No. 610,223. Patented Sept. 6, 1898.

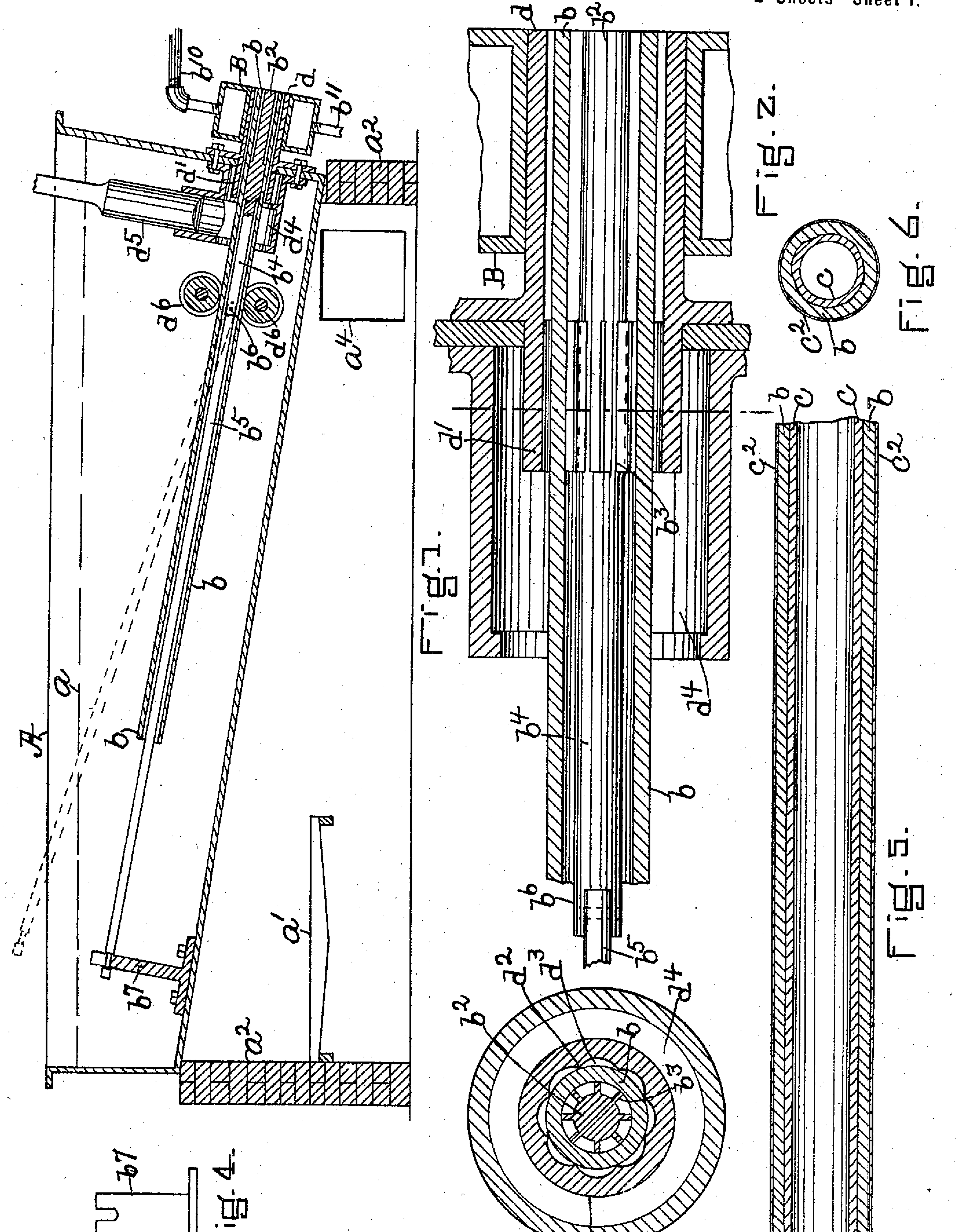
E. I. BRADDOCK,

APPARATUS FOR MANUFACTURING COMPOSITE NON-CORRODIBLE PIPE.

(Application filed Dec. 30, 1897.)

(No Model.)

2 Sheets—Sheet 1.



WITNESSES.

Matthew M. Blunt.

J. Murphy

INVENTOR.

Edward I. Braddock

by Jas. H. Churchill

ATT'Y.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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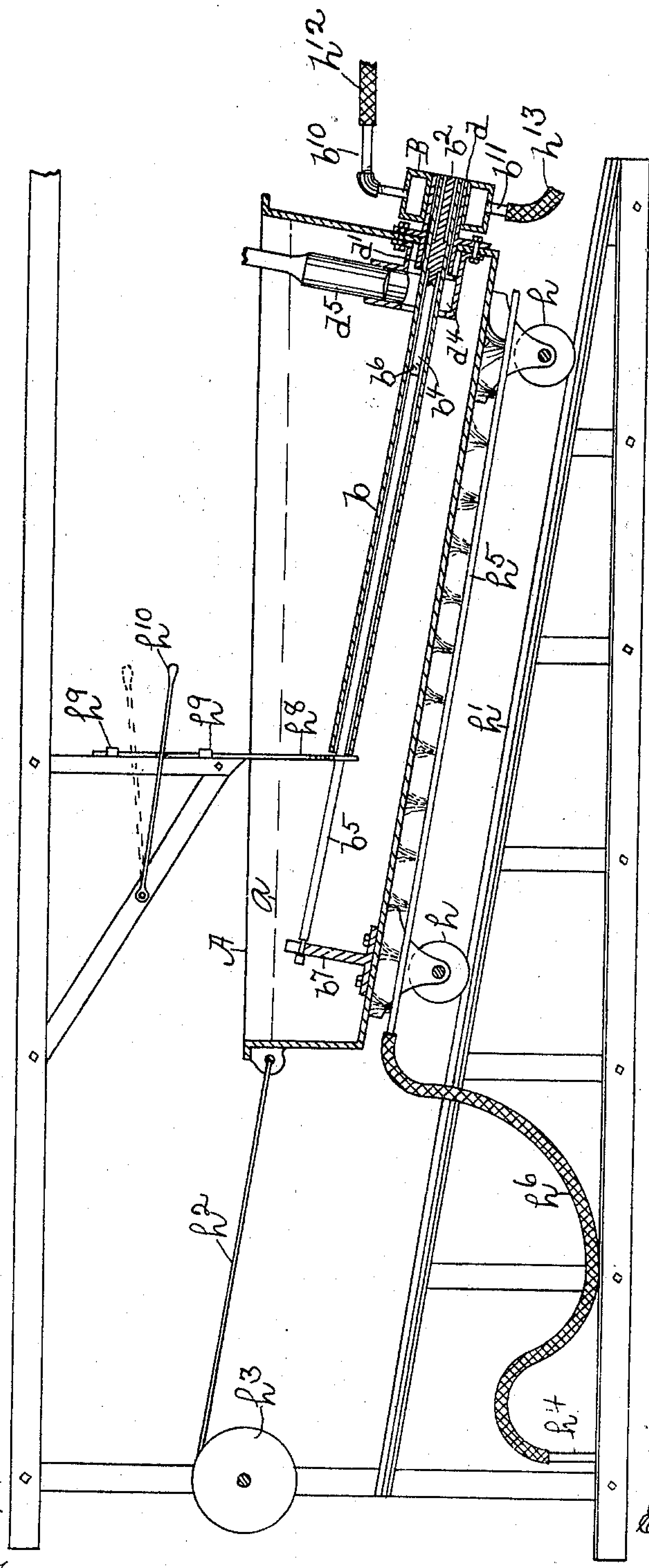

FIG. 7.

WITNESSES.
Matthew M. Blunt.
J. Murphy.

INVENTOR.
Edward I. Braddock
by Jas. H. Churchill
ATT'Y.

UNITED STATES PATENT OFFICE.

EDWARD I. BRADDOCK, OF MEDFORD, MASSACHUSETTS.

APPARATUS FOR MANUFACTURING COMPOSITE NON-CORRODIBLE PIPE.

SPECIFICATION forming part of Letters Patent No. 610,223, dated September 6, 1898.

Application filed December 30, 1897. Serial No. 664,612. (No model.)

To all whom it may concern:

Be it known that I, EDWARD I. BRADDOCK, a citizen of the United States, residing in Medford, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Apparatus for the Manufacture of Composite Non-Corrodible Pipe, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to an apparatus with which may be produced a composite metal pipe made up of two or more axially concentric tubes, one of which is composed of iron or steel and the other or others of a metal of lower fusing-point, the tube or tubes of lower fusing-point being permanently united while in a fused condition to one or both surfaces of the iron or steel tube previously formed.

The apparatus referred to consists, mainly, of a tank or chamber in which the metal that is to form the secondary tube or tubes is contained and kept in a molten state by heat; a core or mandrel of a diameter equal to the desired bore of the composite pipe, with devices attached to said core to retain it in position against the frictional action of the moving primary tube and metal for the secondary tube, to center it when inserted in the primary tube, and at the same time to permit the flow of the molten metal to the bore-forming part of the core; at one end of the tank a cylindrical die or passage of a diameter equal to that desired for the external diameter of the composite pipe and devices contiguous to said die to center the primary tube and also permit the flow of molten metal to the die, and a chilling-jacket upon an extension of said die outside of said tank to congeal and solidify the metal of the secondary tube or tubes and cause them to contract upon and become securely united with the primary tube, and mechanism to cause the primary tube and molten metal in contact with it to move past the forming-surfaces of said die and mandrel.

This apparatus is especially adapted for use in the construction of a composite pipe in which the primary tube is of comparatively inexpensive and strong, although easily-corrodible, metal having a relatively high melting-point, such as iron or steel, but commonly known in the arts as "corrodible" metal, and the secondary or protecting tube or tubes are of metal having a relatively low melting-point, such as lead, tin, or zinc or their alloys, commonly known in the arts as "non-corrodible" metals. When the composite pipe is produced with an apparatus such as that above described, the primary tube is chemically cleansed by pickling in the usual manner, treated with a liquid flux, such as chlorid of zinc, and then immersed in the tank of molten non-corrodible metal which is to form the secondary or protecting tube or tubes. Thus when the iron tube with the core inserted therein is fed forward through the die at the end of the tank and through the chilling portion of the die a composite pipe is formed with a tubular covering of the non-corrodible metal, progressively built upon one or both surfaces of the primary tube as fast as that tube advances into the chilling portion of the die. It may also be found convenient under some conditions to cause the primary tube and molten metal to pass the forming-die and mandrel by moving the latter along over the former, and the same result will be obtained in each case, however—namely, forming and uniting with the primary tube of iron or steel a superposed tube or tubes of non-corrodible metal by progressively solidifying the last-named metal upon the said primary tube.

Hereinafter for the sake of brevity the word "iron" only will be used when naming the metal for the primary or corrodible tube and the word "tin" when naming the metal for the secondary or non-corrodible tube.

An apparatus with which composite metal pipe may be successfully made is illustrated in the drawings, wherein—

Figure 1 is a longitudinal sectional elevation of the apparatus. Fig. 2 is a horizontal section through the forming-die, with the primary tube of metal containing the mandrel inserted in said die. Fig. 3 is a section on line x x in Fig. 2. Fig. 4 is a front view of the device within the tank for engaging the rod which holds the mandrel in a stationary position. Fig. 5 is a longitudinal section of the improved composite pipe. Fig. 6 is a cross-section of such pipe, and Fig. 7 a view in elevation and section of a modification to be referred to.

Referring to Fig. 1 of the drawings, A is a metal tank or vessel for holding the metal from which the secondary or protecting tubes are to be formed and in which that metal is maintained in a molten condition by a furnace, indicated by a grate *a'*. The tank is supported upon suitable walls a^2 a^2, the products of combustion from the furnace having an outlet to the chimney at a^4. Preferably the tank is constructed with an inclined bottom, as shown, so that the primary tubes to be covered may be readily introduced into the forming-die, which has a similar inclination and is attached at one end of the tank, and thus the molten metal may flow by gravity through such die and also through the interior of the tube which is under operation when it is immersed in the bath of metal.

The tank A is provided with a suitable opening for the insertion into it of the iron or steel tube and, as herein shown, is open at its top.

The broken line *a* may represent the level of the molten metal.

b is the iron tube to be covered; b^2, the mandrel, around which the interior secondary tube *c* is formed within the primary tube *b*. Upon the inner end of this mandrel longitudinal ribs or wings b^3 are formed or attached to serve as centering devices for the forming portion b^2 of the mandrel. The height of the projecting centering-ribs upon the mandrel and the size of the mandrel itself are determined by the size of the bore of the primary tube and the size of the bore desired for the composite pipe.

b^4 is an extension of the mandrel, to which a rod b^5 is hinged at b^6. This rod is provided with a shoulder upon its outer end to engage a standard b^7, secured within the tank to prevent the rod, and with it the mandrel, from being carried out of the tank with the tube *b* when it is fed forward.

d is the cylindrical die, in which the exterior secondary tube c^2 of the composite pipe is formed. *d'* may be a portion of the same cylindrical tube as the die *d*, but extending into the tank A, and it has formed upon its inner surface or connected therewith ribs d^2, which serve to center the tube *b* within the die *d* and which form longitudinal grooves d^3, Fig. 3, along the interior of that portion to permit the flow of molten metal into the die *d*. Around the outer end of the die *d* is a chilling-jacket B, provided with an inlet-pipe b^{10} and an outlet-pipe b^{11}.

Within the tank A and attached to the wall thereof immediately back of the outlet into the forming-die is a valve-chamber d^4, through which the tube *b* passes when inserted into the die, and when the tube *b*, with its mandrel, is removed from the forming-die the outlet-passage is closed by means of a plunger-valve d^5, which is pushed down into the valve-chamber d^4 across the passage leading to the forming-die.

d^6 d^6 are two grooved rolls, which guide the tube *b* and move it forward through the tank and forming-die. The length of the ribs b^3 upon the mandrel b^2 should be sufficient to give a stable bearing upon the interior of the tube *b* and hold the mandrel proper, which is to determine the interior bore of the composite pipe in an accurately central position within the tube *b*, and also the length of the portion *d'* should be sufficient to give a stable bearing to the tube *b* and hold it in an accurately central position in the die *d*.

In Figs. 5 and 6, which represent the completed composite pipe, *b* is the primary tube, of iron, *c* the interior secondary tube, of tin or similar metal, and c^2 the exterior secondary tube. The thickness of these two secondary tubes may be regulated, as desired, by varying the size of the mandrel b^2 in relation to the bore of the tube *b* and the size of the interior diameter of the die *d* with relation to the exterior diameter of the said tube *b*.

When it is desired to unite a secondary non-corrodible tube to the interior only of the tube *b*, the grooves d^3 in the portion *d'* are omitted, and thus leave a closely-fitting cylindrical collar around the exterior of the tube *b*, which will prevent the flow of metal along the outside of it.

The operation of forming a composite pipe in this apparatus is as follows: Having filled the tank A with molten tin or similar non-corrodible metal up to a level, for instance, as indicated by the broken line *a*, a section of iron tube *b*, properly fluxed, is slipped over the mandrel and its retaining-rod b^5. The end of the tube in which the mandrel is located is inserted into the bath of molten metal, pushed between the rolls d^6, and thence against the valve d^5. That valve is then raised and the tube *b*, with the mandrel, is moved forward through the centering portion *d'* out into the die *d*. The molten metal enters the tube *b* and molecularly unites with the portion of the said tube with which it makes contact. As soon as the valve d^5 is raised the molten metal will flow out into the die *d*, but before it can flow out from the end of that die the chilling-jacket B will have congealed and solidified it, thus forming a solid plug of metal which will prevent the escape of any portion of the metal in the molten state. Then as the tube *b* is caused to pass along over the mandrel and through the forming-die this plug of metal will be pushed out and the molten metal in the tank will flow forward through the grooves d^3 in the portion *d'* and between the ribs b^3 on the inner end of the mandrel. Immediately after passing beyond these grooves into the inner part of the die *d* and around the mandrel b^2 the molten metal will begin to be cooled by the chilling-jacket around the outer end of the forming-die, and before it has passed far within the portion of that die which is surrounded by the chilling-jacket this non-corrodible metal will be congealed and solidified around the exterior and upon the interior of the tube b and securely united therewith. As the movement of the tube b is continued through the die d the molten metal will continue to flow through the said grooves into the forming-die and around the mandrel and will be solidified around and within the tube b at the part near the end of said die and mandrel, this solidified portion being always followed by and immediately joined to other portions of such metal in a molten condition, which in turn is chilled as the iron tube is moved forward through the die, and this chilling action is continuous as the primary tube progresses through the chilling-die, the solidification of the non-corrodible metal being gradual from the molten to the solid state of the metal. The chilling of the metal in this manner to form the secondary tubes is what I prefer to designate as a "progressive chilling" of the non-corrodible metal, and the completed composite pipe thus formed is readily pushed out of the die and off from the mandrel. As soon as one length of pipe has been fed through the die, so that its rear end has passed the hinge b^6, the rod b^5 is raised from the tank to the position indicated by dotted lines, Fig. 1, another length of pipe slipped over the rod entered between the feeding-rolls d^6, and the rod b^5 with the tube thereon dropped back to the position shown in full lines in Fig. 1, and the pipe-forming process continued; and in this way the manufacture is substantially continuous as long as desired, a fresh supply of tin or similar metal being supplied to the tank as it is consumed in the formation of the non-corrodible covering for the iron tube.

In Fig. 1 the mandrel and die are stationary and the iron or steel tube is movable relative thereto; but, as above stated, the composite pipe may be made with a reverse arrangement of apparatus—namely, with the iron or steel tube stationary and the mandrel and die movable with relation thereto. This latter arrangement of the apparatus is illustrated in Fig. 7, wherein the tank A is shown as mounted upon suitable wheels h, which may be made to travel up an inclined railway h' by a cord or chain h^2, passed about a pulley or drum h^3, mounted on a shaft h^4, which may be turned by hand or otherwise. The metal a may be kept molten by a gas-burner h^5, suitably attached beneath the tank A to move therewith and connected by a flexible pipe h^6 to a gas-supply pipe h^7. The iron or steel tube b may be held from moving with the tank A, as herein shown, by a rod or bar h^8, forked at its lower end to straddle the mandrel and bear against the upper end of said tube. The rod or bar h^8 is movable vertically in guides h^9 to engage its forked end with the tube b and disengage it therefrom by means of a lever h^{10}.

The inlet and outlet pipes b^{10} b^{11} for the chilling-jacket B have attached to them flexible pipes h^{12} h^{13}.

The union between the primary and secondary tubes, produced as above described, is a molecular union similar to that effected by such an operation as tinning, galvanizing, brazing, or soldering.

I claim—

1. In an apparatus for the manufacture of composite non-corrodible pipe, from a tube of iron or steel and a non-corrodible metal of lower melting-point, the combination of a tank to contain the non-corrodible metal and means to keep it in a molten condition, an outlet-pipe which extends into and outside of said tank, and has devices within the inwardly-extending portion to center the iron tube, and a chilling-jacket around the outwardly-extending portion of the outlet-pipe, a mandrel extending through said outlet-pipe to determine the bore of the composite pipe, and devices upon said mandrel to center it within the said iron tube, substantially as described.

2. In an apparatus for making composite pipe of a primary tube of iron or steel and an axially-concentric tube of metal having a substantially lower melting-point than that of the primary tube; the combination of a vessel to hold and maintain in a molten state the metal of the lower melting-point, means for heating said vessel, an opening in one end of said vessel to receive the primary tube; a mandrel with devices to center it in the primary tube, yet to permit the passage of molten metal; a chilling-chamber outside of the said vessel adjacent to the said opening therein; mechanism to maintain the said mandrel within the primary tube at the location of the chilling-chamber, and means to feed the primary tube through the openings in said vessel and chilling-chamber and over the said mandrel, substantially as described.

3. In an apparatus for making composite pipe of two axially-concentric metal tubes, the outer one of which is of metal having a substantially lower melting-point than that of the inner one constituting the primary tube; the combination of a vessel to hold the metal of the lower melting-point, means to heat it and maintain the metal of lower melting-point in a molten state, a forming-die opening into said vessel and provided with means projecting inwardly to center the primary tube therein and yet permit the flow of molten metal; a chilling-jacket around the outer end of said forming-die, and mechanism to feed the primary tube through said vessel and die, substantially as described.

4. In an apparatus for making composite pipe by uniting to both the interior and exterior surfaces of a primary metal tube, axially-concentric secondary tubes of metal having a substantially lower melting-point than that of the primary tube; the combination of a vessel to hold the metal of the lower melting-point; means to heat said vessel; a form-

ing-die, which opens into said vessel and has devices to center the primary tube therein yet to permit the flow of metal; a mandrel with devices to center it in the primary tube and to maintain it within the forming-die yet to permit the flow of metal; a chilling-jacket around the forming-die outside of the vessel, and mechanism to move the primary tube through said vessel and die and over the mandrel.

5. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metal, the combination of the following instrumentalities, viz: a tank or vessel having an inclined bottom and provided with an outlet-pipe for the flow of molten metal therefrom, means to heat said vessel, a mandrel to determine the bore of the composite pipe inserted into said outlet-pipe and extended into said tank and upon which the corrodible pipe is placed, and a forming and chilling die into which said mandrel is extended to form a space between it and the corrodible pipe within the said die, into which the molten metal flows and wherein it is solidified, substantially as described.

6. In an apparatus for the manufacture of composite non-corrodible pipe, the combination of the following instrumentalities, viz: a tank or vessel for containing a bath of molten non-corrodible metal provided with an opening for the insertion of a corrodible pipe into said vessel, an outlet-pipe for said tank or vessel, means to heat said vessel, a chilling-die axially in line with said outlet-pipe, and a mandrel anchored at one end and having its other end extended from within the tank through said outlet-pipe into said chilling-die, substantially as described.

7. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal provided with an opening for the insertion of a corrodible pipe into said vessel, means to heat said vessel, an outlet-pipe in said vessel, which pipe is adapted to receive the corrodible tube and is provided upon its interior with one or more longitudinal channels or grooves for the passage of non-corrodible metal, a die to form the exterior of the composite pipe having a chilling-jacket and located axially in line with said outlet-pipe, and a mandrel extended from within said tank through the outlet-pipe and into the said chilling-die and upon which the corrodible pipe is placed, substantially as described.

8. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal, means to heat said tank, an outlet-pipe for said tank, a forming and chilling die axially in line with said outlet-pipe, a mandrel within said outlet-pipe and die, and a device to retain the mandrel in position, which device is normally in line with the mandrel within the said tank and is constructed and arranged to be raised from the tank independent of the mandrel, substantially as described.

9. In an apparatus for the manufacture of composite non-corrodible pipe, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal provided with an opening for the insertion of a corrodible pipe into said vessel, means to heat said vessel, an outlet-pipe for said tank, a chilling-die located outside of the tank axially in line with the said outlet-pipe, a mandrel located in said outlet-pipe and extended from within the tank into said chilling-die and removable therefrom, and means to close the said outlet when the mandrel is removed.

10. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal, means to heat said tank, an outlet from said tank of the size of the external diameter of the corrodible tube and having one or more grooves or channels extended longitudinally through said outlet, a die for forming the non-corrodible tube, which is of larger diameter than the said outlet, and is located outside of said tank, a chilling-jacket upon the said die, and a mandrel of less diameter than said outlet and extended through the outlet and into said die, substantially as described.

11. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain the non-corrodible metal and maintain it in molten condition, provided with an opening for the insertion of a corrodible pipe into said vessel and with an outlet for said metal and corrodible pipe, means to heat said vessel, a chilling-die located axially in line with and beyond said outlet, and a mandrel within the tank extended through the outlet and into said chilling-die and of a diameter within the die equal to the bore desired of the non-corrodible tube to permit the composite pipe to be moved from within the tank over the mandrel and through the chilling-die, substantially as described.

12. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal, provided with an opening for the insertion of a corrodible pipe into said vessel and with an outlet for the passage of a corrodibe tube and said molten metal, means to heat said vessel, a chilling-die located axially in line with said outlet, a mandrel extended from within the tank through said outlet and corrodible tube into said chilling-die and of a diameter within the die equal to the bore desired of the non-

corrodible tube, devices to render the mandrel stationary, and means thereon to center it within the tube of corrodible metal, substantially as described.

13. In an apparatus for the manufacture of composite pipe of corrodible and non-corrodible metals, the combination of the following instrumentalities, viz: a tank or vessel to contain a bath of molten non-corrodible metal, provided with an inlet-opening for the insertion into the tank or vessel of the corrodible tube and with an outlet-opening for the passage of the corrodible tube and said molten metal out of said tank; means to heat said tank or vessel; a chilling-die located axially in line with said outlet-opening; a mandrel extended from within the tank through said outlet-opening and corrodible tube into said chilling-die and of a diameter within the die equal to the bore desired of the non-corrodible tube, and means on said mandrel to center it within the tube of corrodible metal, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD I. BRADDOCK.

Witnesses:

JAS. H. CHURCHILL,

J. MURPHY.