

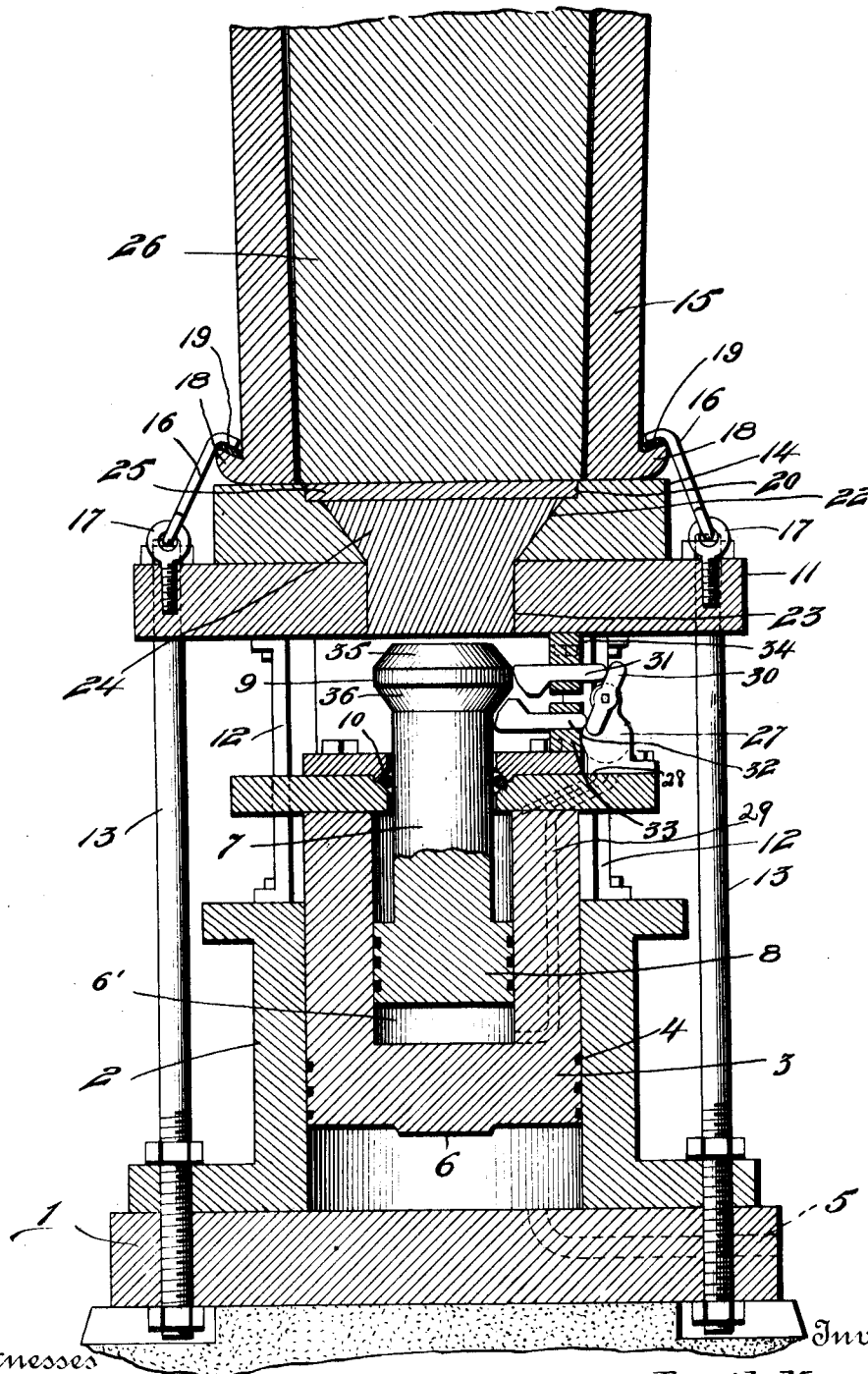
D. MAXWELL.
METHOD OF MAKING CASTINGS.
APPLICATION FILED JAN. 9, 1911.

1,062,287.

Patented May 20, 1913.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses
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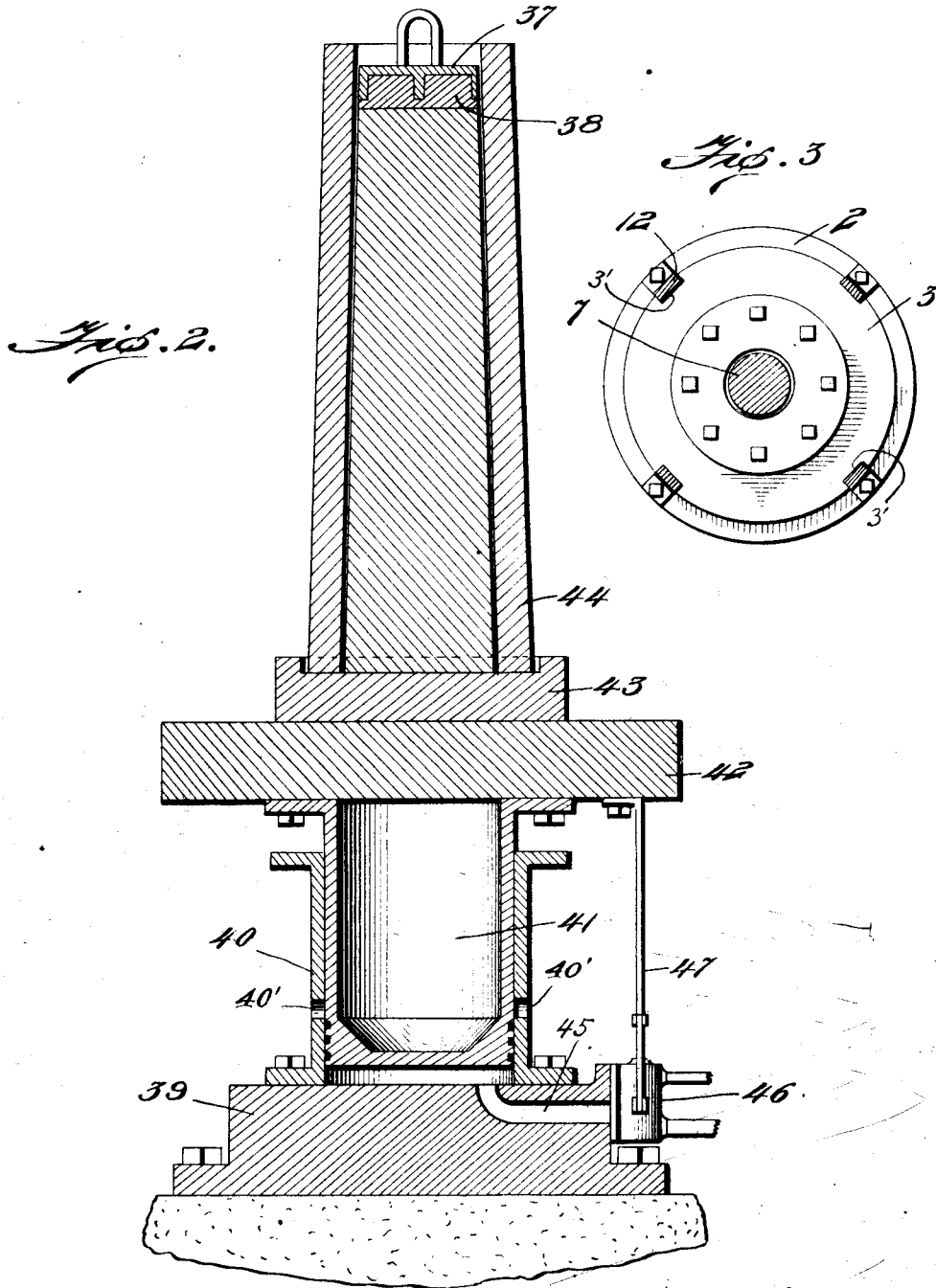
Inventor
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2 SHEETS—SHEET 2.



Witnesses
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UNITED STATES PATENT OFFICE.

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METHOD OF MAKING CASTINGS.

1,062,287.

Specification of Letters Patent.

Patented May 20, 1913.

Application filed January 9, 1911. Serial No. 601,742.

To all whom it may concern:

Be it known that I, DAVID MAXWELL, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented new and useful Improvements in Methods of Making Castings, of which the following is a specification.

This invention relates to the art of casting, and while applicable to castings in general is particularly designed for use in the making of ingots, and has for its object to prevent piping and segregation. Many attempts have been made to overcome these objections, mostly on the assumption that the defects were caused by the accumulation of gases, and the treatments have been for the most part chemical.

As the result of my investigations I am satisfied that the defects are mechanical, as well as chemical, and therefore I propose to prevent the defects by mechanical manipulation of the casting during solidification.

In carrying out my invention, I submit the casting during solidification to a succession of impacts, preferably in a vertical direction, whereby successive downward impulses are given to the metalloids which will thereby be prevented from floating or rising to the top of the casting. It will therefore be apparent that my method will effectually prevent segregation and produce a homogeneous casting. During the pipe forming period of solidification, whenever any bridges, hanging walls, or crusts form or tend to form, the impacts applied to the casting will effectually break down such bridges, hanging walls and crust, whereby the broken portions and molten metal combine into a molten mass. Consequently permanent bridges, hanging walls and crusts are effectually prevented and there is substantially no segregation nor piping of the casting.

In the drawings,—Figure 1 is a vertical central longitudinal sectional view of one form of apparatus for practising the invention. Fig. 2 is a similar view of another form of apparatus for applying the impacts in a different manner from that of Fig. 1. Fig. 3 is a reduced plan view, partly in section, showing the manner of guiding the hydraulic or adjustable piston.

Referring at first to Fig. 1 of the accom-

pany drawings, 1 designates any suitable base or bed from which rises a cylinder 2 55 having an open top through which works a piston 3 suitably packed, as at 4. Water is admitted into the bottom portion of the cylinder 2 through a suitable port 5 formed through the bed or base 1 or located at any 60 other suitable point as may be desired. The bottom of the piston 3 is provided with a central depending boss 6 designed to strike the base or bed 1 so as to support the bottom of the piston slightly above the bed or bot- 65 tom 1 to provide a space to receive the water initially introduced into the cylinder. It will of course be understood that the exhaust from the cylinder passes out through the port 5. The piston 3 is hollow or pro- 70 vided with a central longitudinal bore 6' opening through the top of the piston. Working in the bore of the piston is a plunger including a stem or shank 7 of somewhat less diameter than that of the bore of 75 the piston. This shank is provided at its lower end with a piston head 8 suitably packed and working in the cylinder formed by the hollow piston 3. At the upper end of the stem 7 there is a striking head 9 de- 80 signed to apply impacts to the casting as will be hereinafter explained. The top of the cylinder 3 is provided with a suitable gland 10 through which the piston shank or stem 7 works. For the support of an ingot above 85 the striking head 9 there is provided a table or platform 11 supported by standards 12 rising from the top of the fixed or stationary cylinder 2. Suitable tie bolts or rods 13 extend between the base or bed 1 and the 90 table or platform 11. Upon the table or platform 11 is a casting plate 14. Any form of mold, such for instance as an ingot mold 15 rests upon the casting plate 14, and is held down against said plate by means of 95 suitable fastenings. As illustrated in the accompanying drawing, these fastenings consist of hooks 16 hinged or loosely connected to the table or platform 11 by means of eyes 17, each hook being designed to be 100 engaged with a suitable ear or lug 18 as commonly provided upon ingot molds. In order to insure a snug engagement between the hook and adjacent lug or ear a wedge 19 is driven in between the hook and ear. 105 By the means just described, a mold may be

very conveniently and rigidly held against the casting plate so as to avoid displacement by the blows imparted by the striking head 9 of the reciprocating plunger 7.

5 In the top of the casting plate 14 is a central depression or seat 20 of suitable shape corresponding to the cross sectional shape of the lower end of the casting. A downwardly tapered opening 22 extends
10 through the casting plate from the seat or socket 20, with its lower open end registering with an opening 23 extending through the table or platform 11 in alinement with the striking head of the reciprocating
15 plunger. Working in the openings 22 and 23 and conforming to the shape thereof is an impacting and stripping head 24, the lower end of which is in the path of the striking head 9 so as to be driven upwardly
20 thereby when the percussive piston 7 is in operation. A suitable plate 25 rests loosely in the seat or socket 20 so as to be interposed directly between the impacting and stripping head 24 and the casting or ingot
25 26 in the mold.

For the automatic control of the percussive piston there is provided a valve chest 27 carried by the cylinder 3, there being upper and lower ports 28 and 29 communicating between the valve chest 27 and the
30 top and bottom, respectively, of the bore of the cylinder 3. The valve in the chest 27 is controlled by suitable tappet mechanism including a rocker arm 30 and upper and
35 lower reciprocating tappet elements 31 and 32 arranged to cooperate with the striking head 9 and the rocker arm 30. The lower tappet member is mounted in a suitable guide 33 carried by the top of the adjustable
40 cylinder 3, while the upper tappet member works in a guide 34 carried by the table or platform 11. The striking head 9 of the percussive piston is provided with upper and lower beveled portions 35 and 36 cooperating
45 with the respective tappet elements 31 and 32 to slide the same back and forth and thereby throw the rocker arm 30 to shift the valve in the valve chest 27.

For the purpose of guiding the adjustable cylinder 3, the head of the cylinder, as best shown in Fig. 3 of the drawings, is provided in its outer edge with notches or
50 recesses 3', each of which receives one of the standards 12, whereby the cylinder 3 is guided in a true vertical direction during its up and down movements.

In practising my invention by means of the apparatus herein shown and described, molten metal is poured into the mold
60 through the open top thereof, and after a suitable quantity has collected in the bottom of the mold, depending upon the character of the metal under treatment, air or other compressible fluid under pressure is admitted into the bottom of the cylinder 3

through the port 29 so as to drive the percussive piston upwardly to strike the reciprocating impacting head 24 and thereby apply an impact directly against the ingot 26. When the percussive piston reaches its
70 upper limit by striking the bottom of the reciprocating head 24, the tappet 31 will have been moved outwardly to its limit by the striking head 9 wiping across the ends of the tappet, whereby the rocker-arm 30
75 will be thrown and the valve in the valve chest 27 reversed so as to admit air through the port 28 to force the percussive piston downward, during which time the port 29 is an exhaust port. When the percussive
80 piston 7 reaches its downward limit, it will actuate the tappet member 32 to return the valve in the valve chest 27 to its original position, whereupon air will be admitted beneath the piston head 8 and the percussive
85 piston again driven upwardly. By this means, a succession of impacts may be very conveniently and effectively applied directly to the metal in the mold. The effect of the impact or jars upon the metal is such as to
90 cause the metal to pack convergently downward along the longitudinal axis of the casting, whereby secondary pipe is effectively prevented.

In the initial impacting operation, the apparatus is controlled so as to impart a vibrating or trembling motion to the molten metal for the purpose of maintaining the metalloids in suspension. As the level of the molten metal gradually rises in the mold, this trembling or vibration of the molten metal is kept up in order that the metalloids may always be in suspension throughout the successive levels of the molten metal during the pouring operation. By thus maintaining the metalloids suspended, segregation is effectually prevented. As the level of the molten metal rises in the mold it becomes necessary to increase the impact, depending upon the character of the metal under treatment. To effect this change in the character of the impact all that is necessary to do is to lower the adjustable cylinder 3 by permitting water to escape through the port 5, whereby the stroke of the percussive piston will be increased and the power of the impact correspondingly increased.

When the level of the molten metal reaches the upper portion of the mold where there is a tendency to form bridges, hanging walls and piping, the power of the impacts is materially increased for the purpose of breaking down any hanging walls, bridges and crust which form or tend to form at the upper portion of the casting. By thus breaking down the bridges, hanging walls and crust, the broken portions are thrown into the molten portion and are re-melted therein, whereby bridges and piping are effectually prevented and the top of the metal is

maintained in a molten condition except for the annular freezing at the inner walls of the mold.

From the foregoing description of the operation, it will be understood that the impacts are quick and relatively light during the initial pouring of the mold and, as the level of the molten metal rises, the character of the impacts is varied by increasing the length of the stroke of the percussive piston and decreasing the rate thereof, the heaviest blows being struck during the pipe forming and bridge-forming periods.

After pouring, and for the purpose of preventing the molten metal from splashing out through the open top of the mold and also to retain heat, I employ a cover 37 which fits loosely within the open top of the mold and floats upon the molten metal. This cover preferably is in the form of a spidered casting filled with some suitable refractory or infusible material 38 forming a facing for the lower side of the cover to come in direct contact with the molten metal. By the use of this cover, oxidation of the upper surface of the molten metal is prevented and the metal is maintained in a molten condition for a relatively long period.

Due to shrinkage of the metal, a cup will be formed in the top of the casting containing some molten metal. This cup may be filled up by the addition of molten metal, the cover replaced and the impacts continued until the metal in the cup portion of the casting has become solidified. When the additional molten metal is poured into the cup portion a violent eruption is produced by reason of the very hot metal mingling with the relatively cooler metal, whereby all the impurities in the molten metal contained in the cup will rise to the surface, and the molten metal will solidify and unite to the walls of the cup and thus render the casting homogeneous clear to the top thereof.

After the treatment of the casting has been completed, the adjustable cylinder 3 is elevated to its limit, and hydraulic fluid pressure is admitted beneath the bottom of the percussive piston to force the same slowly upward, whereby the solidified ingot will be stripped upwardly through the mold which is held down by the hooks 16, until the top of the ingot can be caught by a crane and pulled entirely out of the mold.

As soon as an ingot has been stripped from the mold, it is of course apparent that the latter can be immediately poured and the treatment of the ingot proceeded with in the manner hereinbefore described. In other words, a single mold serves for successive castings and need not be removed from the impacting apparatus until it has become un-serviceable.

Instead of applying the impacts directly to the material in the mold while holding

the mold fixed, the mold and its contents may be lifted and dropped so as to apply impacts to the metal. This manner of applying impacts may be carried out by an apparatus such as shown in Fig. 2 of the accompanying drawings wherein 39 designates a suitable base upon which is supported an upright cylinder 40 containing a piston or plunger 41 working through the upper open end of the cylinder. Upon the top of the piston or plunger is a table or head 42 designed to support a casting under treatment. Where it is an ingot that is being treated the usual casting block 43 is placed upon the head or table, and the open ended ingot mold 44 is placed upon the casting plate in the usual manner. Impacts are applied to the casting by admitting fluid pressure into the bottom of the cylinder 40 through a suitable port 45 and afterward exhausting through this port so as to drop the cylinder and the table or head carrying the mold. With this type of apparatus, the impacts are not applied directly to the metal in the mold independently of the mold while the latter is held fixed or stationary, as in Fig. 1 of the drawing, but the mold and its contents are lifted and then dropped.

The cylinder 40 is provided with ports or openings 40' normally closed by the plunger 41 so as to prevent the escape of fluid pressure in the cylinder 40, but which operate as escape ports in the event of the plunger 41 being elevated above such ports, thereby to prevent excessive elevation of the plunger.

It will of course be understood that a floating cover 37 is employed as hereinbefore explained in connection with Fig. 1.

The admission and exhaust of fluid pressure to the cylinder is effected by means of a valve chest 46, the valve of which is controlled by a connecting rod 47 extending between the valve in the chest and the head or table on the top of the piston. Any suitable or preferred means may be employed for adjusting the rod 47 to vary the throw of the valve for the purpose of increasing the stroke of the piston and for increasing the rate thereof.

In using either form of apparatus for carrying out the method, the mold may be used with its small end uppermost or its large end uppermost as may be desired, and the effects of the two machines on the metal in the mold are identical.

What is claimed is:—

1. The method of casting, which includes the step of imparting a succession of impacts to the casting while pouring, and varying the character of the impacts.

2. The method of casting, which includes the step of imparting a succession of vertical impacts to the casting while pouring, and varying the character of the impacts.

3. The method of casting, which includes

- the step of imparting a succession of impacts to the casting in a straight line while being poured, and varying the character of the impacts.
- 5 4. The method of casting, which includes the step of imparting a succession of impacts to the casting in a straight vertical line while being poured, and varying the character of the impacts.
 - 10 5. The method of casting, which consists in subjecting the casting to a succession of impacts applied longitudinally thereto in a straight line while the casting is being poured, and varying the character of the impacts.
 - 15 6. The method of casting which consists in subjecting the casting to a succession of impacts applied vertically and longitudinally thereto while the casting is being poured, and varying the character of the impacts.
 - 20 7. The method of casting, which consists in subjecting the solidifying casting with its larger end uppermost to a succession of impacts applied vertically thereto in a straight line, and varying the character of the impacts.
 - 25 8. The method of casting, which consists in pouring the casting with the wide end of the mold uppermost, and subjecting the casting to a succession of impacts applied vertically in a straight line during pouring.
 - 30 9. The method of casting, which consists in subjecting the solidifying casting to impacts throughout at least a portion of the pouring thereof, and varying the character of the impacts.
 - 35 10. The method of preventing segregation in castings, which consists in subjecting the solidifying casting to impact throughout the pouring of the casting, and varying the character of the impacts.
 - 40 11. The method of preventing segregation in castings, which consists in subjecting the solidifying casting to impact prior to the pipe forming period, and varying the character of the impacts.
 - 45 12. The method of preventing piping of castings, which consists in applying impact to the solidifying casting during the pipe forming period, and varying the character of the impacts.
 - 50 13. The method of preventing segregation and piping of castings, which consists in applying impacts to the solidifying casting prior to and during the pipe forming period, and varying the character of the impacts.
 - 55 14. The method of preventing segregation and piping in castings, which consists in applying impacts to the solidifying casting prior to the pipe forming period, during the pipe forming period, and continuing the impacting while any portion of the metal remains in a liquid state.
 - 60 15. The method of casting, which consists in imparting a succession of impacts to the bottom of the casting while solidifying and varying the character of the impacts.
 - 65 16. The method of preventing segregation in castings, which consists in imparting a succession of impacts to the bottom of the casting while solidifying, and varying the stroke of the impacts.
 - 70 17. The method of preventing segregation in castings, which consists in imparting a succession of impacts to the casting while solidifying, and varying the stroke and rate of the impacts.
 - 75 18. The method of preventing segregation in castings, which consists in imparting a succession of impacts to the casting while solidifying, and decreasing the rate of the impacts.
 - 80 19. The method of preventing segregation in castings, which consists in imparting a succession of impacts to the bottom of the casting, while solidifying, and increasing the stroke of the impacts.
 - 85 20. The method of preventing segregation in castings, which consists in imparting a succession of impacts to the casting while solidifying, and decreasing the rate and increasing the stroke.
 - 90 21. The method of preventing segregation in castings, which consists in maintaining the metalloids in suspension until set by mechanically manipulating the casting in a molten condition.
 - 95 22. In the making of castings, the mechanical preventing of flotation of metalloids by the application of impacts.
 - 100 23. The method of preventing piping in castings which consists in mechanically manipulating the casting during the hanging-wall-forming period to break down any hanging walls and prevent the formation of bridges and crust.
 - 105 24. The method of preventing piping in castings which consists in the application of impacts to the casting during the hanging-wall-forming period to break down hanging walls, bridges and crust.
 - 110 25. The method of preventing piping in castings, which consists in mechanically manipulating the casting while pouring and continuing the manipulation during the hanging-wall-forming period to break down any hanging walls and prevent the formation of bridges and crust.
 - 115 26. The method of casting, which includes the steps of imparting a succession of impacts longitudinally to the casting in a straight vertical line while solidifying, and maintaining a float upon the surface of the molten metal during the impacting operation.
 - 120 27. The method of casting, which includes the steps of imparting a succession of impacts to the casting in a straight vertical
 - 125
 - 130

line while solidifying, maintaining a float upon the surface of the molten metal during the impacting operation, whereby a cup is formed in the top of the metal, and introducing molten metal into said cup.

28. The method of preventing segregation in castings, which consists in maintaining the metalloids in suspension throughout the successive levels of the molten metal until the latter becomes set.

29. The method of preventing segregation in castings, which consists in pouring a mold, and maintaining the metalloids in suspension throughout the successive levels of the molten metal until the latter becomes set.

30. The method of preventing segregation in castings, which consists in pouring a mold and maintaining the metalloids in suspension throughout the successive levels of the molten metal by the application of impacts.

31. The method of preventing segregation in castings, which consists in preventing precipitation during the initial pouring of the mold, and thereafter maintaining the metalloids suspended throughout the successive levels of the molten metal.

32. The method of preventing segregation in castings, which consists in preventing precipitation during the initial pouring of the mold by the application of impacts and thereafter maintaining the metalloids suspended throughout the successive levels of the molten metal by the application of impact.

33. The method of making castings, which consists in pouring a mold, applying impacts to the metal while pouring, placing a floating cap on top of the molten metal after pouring, and applying impact to the metal while the cap is floating thereon.

34. The method of making castings, which consists in pouring a mold, applying impacts to the mold while pouring, placing a floating cap on top of the molten metal after pouring, continuing the impacts while the cap is floating on the metal, removing the floating cap, pouring in additional metal, replacing the floating cap, and continuing the impacts.

35. The method of casting, which consists in pouring a mold, and subjecting the metal in the mold to impacts independently of the mold while pouring.

36. The method of casting which consists in pouring a mold, holding the mold fixed and applying impacts to the metal in the mold independently of the mold during the pouring operation.

37. The herein described method which consists in pouring a mold, applying impacts to the bottom of the casting, and stripping the casting from the mold by the impacting means.

38. The herein described method which consists in pouring a mold, applying im-

pacts to the casting at the opposite end of the mold, and stripping the casting from the mold by the impacting means.

39. The method of casting which consists in pouring a mold, holding the mold fixed, applying impacts to the metal in the mold independently of the mold during the pouring operation, and stripping the casting from the mold by the impacting means.

40. The method of making castings which consists in pouring a mold with its large end uppermost, stripping the casting without removing the mold from its position, and repouring the mold while it is still hot from the heat of the prior casting.

41. The method of making castings which consists in pouring a mold supported on a pouring base, applying impacts, and stripping the casting while the mold remains upon the pouring base.

42. The method of making castings, which consists in applying impacts to the bottom of an inert body of molten metal to elevate the same, and permitting the body of metal to gravitate between impacts.

43. The method of making castings, which consists in applying impacts to the bottom of an inert body of molten metal to elevate the same thereof, permitting the body of metal to gravitate between impacts, and varying the character of the impacts.

44. The method of preventing segregation and piping in castings, which consists in applying impacts to the solidifying casting prior to and during the pipe-forming period, and varying the character of the impacts of the different impacting periods.

45. The method of preventing segregation and piping in castings, which consists in applying impacts to the solidifying casting prior to the pipe-forming period, during the pipe-forming period, continuing the impacting while any portion of the metal remains in a liquid state, and varying the character of the impacts of the different impacting periods.

46. The method of preventing segregation and piping in castings, which consists in applying impacts to the solidifying casting prior to the pipe forming period in order to hold the metalloids in suspension, and applying impacts of a different character during the pipe-forming period in order to break down any hanging walls and prevent the formation of bridges and crusts.

47. The method of preventing piping in castings, which consists in applying impacts to the bottom of the casting while pouring, and continuing the impacting after pouring with such character of impacts as will break down any hanging walls and prevent the formation of bridges and crust.

48. The method of preventing piping in castings, which consists in applying to the bottom of a casting during the hanging-wall-

forming period, such impacts as will break down any hanging-walls and prevent the formation of bridges and crust.

49. The method of casting which includes the steps of pouring a mold, applying such impacts to the casting as will form a cup-shaped cavity in the top thereof, pouring molten metal into the cavity and continuing the impacts.

50. The method of casting which includes the steps of pouring molten metal into a hot mold and subjecting the casting to impacts while solidifying.

51. The method of casting, which consists in pouring molten metal into a hot mold and subjecting the casting to impacts while pouring.

52. The process of producing dense steel ingots which consists in confining the molten metal in a mold and causing the metal to settle or be compressed toward the bottom of the mold by impact against the bottom of the mold and during pouring thereof, the said mold being so formed that the metal is compressed laterally as it settles.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

DAVID MAXWELL.

Witnesses:

WALTER S. WHEELER,
BEATRICE D. VERNON.