

Nov. 25, 1941.

N. CRANE

2,264,146

METHOD OF MAKING PERFORATED MOLDS

Filed July 27, 1937

2 Sheets-Sheet 1

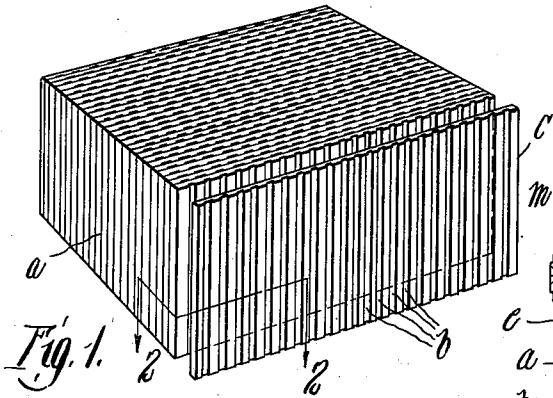


Fig. 1.

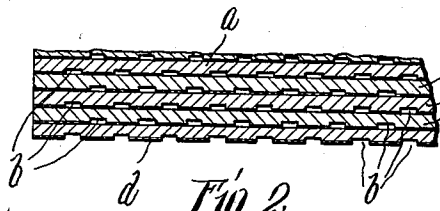


Fig. 2.

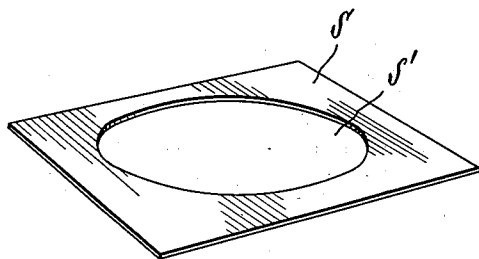


Fig. 3.

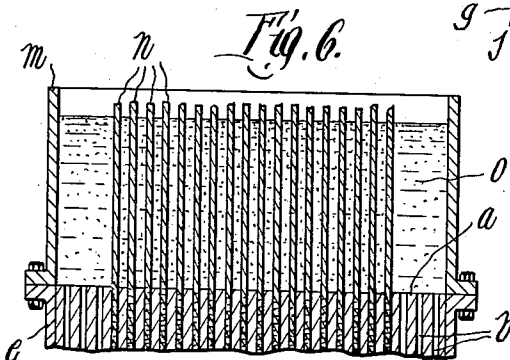


Fig. 6.

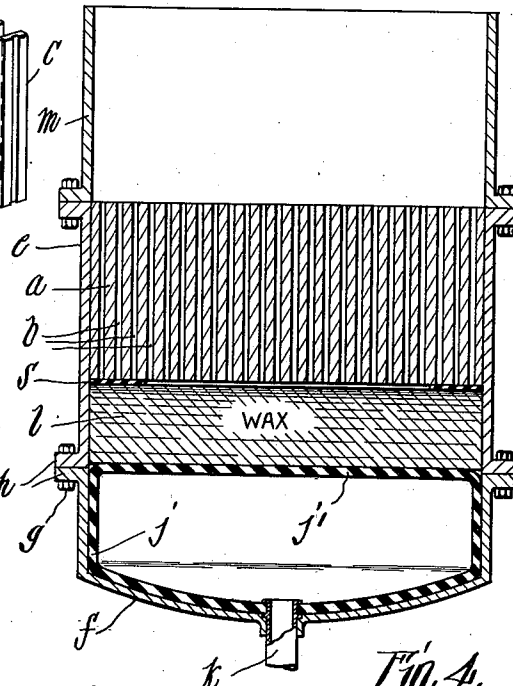


Fig. 4.

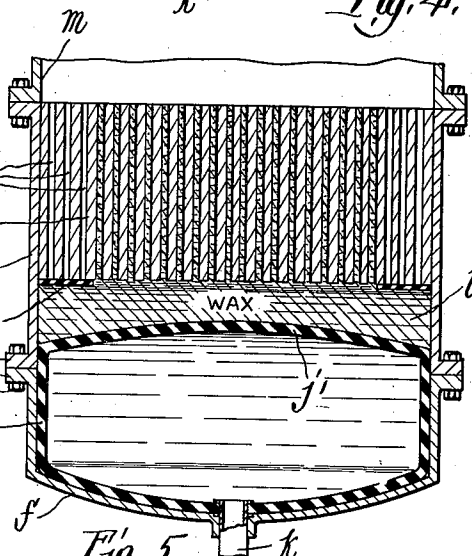


Fig. 5.

Inventor
Newton Crane
by Wright, Brown, Smith & Thayer
Attys.

Nov. 25, 1941.

N. CRANE

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2 Sheets-Sheet 2

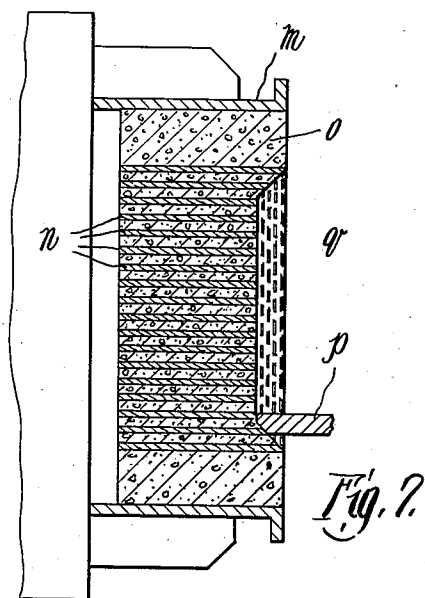


Fig. 7.

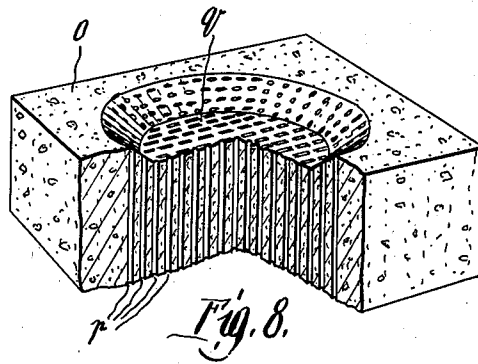


Fig. 8.

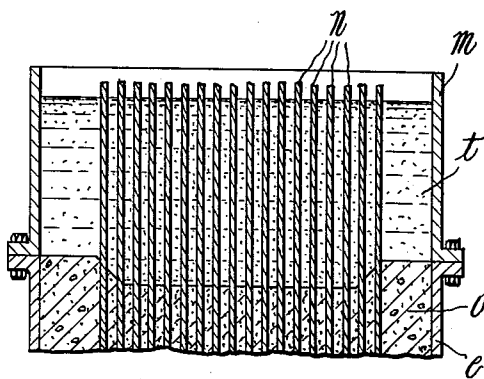


Fig. 10.

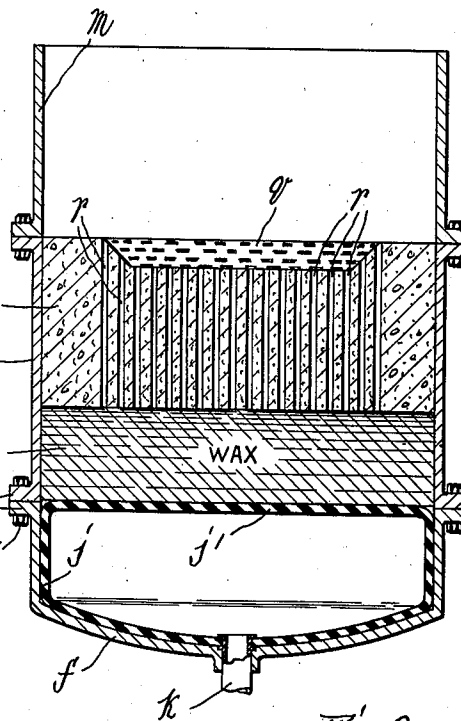


Fig. 9.

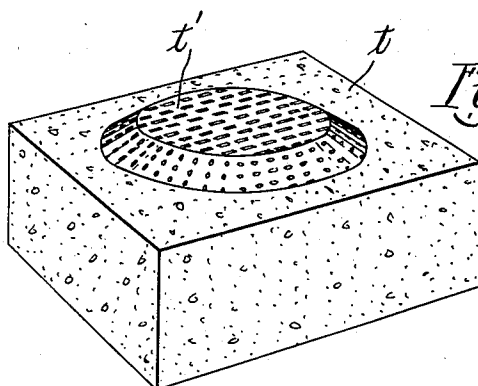


Fig. 11.

Inventor
Newton Crane
by Wright, Brown, Dunsen & Tracy
Attys.

UNITED STATES PATENT OFFICE

2,264,146

METHOD OF MAKING PERFORATED MOLDS

Newton Crane, Needham, Mass.

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5 Claims. (Cl. 25—155)

The present invention relates to molds adapted to form articles from paper pulp and similar mixtures of fibers and liquids; in other words, molds adapted to give form under pressure, to masses of material containing liquid which must be released or extracted from the mass in the course of molding, in order that the resulting article may be sufficiently compact and dry to serve its intended purposes. Molds of this character are extensively used for producing plates and other articles from wood pulp containing a very large proportion of water, as well as from other mixtures of fibers and liquids. An essential characteristic of such molds is a multiplicity of perforations or passages running from the molding surface to the discharge side of the mold, sufficiently numerous, capacious and well distributed to permit a rapid discharge of the liquid when the pulp mass is subjected to pressure, and of vapor when the article is heated or otherwise dried to expel the residue of liquid which is not extractable by pressure alone. Such molds must also be rigid enough to retain their form and surface contours under the pressure of molding, whether such pressure is that of the atmosphere effected by partial vacuum at the discharge side of the mold, or is fluid pressure otherwise created and applied, or the mechanical pressure of a complementary molding die or form. The molds and dies of this nature heretofore made are expensive, and those which are made wholly or in part of wire fabric are more or less weak and flimsy and liable to injury and deformation.

My object is to produce molds and dies of the type indicated, having adequate strength and rigidity to sustain the greatest pressures used in molding pulp articles and the like, which may have any configuration and contours of molding surface, are provided with adequate escape passages for the liquid, and are producible at a fraction of the cost of the molds and dies heretofore known. The invention comprises a new method for making such perforated molds; including the illustrative embodiment described in the following specification and all substantial equivalents of such embodiment within the scope of the appended claims.

In the drawings, a form of apparatus used in carrying out this method, the steps of the method, and two complementary or cooperative molds resulting therefrom are shown.

Fig. 1 of the drawings represents in perspective one of the elements of the apparatus which I may call the core extrusion block;

Fig. 2 is a sectional view of a portion of the core extrusion block taken on line 2—2 of Fig. 1 and represented on an enlarged scale;

Fig. 3 is a perspective view of a plate or diaphragm which is optionally usable to limit the number and locations of the cores extruded from the extrusion block;

Fig. 4 is a sectional view of the essential parts of a complete apparatus for carrying out the method; auxiliary parts, such as supporting means, pump, etc., which are practically necessary but involve nothing new with the present invention, being omitted;

Fig. 5 is a view of the apparatus shown in Fig. 4 after partial operation in carrying out the method;

Fig. 6 illustrates a further step of the operation;

Fig. 7 shows the step of shaping the molding surface of a mold or matrix produced by this invention;

Fig. 8 is a perspective view of the mold finished by the operation shown in Fig. 7, being partly broken away to show the liquid extraction passages;

Figs. 9 and 10 are views similar to Figs. 4 and 6 respectively showing the application of the same method to produce a complementary mold with the use of the mold shown in Fig. 8 as a matrix and core extrusion block;

Fig. 11 is a perspective view of the mold resulting from the last mentioned performance of the method.

The basic principle on which this invention rests is that of casting the molds from a solidifiable fluid mixture or composition, and the formation within them of passages by means of extruded cores which are passed through such composition while the latter is in the fluid state. The preferred material which I use for the mold composition is hydraulic cement in finely divided condition, mixed with a large excess of water, and with a small proportional content of known materials which retard setting to extreme hardness. The cores are made from a material which is capable of extrusion through passages and orifices, preferably a wax sufficiently plastic to be thus extruded at ordinary room temperatures, and hard enough to retain the form given by the extrusion orifice when subjected to external forces of moderate intensity. The necessary qualities of such material are explained in the following description.

An important factor of the apparatus is an element which I have called the core extrusion

block, since its function is to conduct the plastic material through extrusion passages and cause the material issuing therefrom to have shapes and dimensions suitable to serve as cores in the mold material during the settling and solidification of the mold. Such extrusion block is designated *a* in the drawings. It contains a large number of parallel passages *b*. The preferred form of such block, shown herein, embodies an invention for which I claim protection; such invention resulting in the practical maximum number of passages, and exact control of their locations and dimensions.

The extrusion block here shown is made of flat metal plates *c*, *c*, in one face of each of which shallow grooves *b* are cut. The plates are thinly coated with solder *d* on one face (which may be either the front face in which the grooves are cut or the back face), are placed face to back against one another and clamped in a compact bundle, and heated sufficiently to melt the solder so that, after cooling, the plates are bonded together in a solid block. It is to be understood that in place of solder other means suitable for correspondingly bonding the plates together may be used and are within the scope of the invention; also that where solder is used the plates are suitably prepared in known manner to insure adhesion of the solder to them.

The plates may be made of any desired thickness and of any metal suitable to be secured together in the manner described. They may also be curved cylindrically instead of flat, although the flat form is preferable on account of the ease of cutting grooves in them and of assembling them in a block without need of careful fitting. The grooves also may be of any desired depth, width and spacing, provided only that their dimensions are large enough to permit flow of the plastic or semi-liquid core material and to give sufficient strength and stiffness to the cores so extruded. For example, in the work which I have done, I have found that grooves approximately .030" wide and .010" deep are satisfactory; but these are not in any sense limiting values and the grooves may be wider or narrower, deeper or shallower without departure from the invention. The spacing of the grooves is limited on the one hand by the width of lands necessary to hold the bonding medium, and on the other hand by the required number of passages in one row. When the plates are assembled as described, the originally open grooves become completely enclosed passages. The width of the plates may also be of any desired value, and is established practically as that which makes the block as a whole sufficiently rigid to withstand the pressure applied in forming cores by extrusion.

It may be observed that while soldering or an equivalent bond is desirable because it makes of the block a self-contained unit in which single plates cannot be displaced by the forces encountered in service, yet it is not essential, as the plates may be held and clamped in a form or frame tightly and firmly enough to serve the purpose. When solder or the like is used as described, even in the thinnest possible films, it may be squeezed more or less into the passageways *b*, when melted and under the pressure used in crowding the plates together. When this occurs the passageways may be cleared by passing a rod or drift through them. When once completed, such extrusion block, though initially expensive, may be used so many times without

deterioration and in the production of so many molds, that the fraction of its cost chargeable to any single mold becomes inappreciable.

The extrusion block, whether of the construction above described, or of any other construction suitable for the purpose, is placed and secured within a casing or holder *e*, which is connected with another casing part or head *f* so as to form a chamber below the extrusion block. These parts *e* and *f* are here shown as detachably connected by bolts *g* passing through external flanges *h* on their sides. But they may be joined integrally or by other suitable means. The space in the chamber next to the head is occupied by a distensible bag *j*, preferably made of a vulcanized rubber composition so that it is stretchable and elastic and capable of confining fluids without leakage. It is connected to a pipe *k* passing through the head *f*, through which water or other fluid may be admitted and discharged. The wall *j'* of this bag is in effect a diaphragm which may be deflected and displaced toward the nearer side of the extrusion block by the pressure of fluid forced into the interior of the bag.

In the normal relaxed, or withdrawn, position of this diaphragm, there is a space or chamber for extrudable core material, in which is placed a body *l* of such material. Preferably a material which is plastic at ordinary room temperatures is used here, such as beeswax, or other waxes or wax mixtures having qualities of plasticity and firmness suitable for my purpose. The plasticity or fluidity required is that which will permit the material to flow through narrow passages of the order of the passages *b* when impelled by pressures of sufficient intensity, say in the order of 500 pounds per square inch. The necessary firmness or hardness of the material is that which will enable rods or ribbons extruded vertically from such passages to pass through superposed liquid containing finely divided solid matter in suspension, and to remain substantially parallel to one another. Waxes and wax compositions having these qualities are known and available on the market. It is within my contemplation, however, to use other plastics, or fusible solids, which will melt or become plastic at temperatures below the boiling point of water, and are substantially hard at room temperatures. Means for application of heat to the material below the extrusion block, and absorption of heat from the region above the block may be applied within the purview of this invention to aid the carrying out of the operation when alloys and plastics of the type last indicated are used. But it would not be a departure from the invention to use lead, and apply a pressure great enough to extrude it through the passageways.

A frame or flask *m* is secured detachably, and liquid tight, to the upper end of the apparatus so constituted, as by the bolts and flanges shown in the drawings. Into this flask is poured a mixture of water and finely divided hydraulic cement, of which the water content is sufficient to give it a fluidity approximating that of cream; or at least to make it thin enough so that rods of wax extruded from the block *a* will pass through it.

Water or other fluid, being then forced or pumped into the bag *j* distends the bag and its diaphragm *j'* and forces the wax through the extrusion block, as shown in Fig. 5. The streams of wax issuing from the block form rods or ribbons *n* which rise through the body *o* of cement

mixture in the flask *m* until they emerge from the upper surface of such mass. These rods constitute cores which are surrounded by the cement mixture. The particles of cement, being very small and held in suspension in water, do not obstruct the slow passage of the wax cores of even such small dimensions as herein indicated, while the specific gravity of the wax, being less than unity, assists the upward flow of the cores and overcomes the tendency of gravity to bend and deflect them. The wax has sufficient cohesion to prevent its buoyancy from detaching the extruded rods from the masses in the passageways of the block or from attenuating them.

The flask is allowed to remain in connection with the extrusion apparatus until the cement body has set and hardened enough to be no longer fluid. It may then be removed and another flask substituted to receive another cement casting.

When the removed casting has become firm enough to be carved without distortion, but while it is still soft and friable, one of its surfaces is carved to the shape and contours of any desired hollow mold or protuberant die. To form a mold of circular shape, such as that for a plate or other dish, the flask may be secured in the chuck of a turning lathe, as shown in Fig. 7, and rotated relatively to a cutting or scraping tool *p*, which is fed in the directions required to cut the prescribed contours. Or other contours can be carved in any other suitable way. During the cutting operation, the cores *n* remaining in the casting support the cement in contact with them and are firm enough to prevent being distorted in the cutting operation and thus prevent distortion of the surfaces of the cement body in contact with them.

Finally, after the casting has aged to a condition of sufficient hardness and cohesiveness, it is heated sufficiently to melt the contained cores whereupon the latter run out, or may be blown out. There is thus produced a casting *o* in the form of a solid rigid block, having a molding cavity *q* and passages *r* running from the surface of the molding cavity to the opposite side of the block. Such passages are like, in dimensions, number and spacing, unto the passages *b* of the extrusion block, and provide discharge or extraction outlets for liquid when the mold is used in molding objects from pulp, whether by suction, mechanical pressure, air pressure and permeation, or with the application of heat to discharge residual moisture.

In order to limit the formation of passages in the casting to the area only where such passages are desired, a mask or screen *s* may be placed between the extrusion block and the plastic composition, as shown in Figs. 4 and 5. The mask suitable for the specific mold here illustrated is a plate having a central circular opening *s'* (see Fig. 3) with the same diameter as the mold cavity *q*. But obviously the outline, placement and number of equivalent openings may be of any character to correspond with the mold to be produced.

Any mold made as before described is capable of being used alternatively as a combined block and matrix for a counterpart mold or die. Such use is illustrated in Figs. 9 and 10, wherein the casting *o* is placed in the extrusion apparatus in substitution for the block *a*, and used in the same manner as described to cast a complementary die *t*. In this procedure, the formation of the ultimate product is simplified in that the mold-

ing portion is shaped directly by the molding cavity of the matrix, wherefore no final cutting or carving operation is needed. And the last described mold or die may in its turn be used to make other molds of the first form. Thus from an original extrusion block of neutral character, and by subsequent carving, an endless variety of mold forms may be made which are usable not only for molding, but also for the reproduction of molds in geometrical progression. The casting process, with the use of extruded cores, is a most inexpensive mode of making rigid and durable perforated molds with any required number of exhaust passages.

The oblong or flattened shape of the passages in cross section is an important feature, in that such passages provide area enough for rapid discharge of water, while at the same time they may be so narrow that the pulp cannot be impressed into them to any appreciable extent. That is, molds having passages of this character mark the pulp much less, even under extremely heavy molding pressure, than molds of which the contact faces are made of wire mesh or which have circular perforations. The construction of the original or master extrusion block from grooved plates enables such passages of unequal transverse dimensions to be made.

While, as previously stated, other materials than wax may be used for extrusion cores as described, wax is preferred because of its light specific gravity and because its hardness is very nearly equal to that of the partially cured cement casting when the latter is in condition for turning or carving. Thus the cutting tool cuts the cores as easily as the cement and the tendency, which exists with harder cores, to be displaced by the cutting tool and to break and crumble the cement, is avoided. I reserve the right to use, and to protect within the scope of this invention, other materials than waxes which may be discovered or developed and which may have qualities superior to wax in this regard. I also reserve the right to use and protect other substances than hydraulic cement which may be available for casting in molding flasks and in association with core extruding apparatus as described.

Plasticisers and setting accelerators are known which, when added to cement mixtures, produce desired effects in retarding or hastening the setting of the cement suspension into a rigid body. I may use any suitable plasticiser or accelerator with cement mixtures in this process to obtain whatever time may be needed to bring a casting to the carving step, or to minimize the delay necessarily intervening before the casting is firm enough to be carved. Such plasticisers and others may be used also for the purpose of giving the partially cured casting a quality of plasticity and cohesiveness enabling it to be carved smoothly, particularly on protuberant portions, without crumbling or tearing away below the path of the cutting tool.

The amount of wax used is calculated in accordance with the areas of the extrusion passages and the depth of the cement mixture or the like placed in the molding flask, so that the individual cores will not rise above the surface of the liquid casting mixture; and the pressure bag *j* has sufficient flexibility and extensibility to carry its diaphragm wall *j'* up to the under face of the extrusion block, when made of such proportions that, in its unstressed condition, the diaphragm is far enough removed from the ex-

trusion block to admit the said prescribed quantity of wax. It results from these factors that, even though the streams and ribbons of wax might flow more easily and rapidly through the passageways in the middle area of the block than in the peripheral parts, yet ultimately the cores extruded from all the passageways will rise to approximately the same height. Where the flow is most rapid, the diaphragm is locally deflected, in principle as illustrated in Fig. 5, until the most advanced portions come into contact with the block; after which the further distention of the bag displaces the wax from surrounding, or other adjacent, areas, until all of the wax in the chamber or space *l* has been expelled from such space. When the diaphragm comes into contact with any part of the under side of the extrusion block, it shuts off the passages in such part, wherefore the remaining portions of the unextruded wax body can enter only the passages which still remain uncovered.

Thus the extruded core rods are made all of nearly the same length and height, which is sufficient to bring their upper ends above the solid body of the casting when the suspended particles of cement have settled, but all are below the level of the water layer which then overlies the sedimentary block. The value of this feature is that the buoyancy of the extruded rods holds them from deflection, and that the passages resulting from their core effect extend throughout the thickness of the final casting, straight and parallel to one another.

The casting may be made of any thickness necessary for rigidity, and to permit carving of the surface contours to any desired depth and shape, without sacrifice of rigidity. In the case of a mold which is made with large differences in depth between different parts of its area, the lengths of the passageways vary correspondingly if the back face is left plane. This might produce undesirable effects in the case of hollow articles made by transfer of pulp from a body or mass of pulp by suction. The less resistance to escape of water through the shorter passages would cause deposit of pulp to greater thickness in the deep parts of the mold than in the higher or shallower parts. To prevent this, and make the passages of the same or approximately the same length in all parts of the mold, the back may be carved with contours the reverse of those in the face. Thus for instance, if a mold like that shown in Fig. 8 is so treated, the back would have the same contours as the mold shown in Fig. 11. Obviously a mold of any shape or form may thus be made by any desired manner or means of carving.

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

1. The method of producing perforated molds which consists in providing a block having a plurality of passageways opening through its upper surface, placing a frame on the upper surface of such block, pouring a fluid cement mixture into such frame, forcing a plastic substance through the passages of said block and upwardly therefrom through the fluid cement in the superposed space, said substance having stiffness and cohesion sufficient for penetration through said fluid cement and to maintain its extruded shape, and, after solidification of the cement, discharging the masses of plastic material therein so as to leave open passageways.

2. The method of making perforated molds which consists in providing an extrusion block with passageways opening in one face thereof, mounting the block with such face substantially horizontal, providing a body of extrudable plastic material having stiffness and cohesion sufficient for penetration through the aftermentioned cement and to form the after-mentioned cores, adjacent to the opposite ends of such passageways, confining a body of fluid cement mixture in contact with the substantially horizontal face of said block, and applying pressure to the extrudable material sufficient to cause flow thereof through the passageways of the block and extrusion from the block as cores which are advanced through the fluid cement.

3. The method as set forth in claim 2 combined with the further step of carving the cement mass and the contained cores after solidification of the mass, and then removing the cores.

4. The method of making perforated molds which consists in providing a mass of fluid cement, placing cores in such mass extending through from one face to an opposite face thereof while fluid, allowing the mass to solidify, carving a face of the mass and the portions of the cores which lie in and near such face, and removing the cores.

5. The method of producing perforated molds and the like, which consists in placing a quantity of solidifiable fluid material in a confined space, extruding through such material, from one boundary of the space containing it, a plurality of cores formed of cohesive material which is liquefiable by heat and, at temperatures below the liquefaction temperature, is plastic with sufficient hardness to maintain the shape of such extruded cores while being forced through said fluid solidifiable material, and, after solidifying of said fluid material, melting and discharging said cores.

NEWTON CRANE.