

No. 869,205.

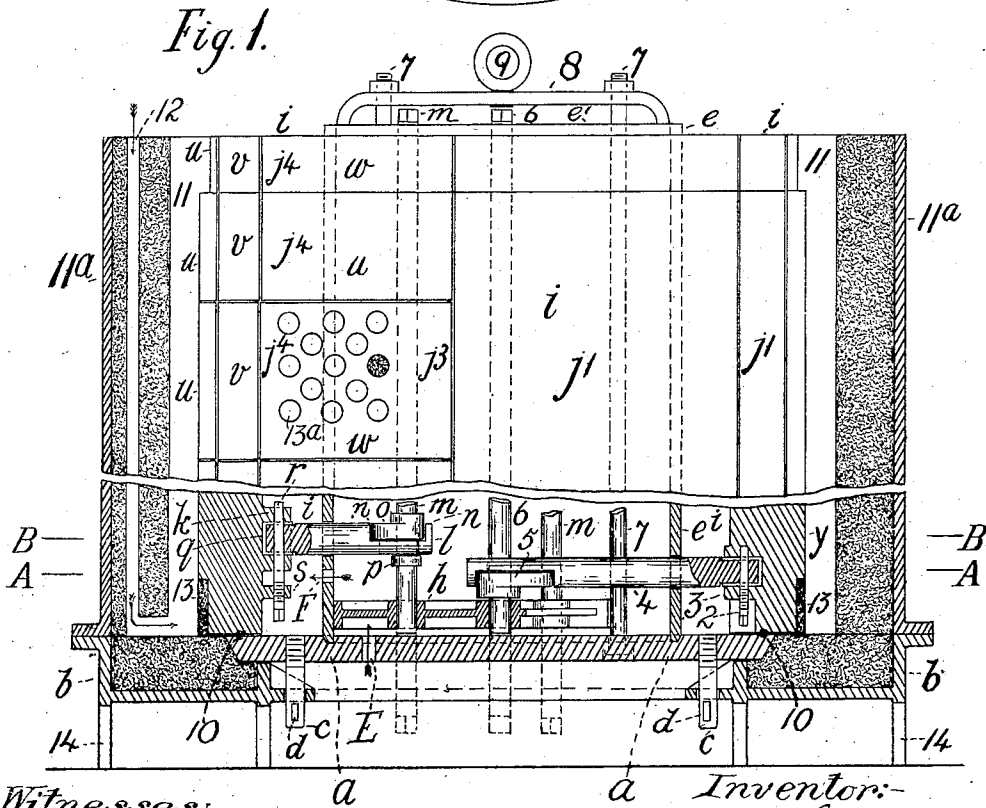
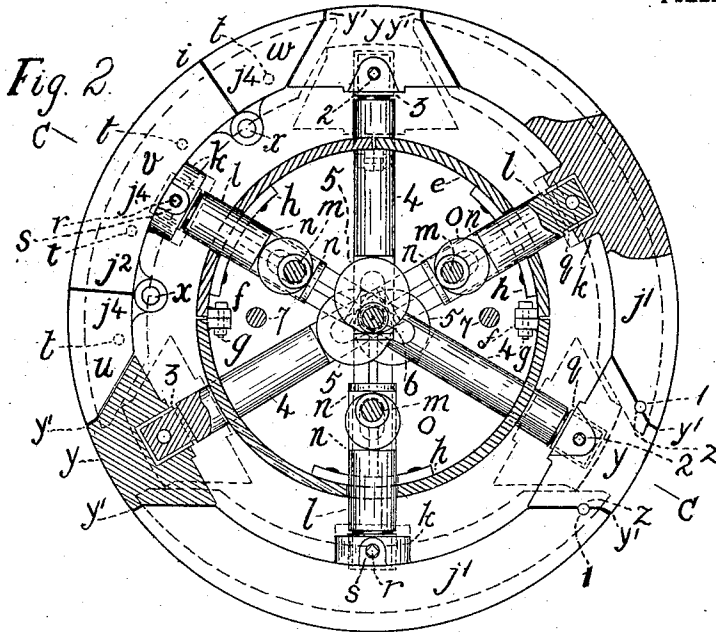
PATENTED OCT. 22, 1907.

J. BUTLER.

INTERNAL CHILLING APPARATUS FOR HOLLOW CASTINGS.

APPLICATION FILED MAR. 22, 1904.

4 SHEETS—SHEET 1.



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4 SHEETS—SHEET 2.

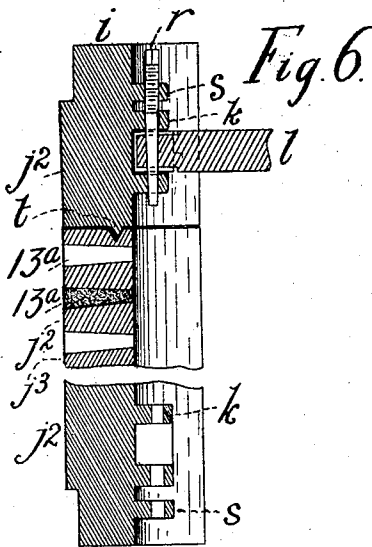
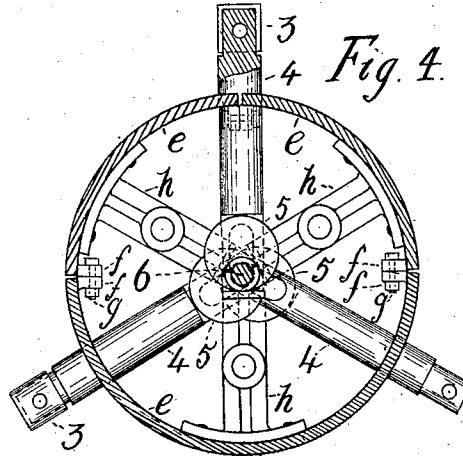
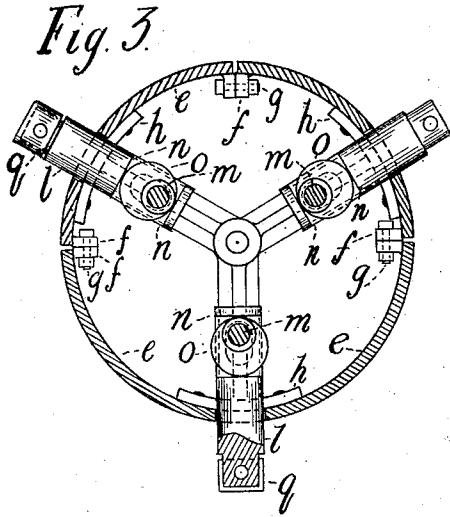
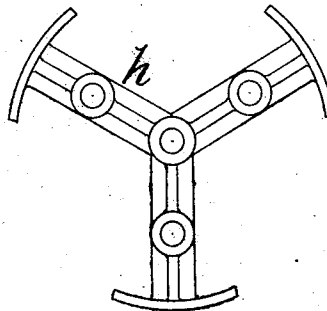


Fig. 5.



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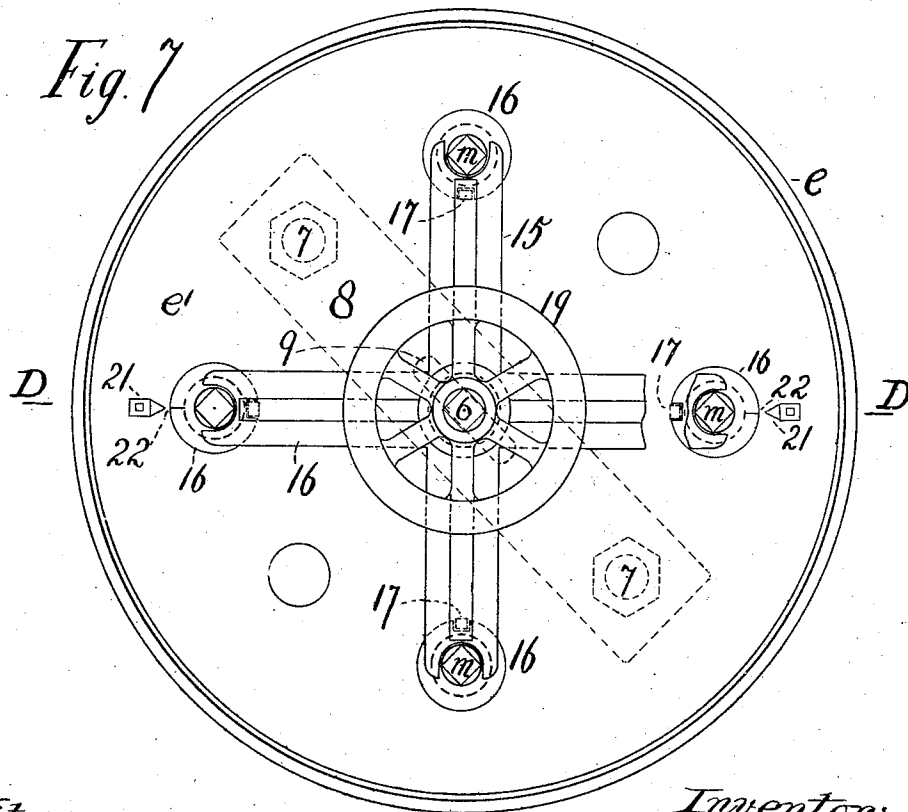
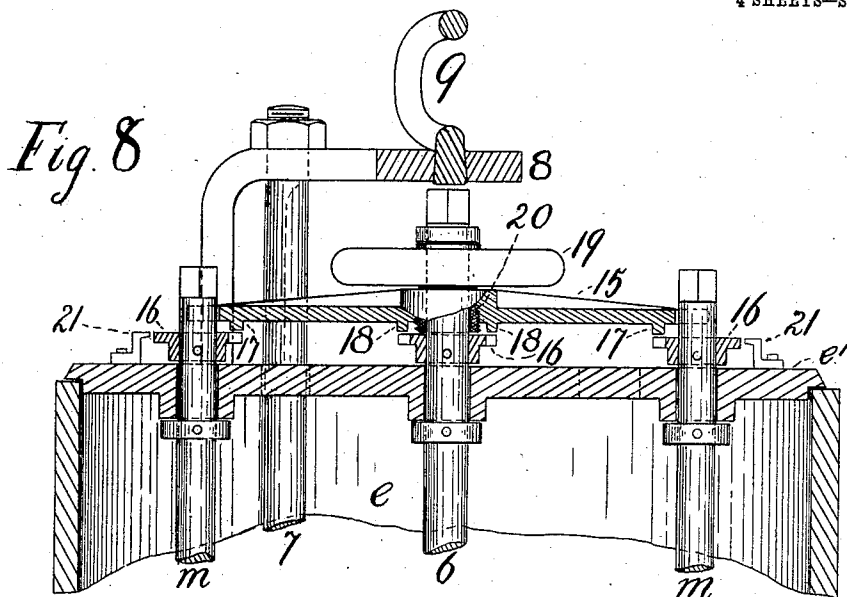
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4 SHEETS—SHEET 3.



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No. 869,205.

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INTERNAL CHILLING APPARATUS FOR HOLLOW CASTINGS.

APPLICATION FILED MAR. 22, 1904.

4 SHEETS—SHEET 4.

Fig. 9.

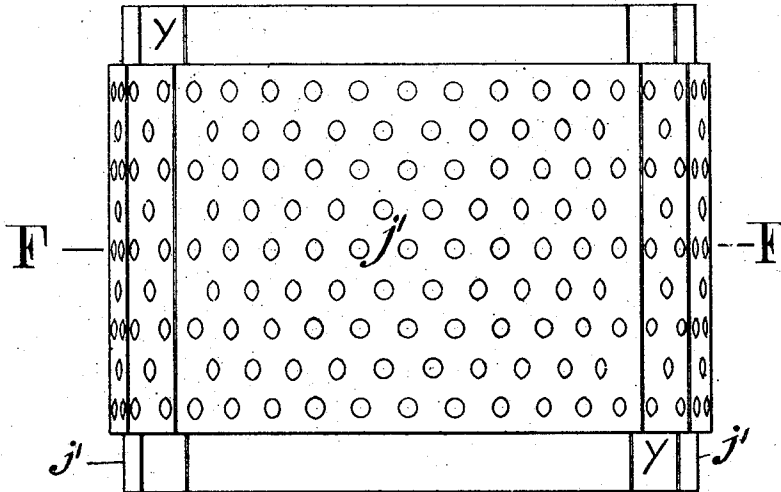
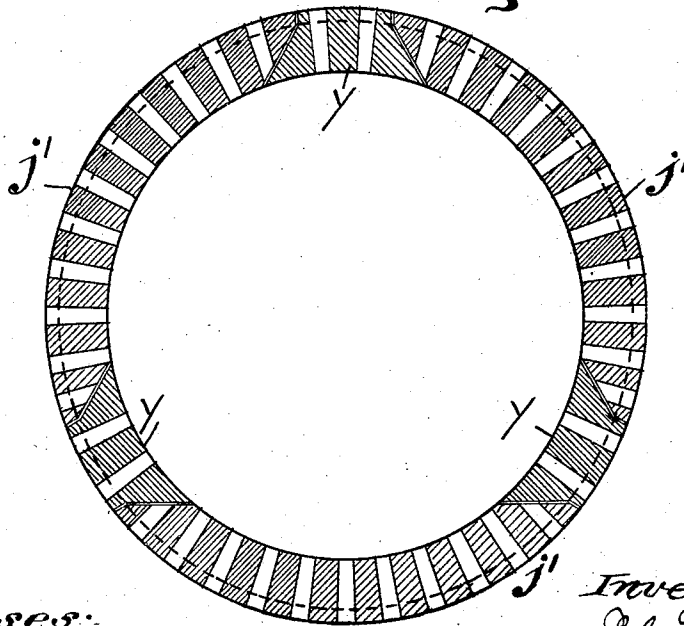


Fig. 10.



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UNITED STATES PATENT OFFICE.

JOHN BUTLER, OF SALFORD, ENGLAND.

INTERNAL-CHILLING APPARATUS FOR HOLLOW CASTINGS.

No. 869,205.

Specification of Letters Patent.

Patented Oct. 22, 1907.

Application filed March 22, 1904. Serial No. 199,490.

To all whom it may concern:

Be it known that I, JOHN BUTLER, commercial traveler, a subject of the King of the United Kingdom of Great Britain and Ireland, and resident of 219 High street, Pendleton, Salford, in the county of Lancaster, England, have invented certain new and useful improvements in internal-chilling apparatus for hollow castings in cast-iron and apparatus forming hollow castings in other metals and alloys, of which the following is a specification.

Hitherto castings of cylindrical forms such as the cylinders of steam-engines, gas-engines and oil-engines have been very unsatisfactory owing to cracks ruptures and the like defects resulting from the cores and chills hitherto in use not having the capability of yielding to the quick contraction of the inner diameter of the chilled surface.

To overcome these difficulties is the main object of my invention. This is accomplished as follows:—
Upon a suitable table or plate there is fitted or attached a frame or frames or suitable framework, that is to say, a tubular or other bar furnished with mechanism to hold and move upwards and outwards parts of segmental or other form made to surround it and to be adjusted so as to support one another in position for use. In case a framework is used it is fixed in or on the plate so that it is held in the vertical position while in use. There are formed or cast suitable segmental pieces in cast iron of any suitable thicknesses which may be built up in any suitable number into a body with divisions parallel and transverse to its length or otherwise. Upon the inner surfaces of these segmental pieces are cast or formed a suitable number of lugs, sockets or engaging pieces which are made to fit on to suitable bolts or pins. These bolts or pins are worked by suitable mechanical means placed inside the frame or frames and operated from above or below as may be convenient so that by these means the bolts or pins can be caused to protrude through the frame or frames and so engage the lugs or sockets as to hold or grip the segmental parts firmly in the position required when in use for casting. The segmental parts hereinbefore described which are built up to form the chill-body being separated by longitudinal divisions, the spaces forming the divisions between one and another are filled by triangular or wedge-shaped or other pieces of suitable size, built up and formed similarly to the segmental parts and held in position and actuated by similar mechanical means. After the chill is placed in the mold, the metal is run in and time being allowed for solidification the mechanism inside the frame or frames can be so manipulated as to draw in the triangular, wedge-shaped or other pieces towards the center of the frame or frames and the mechanism holding the segmental parts forming the chills can be set to allow the chilling surfaces to yield automatically to the contraction or shrinkage of the metal

casting. When desired the mechanism inside the frame or frames is further actuated so as to draw in the chilling surfaces clear from the casting allowing space for the passage of air and so preserve the life of the chilling surfaces.

In certain parts of the castings where uneven thicknesses or double walls of metal would occur as in the portways of a steam-engine cylinder, cavities or channels are provided in the chilling surfaces which cavities or channels are filled up with sand or suitable refractory material in order to lessen the depth of the chilling action at these particular parts and so guard against cracking or rupture when contraction takes place.

A further object of this invention is to facilitate the contraction of the metals or alloys used in the casting of steel or copper and various alloys into hollow forms, for instance bodies for drawing out into tubes, sleeves or bushes and the like and for this purpose there are employed chills built up around a suitable frame or frames as hereinbefore described and surrounded by a suitable cast-iron-chill-body or bodies which are secured in a suitable manner so that a suitable matrix is left for the steel, copper or alloy to flow in between the inner chill-body and the outer chill-body or bodies and so complete cylindrical or other hollow bodies.

In the accompanying drawings in all the figures of which the same letters and figures of reference are employed to indicate corresponding parts, Figure 1 is a vertical section showing certain parts in side elevation and illustrating the construction and employment of a framework and several forms of segmental pieces built up to form a chill-core-body suitable for forming a chilled cylinder-liner and also illustrating how, if it be desirable to do so, chilling may be more or less reduced or prevented from occurring at any parts. Fig. 2 is a view of the lower end of the framework and chill-body shown in Fig. 1 showing certain parts in horizontal section, the line A A of Fig. 1 indicating the plane upon which the section in Fig. 2 is taken, and with certain parts inverted so as to be more clearly shown. Fig. 3 is a horizontal section taken on the plane indicated by the line B B of Fig. 1 and Fig. 4 is a horizontal section taken on the plane indicated by the line A A of Fig. 1 and seen in an upward direction, certain parts being omitted from each figure in order that those shown may be more clearly illustrated. Fig. 5 is a plan illustrating one of the spiders or end-frames employed in the framework illustrated in Fig. 1. Fig. 6 is a vertical section taken on the plane indicated by the line C C of Fig. 2. Fig. 7 is a plan and Fig. 8 a vertical section taken on the plane indicated by the line D D of Fig. 7 illustrating an arrangement of detent which may be used to secure shafts similar to those illustrated in Figs. 1 and 2 after they have been adjusted in readiness for the chill-body to be used in casting.

In so far as Fig. 1 is a vertical section it is taken upon the plane indicated by the line C C of Fig. 2. In the upper part Fig. 1, where it is a side elevation, is drawn somewhat inconsistently with regard to Fig. 2 in order that the chill-body may be better illustrated. Fig. 9 is a side elevation and Fig. 10 is a partial horizontal section taken on the plane indicated by the line F—F of Fig. 9 illustrating the external parts of a modified apparatus constructed according to this invention.

- 10 The plate or table with which the framework and chill-core-body illustrated in Figs. 1 and 2 of the accompanying drawings are used is shown at *a*, in Fig. 1 and is shown as mounted in an annular molding box *b* to which it is secured by means of studs *c* which are
15 screwed into such plate *a* and made to extend through lugs projecting into the central aperture of the box *b* and are provided with cotters *d*. The upper surface of the plate *a* is formed with a groove to receive the lower end of the framework *e* which is formed of three seg-
20 ments connected by lugs *f* and bolts and nuts *g* and also secured to arms of spiders *h* of which one is provided at each end of a framework and if need be at convenient places in the interior thereof.

- The chill-body *i* which is formed of segmental pieces
25 of cast-iron of any suitable thickness is built up in the case illustrated of segments of different form and size in different parts, there being segments *j'* which extend from end to end of the chill-body and segments *j''*, *j'''*, *j''''* which form only parts of the length of such
30 chill-body. Upon the segments *j'* and some of the segments *j''* at parts which in use will be near the ends of the chill-body and if it be requisite or desirable at other parts, there are provided lugs, sockets or engaging pieces *k* which are made to fit on to bolts or pins *l*
35 mounted in the framework *e* and worked by suitable mechanical means. In the case illustrated the pins *l* are made to project through holes formed in the framework *e* and are provided with slots made to embrace shafts *m* mounted so as to be capable of being oscil-
40 lated in the spiders *h*, each pin *l* being thus guided by the hole in which it is mounted and the shaft *m* which passes through its slot. Each pin *l* is provided with a recess the ends of which form projections *n* *n* to be acted upon by an eccentric cam *o* secured upon the
45 shaft *m* passing through the said pin *l* which is secured against movement lengthwise of the shaft *m* by means of the corresponding eccentric cam *o* and a collar *p* secured to the said shaft *m*. By the shafts *m* being oscil-
50 lated by means of keys applied to the square portions formed at the upper ends thereof the pins *l* may be moved outwards and inwards relatively to the frame-
work *e*.

- In the case illustrated each of the segmental parts *j'* or *j''* to be connected to a pin *l* is provided with a lug or
55 socket *k* to receive the end of the pin *l* and also a cap *q* of asbestos or other bad-conductor of heat which is placed upon the end of the corresponding pin *l* to minimize the transmission of heat thereto and each of such segmental parts is provided with a pin *r* screwed into a lug *s* formed
60 on such segmental part and provided with a taper part made to pass through holes formed in the socket *k* and the pin *l* inserted therein, the pin *r* thus securing the said segmental part *j'* or *j''* to the pin *l*. The segmental parts *j'* are made to extend from the top to the bottom
65 of the chill-body and the segmental parts *j''*, *j'''* extend

for only a part of the height of the chill-body and in order that the segmental portions such as those marked *j'''* which are not provided with lugs *k* for connection to pins *l* may be secured in position relatively to segmen-
70 tal parts which are provided with lugs *k*, dowels or projections *t* are provided on one part to enter holes in another in the manner clearly indicated in Figs. 2 and 6. In the case of segmental parts which extend around a large portion of the circumference of a chill-body and especially if the chill-body be of large diameter it is
75 preferable to form the segmental parts of two or three pieces connected together by hinges as is illustrated in the case of the segmental parts *j''''* shown in Figs. 1 and 2 each of which is shown as formed in three portions *u*, *v*, *w*, the parts *u* and *w* being connected by hinges *x* to the
80 part *v* which is arranged to be connected to the pin *l* used with the segmental part *j''''*, suitable pins or dowels being provided to connect the parts of one hinged segmental part to the corresponding parts of that or those adjacent to it so that all the corresponding parts may
85 move alike.

To fill up the longitudinal spaces between each of the segmental parts *j'*, *j''*, *j'''* and those adjoining it to right and left around the circumference of the chill-body, filling pieces *y*, which are mainly of wedge-shaped form
90 in transverse section but provided at the angles which are outward with sides *y'*, which are parallel to one another, are provided to bear against the adjacent ends of the segmental parts *j'*, *j''*, *j'''*, *j''''* when the chill-body is ad-
95 justed for casting, the parts *y* and the adjoining parts of the segmental parts *j'*, *j''*, *j'''*, *j''''* are provided with grooves *z* and *l* respectively in any case in which they may be desirable and as shown in one case in Fig. 2 so as to facilitate the application of plumbago or other refractory material or suitable fusible alloy between the parts *y*
100 and the adjacent segmental parts. The parts *y* are connected by means of pins 2 and with caps 3 of asbestos or other bad-conductor of heat interposed, to pins 4 which are capable of being slid inwards and outwards in the framework *e* by means of eccentric cams 5 mounted
105 fast upon a shaft 6 which passes through slots with which the pins 4 are respectively provided. The shaft 6 and the sides of the slots in the pins 4 and the holes in the framework *e* through which such pins 4 are passed serve as guides to the said pins 4. The pins 4 in each group
110 being between the inner and outer cams of the three used therewith are so held against movement in the direction of the shaft 6. Each of the eccentric cams 5 is made to enter a recess in the corresponding pin 4 so that
115 by the shaft 6 being turned in one direction or the other the pins 4 and parts *y* may be moved inwards and outwards relatively to the framework *e*.

When the segmental parts *j'*, *j''*, *j'''*, *j''''* have been built up into position and connected to the pins *l* directly or by means of other adjacent segmental parts as herein-
120 before described and the parts *y* have been secured to the pins 4 the framework *e* is secured to the plate *a* by means of bolts 7 provided with nuts and made to pass through the plate *a* through the interior space of the framework *e* through a plate *e'* secured at the upper end
125 thereof and through the cross-bar 8 provided at the upper end of such framework and furnished with a ring 9 by means of which the plate *a* and the framework and other parts mounted thereon may be lifted by a crane or otherwise, the bolts 7 thus securing the cross-bar 8,
130

plate *c'* framework *e* and plate *a* together while when the nuts of the bolts 7 are unscrewed therefrom the said parts may readily be separated.

When the segmental parts *j'*, *j*², *j*³, *j*⁴ and bars *y* have been secured to the pins *l*, 4 respectively, the shafts 6 may be turned so that the segmental parts *j'*, *j*², *j*³, *j*⁴ and bars *y* may be moved from the positions in which they are indicated by dotted lines in Fig. 2 to the position in which they are indicated by full lines in such figure, or from the position in which they are indicated by full lines to the position in which they are indicated by dotted lines. To facilitate the movement of the segmental parts *j'*, *j*², *j*³, *j*⁴ and bars *y* upon the plate *a* it is convenient to provide balls 10 mounted in grooves formed in the plate *a* and in the adjacent parts of the segmental parts *j'*, *j*², *j*³ or *j*⁴ and bars *y* in proximity to the plate *a*.

When the chill-body formed by means of the segmental parts *j'*, *j*², *j*³, *j*⁴ and parts *y* is being prepared for use, plumbago or other refractory material or suitable fusible alloy is applied so as to fill and pack the joints between adjoining segmental parts and between the segmental parts and the parts *y* so that when the shafts *m* have been turned to move the several segmental parts into the positions in which they are indicated in full lines in Fig. 2 and the shaft 6 is turned so as to force the parts *y* outwards into the position in which they are shown in full outline in Fig. 2, the said plumbago or other refractory material or alloy shall form a joint between the parts *y* and segmental parts sufficiently tight to prevent air from passing through the joints of the chill-body and interfering with the soundness of the casting to be formed. The said plumbago or other refractory material or alloy yielding to pressure also enables the segmental parts *j'*, *j*², *j*³, *j*⁴ and bars *y* to expand as they become heated by the metal to be cast around the chill body and prevents air from getting in through the joints and if it be requisite or desirable the interstices between the segmental parts and between the segmental parts and the parts *y* on the outer surface of the chill-body may be filled or calked in any convenient manner with plumbago or other refractory material so that the chill-body may be made to present a cylindrical outer surface as nearly smooth as may be necessary.

The shafts *m*, 6, which are mounted on the eccentric cams *o*, 5 are arranged so that when turned to move the segmental parts and parts *y* into the positions in which they are shown in Fig. 2, the eccentric cams *o*, 5 shall not be liable to be turned by pressure exerted upon the pins *l*, 4 respectively. In the case illustrated channels are formed around the top and bottom of the chill-body, each channel being formed in parts in the several segments and the bars *y* crossed by it to receive loam or other refractory material to preserve the casting from chilling at the parts opposite to such channels.

In the case illustrated in Fig. 1 the chill-body *i* is surrounded by a molding-box 11^a containing a mold 11 formed with gates or runners 12 of which only one is shown, by which molten metal may be conveyed to the bottom of the mold so as to fill the mold by rising therein. The loam or refractory material 13 around the lower end of the chill-body serves in this case to prevent the molten metal from being chilled before it is able to rise in the mold. The metal might however be

poured into the mold 11 from the top if preferred. When the mold 11 has been filled with the molten metal and time has been allowed for the solidification of the metal, the shaft 6 is turned so as to cause the eccentric 5 to draw in the bars *y* into the position in which they are indicated in dotted lines in Fig. 2 and the shafts *m* are slightly turned so that as the metal cast around the chill-body contracts and presses upon the segmental parts *j'*, *j*², *j*³, *j*⁴, the pins *l* shall be made to turn the eccentric cams *o*, the segmental parts *j'*, *j*², *j*³, *j*⁴ thus yielding automatically to the contraction or shrinkage of the metal casting. Afterwards at any convenient time the shafts *m* may be further turned to draw the segmental parts *j'*, *j*², *j*³, *j*⁴ away from the internal surface of the casting to allow air to pass between the casting and the outer surfaces of the segmental chilling surfaces *j'*, *j*², *j*³, *j*⁴ so as to preserve them in condition for use as long as possible. Holes *E*, *F* are provided in the plate *a* and framework *e* to allow air to pass into and out of the space surrounded by the segmental parts *j'*, *j*², *j*³, *j*⁴. When the casting formed around the chill-body *i* has become cooled sufficiently the cotters *d* may be removed from the pins *c* and the plate *a* and chill-body *i* may be removed from the casting by means of the rings 9 and then the chill-body *i* may be prepared for use for another casting for which either the segmental plates *j'*, *j*², *j*³, *j*⁴ and bars *y* or other similar parts may be used.

The segmental parts *j*³ are shown as provided with holes 13^a to receive sand or other refractory material so as to reduce the depth of or prevent the chilling action on adjacent parts of the casting formed around the chill-body at any parts where deep chilling or any chilling may be undesirable as for example where it may be requisite to guard against cracks or rupture at places where uneven thicknesses or double walls of metal would occur in the casting, as for example in the portways of a steam-engine-cylinder. Instead of being arranged to be turned by means of keys applied to square portions at their upper ends as in the case illustrated in full lines in Fig. 1 the shafts *m*, 6 may be arranged in any case in which it may be preferable, to be turned by means of keys applied to square or other parts at their lower ends and in any such case the shafts *m*, 6, will be made to extend downwards through holes in the plate *a* in the manner indicated by dotted lines in Fig. 1 so that access to the lower ends of the said shafts for the application of keys thereto may be obtained through spaces 14 provided between the legs or other supports or in the lower part of the molding box *b*.

It is generally desirable and in the case of a chill-body of great length, as for example about 2 feet long, it is necessary to guard against accidental premature displacement of the parts *y* or segmental parts *j'*, *j*², *j*³ and *j*⁴ and in any such cases I provide means to lock the shafts *m*, 6 in position to hold the segmental parts and parts *y* in the position in which they are indicated in full lines in Fig. 2 and Figs. 7 and 8 illustrate one apparatus for the said purpose as applied in conjunction with four shafts *m* and a shaft 6. Around the shaft 6 illustrated in Figs. 7 and 8 is placed a frame 15 provided with arms each of which embraces one of the four shafts *m*. The shaft 6 and each of the shafts *m* shown in Figs. 7 and 8 are provided with collars 16. The collar 16 upon each

of the shafts *m* is provided with a notch to receive a corresponding projection 17 provided upon the frame 15 when the said shaft *m* has been turned into position to hold the segmental part or parts *j'*, *j''*, *j'''*, or *j⁴* connected to it in position for casting. The collar 16 upon the shaft 6 is provided with two notches in which two projections 18 upon the frame 15 may enter when the shaft 6 has been turned into position to hold the wedge-shaped bars *y* operated by means of it in position for casting. The frame 15 may be arranged at the upper ends of the shafts *m*, with which it is used and in that case may be simply allowed to fall so that the projections 17, 18 may pass into engagement with the notches in the collars 16 or the frame 15 whether arranged at the upper ends of the shafts *m*, 6 with which it is used or at the lower parts thereof may be moved by means of any mechanical appliance, for example, as in the case illustrated in Figs. 7 and 8, a hand-wheel 19 provided with a screw 20 engaging with screw-threads formed in the frame 15 may be mounted upon the shaft 6 so that being turned it will raise or lower the frame 15, though obviously a locking apparatus of any other suitable kind, may be provided. It is convenient to provide pointers 21 two of which are indicated in Figs. 7 and 8 upon the plate *e'* of the framework *e* to indicate in conjunction with marks 22 upon the collars 16, when the shafts *m*, 6 have been turned into position to hold the segmental chilling parts and bars *y* in position for casting.

It is obvious that as chilling apparatus constructed according to this invention will be constructed and employed for use in the casting and chilling of articles of different sizes and forms at different times, there are many varieties of fastenings and attachments which may be employed in different cases to enable chilling surfaces to be secured to the parts used to carry them.

It will be readily understood that the mold 11 surrounding the chilling apparatus constructed according to this invention and the mold below and the mold, if any, above a chilling apparatus constructed according to this invention may be made of sand, loam or metal or any other material according to the form of the casting to be produced and the nature whether chilled or otherwise which it is desirable to impart to the outer surfaces thereof, and that the chill-bars *y* whether continuous or built up in sections may be formed with holes or channels to receive sand or other refractory material at parts thereof for the reduction of the chilling effect in parts of the castings to be produced.

An expansible and contractible chilling apparatus constructed according to this invention while enabling any requisite chilling effect to be produced upon the castings formed by its use also enables all strain or other injury of or to the castings to be obviated and this invention also enables chill-bodies of very different sizes and forms to be very readily built up from time to time as may be necessary and also facilitates the casting of chilled cylinders and chilled cylinder-liners for steam-engines and internal combustion motors and chilled casings for use in turbines operated by steam or by the action of combustible gases or vapors or sprays.

The application of chill-bodies constructed according to this invention in the casting of steel or copper or other metals or alloys into hollow forms, for instance, bodies to be drawn out into tubes, sleeves or bushes or

the like will be readily understood from the preceding description of the apparatus as used for iron castings and is especially advantageous in enabling provision to be made for the rapidity and extent of the contraction experienced in casting copper and steel and brass and other alloys.

The application of sand or other refractory material as hereinbefore described with reference to the application of the loam 13 and with reference to the holes 13^a facilitates the running of molten steel, aluminium and brass or other alloys into molds at any parts at which it may be desirable to insure the rapid flow of the molten metal or alloy and preserve the "life" of the chill-body as much as possible.

In forming castings in steel it is necessary to form holes extending through the chill-body and formed at suitable distances apart throughout the whole extent thereof so that sand or other refractory material may be placed therein in order to preserve the "life" of the chill-body as much as possible in the manner indicated in Figs. 9 and 10.

It will be obvious that the segmental chilling parts and triangular or wedge-shaped or other parts to fill longitudinal spaces used in a chill-body according to this invention whether used for casting in iron or for other metals or alloys being removable, may be readily replaced by other corresponding parts when burned or otherwise injured.

What I claim and desire to secure by Letters Patent is:—

1. In an expansible and contractible chilling apparatus for internally chilling hollow castings in cast iron, the combination with a plate or table of segmental chilling parts, forming when used together a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and to be connected to the said segmental chilling parts and means to connect the said pins to the said segmental chilling parts, cams to move the said pins and to be set to be moved thereby and devices to support the said cams and to turn them, and so to move the said segmental parts into and out of position for casting and to set them in position to be moved by the said segmental parts in the contraction and shrinkage of castings, and mechanism to be used to move the said filling pieces into and out of and hold them in position for casting, substantially as hereinbefore described.

2. In an expansible and contractible chilling apparatus for internally chilling hollow castings in cast iron, the combination with a plate or table, of segmental chilling parts, forming when used together a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts and means to connect the said pins to the said segmental chilling parts, cams to move the said pins and to be set to be moved thereby and shafts to move the said cams and so to move the segmental parts into and out of position for casting, and to set them in position to be moved by the said segmental parts in the contraction and shrinkage of castings, and mechanism to be used to move the said filling pieces into and out of and hold them in position for casting, substantially as hereinbefore described.

3. In an expansible and contractible chilling apparatus for internally chilling hollow castings in cast iron, the combination with a plate or table, of segmental chilling parts, forming when used together a chill-core-body with

divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts, and means to connect the said pins to the said segmental chilling parts, cams to move the said pins, shafts to move the said cams and so to move the segmental parts into and out of position for casting, and to set them in position to be moved by the said segmental parts in the contraction of castings, pins mounted to slide in the said framework to receive and be connected to the said filling pieces, cams to move such pins, a shaft to move the said cams and to move the said filling pieces into and out of position and hold them in position for casting, substantially as described.

4. In an expansible and contractible apparatus for chilling hollow castings in cast iron, the combination with a plate or table, of segmental chilling parts, forming when used together a chill-core body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts, and means to connect the said pins to the segmental chilling parts, cams to move the said pins and to be set to be moved thereby, shafts to move the said cams, and so to move the segmental parts into and out of position for casting and to be set to allow the said segmental parts to be moved by the contraction of castings, pins mounted to slide in the said core-bar to receive and be connected to the said filling pieces, cams to move such pins, a shaft to move the said cams and to move the said filling pieces into and out of position and hold them in position for casting, and means to lock and release the said shafts, substantially as described.

5. In an expansible and contractible apparatus for chilling hollow castings in cast iron, the combination with segmental chilling parts grooved on the parts intended to adjoin filling pieces correspondingly grooved, of filling pieces grooved on the parts intended to adjoin the correspondingly grooved segmental chilling parts, the grooves of the segmental chilling parts and the filling pieces serving to facilitate the application of refractory material to prevent air from passing through the divisions of the expansible and contractible apparatus to the iron cast around it and from interfering with the production of a chilled surface on the interior of the casting, substantially as hereinbefore described.

6. In an expansible and contractible apparatus for forming the interiors of hollow castings, the combination with a plate or table of segmental chilling parts, forming when used together a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts and means to connect the said pins to the said segmental chilling parts, cams to move the said pins and to be set to be moved thereby and devices to support the said cams and to turn them and so to move the said segmental parts into and out of position for casting and to set them in position to be moved by the said segmental parts in the contraction and shrinkage of castings, and mechanism to be used to move the said filling pieces into and out of and hold them in position for casting, substantially as hereinbefore described.

7. In an expansible and contractible apparatus for forming the interiors of hollow castings, the combination, with a plate or table, of segmental chilling parts forming, when used together, a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and to be connected to the said segmental chilling parts, and means to connect the said pins to the said segmental chilling parts, cams to move the said pins and to be set to be moved thereby, shafts to move the said cams and so to move the segmental parts into and out of position for casting and to set them in position to be moved by the said segmental parts in the contraction or shrinkage of castings and mechanism to be used to move the said filling pieces into and out of and hold them in position for casting, substantially as hereinbefore described.

8. In an expansible and contractible apparatus for forming the interiors of hollow castings, the combination, with a plate or table, of segmental chilling parts forming, when used together, a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts, and means to connect the said pins to the said segmental chilling parts, cams to move the said pins, shafts to move the said cams and so to move the segmental parts into and out of position for casting, and to set them in position to be moved by the said segmental parts in the contraction of castings, pins mounted to slide in the said framework to receive and be connected to the said filling pieces, cams to move such pins, a shaft to move the said cams and to move the said filling pieces into and out of position and hold them in position for casting, substantially as described.

9. In an expansible and contractible apparatus for forming the interiors of hollow castings, the combination, with a plate or table, of segmental chilling parts forming, when used together, a chill-core-body with divisions, filling pieces to fill longitudinal spaces left between adjacent segmental parts when in position for casting, a framework to carry mechanism to operate the said segmental parts and mechanism to operate the said filling parts, pins mounted to slide in the said framework to receive and be connected to the said segmental chilling parts, and means to connect the said pins to the said segmental chilling parts, cams to move the said pins and to be set to be moved thereby, shafts to move the said cams and so to move the segmental parts into and out of position for casting, and to be set to allow the said segmental parts to be moved by the contraction of castings, pins mounted to slide in the said framework to receive and be connected to the said filling pieces, cams to move such pins, a shaft to move the said cams and to move the said filling pieces into and out of position and hold them in position for casting and means to lock and release the said shafts, substantially as hereinbefore described.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of two witnesses, this eleventh day of March 1904.

JOHN BUTLER.

Witnesses:

HOWARD CHELTHAM,
ERNAUD S. MOSELEY.