April 29, 1930. A. W. MORRIS ET AL 1,756,602

ATTACHMENT FOR CASTING MACHINES

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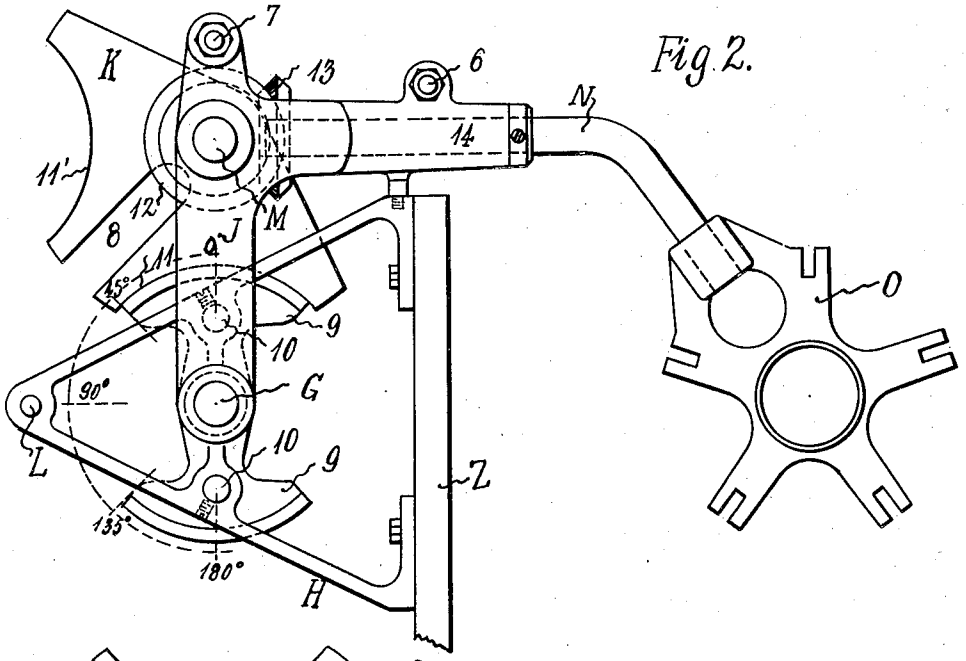


Fig. 2.

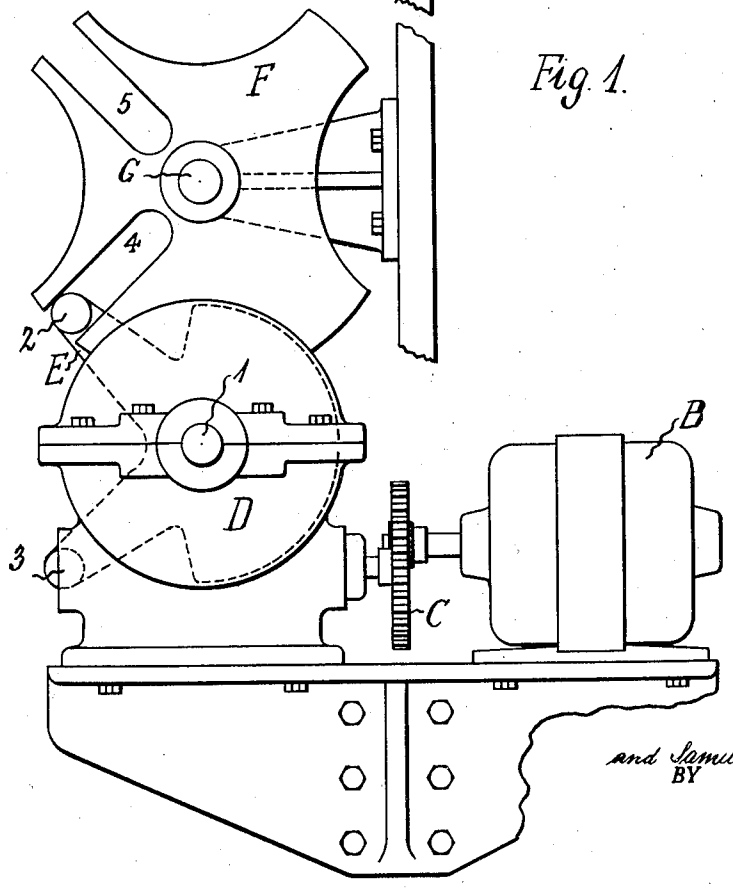


Fig. 1.

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Fig. 4.

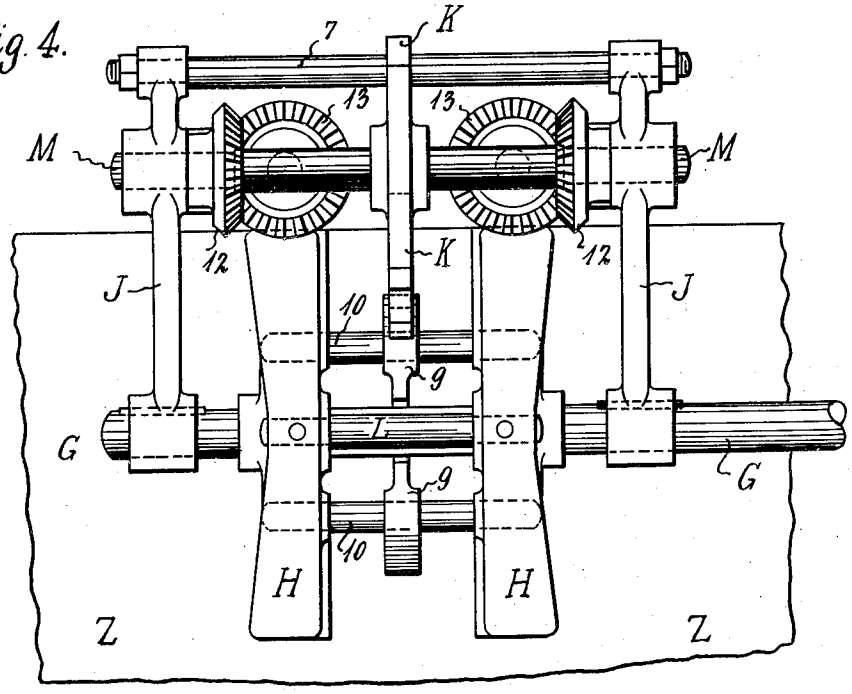
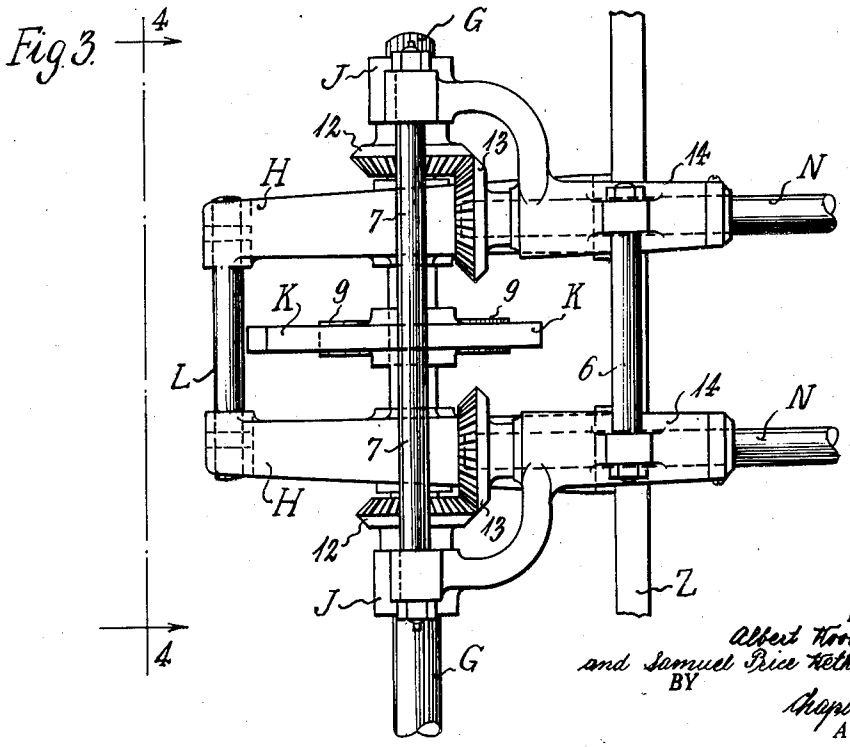


Fig. 3.



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Fig. 5.

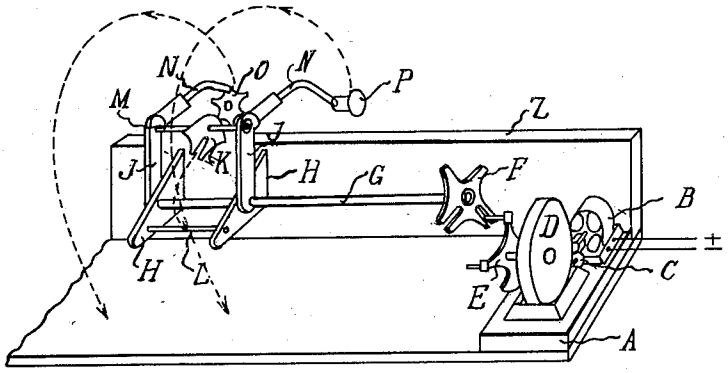
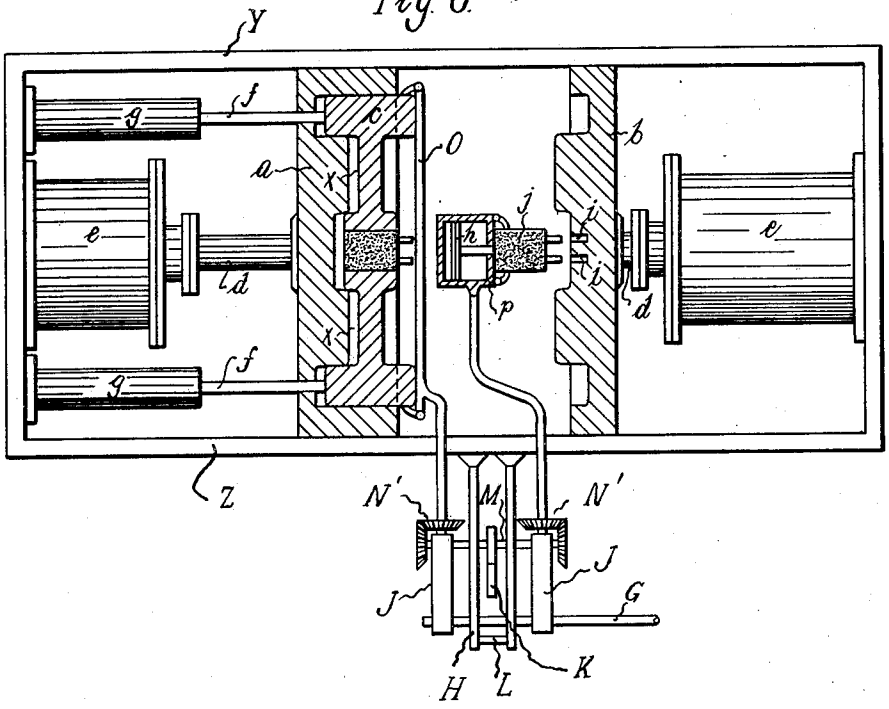


Fig. 6.



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Fig. 7a.

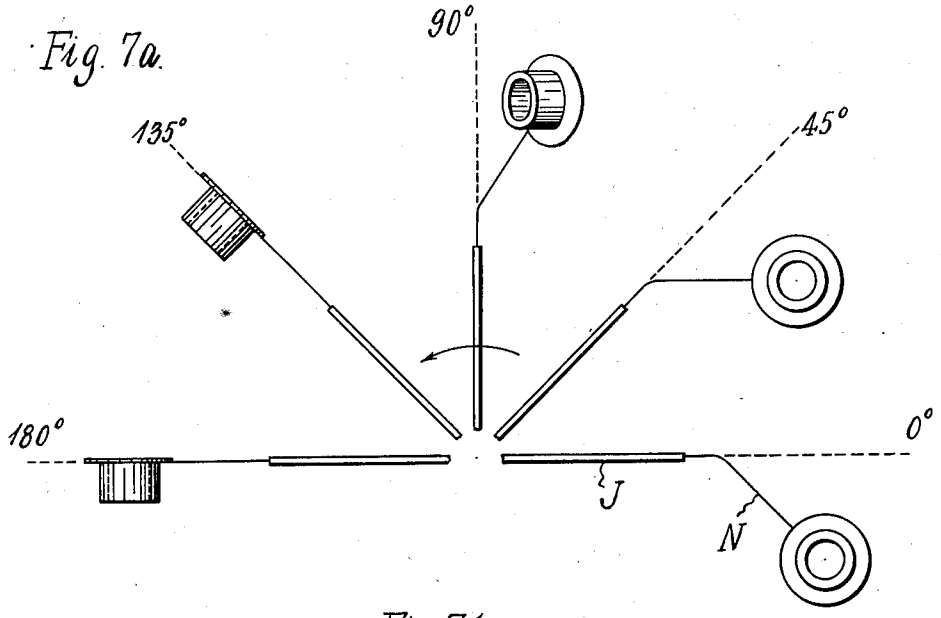
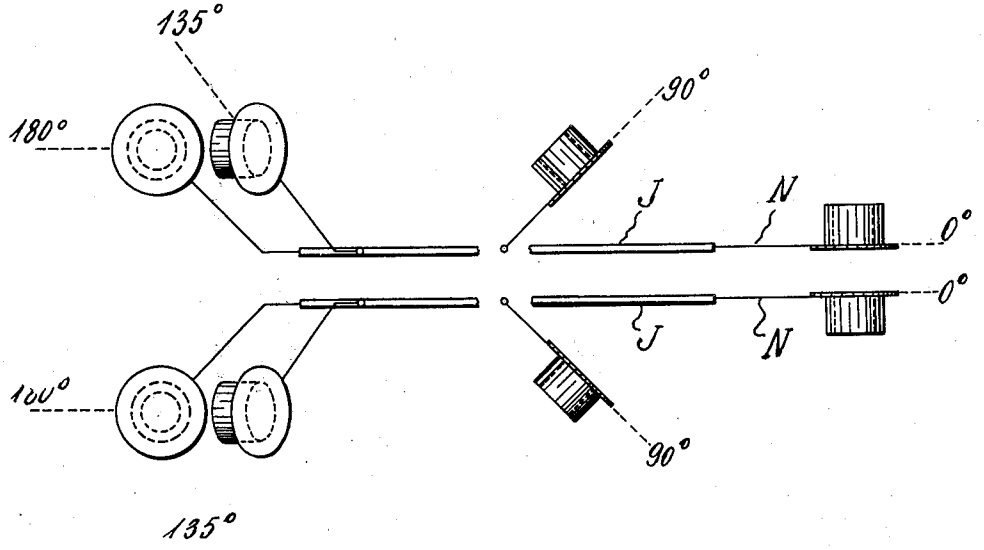


Fig. 7b.



135°

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Fig. 8.

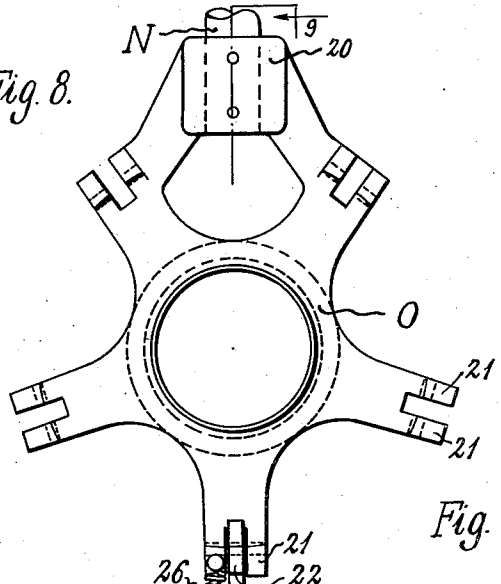


Fig. 9.

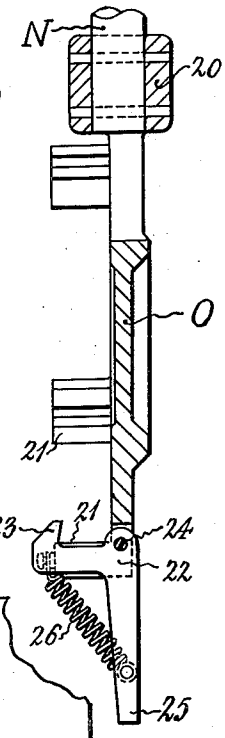


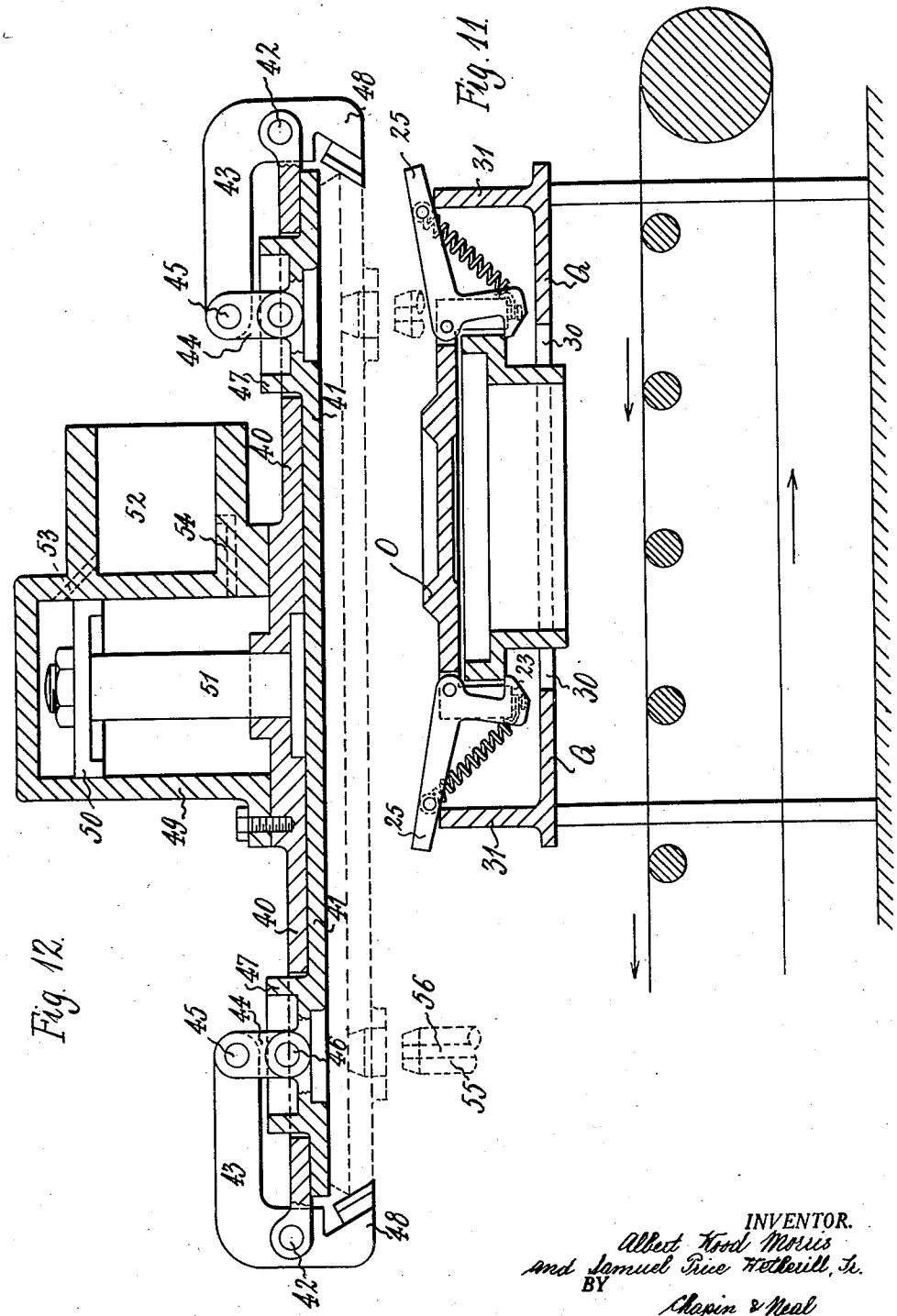
Fig. 10.

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UNITED STATES PATENT OFFICE

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ATTACHMENT FOR CASTING MACHINES

Application filed May 22, 1929. Serial No. 365,164.

This invention relates to automatic devices for removing castings from or putting cores into molds or, more generally, for automatically shifting castings or cores.

The device, as it has been evolved at the present time, according to our invention, is especially adapted to be used in connection with the "Method and apparatus for casting metals" as described in our copending application Serial No. 341,142, but its use is not necessarily confined to such an apparatus.

In order to convey a clearer understanding of the essential features of this invention, some characteristics of the aforesaid method of casting metals may be mentioned.

The paramount requisites of this method are predetermination and speed so that the heat of the metal as supplied to the machine suffices for all steps in the making of castings without any re-heating of the metal in the machine. The mold may be said to be subjected to predetermined cycles, each comprising: core-placing, mold-closing, metal charging, mold-opening, and casting removing. The castings are preferably to be removed from the mold at the hottest temperature compatible with preservation of their form,—sometimes with the inner casting portions still in molten condition,—and then to be taken with the least delay into the cooling or normalizing chamber in order to reduce chilling to a minimum during this transposition.

From these statements, it appears that our method requires mechanical, automatically operating means; and it is also evident that the gentler the removing of the hot castings is carried out, the hotter their temperature may be when carried, resulting in a metallurgically better product. On the other hand, it should be understood that the accurate, quick and predetermined action of our casting and core transposer constitutes superior features of general usefulness in respect to time saving, etc.

The object of the invention in its broader aspect is a casting or core transposer which operates predeterminately and automatically without imparting excessive stresses to the material handled, which is capable of handling very hot pieces, and which works accurately and quickly.

How these various ends and other advantages have been realized in combination will appear from the subsequent description of a preferred form of the device which may be modified in structural features without departing from the scope of the invention.

Fig. 1 shows in elevation the principal detail of the driving mechanism for the transposer comprising an electric motor with worm gear and a Geneva drive;

Fig. 2 shows in elevation the principal detail of the transposer proper to be connected to the driving mechanism;

Fig. 3 is a top view of the transposer with parts broken away;

Fig. 4 is a side view in the direction 4—4 as indicated in Fig. 3;

Fig. 5 schematically illustrates in a perspective view the transposer and the driving mechanism coupled thereto;

Fig. 6 illustrates in a general way (and for convenience out of scale) a transposer with two arms, one of them in the position of gripping a casting and the other of inserting a core;

Figs. 7ª and 7ᵇ show schematically in elevation and top view the kinematics of our double-arm transposer;

Fig. 8 is a plan view of the hand member;

Fig. 9 is a side view of the hand member;

Fig. 10 shows an opener for the hand member in top plan view;

Fig. 11 shows the opener coacting with the hand member for the removal of a casting from the hand grip; and

Fig. 12 is a cross-section of a core-setter.

The operation of the transposer in conjunction with an automatic casting machine according to our copending application Serial No. 341,142 will more easily be understood by referring first to the schematic illustrations Figs. 5, 6, 7ª and 7ᵇ. In Fig. 5, a base plate A serves as mounting for a small electric motor B coupled to a worm-gear D by means of a transmission gear C,—the latter only slightly exposed to view. The shaft of the worm-gear carries the driving pinwheel E of a Geneva drive, the slotted wheel

F of this drive being mounted on the main shaft G. On the vertical panel Z (consider this panel as a frame portion of the automatic casting machine), two standards H with bearings for the main shaft G are mounted. In the illustration, the transposer is shown to have two arm members J with extensions N and hand members O and P, member O for gripping a casting and member P for setting a core at the same time. The arm members are rigidly connected to the main shaft G so that they are rotated by this shaft. The arms have elbow portions J and extensions N, which latter are mounted for rotation in the upper sleeved elbow portion and by means of bevel gears (indicated at N′ in Fig. 6) they are coupled to the spindle M. The spindle M is journaled in the elbows and carries the slotted disk K of a Geneva drive which will engage the stationary strut L as soon as the arms have been turned about shaft G a certain degree out of the plane of the drawing toward the spectator. This engagement by means of the bevel gear transmission will twist the arm extensions and their hands outwardly,—that is, away from each other into divergent relation (see Figs. 7^a and 7^b).

Fig. 6 is a top view showing the transposer operating in conjunction with an automatic casting machine. Though the present illustration is somewhat different from the one shown in our copending application, it will easily be recognized that the underlying principle and the essential features are the same in both representations, and that the differences between the two arrangements are due to a somewhat different setting of the cores and removing of the castings. Within the frame Y—Z (the portion Z corresponds to the panel Z in Fig. 5), two mold sections *a* and *b* are held in guide rails so that they can be reciprocated in a horizontal plane and thereby opened and closed on a vertical division plane. It will be noted that this vertical division cuts the mold into two unsymmetrical sections. The reason for this is that with opening mold sections the casting will stick to that mold section which offers the larger adhesive surface, thus making the operation definite. The mold sections are reciprocated by compressed-air cylinders *e* with piston stems *d*. In the figure the instant has been fixed where the complete casting *c* has just been ejected a little from the mold and pushed between the peripheral grip of the hand member O by means of the compressed-air cylinders *g* with piston stems *f*, a condition which is also indicated by the air interspaces *x* between the casting and the mold. The other hand member P carries a core *j* ready for attachment to mold section *b*. The piston *h* actuated by compressed air pushes the core towards the right, and presses the two little tenons on the core into engagement with two registering holes *i* in the mold.

The complete cycle of events may be described as follows: The closed mold is charged with molten metal under the action of compressed air through gate at the bottom of the mold, and, after a short time for the cooling and congealing of the casting has elapsed, the mold sections are gradually withdrawn while, simultaneously, the hands of the transposer enter the interspaces thus formed between the mold parts where they stop for a short interval in front of the mold sections, just long enough to permit the gripping of the casting and the setting of a new core in the manner explained before. The left or casting-carrying mold section continues to recede further and thereby completely clears the casting which is now freely held in the grip of the transposer. Then, the motor B is started in the way reverse to the way for putting the parts in the position shown, the casting is lifted from between the widely open mold sections and deposited at a disposal point away from the machine in this case on a conveying means for transfer to the normalizing chamber, while the other empty hand of the transposer is put in position to take a new core. Meanwhile, the mold sections have closed and a new casting is formed so that, after another reversal of the motor, the same cycle will be repeated. It is obvious that all these operations require very accurate timing with respect to each other, which is achieved in the same or in a similar way as set forth with respect to the timing device in our above mentioned co-pending application for controlling the fluid to the cylinders and electric switches in timed relation.

In the foregoing description, a double-arm transposer has been shown whose two arms perform different functions,—that is, the one arm serves as a casting remover and the other as a core setter. However, there is also an arrangement possible where both arms have the same function, for instance, if castings without cores are made. In this case, a central stationary mold part co-acts with two reciprocable side sections so that a casting is formed on each side of the central mold part. The two arms of the transposer operate at opposite sides of the stationary mold member and the two hand members grip and deposit a casting at the same time. Since the mechanical hands for holding a casting and those for holding a core are usually different in shape and, therefore, adapted only to the one or to the other function, it will require two properly timed double-arm transposers,—one for removing the castings and another for setting the cores,—if in the preceding example also cores are used in the production of the castings.

The operation of the arms and hand members of the double-arm transposer (irrespective of the question of its use as combined

casting and core conveyer or as casting remover or core setter alone) will more readily be understood from the kinematic diagrams, Figs. 7ª and 7ᵇ.

As will be noted from these figures, the twistable extensions of the arms are inclined with respect to the sleeve portion of the elbow at an angle of about 45 degrees. Two plain cylindrical castings are shown to be held in the disk-shaped hand members. Of the elbows, only the sleeve portions are indicated in the figures. The position denoted by zero degrees corresponds to the gripping position shown in Fig. 6. Altogether, the arms are swept over an angle of 180 degrees. During the first 45 degree travel no twisting of the extensions and their hands takes place since only at the end of this travelling period Geneva member K in Fig. 5 engages the coacting strut member L. (This can be better seen from Fig. 2). During the following 90 degree travel of the arms (that is, between 45 degrees and 135 degrees), the Geneva member K and its spindle M will be turned 90 degrees, and this turn, due to a one-to-one ratio of the bevel gear transmission between the spindle M and the rotatable arm extensions, produces a twist of like amount of the extensions and their hands. For the sake of clearness, the 45 degree position has been omitted in Fig. 7ᵇ. The 90 and 135 degree positions illustrate how the two castings move into spread-apart relation with their axes finally parallel to each other. The last 45 degrees travel between 135 and 180 degrees are traversed without any further twist since the Geneva member K is now out of register with L. During this final rotation of the arms, special means (to be described later on) disengage the castings from the hands. The motor during this last travel is braked and later reversed so that the same cycle of events automatically repeats itself in the opposite direction.

The foregoing general explanations will simplify the subsequent description of the structural details with reference to Figs. 1 to 4, and, since in all figures, like characters indicate like parts, only those details will be pointed out which need further elucidation. In Fig. 1 the arrangement of the gear mechanism C between the motor B and the worm-gear casing D will be noted. The pin-wheel E of the Geneva drive is keyed to the shaft 1 of the worm-gear wheel and lies behind the plane of the drawing sheet. If the worm gear wheel is turned 180 degrees from the position shown in the figure, pin 2 will engage slot 4 of the slot wheel F and turn this wheel by 90 degrees, whereupon pin 3 engages slot 5 and produces another turn of 90 degrees. Since the operation of the motor is oscillatory, the main shaft G will be oscillated about its axis between zero and 180 degrees. Assuming a uniform rotation of the driving pin-wheel, the first 45 degree travel of the slot wheel is one of low initial, constantly increasing angular acceleration, and the second 45 degree travel one of constantly decreasing, low terminal acceleration. During the next two 45 degree sections, the same cycle will be repeated. Since the motor operates mainly in the starting and braking range, its speed characteristic will be one of high initial, quickly decreasing acceleration. This fact, in combination with the opposite behavior of the Geneva drive during the initial starting period, results in a gentle picking-up action of the hands, a feature particularly desirable in removing from the molds castings still susceptible to easy fracture.

The transposing device proper, illustrated in Figs. 2, 3 and 4, is mounted on an extension of main shaft G and it is again shown as having two arm members. The two arms are rigidly coupled with each other by the two cross bars 6 and 7, so that they rotate uniformly about the main shaft G. The Geneva member K is provided with a single slot 8. A double-sector member 9 is held stationary by bolts 10 arranged as reinforcing cross bars between the two standards H. The peripheral faces of this double-sector member serve as a guide for the conforming circular edges 11 and 11′ of the Geneva member K during the first and last 45 degree travel of the elbows about the main shaft (indicated on the dotted semi-circle line) in order to positively prevent any angular displacement with respect to the elbows of the Geneva member K during these traveling periods.

Relative to the drawing sheet, the member K is swung 180 degrees about the stationary strut L during the travel of the arms from 45 degrees to 135 degrees; however, in respect to the elbow members the angular displacement of the Geneva member is only 90 degrees. This angular displacement is transmitted through the spindle M to two gear wheels 12 mounted on said spindle and meshing with corresponding gear wheels 13 fixed to the arm extensions N, which latter are rotatably mounted within the sleeve portions 14 of the elbows J.

In connection with former statements, it will be observed that the twisting movement of the arms will be one of nearly uniform acceleration since the Geneva member K operates with an angular phase displacement of 45 degrees in relation to the Geneva drive F, so that a period of increasing acceleration of member F coacts with a period of decreasing acceleration of member K resulting in an acceleration principally determined by the acceleration of the motor itself. Since the whole twisting action occurs between 45 and 135 degrees, where the acceleration of the motor has already passed its high initial value the twisting movement is favorably smoothed out to meet the conditions as previously

pointed out. Similar considerations apply to the periods of retardation or braking.

Figures 8 to 11 show by way of example how the hand members of a casting remover and the coacting casting releaser may be designed to adapt these devices to certain forms of castings frequently met with in foundry practice. Fig. 12 is in the same sense illustrative of a hand member of a core setter in combination with a little air driven cylinder-piston assembly for pushing the core in position.

Referring first to the casting remover, Fig. 8 shows the star-shaped disk O with sleeve portion 20 for attachment to the end of the arm extension N. Each radiating arm is of such dimension as to conform to the shape of the article to be gripped, and its end is bifurcated and upwardly extended into two oppositely arranged prongs 21 for pivotally receiving between them the pawls or finger elements 2. (See also Fig. 9.) The gripping ends 23 of these elements are turned inwardly to form with the faces of the radiating arm a pair of tongues. In the drawing, arrangements are shown for five grippers for circumferentially holding the casting. A hole 24 in the finger elements receives a pin for journaling the elements 22 between the prongs 21. The elongated portion 25, normal to and integral with the finger portion 22, protrudes outwardly and radially from the disk. A spring 26 with one end connected to the elongated portion and the other end attached to one of the prongs 21 tends to press the gripping portions inwardly against the casting. Only one of these arrangements is shown, but each extension of disk O is also provided with the same kind of a device. If a casting is inserted or pushed between the circumferentially disposed finger elements 22, the fingers will first slightly recede against their springs in outwardly radial directions and then, after the inwardly turned finger ends have passed over a recess on the casting, snap inwardly into holding position by reason of the springs 26.

Fig. 10 shows the releasing device or opener which cooperates with the hand member so as to automatically open its grip on the casting for releasing the same.

The flat plate Q is provided with a central opening 30 large enough to permit the passage through it of the casting to be deposited by the mechanical hand. The plate is so mounted in horizontal position on a frame or the like near the casting machine (see Fig. 11) that the hand of the casting remover at the end of its travel will lower the casting in said central opening. At the same time the protruding finger portions 25 of the hand member will impinge upon corresponding lugs 31 circularly arranged on plate Q with the effect that the fingers are lifted from the casting. The casting falls a short distance through the opening 30 and may be deposited on some kind of suitable support such as a chain conveyor taking it to the normalizer. As will be noted in Fig. 10, there is an additional lug 32 provided near the periphery of the central opening. This lug is so situated that it will strike against the sprue of the casting and break it off.

The core setter, Fig. 12, may be of round or rectangular shape. The ground plate 40 is provided with a plurality of openings which serve as a guide for corresponding vertical flanges 47 integral with the movable plate 41. The ground plate carries a number of eyes 42 serving as a fulcrum for the angularly-shaped finger elements 43 with gripping portions 48. The elongated finger portion 43 is anchored to the movable plate 41 by means of element 44 pivoted at 45 and 46. The ground plate carries a compressed-air cylinder 49 with piston 50 and stem 51. A sleeve portion 52 extends from the cylinder for receiving the end of the arm extension N of the transposer. Bores 53 and 54 in this sleeve portion connect the upper and lower chamber of the cylinder to an automatically controlled air pressure supply. If pressure is admitted to the upper chamber, the finger elements will open for picking up or releasing a core, and pressure admitted to the lower chamber presses the fingers into gripping position.

In both instances, that is for the casting remover and the core setter as well, mechanical gripping and holding means have been shown for illustration; however, other suitable means could be substituted for them without departing from the spirit of the invention: for instance, the suction action of rarefied air for picking up cores in combination with some ejecting means for setting the cores in the mold, or electromagnetic forces for pulling the casting out of the mold instead of ejecting it therefrom.

The tenons or little pins which serve to attach the core to the mold in the way shown are advantageously so disposed that they also take care of the necessary ventilation of the core. For this purpose the tenons are provided with a bore that communicates with a ventilating channel in the mold and may also communicate with a special gas channel in the core. This is indicated in Fig. 12 by showing a tenon 55 with bore hole 56. In this illustration, the tenon is supposed to be part of the mold section and to register with a corresponding hole in the core.

It should be understood that shapes of castings and cores and the character of work in the metal casting art varies to such a degree that it is only possible to make our present showing illustrative of one or two uses. To those skilled in the art, many other and obvious specific uses of the machine will occur.

We have mentioned the automatic timed control of the machine but referred to our

copending cases for a more complete showing of a suitable timing device or devices. It is clear from the present showing that our machine is arranged and adapted for automatic timed control so that its cycles may occur in exact timed relation to the casting cycles of an automatic casting machine. The particular machine herein shown in its preferred embodiment for illustrative purposes is designed to work in predetermined automatic relation with an automatic casting machine, such a one for example as shown in our copending case Serial No. 334,304, filed January 22, 1929. One purpose we have is to make a casting for example as large as an automobile flywheel in a completely automatic manner with every step of the operation, even up to the desired cooling of the casting, under a timed control which exactly coordinates every step, which gives the casting the benefit of passing in proper timed relation through every step and speeds up the work while bettering its quality.

To see the ultimate arrangement (although the invention has advantages in many less complete arrangements), one should understand that the timing device shown in our copending application Serial No. 325,364 was worked out to coordinate the machine of the present invention with the machine and method of our application Serial No. 341,142 (the machine of which is shown in more detail in our application Serial No. 325,365) and with the metal supply device of our application Serial No. 347,976 or with other arrangements. This complete assembly for which the present invention happens to be particularly designed is a major development in the art of casting refractory metals like iron in a new way. When large castings are made with great rapidity, the work of properly removing them from the casting machine or keeping the machine supplied with cores presents may difficulties and this present invention overcomes them.

What we claim is:

1. A casting remover comprising driving means, a casting holder adapted to enter between open mold parts and receive a casting as it is ejected from the mold, a movable frame for the holder operable to place the holder in position to take the casting and to place the holder in position to deposit the casting away from the receiving position, said driving means being mechanically connected to the holder to start and end its travel by slow and gentle movements.

2. An apparatus for handling cores and castings comprising a holding means adapted to enter between open mold parts of a casting machine, take a casting from and deposit a core in the mold parts, a movable frame for said holding means and driving means for the movable frame operable to move it to position the holding means into and out of registering position with the mold parts.

3. An apparatus for removing hot castings from casting machines comprising means for holding a casting, a frame for said means movable to place the latter in position to receive the casting directly from an open mold and support the casting as it leaves the mold said frame being also movable to a depositing point away from the mold and operating means for the frame adapted to move it in a predetermined time relation to the operating cycles of a casting machine.

4. An apparatus for removing hot castings from casting machines comprising mechanical gripping means movable between the mold parts of a casting machine to receive and support the casting as it leaves the mold, a device spaced from the mold to which the gripping means is movable and against which the casting is pressed by said means to break off the casting sprue.

5. The combination of a casting machine having a permanent mold and adapted to rapidly repeated casting cycles, a casting remover having a swinging arm with a gripping device at the end and adapted to enter between the mold parts to grip the casting as it leaves the mold, means arranged to swing said arm into and out of casting gripping position in timed relation to the casting cycles, means to release the grip of said arm on the casting when it has swung its full distance away from the mold.

6. The combination of a casting machine having a permanent mold and adapted to rapidly repeated casting cycles, a casting remover having a swinging arm with a gripping device at the end and adapted to enter between the mold parts to grip the casting as it leaves the mold, means arranged to swing said arm into and out of casting gripping position in timed relation to the casting cycles, means to release the grip of said arm on the casting when it has swung its full distance away from the mold, a conveyer to receive the casting from the gripping device and remove it before the next casting arrives.

7. The combination of a casting machine and a casting remover, the latter having a swinging arm with a gripping device at the end adapted to enter the casting machine and grip the casting as soon as it is made in the machine, means arranged to swing said arm out of gripping position and away from the machine, means to make the device loose its grip on the casting when it has swung its full distance away from the machine, and an abutment against which the arm presses the sprue of the casting to break it off as the grip is released.

8. The combination of a casting machine and an apparatus for servicing the mold after each casting is made, said apparatus comprising two swing arms each provided at its

end with a gripping device or hand for registration with the mold parts when open and means to swing said arms into and out of such registering position as soon as the mold of the machine is open, whereby articles such as castings or cores can be handled by said apparatus as the casting machine is working.

9. The combination with mechanically charged, periodically closing and opening mold sections adapted for automatically forming a casting therein during each cycle, of a reciprocating casting transporter adapted to be so timed and having such dimensions as to periodically enter between the opening mold sections, grip the casting, hold it until complete separation from the mold, remove it from between the open mold sections, and transport it to a desired place.

10. The combination with a mechanically charged casting machine adapted for periodically forming a casting therein between automatically closing and opening mold sections and ejecting it therefrom during each cycle, of a reciprocating casting transporter having driving means adapted to be so timed as to periodically insert a transporter element between the opening mold sections, receive the ejected casting, hold it until complete separation from the mold, remove it from between the open mold sections, and transport it to a desired place.

11. The combintion with a mechanically charged casting machine having periodically operable mold sections and means for automatically forming a casting therein and ejecting it therefrom during each period, of a casting transposer adapted to be timed to the periodic operation of the mold sections, comprising an oscillatory swing arm, an arm extension twistable therein, an extreme hand member with means for receiving and holding a casting, and a separate means for releasing the casting from the hand member, said hand member being so shaped and mounted as to be simultaneously swung and twisted, to receive the ejected casting from and between the opening mold members, hold it until complete opening of the mold and separation therefrom, transport it and then deposit it in coaction with said releasing means.

12. The combination with a casting machine having mold members adapted for periodically closing and opening in a vertical plane for automatically forming a casting therein and means for ejecting the casting therefrom during each cycle, of a casting transposer arranged to be timed to the perodic operation of the mold sections, comprising an oscillatory swing arm, an arm extension twistable therein, an extreme hand member with means for receiving and holding a casting, and a separate means for releasing the casting from the hand member, said hand member being so shaped and mounted as to be simultaneously swung and twisted, to receive the casting in horzontal direction from and between the opening mold members, hold it until complete opening of the mold and separation therefrom, remove it from between the mold members and deposit it downwardly in coaction with said releasing means.

13. A transporting device for receiving castings and like articles in one direction, conveying them in a direction substantially normal to the receiving direction and depositing them substantially normal to both said directions, said device comprising an oscillatory swing arm, an arm extension twistable therein and adapted to receive and hold an article, means for reciprocally rotating said arm in a plane normal to said receiving direction, a gear mounted on the arm in mesh with a gear mounted on the twistable extension, and kinematically coacting means for imparting a rotation to said gears during the swing of the arm comprising an element coupled with said gear on the arm and an element mounted separately from the arm.

14. A transposing device for receiving castings and like articles in one direction, conveying them in a direction substantially normal to the receiving direction and depositing them substantially normal to both said directions, said device comprising a controllable and reversible prime mover, a driven shaft, a Geneva drive between said prime mover and the driven shaft, a lever arm with a sleeve portion fixed to the driven shaft, a lever arm extension rotatably held in the sleeve portion, means attached to the extremity of the lever arm extension for receiving and holding an article, a bevel gear rotatably mounted on the sleeve portion in mesh with a bevel gear fixed to the lever arm extension, a Geneva drive slot wheel rigidly and co-axially coupled with said gear on the sleeve portion, a pin fixed to a stationary support for engagement with said slot wheel, and separate stationary means for releasing the conveyed article.

15. A device of the class described for transposing castings and like articles in combination with a member attached thereto for receiving and holding an article, and a member separate therefrom for releasing the article from its hold, said holding member comprising a flat disk, a plurality of resilient finger elements for circumferentially holding an article inserted between their inner coacting faces so disposed at intervals near the edge of said disk as to conform to the shape of the article to be gripped and also extending outwardly therefrom, said separate releasing member comprising a frame having a large enough central opening for passing the conveyed article therethrough, and a plurality of circumferentially arranged lugs on

said frame registering with said disk-outwardly extending finger parts for lifting the fingers from the article and dropping it through said central opening.

16. A device of the class described for transposing cores and like articles in combination with a member attached thereto for picking up, holding, and ejecting an article, said member comprising an air-pressure cylinder mounted in the center of a flat disk and with its piston stem acting through a central aperture in said disk on a movable plate, said movable plate having vertical projections which slidingly engage circumferential apertures in said disk, and a plurality of angularly-bent finger elements pivotally so mounted at intervals near the edge of said flat disk as to conform to the shape of the article to be gripped, each finger element at one end terminating in a gripping claw in front of and coacting with the movable plate and at the other end being linked to the movable plate through said circumferential disk apertures by means of a flexible joint adapted to transmit gripping movements or, in combination with ejecting movements of the movable plate, opening movements to said claws.

17. A casting machine adapted for automatically forming and delivering a casting during each cycle by opening and closing its mold on a substantially vertical plane, this plane being so arranged as to provide unequal adhesive surfaces between the formed casting and the opening mold sections for holding the casting in the more adhesive of the opening sections and delivering it therefrom, and a casting removing machine having a periodically movable gripper to receive the delivered casting and take it out of the casting machine.

18. A casting machine adapted for automatically forming and delivering a casting during each cycle by opening and closing its mold on a substantially vertical plane, means for holding the casting in that section from which it is to be delivered and a casting removing machine having a periodically movable gripper to receive the delivered casting and take it out of the casting machine.

19. In combination with an automatic core setter of the class described, a core and a mold section attachable to each other by means of a pin and registering hole, and a bore in said pin for ventilating the core therethrough.

In testimony whereof we have affixed our signatures.

ALBERT WOOD MORRIS.
SAMUEL PRICE WETHERILL, JR.