E. A. CUSTER.

MODE OF CASTING METAL STRUCTURES IN PERMANENT MOLDS HAVING PERMANENT CORES.

APPLICATION FILED NOV. 28, 1908.

925,803. Patented June 22, 1909.

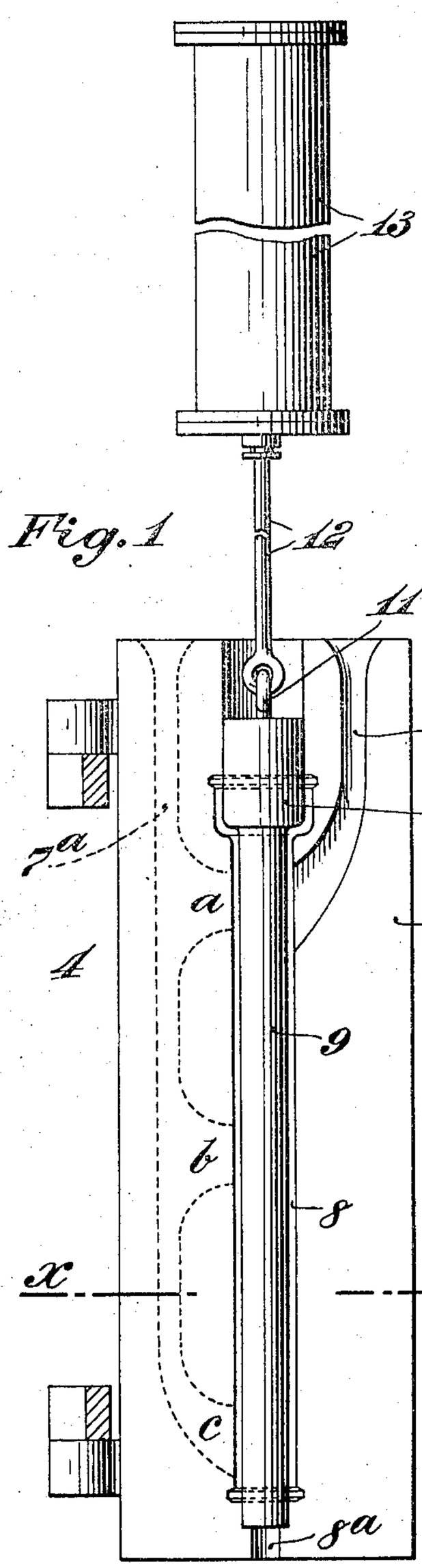

Fig. 1

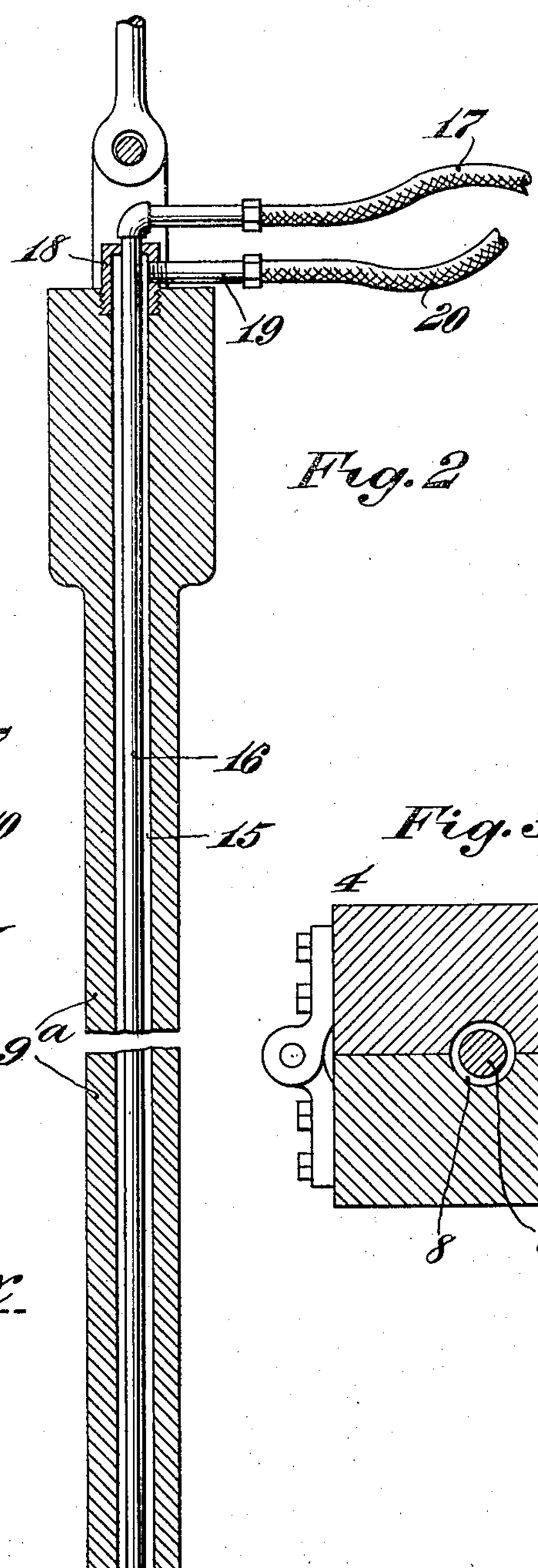

Fig. 2

Fig. 3.

WITNESSES:

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MODE OF CASTING METAL STRUCTURES IN PERMANENT MOLDS HAVING PERMANENT CORES.

No. 925,803. Specification of Letters Patent. Patented June 22, 1909.

Application filed November 28, 1908. Serial No. 464,927.

To all whom it may concern:

Be it known that I, EDGAR ALAN CUSTER, a citizen of the United States, residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in the Mode of Casting Metal Structures in Permanent Molds Having Permanent Cores, of which the following is a specification.

My invention has relation to the mode of producing homogeneous cast structures either soft or hard, as required, by the use of permanent metal cores within permanent metal molds, embracing further developments of the art of casting metal structures forming the subject-matter of U. S. Letters Patent No. 870,817, granted to me under date of November 12th, 1907, and also embodying salient principles of the application for U. S. Letters Patent filed by me, under date of April 7th, 1908, Serial No. 425,672, in which basically the invention of that application as well as the present one, is predicated upon the fact that molten iron when allowed to cool slowly separates the carbon into two forms free or graphitic carbon and combined carbon. The amount of graphitic carbon, present in iron depends upon the rate at which it is cooled. Further graphitic carbon, when molten iron is cooled slowly tends to segregate before the iron reaches the point at which it sets. Graphitic carbon forms very quickly and when the iron is cooled the free carbon divides into two forms, graphitic and annealing. The difference between the two is simply a difference in form, because both have the same chemical characteristics, thus demonstrating that if molten iron is suddenly chilled to a point at which it sets, the formation of graphitic carbon in the iron is prevented and consequently all or nearly all the carbon exists in a combined state. This is equally true in respect to the action of sulfur and phosphorus in the iron and consequently segregation of these elements is prevented in the same said manner. The formation of annealing carbon in iron and of carbid carbon begins after the iron has passed the setting point and such action can only take place when the iron is permitted to cool normally, therefore if molten iron be chilled suddenly from the molten state to the point at which it sets and be then allowed to cool slowly, at atmospheric temperature or at an established falling temperature, undesirable actions as the segregation and formation of graphitic carbon are prevented and desirable actions as the formation of annealing carbon and carbid carbon regularly begin. These actions produce with certainty a thoroughly homogeneous product with such changed molecular conditions, as to give either a soft or hard or tough resultant product, as desired.

My invention broadly considered, consists in presenting molten iron to the direct influence of a permanent metal core in a permanent metal mold to change molecular conditions of the metal so as to establish throughout the homogeneity of the structure cast by the pouring of the molten metal against such a core within the mold to chill quickly or swiftly the molten metal to the point of setting, then removing the core and opening the mold to remove the structure cast so that the same can then cool gradually by surrounding atmosphere to thereby derive a resultant homogeneous cast structure throughout.

My present invention will be more fully understood from the accompanying drawings illustrating different forms of means for carrying into effect the mode of my said invention, in which—

Figure 1, is a view partly in section and partly in elevation of a two-part permanent metal mold, showing internal formations and a permanent metal core suitably connected with a hydraulic or other ram for lifting the core from the mold after setting of the structure cast, in this instance a pipe, so that the mold can then be opened to allow the throughout homogeneous structure cast to cool by its own annealing heat gradually in the surrounding atmosphere or in an established falling temperature according to conditions and requirements. Fig. 2, is a similar view, of a modified form of metal fluid cooled core adapted for use in a permanent mold, where structures are to be cast with greater thicknesses as to the walls than in the use of a solid metal core of the type of Fig. 1; and Fig. 3, is a transverse sectional view through the permanent metal mold and metal core on the line x, x, of Fig. 1.

Referring to the drawings 4, is a permanent two-part metal mold 5, 6, or which may be arranged so as to consist of a cope and a

drag depending upon whether occupying a vertical or horizontal position for use. The vertical mold as shown is provided with either a single pour-hole 7, to the right in Fig. 1, or a single pour-hole 7ª, to the left in said Fig. 1, with a series of branches *a*, *b* and *c*, leading directly to the main cavity 8, of the mold 4, provided with a contracted cylindrical orifice or opening 8ª, in the base portion as clearly shown in Fig. 1, for escape of gases, etc. The internal mold cavity 8, is so arranged as to receive a permanent metal cylindriform core 9, which as shown in Figs. 1 and 2, is provided with an enlargement 10, at one end having an eye 11, to be connected with the piston-rod 12, of a hydraulic ram or other means 13, for liberating the core when required. The two-part mold 4, in Fig. 1, is arranged in a vertical position for the casting operation with the gates or pour-holes 7 and 7ª, in the top, but a horizontal mold may be used with equally good results. In such instance, the pour-holes into channelways of the interior of the mold 4, will be arranged in substantially the manner shown and described in U. S. Letters Patents granted to me under the No. 887,070, May 12th, 1908, and No. 898,631, dated September 15th, 1908.

In Fig. 2, is shown a thick wall hollow permanent metal core 9ª, the internal chamber 15, of which is provided with a fluid inlet pipe 16, extending downwardly thereinto. At the upper end the same is connected with a hose or other flexible connection 17, with a fluid supply, not shown. There is also provided a capping 18, having a discharge pipe 19, with a flexible connection 20, to a waste receptacle, not shown. In some instances, where a heavy or thick wall structure is to be cast, it is desirable, as practice has demonstrated, to use a fluid cooled metal core, in a permanent mold 4, to insure the proper establishing of the homogeneity throughout of the iron in the resultant product by changed molecular conditions of the metal induced according to the described mode of my said invention and by quickly chilling the molten metal against the core and mold to the point of setting of the metal whereby as practice has established to insure a general character of structure cast which is throughout homogeneous both as to the interior as well as the exterior.

In connection with the temperature of the molten metal it may be remarked that as it leaves the cupola or other furnace the same will range between 2000° and 2800° Fah. about and in passing to pouring means prior to reaching the permanent mold, that temperature is not materially changed or modified but the instant the pourings enter the permanent metal mold and metal core there is effected a violent or sudden change in the temperature of the molten metal which is due to the difference in maintained temperature between the mold and poured metal, and such temperature will range between 1700° and 2200° Fah. as compared to the temperature thereof as above given in passing from the furnace to the pouring means. This results in preventing through such violent or sudden chilling of the metal to the point of setting of the formation of graphitic carbon in the structure cast, because all or nearly all the carbon is held in a combined state, as segregation only occurs, while the iron is in a molten condition. This is equally true as to the action of sulfur and phosphorus in the iron. From the moment when the iron is set follows the formation of annealing carbon and carbid carbon and this action takes place during the period of gradual cooling of the iron in its structural form. The said mode of my said invention embraces and requires for its applications, the employment of a permanent metal mold with a permanent core, solid or fluid cooled, for the making of various kinds or types of castings for use, in foundry arts.

Having thus described the nature and objects of my invention, what I claim as new and desire to secure by Letters Patent is:—

1. The mode of casting a metal structure around a permanent core in a permanent mold which consists in chilling suddenly molten metal to the point of setting in a structure against the metal core within the permanent mold by changing molecular conditions of the metal to thereby establish the homogeneity of the structure cast, removing the core and structure cast from the mold so as to cool gradually, substantially as described.

2. The mode of casting a metal structure in around a permanent core in a permanent metal mold, which consists in chilling suddenly molten metal to the point of setting against the metal core within the permanent mold by changing molecular conditions of the metal to establish throughout the homogeneity of the structure cast, removing the core and structure cast from the mold so as to cool by its own heat in the atmosphere, substantially as described.

3. The mode of casting a metal structure around a permanent water-cooled core in a permanent mold, which consists in chilling swiftly molten metal to the point of setting about the metal core within the permanent mold to by changing molecular conditions of the metal establish homogeneity of the structure cast then removing the core and thereafter the structure cast from the mold to cool gradually in the atmosphere, substantially as described.

4. The mode of casting a structure around a permanent core within a permanent mold, which consists in swiftly chilling molten metal against the metal core confined within

the permanent mold to the point of setting, then removing the metal core and allowing the structure cast upon being freed from its confinement of the mold to cool in the atmosphere, substantially as described.

5. The mode of casting a structure around a permanent core within a permanent mold, which consists in suddenly chilling molten metal against the metal core confined under the influence of the permanent mold to the point of setting, then removing the metal core and allowing the structure cast freed from its confinement in the mold to cool in the atmosphere, substantially as described.

6. The mode of casting metal structures around a permanent core in a permanent mold, which consists in subjecting molten metal at a temperature ranging between 2000° to 2800° Fah. to the influence of the core and mold to quickly lower the temperature to from 1700° to 2200° Fah. to the point of setting, then removing instantly the core and then permitting a gradual lowering of the temperature of the structure by removing from the mold, substantially as described.

7. The mode of casting metal structures around a permanent core in a permanent mold, which consists in subjecting molten metal at a temperature ranging between 2000° to 2800° Fah. and while holding the carbon of the molten metal in solution to the direct influence of the permanent core and mold to thereby quickly lower such temperature of the metal to between 1700° and 2200° Fah. and while maintaining the carbon of the metal in a finely divided state to the point at which the metal assumes form, then removing the core and finally permitting the gradual lowering of the temperature of the structure thereby to provide for the formation of annealing carbon and carbid-carbon therein, substantially as described.

8. The mode of casting metal structures around a permanent core in a permanent mold which consists in chilling suddenly molten iron to the point of setting against the core and mold into a structure, then instantly removing the core and cooling gradually at atmospheric temperature to prevent undesirable actions as segregation and formation of graphitic carbon in the structure and to permit of desirable actions uniformly as formation of annealing carbon and carbid-carbon therein, substantially as described.

In witness whereof, I have hereunto set my signature in the presence of two subscribing witnesses.

EDGAR ALAN CUSTER.

Witnesses:

J. WALTER DOUGLASS,

THOMAS M. SMITH.