

Oct. 29, 1935.

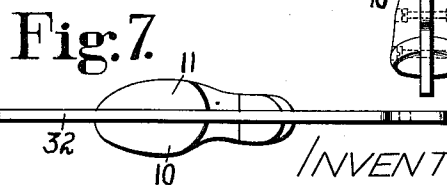
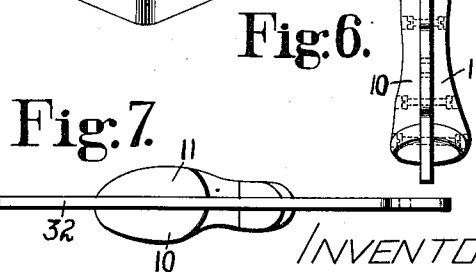
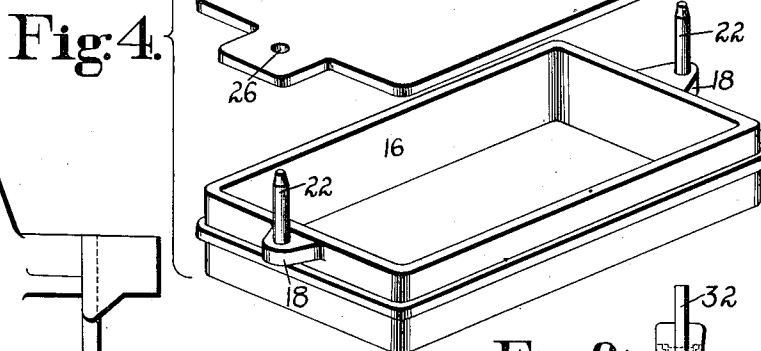
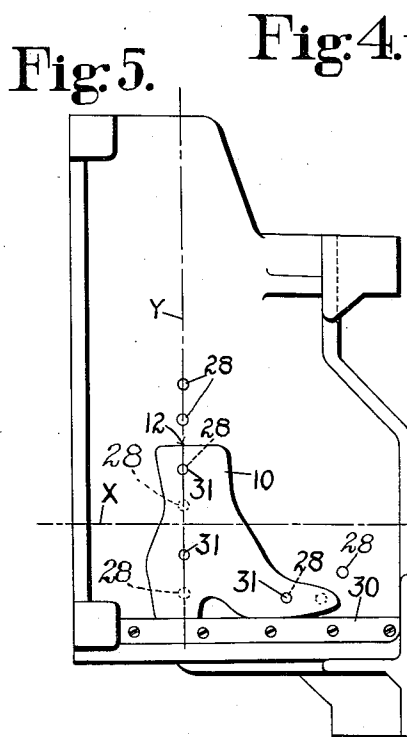
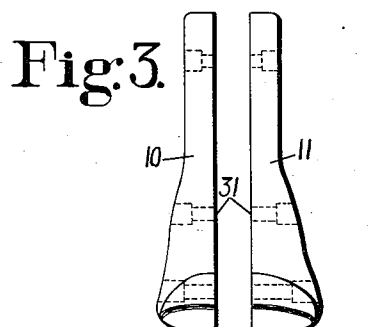
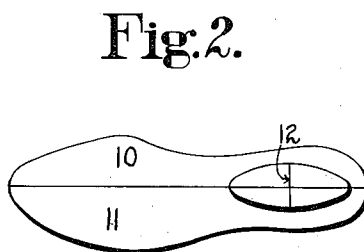
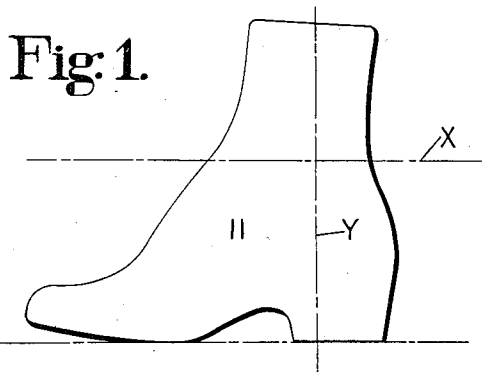
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2,018,675

METHOD OF CASTING HOLLOW OBJECTS

Filed May 23, 1932

4 Sheets-Sheet 1



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Fig.8.

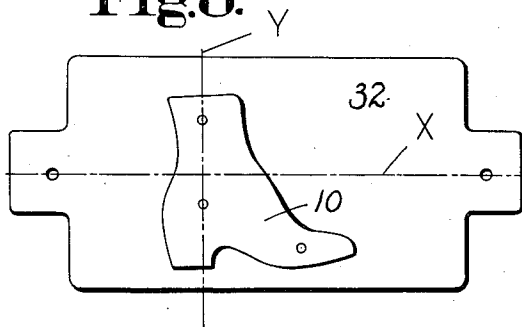


Fig.9.

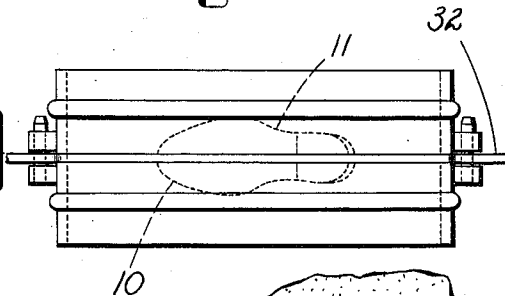


Fig.10.

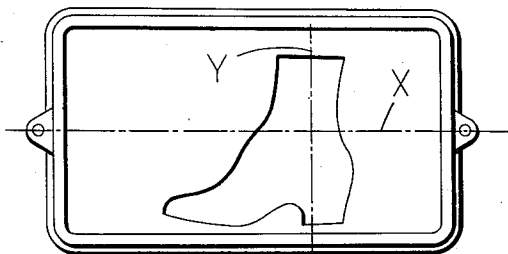


Fig.11.

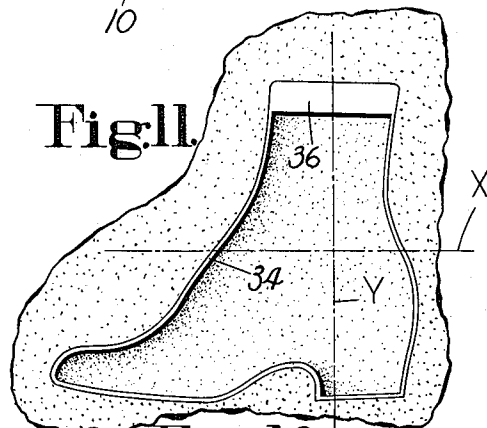


Fig.12.

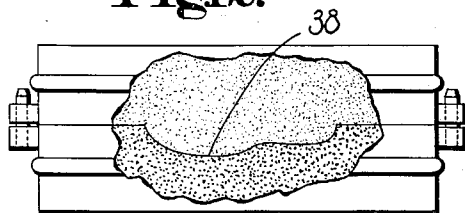


Fig.13.

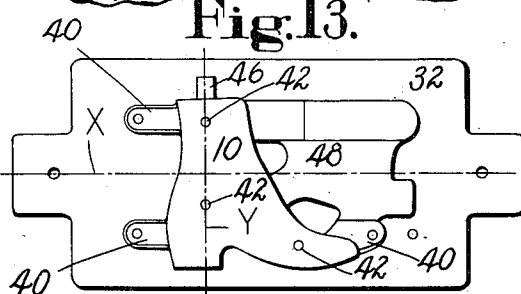


Fig.14.

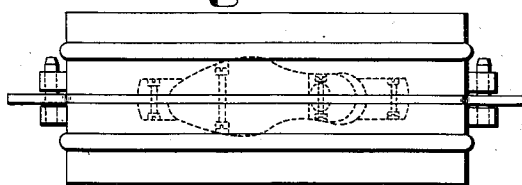


Fig.15.

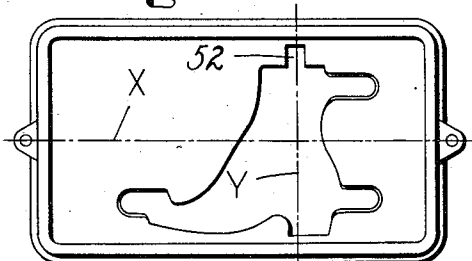
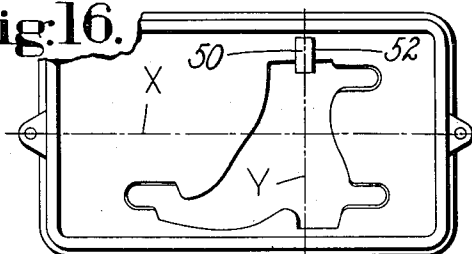


Fig.16.



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Fig:17

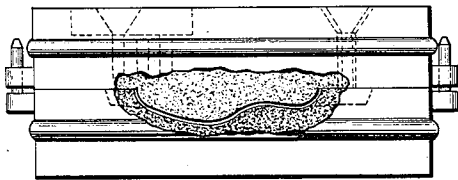


Fig:18.

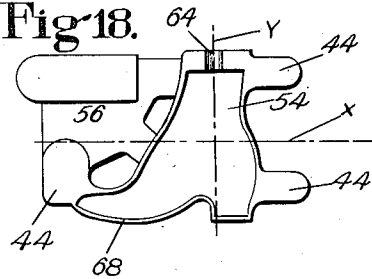


Fig:19.

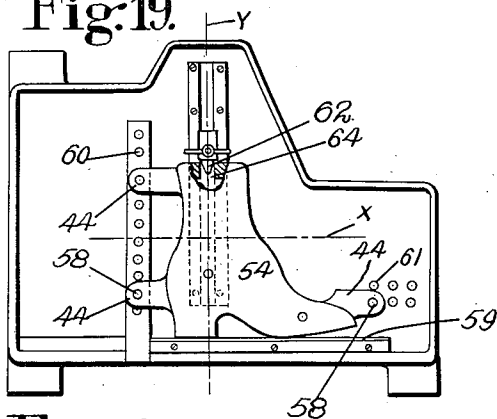


Fig:20.

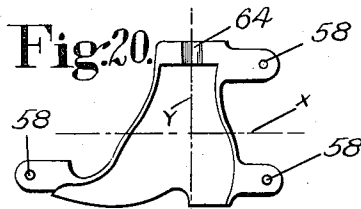


Fig:21.

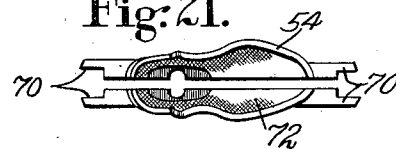


Fig:22.

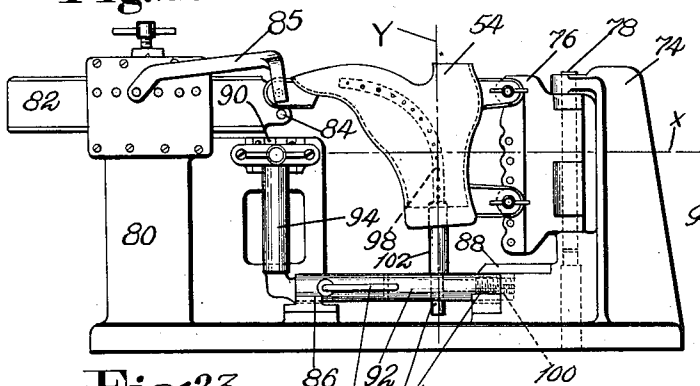


Fig:24.

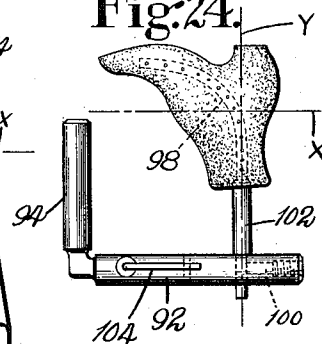
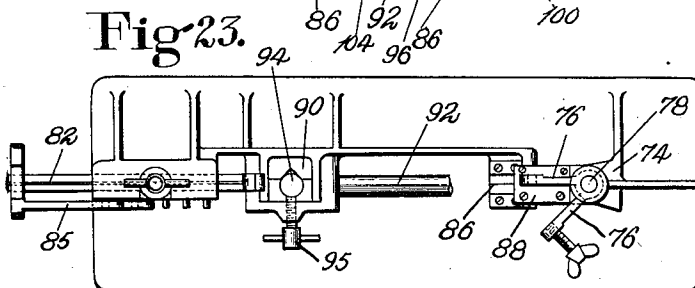


Fig:23.



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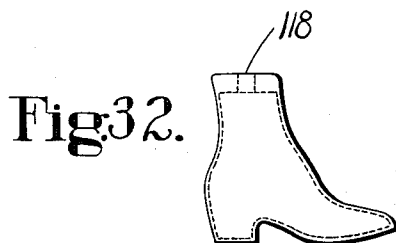
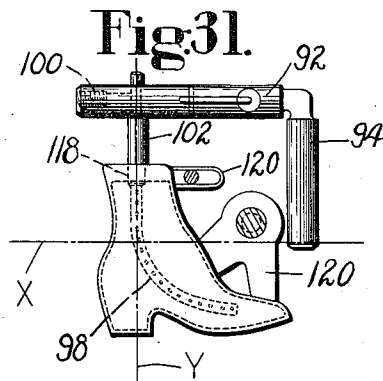
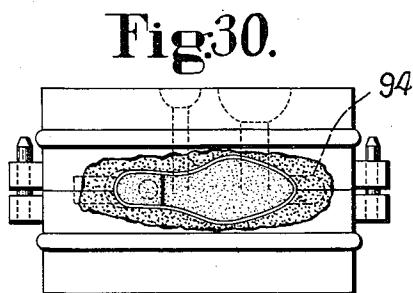
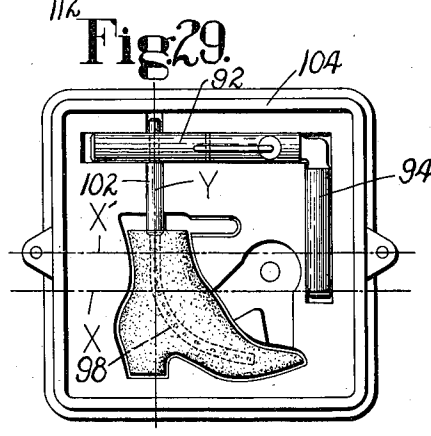
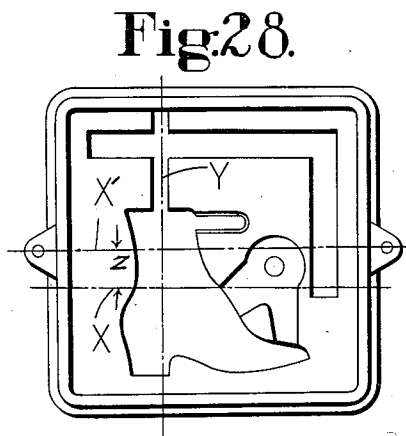
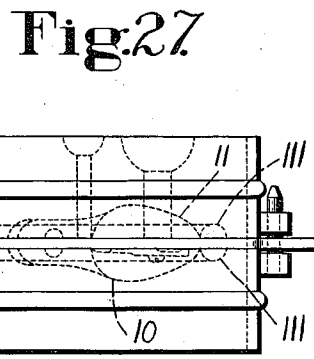
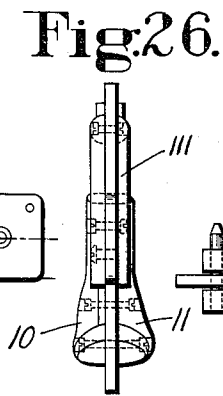
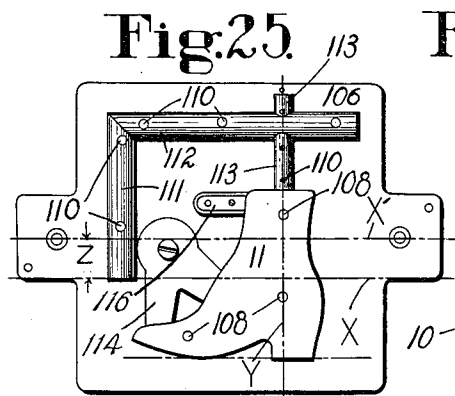
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2,018,675

METHOD OF CASTING HOLLOW OBJECTS

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4 Sheets-Sheet 4



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2,018,675

METHOD OF CASTING HOLLOW OBJECTS

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Application May 23, 1932, Serial No. 613,002

12 Claims. (Cl. 22—193)

This relation relates to the art of casting hollow objects, and is disclosed in connection with a method of casting hollow metal lasts for use in making rubber shoes.

5 In casting hollow objects it is necessary to support a core within the pattern impression, that is, the hollow in the sand, the periphery of which corresponds to the outside surface of the pattern. In case the object is such that a number of holes in it are permissible, the core may be supported
10 on arms extending through the holes into the sand in the flask; in case such holes are not permissible, chaplets are used to space the core properly from the mold.

15 In the case of metal shoe lasts, these procedures are not of utility. It is not possible to produce a good rubber shoe on a last having a hole at any point where it is covered by the shoe, since local injury takes place at the hole which limits the location of an external support to the top of the
20 last, outside the shoe, and the use of chaplets results in small holes in the work, since the chaplets remain in the casting and are never perfectly amalgamated with it.

25 In order to avoid waste of metal, it is necessary to support the core accurately within the pattern impression in the casting flask. If it is not so supported, the wall of the work piece will be too thick on one side and too thin on the other, unless
30 as has been the case, the average thickness of the wall is considerably increased, thus wasting metal and adding often undesirably to the weight of the casting. It has heretofore been impossible to support the core in this accurate manner without a repeated cut and try method of casting a
35 trial last, sawing it in two, then readjusting the relationship of the core to its support to correct the unbalanced condition found, and casting a succession of trial lasts, this process having to be
40 repeated for every different size and style of last.

It is an object of the present invention to provide a method of making and supporting the core which shall produce an accurate result at the first trial, without the necessity of any adjustments.

45 To this end I contemplate the establishment in the pattern of a reference frame comprising a pair of axes extending transversely to each other, at the beginning of the series of steps looking to the production of a work piece, and in certain subsequent steps in the series gaging or locating from
50 similar axes the part being produced or treated, in the same relation to the axes as was exhibited by the pattern. The core and its support and the pattern impression, being all located in the same
55 way from these axes, will necessarily assemble in

exactly the desired relation. These axes are established in the objects to which they relate by various physical indices, such as marks or scratches, drilled holes, flask pins and flask pin and match plate holes, and other gaging means or surfaces of various types.

The method will be understood from the following description of its application to the casting of hollow metal lasts which is illustrated in the drawings, in which

Fig. 1 is a side elevation of the last pattern;
Fig. 2 is a plan of the last pattern;
Fig. 3 is a front elevation of the last pattern;
Fig. 4 is an exploded view of a flask;
Fig. 5 is a plan of the pattern drilling jig;
Figs. 6 and 7 are end and side elevations of the match plate with the pattern attached;
Fig. 8 is a plan view of the same;
Fig. 9 illustrates the impression made from the match plate of Figs. 6, 7 and 8;
Fig. 10 shows one of these impressions;
Fig. 11 illustrates the lining of the impression of Fig. 10;
Fig. 12 illustrates the making of the mold for the inside core box surface;
Fig. 13 shows the match plate ready to make the impression for the outside core box surface;
Fig. 14 illustrates the impressions made from the match plate of Fig. 13;
Fig. 15 shows one of these impressions;
Fig. 16 shows the core print in place in the impression of Fig. 15;
Fig. 17 illustrates the casting of the half core box;
Fig. 18 shows the half core box;
Fig. 19 shows the core box drilling jig;
Fig. 20 shows the finished half core box;
Fig. 21 is a bottom plan of the complete core box;
Figs. 22 and 23 are a side elevation and plan of the core box stand;
Fig. 24 shows the finished core and its support;
Fig. 25 is a plan of the match plate with the last and core support patterns;
Fig. 26 is an edge view of the same;
Fig. 27 illustrates making the impressions for the last to be cast;
Fig. 28 shows one of the impressions;
Fig. 29 shows the core and its carrier in position in the impression;
Fig. 30 illustrates the casting of the last;
Fig. 31 shows the last and core carrier as removed from the flask; and
Fig. 32 shows the finished work piece.
The last which it is proposed to cast hollow in

metal is shown in Figs. 1 and 2. It is either turned in one piece and then split, and the thickness of the kerf filled with thin plates of veneer, or it is turned from two pieces of wood 10, 11 temporarily fastened together and readily separated when the turning is done. The last parts so separated are shown in Fig. 3. A central gage mark 12 is made across the top of the pattern last parts from side to side as shown in Fig. 2.

10 In making the core box and the finished hollow article, an ordinary flask, preferably of metal with well fitting parts, is used. This flask is shown in Fig. 4 and comprises an upper frame 14, called the cope, and a lower frame 16 called the drag or nowel. These frames have no top or bottom, and are provided at their ends with ears 18 having holes 20 through which pins 22 can be thrust to hold them in exact alinement one above the other. These pins are generally fixedly mounted on the ears of the drag. A match plate 24, which is simply a flat plate with holes 26 in its ends registering with the holes in the ears in the flask parts, so that the plate can be held accurately between the two flask parts, is used in some steps of the method.

The fundamental axes X and Y (Fig. 1) are first related to the pattern, and in this operation the gage mark 12 and the line tangent to the heel bottom and ball portion of the last are used as gages, by means of which the locations of the axes can be actually marked on the pattern if desired.

One half of the pattern 10 is put on a jig (Fig. 5) which has a series of holes 28 and a rib 30 which are definitely located relatively to two (perhaps imaginary) axes or lines X and Y. The quantitative nature of the location is not important but its definiteness is important since the match plate to be used has holes in it located at the same distance from similar axes. One co-linear row of holes may be and as illustrated is centered on the line Y in the jig. The line X and the rib 30 are at right angles to the line Y.

The half pattern 10 is put on the jig with its heel and forepart bottom resting on the rib 30, and the gage mark 12 in its top in alinement with the line Y. The half pattern is then clamped down on the jig in any convenient way and suitable holes 31 are drilled in it through selected holes 28 of the jig, and the known relation between the holes 28 in the jig and the axes X and Y effectively locates such axes in the half pattern last. The jig is provided with numerous holes, not all shown in Fig. 5, for a large variety of sizes and shapes of lasts, and those holes are used that are best adapted to the particular job. The jig may be turned over and used on its other side for the other half last pattern 11, which is then treated in the same way, or the half pattern 11 may be drilled directly from the half pattern 10. Thus the holes in the two drilled half patterns will exactly match.

The half patterns 10, 11 are then bolted on a match plate 32, Figs. 6, 7 and 8, provided with the same series of holes that have been used in drilling the half patterns, located in the same way relatively to two lines X and Y, the former of which conveniently passes through the pin holes, and the latter of which is conveniently located at one side of the center of the plate, for economy in sand and to lighten the flask. The match plate 32 with the attached pattern is shown in Figs. 6, 7 and 8.

The making of the core box will next be discussed. This is a hollow box for shaping the core

that is to be supported in the impression indicated in dotted lines in Fig. 9 and corresponds to the air space in the finished hollow last. To make this box a pair of impressions is taken from the match plate and pattern of Figs. 6, 7 and 8. The making of such impressions is indicated by Fig. 9. They are related to the axes X and Y exactly as the pattern is. These impressions are made of a mixture of sand and plaster of Paris which sets fairly hard and are preferably coated with shellac. Such an impression of the right half of the pattern is shown in Fig. 10. This impression is lined with some convenient substance 34 (Fig. 11), such as a rubber fabric about $\frac{1}{2}$ of an inch thick, the thickness being that of the walls of the finished article desired. The lining 36 of the top of the impression is made about $\frac{3}{4}$ of an inch thick and is formed of plastic clay, or other plastic material. The result is shown in Fig. 11. Another half flask is then placed on top of the half flask shown in Fig. 10, and a mold 38 is made in it in green sand, from the impression of Fig. 10. This is illustrated in Fig. 12. The mold 38 thus formed corresponds to the inside of the core box, being $\frac{1}{2}$ of an inch smaller than the pattern except at the top, where the deficiency is $\frac{3}{4}$ of an inch. This mold is related to the axes X and Y in the same definite way as heretofore discussed. A mold is made in the same manner from the other half of the pattern.

The impression for the outside of the core box is made as follows. Wooden lug patterns 40, preferably three in number, Fig. 13, are applied to each side of the match plate 32 of Figs. 6, 7 and 8, adjacent to the half patterns, and are bolted to the match plate by bolts passing through conveniently located holes 42 (not shown in Figs. 6, 7 and 8). These lug patterns 40 serve to make the impressions from which the lugs 44 (Fig. 19), which hold the two halves of the core box together, are cast. A semi-cylindrical core print 46 is also attached to each side of the match plate; this is to make an impression 52 which is to hold a core 50 which makes a hole 64 for the core support to be described. A gate pattern 48 is also applied to one side of the plate. The match plate is then assembled with two half flasks, and impressions formed from both sides of it, which are shown assembled in Fig. 14. Fig. 15 shows the right side impression. These impressions have the same relations to the axes X and Y as heretofore discussed. A semi-cylindrical core 50 is put in the core print impression 52. This core is longer than the core print impression by the thickness of the filling 36 at the top of the impression in Fig. 11. The mold, Fig. 12, for the inside surface of this side of the core box is then assembled with the impression of Fig. 16, in their half flasks, Fig. 17, and the half core box 54 shown in Fig. 18 is cast. This has the same definite relation to the axes X and Y heretofore discussed. The gate metal 56 is then cut away. The holes 58 in the lugs 44 are drilled in a jig (Fig. 19) having a rib 59 located relatively to the axes X and Y exactly as is the rib 30 (Fig. 5) and having suitable holes 60, 61 for use in drilling the lugs 44. These holes may be located exactly like the holes 42 for attaching the lug patterns 40 in Fig. 13 but they need not be so located, as it is necessary only that they correspond with holes in the core box stand, to be described. The inside edges of the half core box 54 are first ground flat, and it is placed on the jig, shown in Fig. 19, with its bottom which is thus used as a gaging surface, on the rib 59, and

with a semi-conical plug 62 arranged to slide along the axis Y positioned to fit in the hole 64, another gaging surface, which has been formed in its top by the core 50. The holes 58 in the lugs are then drilled through the appropriate holes 60 of the jig. The jig is reversible so that the other side can be used for the other half of the core box. The bottom wall 68 of the core box is cut away and the lugs 44 are cut back on their inside surfaces at 70 to receive suitable supports (Fig. 22), as will be seen. The finished half core box 54 is shown in Fig. 20. The other half core box 72 is made in the same way and the two halves are shown in Fig. 21. These half core boxes have the same definite relation to the axes X and Y, as heretofore discussed, and the hole 64 and floor line, and the drilled holes, constitute two sets of gaging means by which the axes can be actually marked on the core box if desired.

In making the core the halves 54, 72 of the core box are mounted on a core-making or core box stand shown in Figs. 22 and 23, the elements of which are all located relatively to axes X and Y, as will be seen. This stand has a post 74 at one end to which the two leaves 76 of a hinge are pivoted on a vertical axis 78. These hinge leaves are provided with holes located relatively to the axes X and Y exactly as are the holes 60 for the rear lugs in the drill jig of Fig. 19, and are accurately fitted so that there is no lost motion. At the other end of the stand is a post 80 having a horizontal slide 82 with two holes 84 having the same spacing from the axis X as the holes 61 for the toe lugs in the drill jig of Fig. 19. The holes 60 and 61 are used as gaging means for locating the core box on the stand, as will be seen. The two halves 54, 72 of the core box are bolted to the hinge leaves, in the holes corresponding to those used in the drill jig, and are freely swingable about the axis of the hinge. When swung together they can be pinned through the appropriate hole to the slide 82 at the toe by a latch 85. The core-making stand has two fixed V blocks 86 and an overhanging member 88 located on its base, and another fixed V block 90 located on the post at its end. These V blocks are located at definite distances from the axes X and Y and are arranged to hold a core support, comprising two cylinders 92, 94 at right angles, which nests in them and is positively held in a definite position in them by a screw 95 at the upper V block. The horizontal cylinder 92 is held steady under the member 88 and has a hole 96 in line with the axis Y in which a core arbor tube 98 is held by a set screw 100. The core arbor tube 98 is surrounded by a sleeve 102 long enough to reach through the thickened top of the core box, and a little way into its interior. The core box, when placed on the stand and closed, is packed with green sand and plaster and the two sides 54, 72 are then opened up and the core and its support removed, as shown in Fig. 23. The horizontal cylinder 92 has a member 104 pivoted in a slot in it, like a jack knife blade, which can be turned out and used to prop the core and its arbor in an approximately vertical position. Thus the core and its support have been definitely related to the axes X and Y.

In order to cast the hollow last itself, a somewhat differently shaped flask is preferably used, in order to effect economy of sand, and convenience in handling. The axis X' of the two pin holes in the flask is located at a known distance Z from the axis X. The match plate 106 (Fig. 25) for this flask is equipped with the same se-

ries of holes 108 as the match plate of Figs. 6, 7 and 8, located in the same way relatively to the axes X and Y, and the two half last patterns 10, 11 are bolted on this plate in the same way as in Figs. 6, 7 and 8 and are thus in the same relation to the axes X and Y. The match plate 106 of Fig. 25 is also equipped with holes 110 located on lines located relatively to the axes X and Y in exactly the same way as the center lines of the cylinders 92, 94 of the core support and of the core arbor tube. By means of these holes semi-cylindrical patterns 111, 112, and 113 are bolted on the match plate, corresponding to the core support and the tube and sleeve. Both sides of the match plate are equipped in this way, as shown in Fig. 26, and a gate pattern 114, and an outlet pattern 116 are provided on one side of the plate. The plate 106 is then assembled with a flask as shown in Fig. 27, and impressions of its two sides are made, that in the nowel being shown in Fig. 28. The core support and core are then placed in position in the nowel as shown in Fig. 29. This is conveniently done by holding the whole unit by the jack knife member 104, settling the horizontal cylinder 92 into place and allowing the core and the vertical cylinder 94 to drop gently into place. The core support and its impression in the sand thus serve as gaging means for the core and pattern impression. The cope is then put into position, as in Fig. 30, and the hollow last is cast. When cool, the contents of the flask are removed, as shown in Fig. 31, the set screw 100 is loosened, the core support cylinders 92, 94 removed, the sleeve 102 slipped off and the core arbor tube 98 moved around to loosen the sand. The sand and arbor tube member are shaken out of the hole 118. The gate and outlet metal 120 are then cut off and the finished product is as shown in Fig. 32.

To recapitulate the above-described procedure, a definite relation is first established between the pattern and its axes in the pattern drilling jig, the same relation is then established between the pattern and the core box casting flask axes by bringing the two pairs of pattern and flask axes into coincidence in the flask, a surface interior to the pattern is then formed in definite relation to these coincident pairs of axes, a mold of the interior core box surface is formed in the same definite relation to these axes, a core box is cast in the same relation to these axes, the core box is drilled in a certain definite relation to these axes, the core box is gaged on a core box stand by means of the drilled holes, in the same relation to the axes, a core support is held on the stand in a definite relation to the axes, a core is formed on it in the core box, the core and its support are combined with an impression of the pattern and of the core support in a pattern casting flask, all in the same relation to the axes, and the work piece is then cast.

While this procedure has proved successful, economical and convenient, not all of its steps are vital to the invention in its broadest aspect. It is not necessary that the core box itself be made by the exact procedure described, since any core box having suitable gaging means on it can be introduced into the method of the invention. The particular jig of Fig. 19, for example, will handle any core box the lower face of which corresponds to the lower face of the pattern last, and which has a properly centered hole in its top surface. In a broader aspect

therefore the invention contemplates establishing in a core box made for the pattern a pair of axes having the same relation to the inside surface of the core box as have the pattern axes to the corresponding surface inside the pattern, making a core in the box, thus relating the core to the axes, and assembling the core and an impression of the pattern with the core axes and pattern axes in coincidence.

10 Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. The method which consists in applying on a pattern suitable physical indices indicating two axes lying transversely to each other, locating in a core box made for said pattern suitable physical indices indicating two axes also lying transversely to each other and located in the same relation to the interior surface of the core box as the two first-mentioned axes bear to the surface inside the pattern which corresponds to the desired interior surface of the finished casting, making a core in the core box thus establishing the same relation between the axes previously located in the core box and said core, making an impression from the pattern in proper relation to physical indices determining two axes lying transversely to each other and located in the same relation to the surface of the impression as the two first-named axes bear to the surface of the pattern, and assembling the core and the impression from the pattern with the pair of axes on the impression and the pair of axes on said core in coincidence, whereby the core is positioned accurately in a predetermined position in the impression from the pattern, thereby to insure equal thickness of the walls of the finished article.

2. Establishing in a pattern, through physical indices on the pattern, two axes lying transversely to each other, establishing through physical indices in a core box made for said pattern two similarly relatively located axes in the same relation to the interior surface of the core box as the two first-mentioned axes bear to the surface inside the pattern which corresponds to the desired interior surface of the finished work piece, making a core in the core box in rigid attachment to a core carrier which is located in a predetermined relationship to the core box indices, thus establishing the core box axes relatively to the core and the core carrier, making an impression of the pattern combined with an impression of the core carrier, the latter impression having the same relation to the pattern axes as the core carrier itself had to the core axes when the core was made, and assembling the core and the combined impressions with the pattern axes and the core axes in coincidence.

3. Establishing physical indices in a pattern which define two axes lying transversely to each other, forming on a core box made for said pattern gaging indices in a definite relation to a pair of axes having the same relation to the inner surface of the core box as have the first-named axes to a surface inside the pattern which corresponds to the desired inside surface of the finished work piece, mounting the core box on a core box stand having gaging indices cooperating with the core box gaging indices and predeterminedly related to a second gaging surface located in the stand, making a core in the core box rigidly connected with the second said gaging surface, making an impression of the pattern combined with an impression of the last-

named gaging surface, the latter impression having the same relation to the pattern axes in the pattern impression as the gaging surface itself had to the core axes when in the core box stand, and assembling the core and the combined impressions with the pattern axes and the core axes in coincidence.

4. Locating by means of physical indices in a pattern two axes lying transversely to each other, forming on a core box made for said pattern a gaging surface in a definite relation to a pair of axes having the same relation to the inner surface of the core box as have the first-named axes to an imaginary surface inside the pattern which corresponds to the desired inside surface of the finished work piece, mounting the core box on a core box stand having a gaging surface cooperating with the core box gaging surface, mounting in said core box stand a core carrier in a definite relation to said core box gaging surface, and thereby in a definite relation to the core box axes, making a core in the core box and on said core carrier, thereby relating the core and core carrier as a whole to the core box axes, making a combined impression of the pattern and of the core carrier, the latter being now located in the same relation to the pattern axes as had the core carrier to the core box axes, and assembling the combined impression and the core and carrier with the core axes and the pattern axes in coincidence.

5. Locating by means of physical indices in a pattern two axes lying transversely to each other, locating by means of physical indices in a flask two similarly relatively located axes, forming in the flask a surface corresponding to the desired inside surface of the finished work piece and located relatively to the flask axes in the same relation as is the corresponding surface inside the pattern to the pattern axes, casting in the flask a core box having the said surface as its interior surface, thereby locating the flask axes in the core box, and forming on the core box physical gaging means having a predetermined relation to the core box axes.

6. Locating by means of physical indices in a pattern two axes lying transversely to each other, locating by means of physical indices in a flask two similarly relatively located axes, forming in the flask a surface corresponding to the desired inside surface of the finished work piece and located relatively to the flask axes in the same relation as is the corresponding surface inside the pattern to the pattern axes, casting in the flask a core box having the said surface as its interior surface, thereby locating the flask axes in the core box, forming on the core box physical gaging means having a predetermined relation to the core box axes, placing the core box on a core box stand having gaging means cooperating with the said core box gaging means, placing also on the core box stand a core support in a definite predetermined relation to the core box axes, by means of the two gaging means on the box and the stand, and making a core in the core box in rigid connection with the core carrier.

7. Locating by physical indices in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting an interior core box surface from said mold, in the

same relation to said axes, thereby locating the axes in the core box, establishing in a core box stand two axes having the same relative positions as those of the already-mentioned pairs of axes, mounting the core box on the stand with the core box axes and stand axes in coincidence, and forming a core in said core box in a definite relation to said axes.

8. Locating by physical indices in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting an interior core box surface from said mold, in the same relation to said axes, thereby locating the axes in the core box, establishing gaging means on said core box in a definite relation to the core box axes, establishing gaging means on a core box stand in the same definite relation to core box stand axes having the same relative position as the axes previously mentioned, mounting the core box in the stand, by means of the two said gaging means, with the core box axes and stand axes in coincidence, forming a core in the core box on a core support placed in a known relation to said axes, and assembling in a flask the support and core, and an impression of the pattern, with the pattern and core axes in coincidence.

9. Locating by physical indices in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting a core box wall from said mold in the same relation to said axes, thereby locating the axes in the core box, establishing in a core box stand two axes having the same relative positions as those of the already-mentioned pairs of axes, mounting the core box on the stand with the core box axes and stand axes in coincidence, forming a core in the core box in a definite relation to said axes, forming in a flask an impression from the pattern, supporting the core in said impression with the core axes in coincidence with the pattern axes, and casting a work piece in said flask.

10. Locating by physical indices in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting a core box wall from said mold, in the same known relation to said axes, thereby locating the axes in

the core box, establishing in a core box stand two axes having the same relative positions as those of the already-mentioned pairs of axes, mounting the core box on the stand with the core box axes and stand axes in coincidence, mounting a core support on said stand in a definite relation to the stand axes, and forming a core in said core box and on said support, in the same known relation to said axes.

11. Locating by physical indices in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting a core box wall from said mold in the same relation to said axes, thereby locating the axes in the core box, forming gaging surfaces on said core box in a known relation to said axes in the core box, mounting the core box in a core box stand having gaging surfaces arranged to cooperate with the first-named gaging surfaces, with the gaging surfaces in cooperation, making a core in the core box on a core support mounted on said stand in a known relation to the core box gaging surfaces, whereby the core and its support, as a whole, are given a known relation to said axes, forming in a flask an impression of the pattern, and an impression of the core support in the same relation to the pattern axes as has the core support to the core axes, supporting the core in said impression with the core axes in coincidence with the pattern axes, and casting a work piece in said flask.

12. Establishing in a pattern two axes lying transversely to each other, establishing in a flask two similarly located axes, placing the pattern in the flask with the two pairs of axes in coincidence, making an impression of the pattern in the flask, lining the impression in the flask, making a mold of said lined impression in a definite relation to said axes, casting a core box wall from said mold in the same relation to said axes, establishing in a core box stand two axes having the same relative positions as those of the already-mentioned pairs of axes, mounting the core box on the stand with the core box axes and stand axes in coincidence, mounting a core support on said stand in a definite relation to the stand axes, forming a core in said core box and on said support in a definite relation to said axes, said core support being connected to said core at one place only, forming in a flask an impression of the pattern, and an impression of the core support in the same relation to the pattern axes as had the core and core support to the core box stand axes, supporting the core in said impression with the core axes in coincidence with the pattern axes, and casting a work piece in said flask.

FRANK P. HYDE.