparatus 10', and the cast structure 110' which has been stripped from the inner mold car 29' is preferably rolled on its supporting ring car 36 to the other side of the apparatus 10'.

After another unit of mold cars is assembled by the use of an additional ring car 36, the inner mold car 29', and the outer mold members 232' supported between the jack frames 70*a* and 70*b*, as illustrated in Fig. 11, the reassembled unit of mold cars may be then carried on the traveling crane 162 on the track system 161 over the units of mold cars in which structures have been cast, and over the unit of mold cars in which a structure is being cast, beyond the mixer 160, ready to be rolled up to position adjacent the mixer for having another structure cast.

I claim:

1. Casting apparatus including an inner car and an outer car, the cars being adapted for being selectively separated from and assembled with each other, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, one of the cars constituting a supporting car and being adapted for supporting engagement with the material of a structure cast in the mold cavity, and the supporting car being arranged for bodily elevation with the cast structure above the other car.

2. Casting apparatus including an inner car and an outer car, the cars being adapted for being selectively separated from and assembled with each other, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, and the mold members on one of the cars being separable from the car, the car having the separable mold members constituting a supporting car and being located in the assembled position for supporting engagement with the material of a structure cast in the mold cavity, and the supporting car being arranged for bodily elevation with the cast structure above the other car.

3. Casting apparatus including an inner car and an outer ring car, the cars being adapted

for being selectively separated from and assembled with each other in relative positions in which the ring car engirdles the inner car, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, the mold members on the ring car being separable from the ring car, the ring car being located in the assembled position for supporting engagement with the material of a cast structure cast in the mold cavity, and the ring car being arranged for bodily elevation with the cast structure above the other car.

4. Casting apparatus including an inner car and an outer car, the cars being adapted for being selectively separated from and assembled with each other, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, one of the cars constituting a supporting car and being adapted for supporting engagement with the material of a structure cast in the mold cavity, and the supporting car being arranged for bodily elevation with the cast structure above the other car, and means for selectively separating and assembling the cars.

5. Casting apparatus including an inner car and an outer car, the cars being adapted for being selectively separated from and assembled with each other, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, and the mold members on one of the cars being separable from the car, the car having the separable mold members constituting a supporting car and being located in the assembled position for supporting engagement with the material of a structure cast in the mold cavity, and the supporting car being arranged for bodily elevation with the cast structure above the other car, and means for selectively elevating the supporting car with the cast structure above the other car and for elevating the separable mold members of the supporting car above the cast structure.

6. Casting apparatus including an inner car and an outer ring car, the cars being adapted for being selectively separated from and assembled with each other in relative positions in which the ring car engirdles the inner car, each car including independent supporting means, mold members on each car, the mold members on the cars forming a mold cavity therebetween when the cars are in assembled position, the mold members on the ring car being separable from the ring car, the ring car being located in the assembled position for supporting engagement with the material of a cast structure cast in the mold cavity, and the ring car being arranged for bodily elevation with the cast structure above the other car, and means for selectively elevating the supporting car with the cast structure above the other car and for elevating the separable mold members of the supporting car above the cast structure.

HARRY J. HICK.