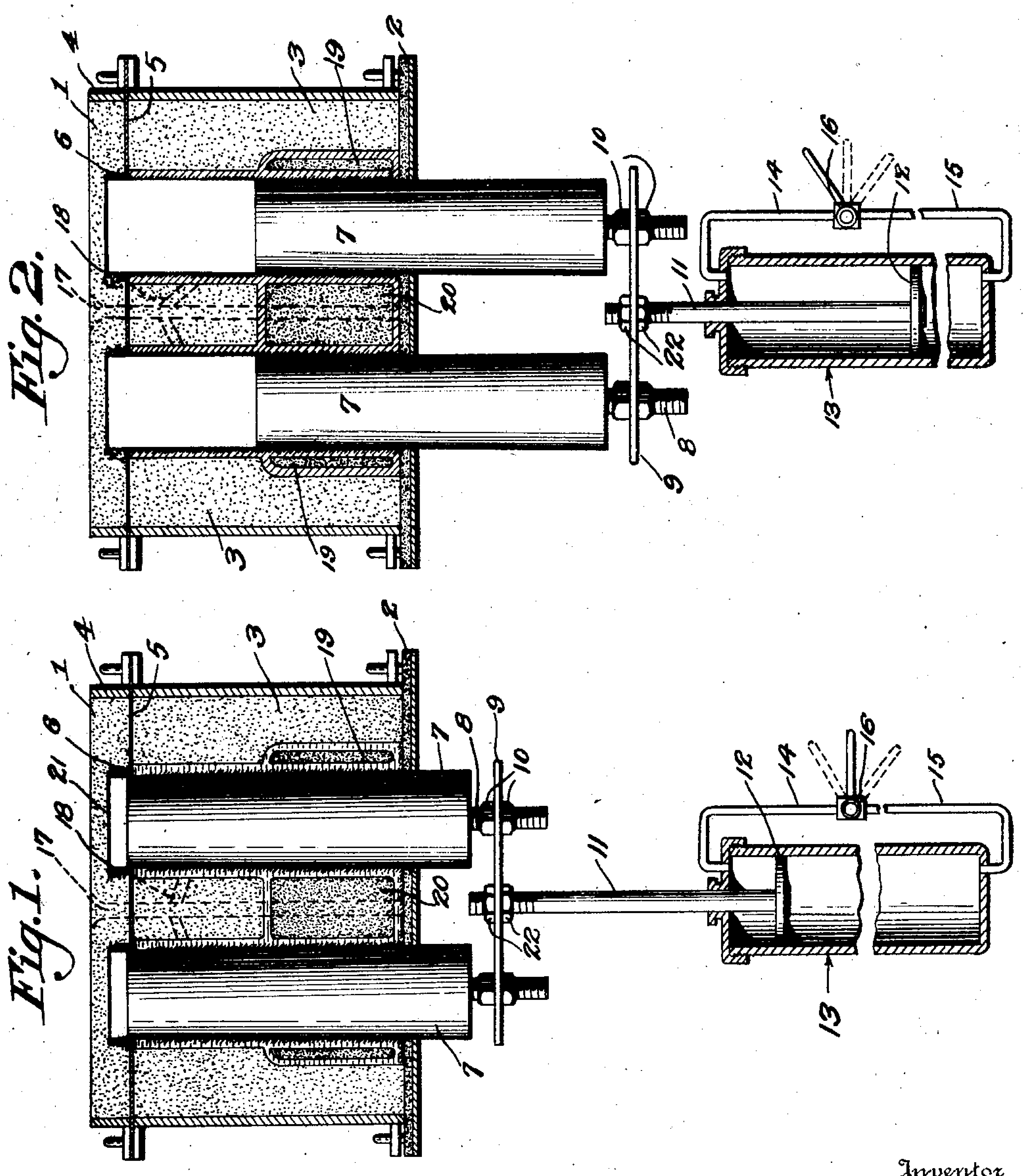
Sept. 4, 1928. 1,683,475

N. LITTELL

PROCESS AND APPARATUS FOR CASTING

Filed May 18, 1923 2 Sheets-Sheet 1



Inventor
Nelson Littell

Sept. 4, 1928. **1,683,475**

N. LITTELL

PROCESS AND APPARATUS FOR CASTING

Filed May 18, 1923 2 Sheets-Sheet 2

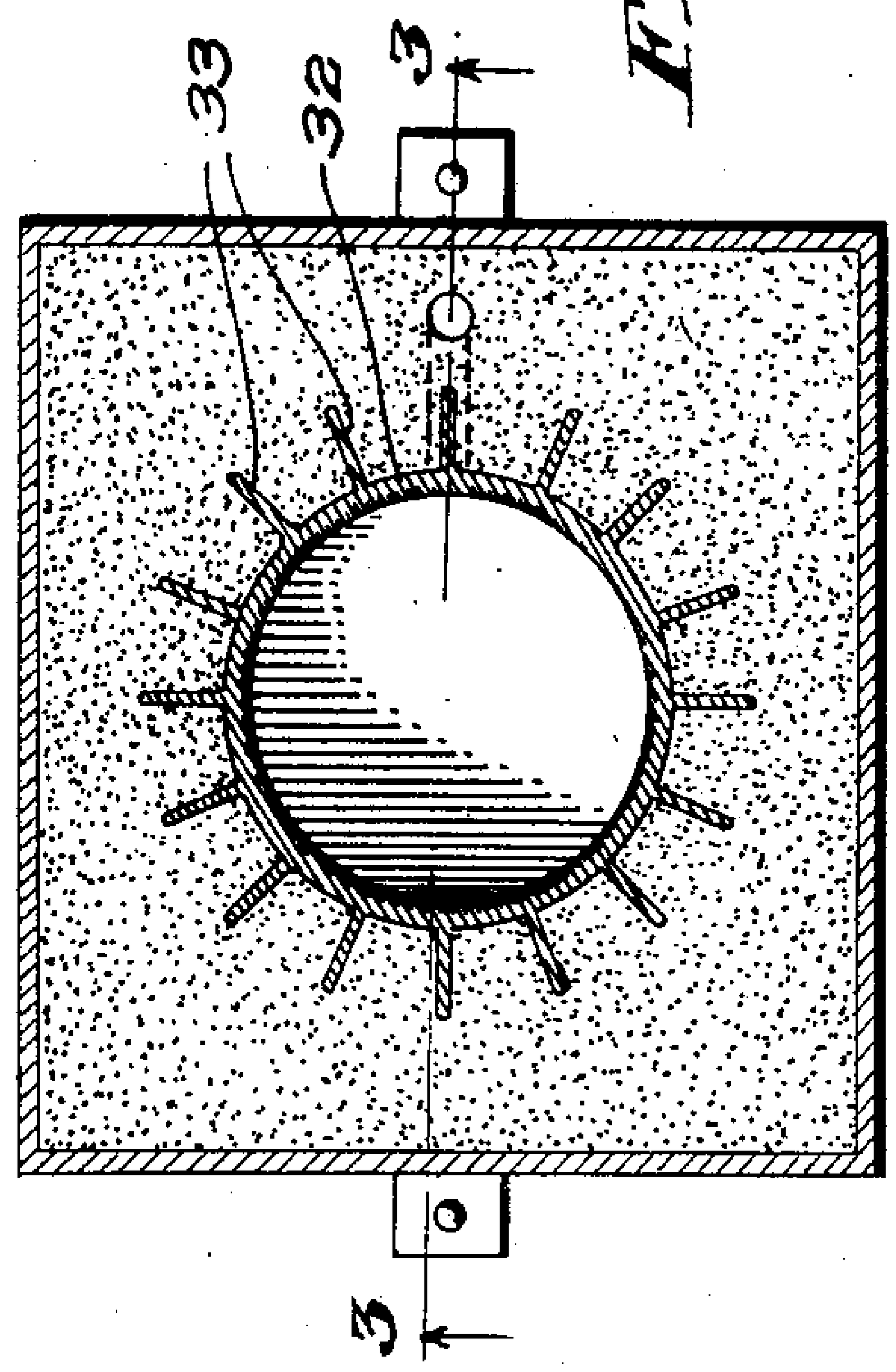


Fig. 4.

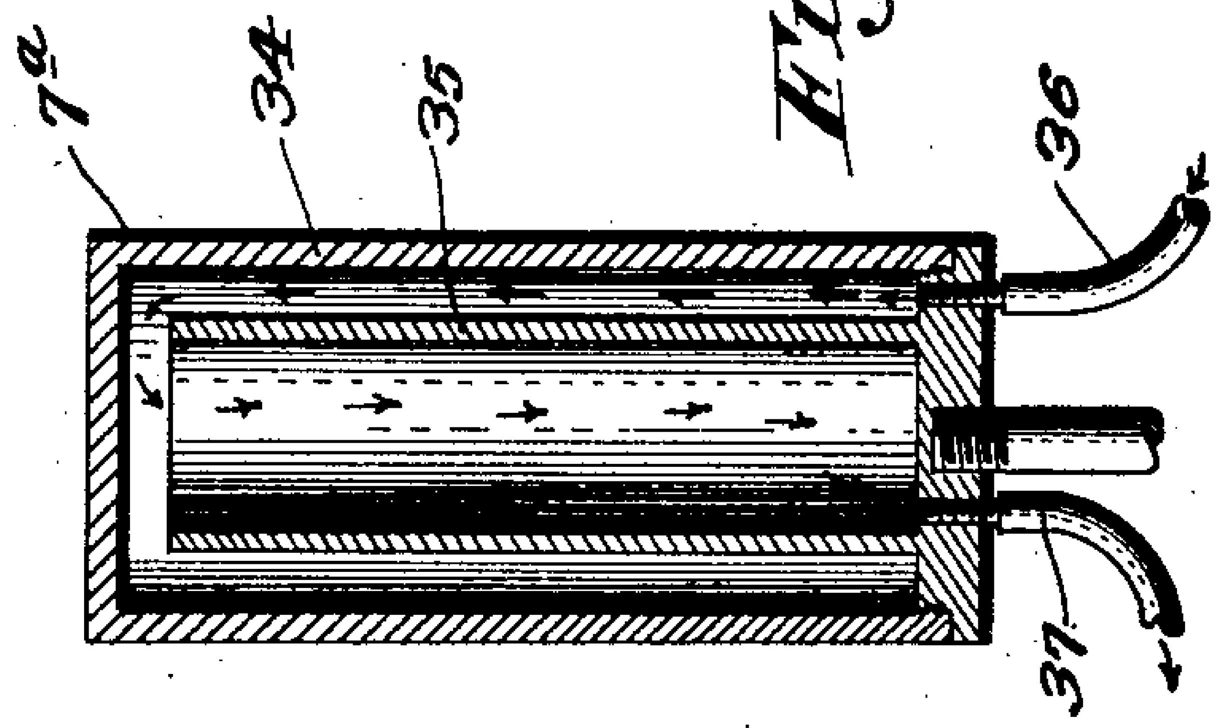


Fig. 5.

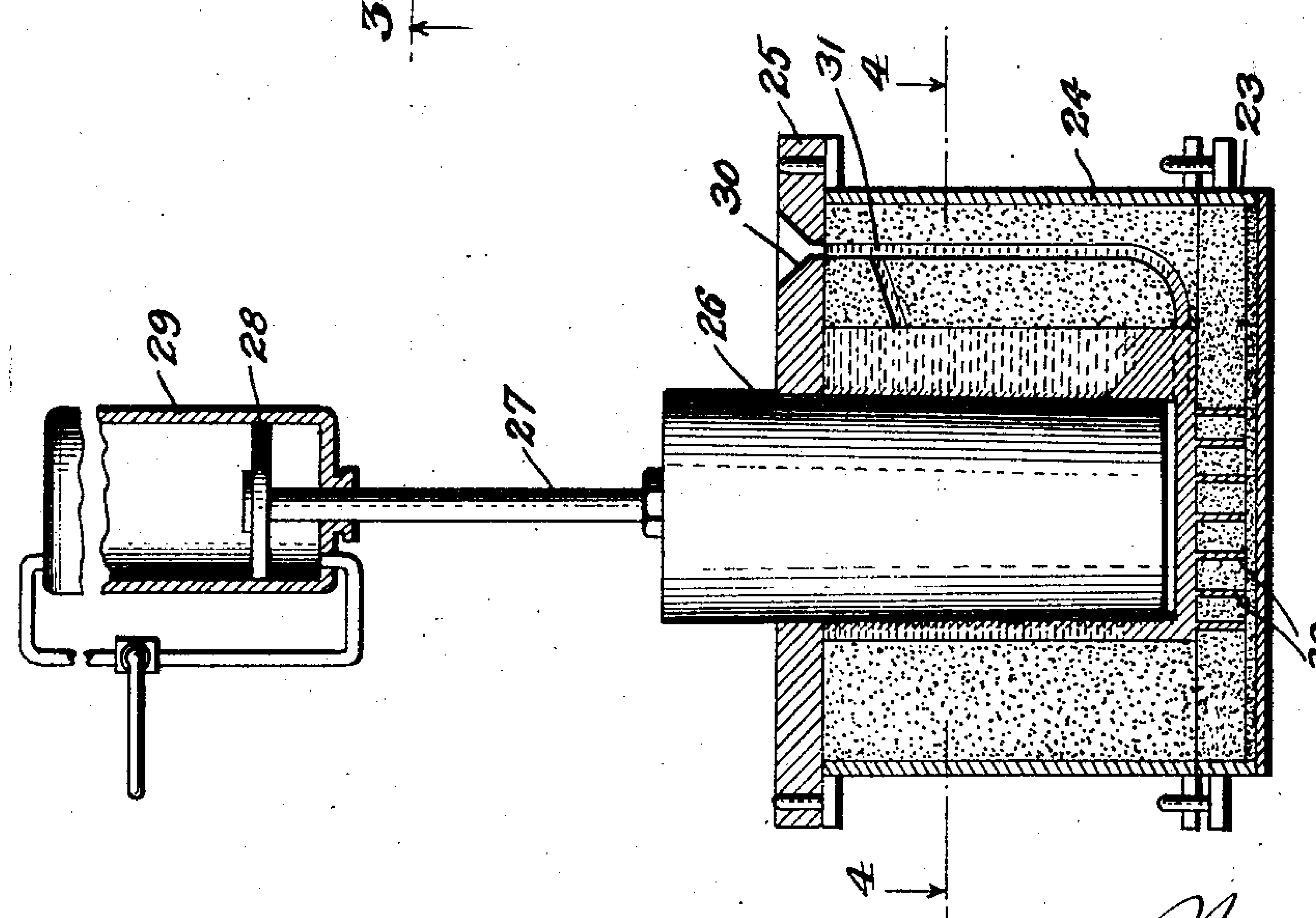


Fig. 3.

Inventor

Nelson Littell

Patented Sept. 4, 1928. 1,683,475

UNITED STATES PATENT OFFICE.

NELSON LITTELL, OF NEW YORK, N. Y.

PROCESS AND APPARATUS FOR CASTING.

Application filed May 18, 1923. Serial No. 639,771.

This invention relates to the casting of hollow cylindrical or cylindroid bodies and more especially to casting them with chill-hardened interior surfaces.

One of the features of this invention is the production of cast iron cylinders with chill-hardened interior wearing surfaces, the remainder of the cylinder being of unhardened metal. By casting the cylinder around an internal chill or core the inner walls thereof are made much harder than the walls of a sand cast cylinder, thereby giving greater strength and enhanced wearing qualities to the cylinder and at the same time permitting the thickness of the cylinder walls and the weight of the cylinder block to be reduced. It is an object of this invention to furnish a process and apparatus by which the cylinder may be cast around a chill core and the core withdrawn from the interior thereof. It is a feature of the invention that the cylinder is cast with a smooth internal bore of white iron which is nearer the ultimate size and shape desired than is possible with sand cast cylinders whereby the amount of boring or grinding necessary to fit the cylinder for use with a piston is reduced.

In accordance with one feature of the invention the cost of producing the cylinders is reduced by substituting a metal core which can be used many times for the sand cores now employed, which can be used but once.

A particular object of the invention is to provide an apparatus and process for producing an internal combustion engine cylinder or cylinder block having the improved qualities outlined above.

The desirability of chilling the inner walls of engine cylinders to cause them to offer greater resistance to the wearing action of the piston and rings reciprocating therein has long been recognized, chilled cylinders have not been produced on a large scale however, because of the difficulty heretofore encountered in removing the chill core from the solidified casting.

When a cylinder is cast around a rigid stationary metal core the contraction of the metal is apt either to cause the casting to crack or to bind around the core so tight as to prevent the removal of said core. Various attempts have been made to overcome this difficulty by using segmental chill core sections distributed in spaced relation around a sand supporting core, as shown for example in the British Patent No. 11,703 of 1913; or by the use of contracting metal cores which are designed to accommodate the shrinkage of the metal. However, the expense involved in the use of such elaborate or delicate devices has prevented the general adoption of such schemes.

In accordance with the preferred form of the invention molten metal which is to form the cylinder casting is poured around a rigid metallic chill core which may have a very slight taper in the direction from which it is withdrawn and the core is withdrawn gradually from the interior as the pouring progresses. The speed of withdrawal and the taper of the core are so correlated with the rate of pouring and the contraction of the casting that the core does not bind in the casting; and the length of the core is such that the top of the interior of the casting is solidified before the top of the core is withdrawn past the top of the mold cavity. The withdrawal of the core is started simultaneously with, or very soon after the pouring of the metal is begun, and the core is kept in continual motion relative to the casting throughout the pouring and until removed from the casting, which is a very important factor in preventing the binding of the casting around the core.

For a clearer understanding of the nature and mode of operation of the invention, reference may be had to the drawings which illustrate the preferred form thereof.

Fig. 1 is a part vertical sectional view illustrating the casting of a water cooled cylinder block for an internal combustion engine, showing the core slightly withdrawn from the mold cavity.

Fig. 2 is a similar view illustrating the casting operation near completion;

Fig. 3 is a view similar to Fig. 1, taken on line 3—3 of Fig. 4, illustrating the invention as applied to the casting of an air cooled cylinder;

Fig. 4 is a sectional view on the line 4—4 of Fig. 3;

Fig. 5 is a sectional view of an artifically cooled or heated chill core.

In Figs. 1 and 2, 1 illustrates a sand mold for the casting of a cylinder block, which mold consists of a base board 2, an intermediate section 3 and a cope 4. The base board 2 may be entirely of metal or be of sand, dry or green, with a metal or wooden support as illustrated; the intermediate section 3 is preferably made of green sand and the cope may be of sand or metal as preferred. As illustrated the cope 4 is separated from the intermediate section 3 by a thin metal plate 5, which prevents sand displaced from the cope by the withdrawal of the cores from dropping down into the mold cavity. 6 is a thick graphite facing to further prevent displacement of the sand in the cope. The plate 5 may of course be omitted and only the lining 6 used to insure a clean draw of the core from the cope.

The cylinder is cast about a rigid chill core 7. This core is longer than the cylinder to be cast, and may be provided with a slight taper toward the top, as illustrated in an exaggerated way in Fig. 1. The core 7 is provided with a threaded stem 8 which is adapted to pass through perforations in plate 9, and to be adjustably locked to said plate by lock nuts 10. The plate 9 is locked in a similar manner to the piston rod 11 of piston 12 which is reciprocable under suitable pressure in the cylinder 13. The pressure medium is conducted to either side of the piston by pipes 14 and 15 and is controlled by a two-way valve 16. The sprue hole is illustrated in dotted lines at 17 in Figs. 1 and 2, and is adapted to introduce the metal at the bottom of the mold cavity, or in case the metal freezes in the bottom, to introduce it into the top of the mold through auxiliary passageways 18. 19 and 20 illustrate sand cores for forming the water jacket around the cylinder walls.

In operation the mold is assembled as illustrated in Fig. 1 and the chill cores are projected through the mold cavity and into the cope as shown at 21, where the cores are illustrated as being slightly withdrawn from the top of the mold cavity. The lock nuts 10 and 22 enable the cores to be adjusted so as to control the distance they will project beyond the mold cavity into the cope, and the cavity 21 is formed of suitable depth to accommodate same. Then the pouring is started and simultaneously therewith, or after a short lapse of time, the pressure medium is admitted to the upper side of piston 12 to gradually but forcefully withdraw the cores 7. The molten metal coming into the mold and striking the chill core, is almost immediately skin frozen and the core is forceably but gradually withdrawn before the casting has time to shrink thereon. The taper of the core and the speed of withdrawal may be such that the casting may shrink at its natural rate as the core is withdrawn, thereby avoiding all unnatural stresses; and will not bind upon the top or any intermediate section of the core. The core is of such length and its withdrawal so slow, that the pouring will be completed and the top of the casting skin frozen sufficiently to hold its shape before the top of the core is withdrawn below the top of the casting. Fig. 2 illustrates the core partially withdrawn and shows the chilled condition of the cylinder walls. It is important that the core be kept in continual motion until it is clear of the cylinder walls.

Figs 3 and 4 illustrate one way of applying the invention to the casting of cylinders with radiating and cooling fins, illustrated here with the head integral. In these figures, the mold consists of a drag 23, cheek 24, and cope 25, the drag and cheek are preferably sand and the cope is preferably metal, although sand may be used for the purpose. 26 illustrates the chill core which in this embodiment is withdrawn from above the mold by means of rod 27 and piston 28 operating in pressure cylinder 29. 30 illustrates a refractory lining for the pouring basin in cope 25 through which the metal is poured into sprue 31. The cylinder wall is illustrated at 32 and the fins on the sides and top thereof are shown at 33. In the embodiment shown these fins are cast integral with the cylinder wall, however, they may be made of preformed inserts of high heat conductivity placed in the walls of the mold so as to protrude into the casting cavity and become welded in the cylinder wall when same is cast. In this modification the bottom of the mold cavity is allowed to fill before the withdrawal of the core is started.

The cores 7 and 26 may be solid cylinders as indicated in Figs. 1 to 4, or they may be artificially heated or cooled as illustrated in Fig. 5, wherein 7^a indicates an artificially cooled core of proper length and taper, consisting of an outer casing 34, an inner casing 35, and a flexible conduit 36 to introduce a cooling or heating medium between the casings 34 and 35, and to withdraw it from casing 35 at outlet 37. The core may be coated with a mixture of graphite and oil, clay wash, or some other suitable protector, before each casting operation.

In the embodiments shown the mold is stationary and the core is withdrawn longitudinally therefrom, however the invention is not limited to such arrangement as the core may be given a compound rotative and longitudinal movement, or the core may be the stationary element and the mold moved relatively thereto.

As indicated by the shading of Figure 2, the invention provides a cylinder the inner wall of which is of chill hardened metal, shading off into ordinary grey iron which strengthens and reinforces the chilled inner walls to enable them to withstand the pressure of the explosions in the engine cylinders.

The term "chilling" as used in the specification and claims of this application (when not used in referring to the core 7) refers to that property of cast iron and certain other alloys which, when rapidly cooled or chilled from a molten state, solidify with part of the carbon in combination with the iron, forming a dense hard white iron known as "cementite", as distinguished from the properties of the same alloy when cooled slowly from a molten state, which slow cooling of cast iron permits the carbon to separate from the iron as graphite, forming grey iron. Inasmuch as certain other alloys in addition to cast iron exhibit this property of chilling, as, for example, certain aluminum-silicon alloys, the invention, is not necessarily limited to cast iron, and the construction may be used to produce cylinders without an internal chill if desired.

The invention is not limited to the casting of internal combustion engine cylinders or the apparatus illustrated herein, but contemplates the casting of cylindrical bodies generally, and the process by which the casting is produced as defined in the appended claims.

I claim:

1. The process of casting a ferrous metal cylinder with a chill-hardened inner surface and an unhardened exterior which consists in introducing molten metal into a refractory mold around a rigid chill core, and withdrawing the core after the core-contacting skin of the casting has solidified, but before the casting shrinks upon the core, the withdrawal of the core commencing soon after the pouring is started and continuing until after the pouring is completed.

2. The process of casting iron cylinders which consists of introducing a molten iron mixture into a refractory mold around a rigid metal core and withdrawing the core after the inner surface has solidified, but before the casting has shrunk upon the core.

3. The process of casting grey iron cylinders with a chilled inner surface which consists of introducing a molten cast iron mixture into a refractory mold around a rigid chill core and withdrawing the core after the inner surface has solidified, but before the casting has shrunk upon the core, the withdrawal of the core commencing before the pouring is completed.

4. The process of casting grey iron cylinders with a chilled inner surface which consists of introducing a molten cast iron mixture into a refractory mold around a rigid chill core and gradually withdrawing the core after the inner surface has solidified, but before the casting has shrunk upon the core, the withdrawal of the core commencing simultaneously with the pouring, and continuing until after the pouring is finished.

5. The process of casting engine cylinders with a chilled interior which consists in pouring a molten chilling alloy into the mold around a rigid chill core extending through the mold cavity and projecting there beyond and withdrawing the core, the withdrawal commencing substantially simultaneous with the pouring operation and being of such speed that the pouring is completed and the interior of the casting is solidified before the projecting end of the core passes the end of the mold cavity.

6. The process of casting internally chilled engine cylinders which consists in pouring a chillable metal into a refractory mold around a rigid tapered chilled core which projects beyond the mold cavity, and withdrawing the core longitudinally from the mold, the withdrawal commencing soon after the pouring is started and being of such speed that the end of the core does not pass the end of the mold cavity until the pouring is completed, and the chilled skin of the casting solidified, and the taper of the core being such that the casting in shrinking will not interfere with its withdrawal.

7. The process of casting jacketed engine cylinders with a hardened interior which consists in pouring a chilling mixture into a mold shaped to form a jacketed casting and provided with a metal core and withdrawing the core from the mold and casting as the skin of the casting solidifies.

8. In a casting apparatus the combination of refractory mold, a mold cavity therein, a cooperating tapered metal core extending through the mold cavity and projecting outside the mold, and power means attached to the core outside the mold for causing the withdrawal of the core from the mold through the lower end of said mold, said withdrawing means operating in such relation to the pouring of the metal into the mold, that the pouring is completed before the top of the core passes below the top of the mold, the degree of taper of the core and the time of operation of the withdrawing means being relative to the degree of contraction of the body of metal cast in the mold, during the process of cooling.

In testimony whereof I affix my signature.

NELSON LITTELL.