(No Model.) 2 Sheets—Sheet 1.

J. B. D'A. BOULTON.

APPARATUS OF FORMING STEEL INGOTS IN A SECTIONAL MOLD.

No. 365,902. Patented July 5, 1887.

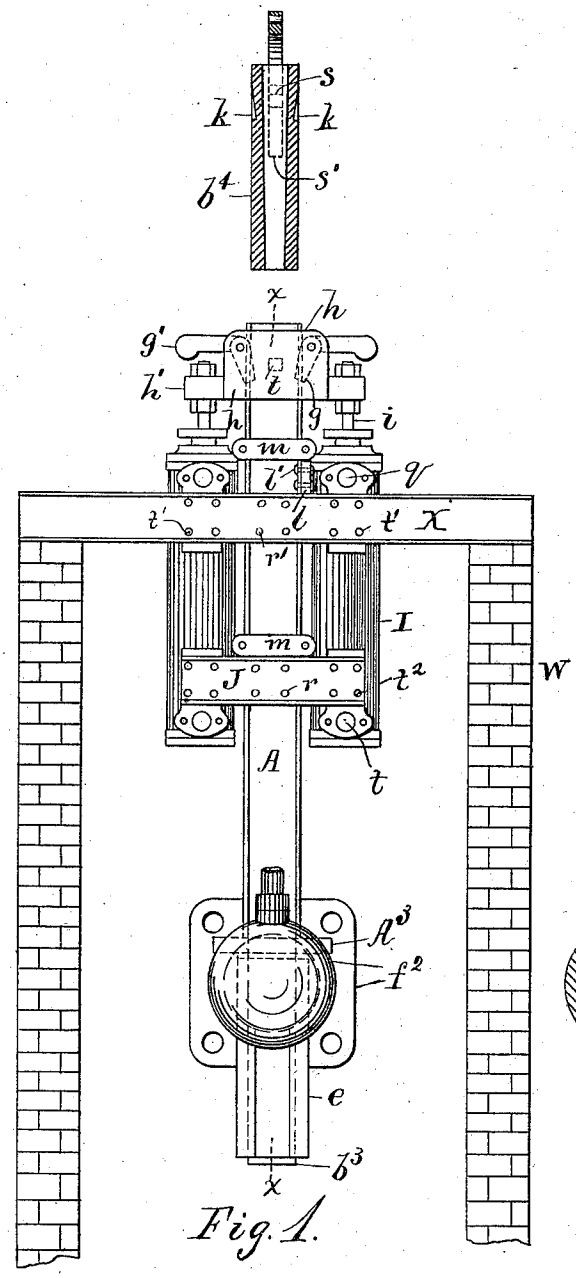


Fig. 1.

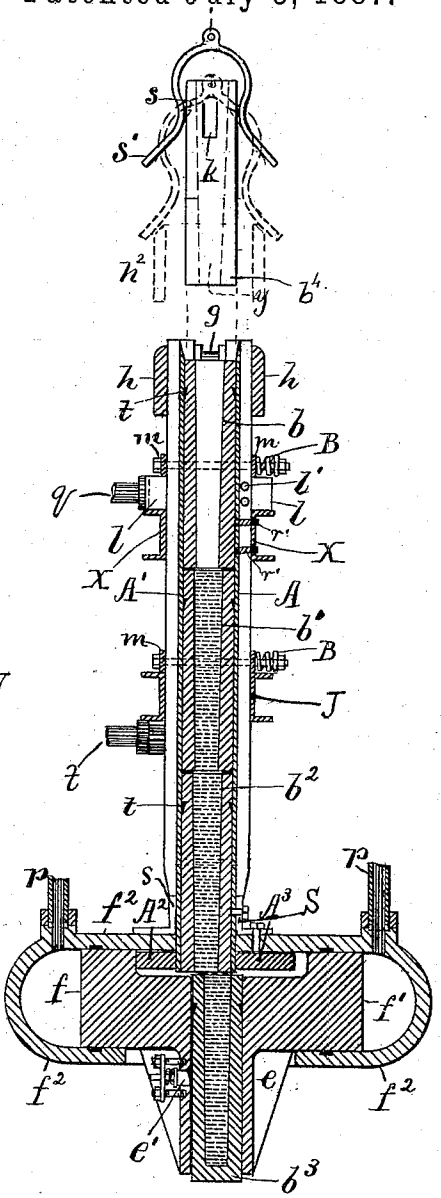


Fig. 2.

Attest:
L. Lee.
Frederick G. Fischer.

Inventor.
James B. D'Arcy Boulton
per Crane & Miller attys

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

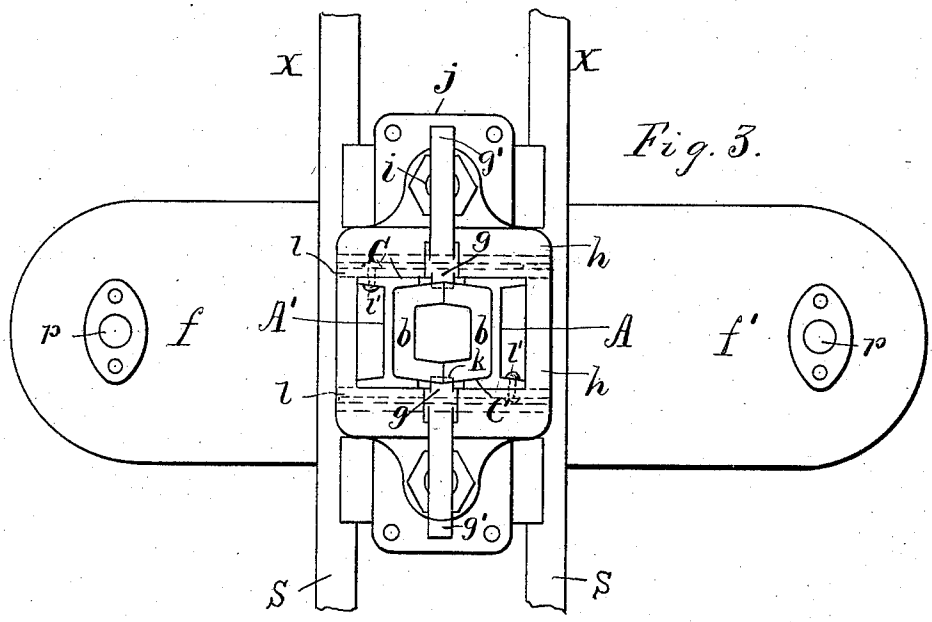
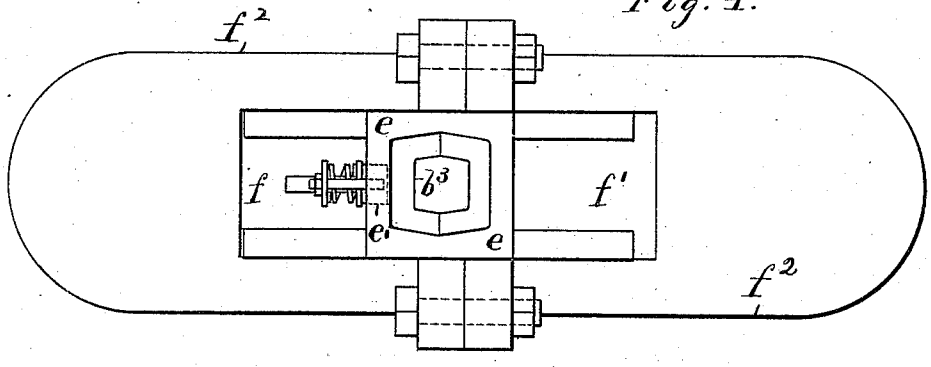


Fig. 4.



Attest:
L. Lee.
F. G. Fischer.

Inventor.
James B. D'Arcy Boulton,
per Crane & Miller, attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JAMES B. D'ARCY BOULTON, OF JERSEY CITY, NEW JERSEY.

APPARATUS FOR FORMING STEEL INGOTS IN A SECTIONAL MOLD.

SPECIFICATION forming part of Letters Patent No. 365,902, dated July 5, 1887.

Application filed March 25, 1887. Serial No. 232,361. (No model.)

To all whom it may concern:

Be it known that I, JAMES B. D'ARCY BOULTON, a subject of the Queen of Great Britain, residing at Jersey City, Hudson county, New Jersey, have invented certain new and useful Improvements in Apparatus for Forming Steel Ingots in a Sectional Mold, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of this invention is to form an ingot of cast-steel or other metal in sectional molds, which, in the apparatus claimed in my present, and according to the method in my copending application Serial No. 232,362, filed March 25, 1887, are superposed successively upon one another and filled with separate charges of fluid metal.

In the apparatus for executing the process the mold-sections, excepting the first one employed, are bottomless, and may be made with parallel sides to form a continuous ingot of equal area, or may be tapered inwardly, as shown in the annexed drawings, so that when the ingot is ruptured at the joint of the mold-sections the contents of the molds may be removed from one end thereof. The molds may be solid with tapering bore, or may be divided longitudinally, as shown in one of the figures in my annexed drawings.

In the drawings, Figure 1 is an edge view of the apparatus. Fig. 2 is a section of the same on line x x in Fig. 1. Fig. 3 is a plan of the top of the apparatus, and Fig. 4 is a view of the lower end of the same. In Fig. 1 mold-section b^1 is sectioned on line y y in Fig. 2.

The essential part of my present invention consists in a holder adapted to retain a series of mold sections superposed one upon another, in combination with means for moving the mold-sections downward within the holder, as herein set forth.

My construction also contains means for separating or rupturing the ingot into sections of size convenient for their intended use. The means for sustaining or mounting the operative parts in their required position is wholly immaterial, and while they are shown in the annexed drawings sustained by metallic bars X, which rest at their opposite ends upon walls W, any other convenient construction may be employed.

The apparatus, as shown herein, includes a spring-holder for sustaining the mold-sections movably in a vertical series, a reciprocating pusher to engage the upper mold and force the series downward, and a cylinder connected transversely with the lower end of the spring-holder and provided with pistons actuating a pocket to receive the lower mold-section of the series and to shift the same laterally to rupture its contained ingot from that in the section above.

X X are two sustaining-girders, between which are placed the spring-holder, and at opposite sides thereof two hydraulic cylinders, I, for actuating the pusher h.

The cylinders are secured to the girders by rivets t', and are also secured together near their lower ends by cross-bars J, which are secured to the cylinders by rivets t^2.

Between the girders X and bars J are suspended two beams, A A′, the beam A being secured by rivets r' to one of the girders X, and by rivets r to one of the bars J.

One strap l is secured to the beam A, and is not secured to the beam A′, and the other strap l is secured to the beam A′, and is not secured to the beam A. These straps l rest upon the top of the girder X, while operating to guide the beam A′ in a limited movement between the girders to and from the beam A. The beam A′ is vertically sustained by the strap l, which is secured thereto and which rests upon both the girders, and is pressed toward the beam A by springs B, which operate upon gibs m, applied outside the beams and drawn together by means of bolts m', extended past the sides of the beams. The beams are provided with flanges C, to guide the mold-sections in their downward movement.

The mold-sections are inserted into the holder from the upper end, filled, and then moved successively downward, and may be formed with a solid body and with a tapering bore, as shown in Figs. 1 and 2, so that the cooled ingots may be slipped out without opening or dividing the molds; or they may be longitudinally divided, as shown in Figs. 3 and 4, and the parts be held in place by dowels in the usual manner; or they may be constructed in any other manner adapted to practice my invention.

The volume of the fluid or cast metal in my

apparatus at one time is contained in several mold-sections, one of which (lettered b) is adjusted just below the top of the holder ready for filling. b' is a section immediately beneath the same and separated therefrom by a packing, c, formed of fibrous material, as asbestus, and perforated to permit the flow of the metal from the upper to the lower section. b^2 is a section beneath the one last filled, and b^3 is a mold-section sustained below the bottom of the spring-holder in a movable pocket adapted to shift such section laterally to rupture the ingot. When thus moved, the strain thrown upon the mold-section b^2 is sustained by abutments, which are formed as two keys, A^2 and A^3, inserted through an aperture in the upper side of a cast-iron cylinder, f^2, which is attached to the lower ends of the beams A A' by brackets S.

The elasticity of the beams above the fastenings S is sufficient to spring the beam A' toward the beam A under the pressure of the springs B, the movement required to hold the beams by friction being exceedingly slight, so that the space required for such movement would not be perceptible in the drawings.

It will be noticed that in Fig. 2 the beams A and A' are both shown in apparent contact with the girders X, which would be the case when the beams were pressed apart by the mold-sections, as shown in such figure; but the beam A' would be pressed slightly away from the adjacent girder X when the spring-holder was entirely empty, which would never occur in practice.

Pistons $f f'$ are inserted in the cylinder with their outer ends exposed to fluid pressure, as of water or steam, introduced through pipes p, and the two pistons are shown as each formed in one piece with a portion, e, which portions together form a pocket, which, when the pistons are moved to one limit of their stroke, coincides with the interior of the holder, so that the mold sections may move from the holder to the pocket.

In a transverse opening at one side of the pocket is located a spring-presser, e', which sustains the weight of the lower mold-section, b^3, when delivered from the holder and carried therein during the movement of the pocket to sever the ingot.

The pocket is actuated in opposite directions by the pistons $f f'$, and a mold-section, b^3, is shown within the pocket e below the mold b^2 and moved laterally beneath the same to partly rupture the ingot-bar.

The sections, when filled, are moved successively downward in the spring-holder by pawls g, attached to a pusher, h, which is shown as a rectangular frame of cast-iron surrounding the upper end of the holder and formed with lugs to which the hydraulic piston-rods i are attached. The fluid is introduced into the cylinders I through pipes q at their upper ends and pipes t at their lower ends, and the movement of the hydraulic piston-rods thus operates to raise the pusher above the upper end of the holder to engage the pawls with a mold-section applied to the one last filled within the holder. The pawls engage the molds by pressing into notches k, formed in the sides of each mold. An empty mold-section, b^4, is shown suspended above the top of the holder at a sufficient distance to admit the fluid steel readily to the mold b in the top of the holder.

The pistons $f f'$ are constructed to strike the keys A^2 A^3 at the proper limit of their stroke, the contact of the piston f with the key A^2 upon one side determining the degree to which the lowest mold-section is moved out of line with that in the holder, and the contact with the piston f' with the key A^3 operating to bring the pocket again in line with the holder, as desired, after the rupture of the ingot.

In Figs. 1 and 2 the mold-section b^4 is shown sustained above the holder by a spring-hanger having two arms, s', provided each with a tooth, s, adapted to enter notches t upon the sides of the mold-section intermediate to the sides having the notches k. The arms of the hanger s' are inclined downward and outward, and are so proportioned that when the section b^4 is lowered to rest upon the section within the holder and the pusher h is elevated sufficiently for the pawls g to engage the notches k, the upper end of the pusher will press upon the inner sides of such arms and separate them sufficiently to detach the teeth s from the notches t, and thus permit the downward movement of the section when the movement of the pusher is reversed.

In Figs. 1 and 2 the pusher is shown at the lower limit of its stroke; but the pusher is shown in dotted lines h^2 in Fig. 2, as when elevated and operating to separate the arms s'.

The pawls g when at the downward limit of their stroke are admitted between the flanges C upon the inner sides of the beams A A', and are thus enabled to force the mold-sections downward below the top of the holder in the required manner.

The pistons $f f'$ may be actuated by water, steam, air, or any other agent, as preferred, being admitted and discharged through pipes p.

It is obvious that the apparatus may be greatly modified in form from that shown in the drawings without departing from my invention, as the means for moving the mold-sections downward within the holder may be adapted to grasp the sections in any convenient manner, as by forming projections upon the latter in place of the notches k to engage the ends of the pawls in their downward movement, or any other suitable means of temporarily attaching the reciprocating pusher to the mold-section may be employed.

The pawls are shown formed with weighted arms g', to press them normally toward the sections, and the pusher is shown formed with ears h', to which are secured the upper ends of the piston-rods i. The pusher may, however, be reciprocated by other mechanism than the hydraulic piston-rods, if preferred.

The operation of the apparatus is as follows: The mold-section in the top of the holder is filled with fluid metal, and the perforated asbestus washer *c* is laid upon its top. The suspended mold-section is lowered to stand upon the said washer, and is centered by the projecting ends of the beams A A'. The pusher with its pawls is now raised to the top of its stroke, and upon its return the pawls engage with the notches superposed in the mold-section, and press down all the sections in the holder until the top of the empty one is a little below the top of the holder. The section previously in the lower part of the holder is now held by the pocket *e*, and while the empty section at the top is being filled this lower one is shifted laterally by the hydraulic pistons and is partly ruptured, and the separation of the bar is completed by the return of the pistons to their original position, thus restoring the pocket *e* to a line with the holder, so that a succeeding mold-section may force out the one in the pocket with its contained ingot. The fluid metal when poured into the empty section penetrates through the hole in the washer to the metal in the section below, with which it effects a perfect union by reason of its great heat. The top mold-sections are thus successively depressed, filled, and their places supplied with empty sections, the metal when poured passing through the bottom of each section and effecting a union with that in the section below. Such ingot may be, however, partly divided by the asbestus washers by forming a hole smaller than the body of the ingot through the washer, and thus limiting the union of the ingot to a stud, *c'*, and the ingot is thus adapted to be separated with very little resistance into distinct sections of the same length as the successive mold-sections. This complete separation is effected with my apparatus by moving the body of the lower mold-section back and forth laterally, with its inclosed metal, until the portion between the ends of the two adjacent mold-sections is ruptured, the adjacent section being meanwhile firmly held with its contents by the abutments provided for that purpose in the keys A^2 A^3.

The entire process is conducted so rapidly that the upper molds in the holder are cooled very little before the metal in them is united; but any suitable cooling means may be applied to the lower molds of the series to fit the cast metal for removal from the molds.

The asbestus washer may be saturated with combustible fluid to prevent oxidation of the fluid metal in the mold. Refined petroleum or alcohol may be used for such purpose. This is immediately inflamed by the heat of the fluid metal already in the mold-section, to the upper end of which it is applied, so that when the succeeding mold-section is placed thereon the flame from such combustible fluid may fill it and expel the air therein before the succeeding charge of fluid metal is poured. The absence of oxygen from the interior of such mold-section thus prevents the oxidation of the metal when poured therein. To absorb the desired volume of combustible fluid, a washer of fibrous material, like asbestus, is decidedly preferable, and it will be understood that the washer must be made of some yielding material, in any case, to form a close joint between the successive mold-sections, and thus prevent the escape of fluid thereat.

The parting or separating device is intended, preferably, to operate upon the metal while it is hot, to avoid a great resistance, and the separating device is preferably operated to effect a peculiar result—namely, a partial rupture of the stud *c'* or cast bar by a movement of the mold-section in one direction and the completion of the rupture by a reversal of the movement, and a return from the pocket to its proper position for the entrance of the next section without any loss of movement.

When commencing the formation of an ingot with this apparatus, a mold with a closed bottom, like that shown at b^3, is necessarily used to receive the first charge of metal, but afterward each preceding charge forms the bottom of the succeeding mold, so as to be united with its contents by fusion. It will be noticed that the mold-sections are all separate and movable, so as to be readily applied to the top of the series within the holder and moved downward within the same when filled. It will also be noticed that the ingot is formed within the successive mold-sections and separated into portions of the desired length before it is removed from the mold-sections in which it was cast, and the cast metal may therefore, if desired, be wholly sustained by the walls of the mold until its hardening is substantially completed; and it will also be noticed that the cast metal is not subjected to any external strain by or during its movement through the apparatus, nor to any exposure liable to cool its substance unequally before it has wholly crystallized.

I am aware that an ingot-bar has been formed by pouring the metal within a mold having a falling bottom, and that it is also common to superpose a number of molds upon one another with perforated dividing-plates of metal or refractory material, a definite number of such molds being arranged to receive the metal at a single pouring or charge, and the perforations in the dividing-plates permitting the flow of the metal from one of such molds to another during the pouring of such charge, as in British Patent No. 4,425 of 1876. I am also aware of British Patent No. 2,886 of 1865, showing several tire-molds piled together with a central ingate adapted to feed them all simultaneously from a single charge of fluid metal, and of British Patent No. 1,221 of 1873, which shows a series of connected molds clamped together upon the head of a crucible to receive the metal simultaneously when the crucible is inverted. I am also aware that William B. Hinsdale has filed a patent application describing the formation of a continu-

ous ingot-bar by the pouring of the metal into a single mold, and moving or shifting the metal downward within the mold after the pouring of each charge, to make room for a subsequent charge. I hereby disclaim the invention described in the aforesaid patents, and especially the invention of William R. Hinsdale, just referred to.

In my invention the successive charges are not poured within the same mold, but in separate mold-sections; and, furthermore, the metal is not, under any circumstances, shifted or moved within the mold or subjected to any external force, as is required for moving the metal within the mold in Hinsdale's invention, and which is liable to injure the strength or continuity of the casting and cause the rupture or weakening of the casting if the movement in the mold be effected before a sufficient hardening of the metal has taken place.

Having thus set forth my invention and distinguished it from others, what I claim as my improvement is—

1. An apparatus for forming a cast steel or metal ingot, consisting in a holder adapted to retain a series of mold-sections in line with one another, and means for moving the sections downward within the holder, substantially as herein set forth.

2. An apparatus for forming a cast-steel ingot, consisting in a spring-holder adapted to sustain by friction a series of mold-sections in line with one another, and means for moving the filled sections downward, substantially as herein set forth.

3. An apparatus for forming and severing into sections a cast-metal ingot, consisting in a holder adapted to retain a series of mold-sections in line with one another, means for moving the mold sections within the holder, abutments for the mold-sections at the bottom of the holder, and a pocket movable laterally beneath the abutments and adapted to move one mold-section transversely to the adjacent mold section, as and for the purposes set forth.

4. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, and means for moving the mold-sections within the holder, of abutments for the mold-sections at the bottom of the holder, and a pocket movable laterally beneath the abutments and provided with a spring-presser to sustain the weight of the mold-section within the pocket, as and for the purpose set forth.

5. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, and means for moving the mold-sections within the holder, of the hydraulic cylinder f^2, containing pistons $f\ f'$, provided with a pocket to successively receive the mold-sections, and a spring-presser to sustain the mold-section within the pocket, as and for the purpose set forth.

6. An apparatus for forming a cast-metal ingot, consisting in a spring-holder adapted to retain a series of mold-sections in line with one another, a reciprocating pusher with pawls for moving the mold-sections downward within the holder, and mold-sections adapted to engage with the said pawls, as and for the purpose set forth.

7. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, and means for moving the sections downward within the holder, of the hydraulic cylinder f^2, containing pistons $f\ f'$, provided with a pocket to successively receive the mold-sections, and a stop to limit the movement of the pocket when in line with the holder, as and for the purpose set forth.

8. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, of hydraulic cylinders arranged at opposite sides of the holder, and a pusher attached to the hydraulic piston-rods, and provided with pawls for moving the mold-sections within the holder, as and for the purpose set forth.

9. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, of a hanger adapted to sustain a mold-section above the holder, and a mold-section having two sets of notches, one to receive the hanger and the other to engage with the means for moving the section downward within the holder, as and for the purpose set forth.

10. In an apparatus for forming a cast-metal ingot, the combination, with a holder adapted to retain a series of mold-sections in line with one another, of a reciprocating pusher provided with pawls for moving the mold-sections within the holder, a hanger adapted to sustain a mold-section above the holder, the hanger being provided with teeth s to engage the mold-section, and arms s', adapted to withdraw the teeth from the mold-section by contact with the reciprocating pusher, substantially as herein set forth.

11. In an apparatus for forming a cast-metal ingot, the combination, with a series of movable bottomless mold-sections applied upon one another, of a fibrous packing applied between each mold-section and supplied with combustible fluid to be ignited by the contents of the filled section and expel the air from the mold-section placed thereon, substantially as herein set forth.

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

JAMES B. D'ARCY BOULTON.

Witnesses:

HENRY V. CONDICT,

CHAS. H. VOORHIS.