May 19, 1942. E. G. MITCHELL ET AL 2,283,450

INGOT MOLD

Filed Dec. 5, 1940 3 Sheets-Sheet 1

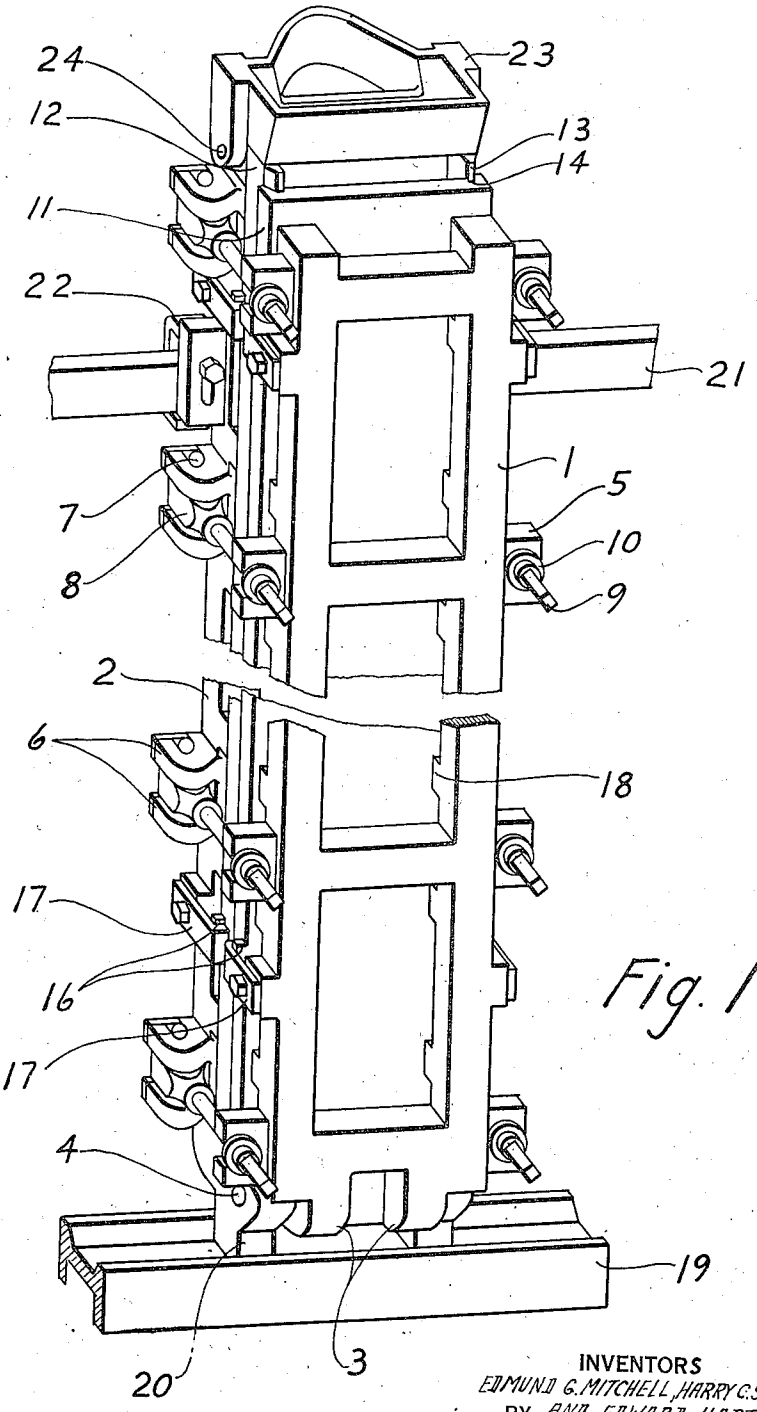


Fig. 1

INVENTORS
EDMUND G. MITCHELL, HARRY C. SCHAPER
BY AND EDWARD HARTSHORNE.
Jos. Bleicher
ATTORNEY

May 19, 1942. E. G. MITCHELL ET AL 2,283,450

INGOT MOLD

Filed Dec. 5, 1940 3 Sheets-Sheet 2

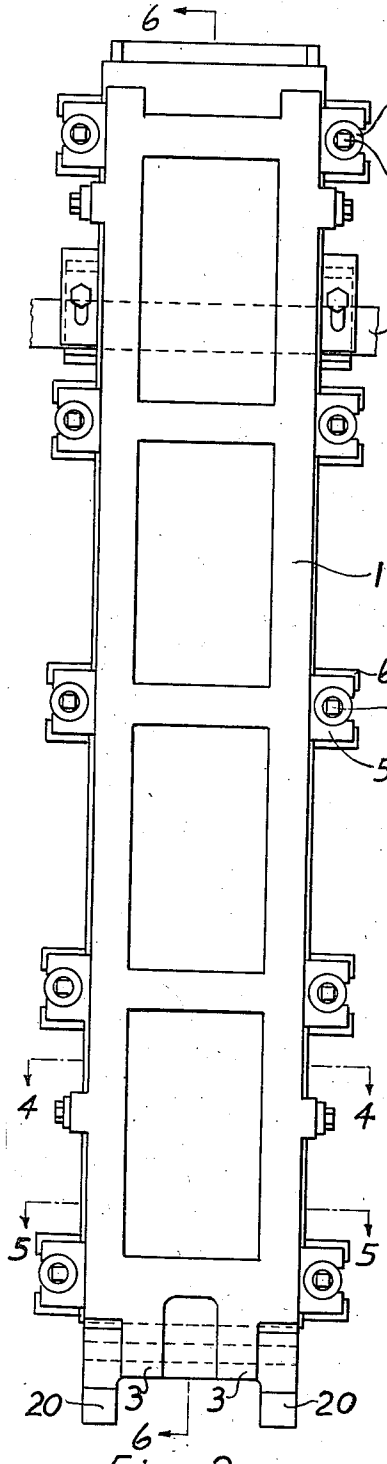


Fig. 2

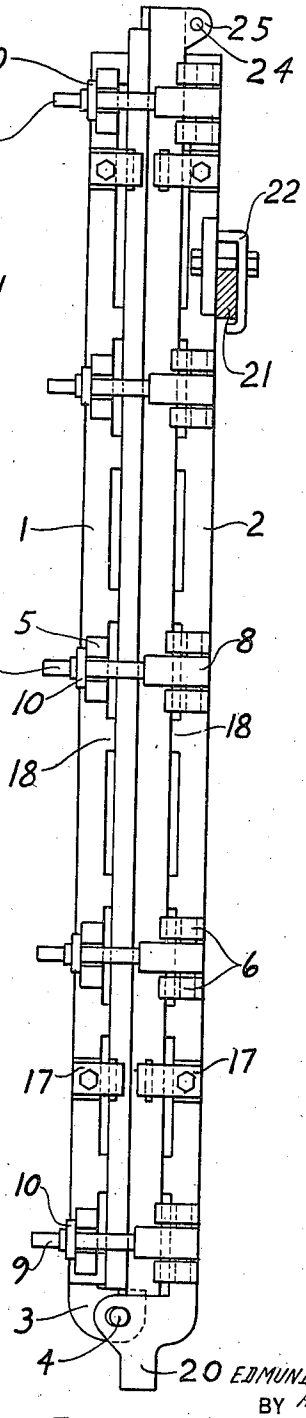


Fig. 3

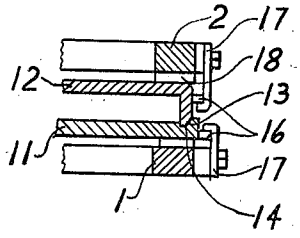


Fig. 4

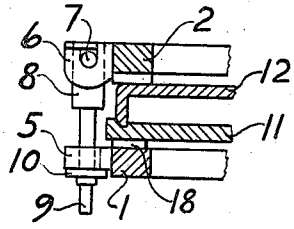


Fig. 5

INVENTORS
EDMUND G. MITCHELL, HARRY C. SCHAPER
BY AND EDWARD HARTSHORNE.
Jos. Fleischer
ATTORNEY

May 19, 1942. E. G. MITCHELL ET AL 2,283,450

INGOT MOLD

Filed Dec. 5, 1940 3 Sheets-Sheet 3

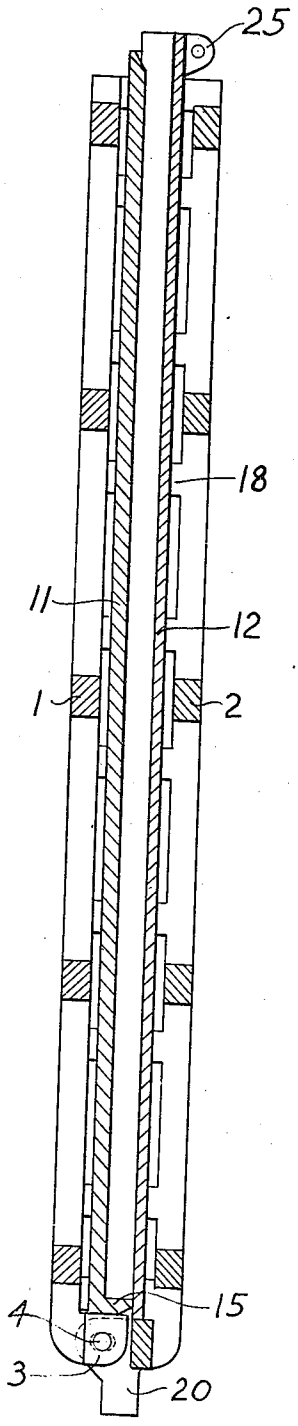


Fig. 6

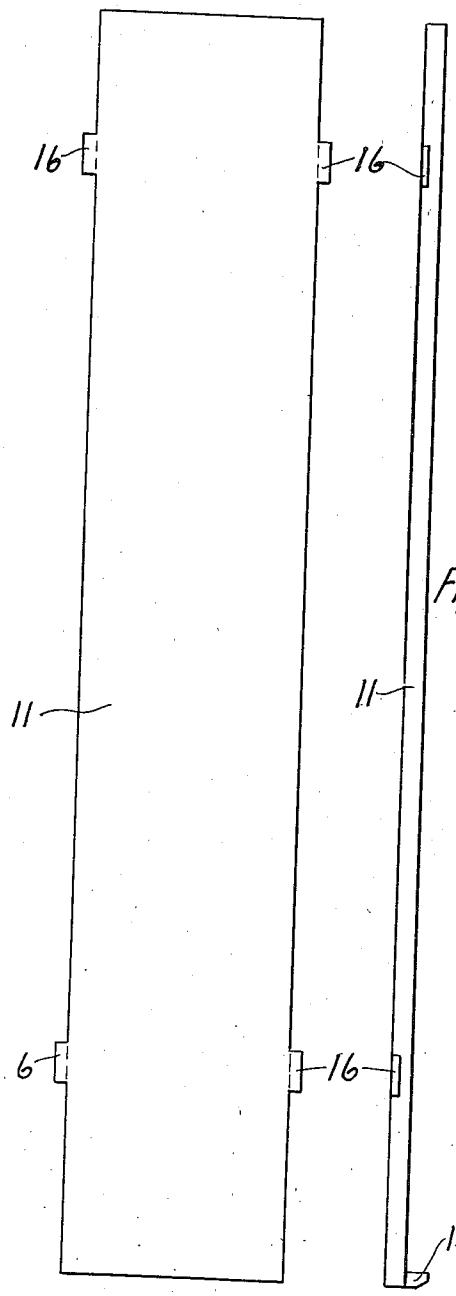


Fig. 7

Fig. 8

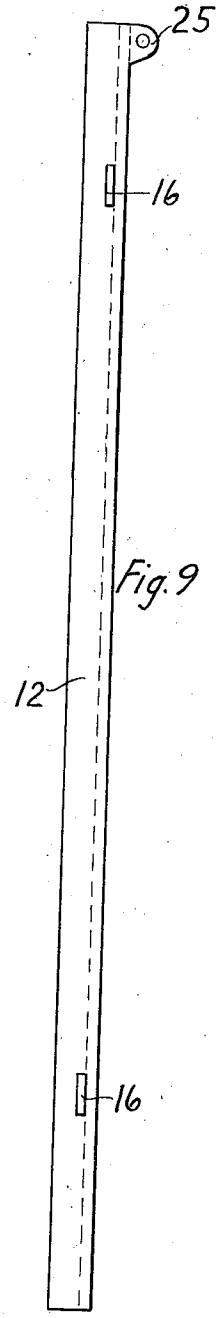


Fig. 9

INVENTORS
EDMUND G. MITCHELL, HARRY C. SCHAPER
BY AND EDWARD HARTSHORNE.
Jos. Fleischer
ATTORNEY

Patented May 19, 1942

2,283,450

UNITED STATES PATENT OFFICE

2,283,450

INGOT MOLD

Edmund G. Mitchell, Godfrey Township, Madison County, and Harry C. Schaper and Edward Hartshorne, Alton, Ill., assignors to Western Cartridge Company, East Alton, Ill., a corporation of Delaware

Application December 5, 1940, Serial No. 368,688

4 Claims. (Cl. 22—146)

This invention relates to molds, and particularly to air-cooled molds suitable for casting metal ingots, for example, elongated slabs of nonferrous metal such as are adapted for rolling into sheets.

The various prior types of air-cooled molds in which a pair of mold sections were fastened together to form an ingot-casting chamber have not provided as good service as desired. In particular, the average working life of such molds has been undesirably short because of the distortion or breakage caused by the tremendous stresses arising from the expansion of the mold parts on heating and contraction of the same on cooling.

In the so-called "hook-type" air-cooled mold, which has been extensively used in the casting of slab ingots, the two mold sections are fastened in operative position by driving hooks attached to one section into place over pins on the other. In order to prevent the bulging of the mold sections between the fastening points, which otherwise would occur after use in a limited number of heats to such an extent that the mold could not be completely closed, it has been necessary to provide mold sections of rugged construction, for example, having heavy reinforcing ribs on the external surfaces of the working faces. This not only slows down the rate at which heat can be removed from the cast metal charge, but also gives rise to uneven temperature distribution and therefore additional stresses in the mold due to the abrupt changes in thickness. The stresses occurring during the operation of such apparatus are necessarily localized, thus accelerating the breakdown of the metal structure, as shown by the fact that breaking of the mold sections almost invariably takes place at one or more of the points of fastening. A further disadvantage of this type of mold assembly is that the uppermost hooks are necessarily fastened some distance from the top of the mold, and accordingly the upper ends of the mold sections tend to bend outward in use; the resulting ingots therefore have excess thickness of metal at the top end which in many cases must be removed before the subsequent operation of rolling into sheets.

Modifications which have heretofore been proposed in order to overcome certain disadvantages have either not fulfilled the objectives in practice or have involved additional serious deficiencies. Prior efforts have failed to provide apparatus characterized both by simplicity of construction and greatly improved durability.

Difficulties with the prior types of mold are considerably magnified in the casting of large ingots, such as the slabs, produced in accordance with modern practice, which are over six feet long, up to two feet wide, and up to several inches thick.

An object of this invention is to provide an air-cooled ingot-mold of simple construction having greater durability than prior molds.

A further object of this invention is the provision of a mold so constructed as to minimize localized stresses during the production of cast metal ingots.

Another object of this invention is to provide an air-cooled ingot mold free of the disadvantages of prior molds.

Other objects will be apparent from the following detailed description.

In accordance with this invention, generally stated, the foregoing objects are secured by providing a pair of substantially rigid frames for retaining complementary mold sections in position for receiving molten metal for the production of cast ingots, while distributing and absorbing the stresses incident to this operation. The sections of the mold are so constructed as to avoid harmful stress gradients during operation and, in the interlocked position, to provide support to the lateral walls, preventing the outward opening of the same. The frames are of open structure, facilitating the rapid dissipation of the heat which must be removed from the ingot and mold before they can be handled.

In the drawings forming part of this specification, there are shown, by way of illustration, a number of views of apparatus forming one embodiment in accordance with this invention, as follows:

Figure 1 is a perspective view of the frames and mold sections assembled in position for receiving molten metal;

Figures 2 and 3 are respectively front and side views of the same;

Figures 4 and 5 are respectively fragmentary sectional views taken along lines 4—4 and 5—5 of Figure 2;

Figure 6 is a longitudinal section along line 6—6 of Figure 2;

Figures 7 and 8 are respectively front and side views of a mold section; and

Figure 9 is a side view of the other mold section.

In the improved air-cooled ingot-mold of this invention, a support for mold sections is provided consisting of a front frame 1 and a back frame 2. Each of these frames is preferably of one-

piece construction, formed of cast steel of substantial thickness, and consists of a pair of vertical end-posts connected by means of a plurality of bars into a rigid open structure. Hinge members 3, integrally formed with the frames, are provided at the base and are adapted for being fitted together and forming a hinged joint between the frames on insertion of the pin 4.

For fastening the two frames together, a plurality of lugs are provided, integrally formed with and extending laterally from the end-posts in cooperating positions. When the fastening means consist of the preferred bolt and socket assemblies shown, the front frame is provided with transversely-slotted lugs 5, each of which is opposite a pair of lugs 6, having a longitudinal bore adapted to house pin 7, on the back frame. Threaded sockets 8, pivotally connected with lugs 6 by means of trunnions 7, are adapted to be swung into position aligned with the slots of lugs 5, and the frames may then be fastened together by tightening bolts 9 within the sockets 8, the bolt-heads being provided with collars 10 extending over the edges of the slots in lugs 5.

The ingot-casting chamber is formed of complementary mold sections, a front 11 and back 12, each of which consists of a simple metal casting and is characterized by a projection-free external surface opposite the working face. Back section 12 is provided with longitudinal end walls 13, bevelled at the external edges, which are adapted to form a tight fit within a pair of longitudinal grooves 14 bordering the working face of front section 11. The longitudinal edge portions of front 11, beyond the grooves 14, are somewhat thickened in order to support end walls 13 and prevent the outward opening thereof, which would occur in the absence of such provision after repeated casting operations. Lugs 16 are provided on the mold sections for fastening the same to the respective frames, by means of clamps 17 bolted thereto. Front 11 is provided with a horizontally extending base portion 15, adapted for insertion to form a tight fit between end walls 13 of back 12. Both working faces taper inward, providing a mold chamber slightly thicker at the center than at the edges.

It has been found that the durability of the mold sections is considerably enhanced when their external surfaces opposite the working faces are smooth, that is, free of projecting parts such as reinforcing ribs. Accordingly, harmful stress gradients during the casting process are avoided by providing mold sections which either are of substantially uniform thickness at the working face or gradually increase in thickness from the longitudinal edges to the center of the working face.

Adequate distribution of the stresses arising during operation is insured by the provision of a plurality of fastening devices evenly spaced along the frame end-posts, one set being placed near the top and another near the bottom of the mold sections. Excellent results have been obtained in casting slab ingots about six feet long by the use of five pairs of bolt and socket assemblies evenly spaced along the frames, and of six such sets of fastening means for ingots about eight feet long.

In operative position, contact is provided between the frames and the mold sections, for the support of the latter, at a number of projections 18, integrally formed on the frame and preferably symmetrically disposed with respect to the assembly fastening means. Accordingly, unobstructed lateral openings are provided between the frame and the mold sections, in addition to the relatively extensive front and back openings of the frames, for the free circulation of cooling air at the external surfaces of the mold sections.

In operation, a number of the above-described ingot-mold assemblies are mounted along a channel 19, adapted to receive base 20, forming a unitary extension of back frame 2. Back frame 2 is preferably fastened in slidable engagement with rack-bar 21 by means of clamps 22. To facilitate the pouring of molten metal, a funnel 23 of usual construction may be attached at the top of the assembled mold in any suitable manner, for example, by means of pin 24 inserted through pierced tabs 25 on back section 12.

On receiving a charge of molten metal, the mold sections undergo a large rise in temperature and therefore an appreciable expansion. In the present improved assembly, however, this expansion occurs to a considerable extent in the vertical direction, thus largely avoiding deteriorating effects on the parts, since sections 11 and 12 are free to move longitudinally both with respect to one another and to the frames.

After the metal charge has solidified and cooled to a convenient handling temperature, bolts 9 are loosened and swung out of engagement with the slots of lugs 5, the front frame 1, to which section 11 is fastened, is swung forward to open the mold, and the slab ingot may then be removed. The mold assembly may thereupon be closed to receive another charge of molten metal. Replacement of either the front section 11 or back section 12 may be simply and rapidly effected whenever desired merely by loosening clamps 17, substituting the new for the used section, and tightening clamps 17 over lugs 16.

As an added feature of flexibility, frames of any given size may be utilized to enclose a variety of sizes of mold sections, capable of producing slab ingots differing as much as several inches in width. Accordingly, a much smaller number of frames is required than would otherwise be the case.

As indicated in the drawings, the frames are substantially thicker than the mold sections. For example, in a preferred embodiment, the frame end-posts and connecting bars consist of cast steel one and three-quarter inches thick, while the thickness dimensions of the mold sections formed of cast semi-steel or similar metal alloy, are respectively, for the mold front, one inch at the working face and one and a quarter inches at the edges beyond the grooves, and, for the mold back, one and a quarter inches at the center and three-quarters of an inch at the edges of the working face.

The novel type of air-cooled ingot mold assembly disclosed herein permits the use of mold sections which are considerably lighter than those heretofore employed. For example, mold sections of the present type may have a weight amounting to about 75% or less of the weight of the prior "hook" type mold sections producing ingots of the same size.

The excess weight of the prior "hook" type mold is due partly to the heavy external ribs provided, as has been customary in the art, for reinforcing both the front and back mold sections. Such ribs cause a variation in thickness at the working faces of the mold sections; for example, in the case of a mold producing ingots of rectangular cross-section 12½ inches long and 1¾ inches wide, from two and one-eighth inches at

the ribs to one inch between the ribs, which variation is sufficient to create harmful stress gradients during casting operations.

While in the above-described embodiment, the frames have been described as formed of cast steel, it is to be understood that other suitable metal alloys or different methods of fabrication may be useful; for example, the frames may consist of welded structures. The bars connecting and reinforcing the frame end-posts may be of any suitable type providing a rigid frame and not obstructing the circulation of air at the external surfaces of the mold sections. Although the described bolt and socket assemblies are preferred for securing the frames together, other suitable types of fastening means may at times be employed.

The outstanding advantage of the ingot mold assembly in accordance with this invention is the considerable increase in durability which it provides. Thus, in extended tests of molds, producing copper alloy slab ingots, in which the present apparatus was compared with the prior "hook" type, the mold sections in each case consisting of castings of the same semi-steel alloy, the average life of the mold members in accordance with this invention was from two and a half to three and a half times that for the prior molds. It is furthermore noteworthy that the ingots produced with the present mold are of substantially uniform thickness throughout their length. The durability of the frame members is of such high order that no signs of deterioration are present even after extended use, and the frames can accordingly be expected to outlast many sets of the mold inserts.

It will accordingly be seen that the objects of this invention are accomplished in the provision of an air-cooled ingot mold assembly having outstanding durability, convenience and ease of operation, and which is capable of producing slab ingots of excellent quality. The foregoing description is to be considered as illustrative rather than restrictive as various changes in structure or materials are contemplated within the spirit of the present invention and without departing from the scope of the appended claims.

Having now described the invention, what is claimed as new and is desired to be covered by Letters Patent, is:

1. An air-cooled ingot mold comprising a pair of substantially rigid hingedly-joined frames each consisting of an open one-piece structure of elongated end-posts connected near the ends and at intermediate points by bars, spaced projections integrally formed on the said end-posts, a mold section held in each frame and having longitudinal contact therewith solely at the said projections, said mold sections being adapted to interlock forming a chamber open at one end, and means forcing the said frames toward one another to interlock the said mold sections.

2. An air-cooled ingot mold comprising the combination of a pair of substantially rigid frames each consisting of an open structure of end-posts connected near the ends and at intermediate points by bars; a mold section, having a substantially smooth external surface, clamped in each of said frames, one of said sections having side walls adapted to be received by longitudinal grooves in the second section and said second section being thickened at the edges beyond the said grooves and being provided with a base fitting closely between the said side walls; and means forcing the said frames toward one another to interlock the said mold sections.

3. An air-cooled ingot mold comprising the combination with a pair of interlocking mold sections of a pair of substantially rigid frames, each consisting of an open structure of end-posts connected near the ends and at intermediate points by bars; a plurality of means on the end-posts for forcing the frames toward one another; and a plurality of projections, symmetrically disposed on the said end-posts with respect to the said forcing means, contacting the said sections for holding the same in interlocked position.

4. An air-cooled ingot mold comprising a pair of substantially rigid hingedly-joined frames, each consisting of an open structure of end-posts connected near the ends and at intermediate points by bars; a pair of smooth-surfaced interlocking mold sections, adapted to form an elongated chamber open at one end, in said frames; a plurality of spaced projections on the said frame end-posts contacting the said mold sections near their longitudinal edges; and means forcing the said frames toward one another to interlock the said mold sections.

EDMUND G. MITCHELL.
HARRY C. SCHAPER.
EDWARD HARTSHORNE.