W. McA. JOHNSON.

METALLURGICAL APPARATUS.

APPLICATION FILED SEPT. 20, 1909. RENEWED DEC. 27, 1912.

1,069,260. Patented Aug. 5, 1913.

3 SHEETS—SHEET 1.

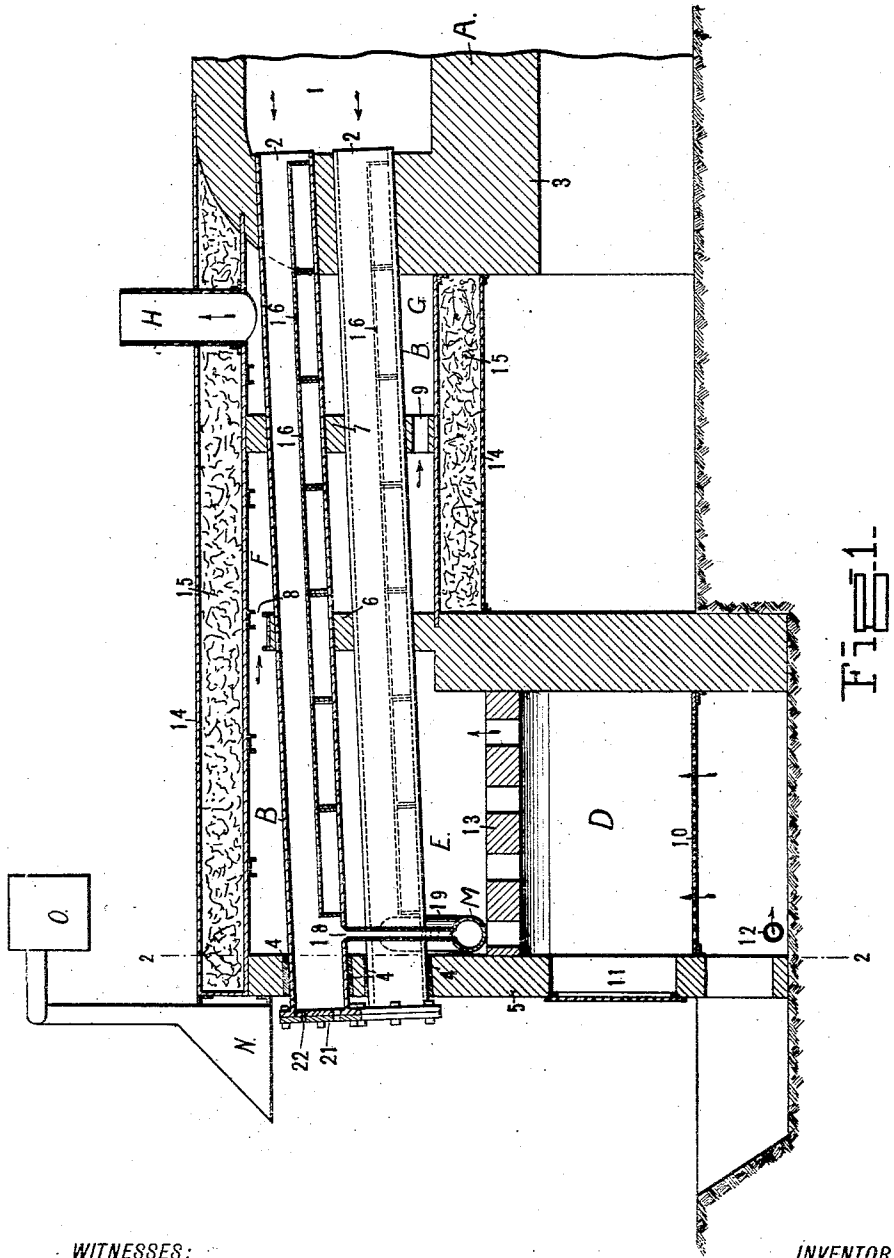

FIG. 1.

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3 SHEETS—SHEET 2.

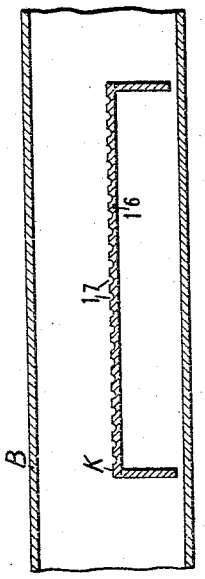

FIG. 3.

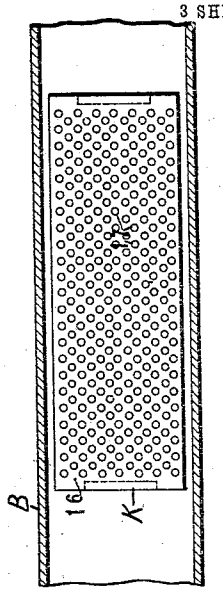

FIG. 4.

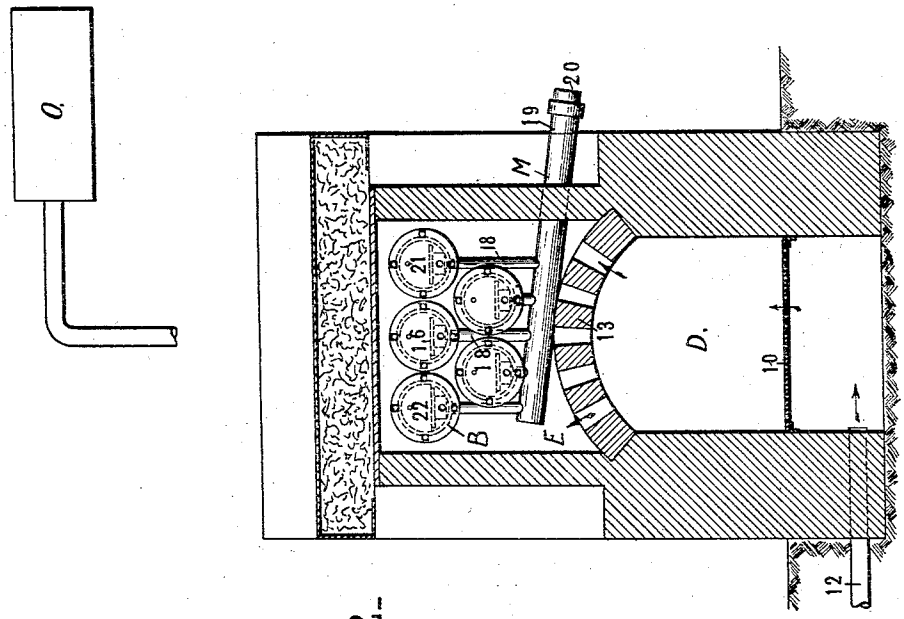

FIG. 2.

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3 SHEETS—SHEET 3.

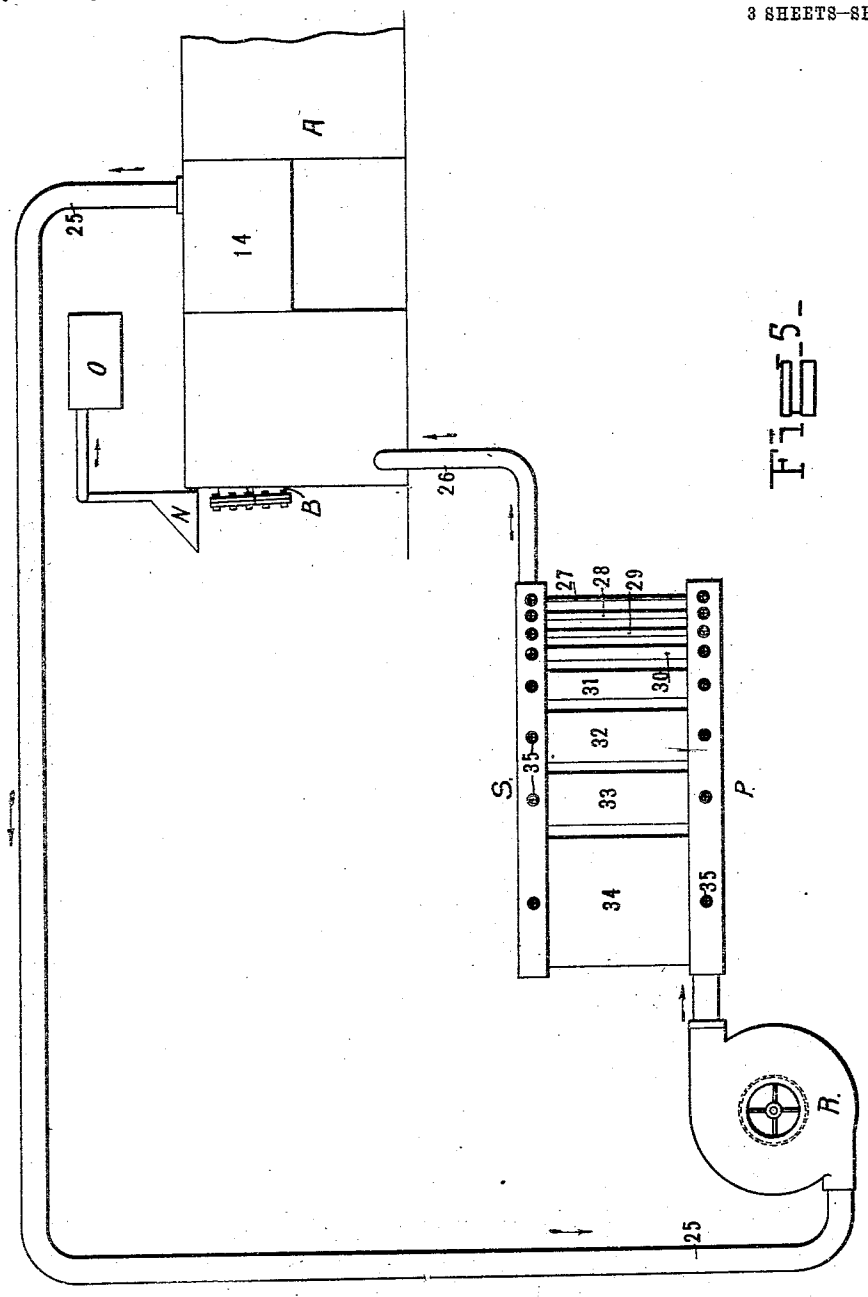

FIG. 5.

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UNITED STATES PATENT OFFICE.

WOOLSEY McA. JOHNSON, OF HARTFORD, CONNECTICUT.

METALLURGICAL APPARATUS.

1,069,260. Specification of Letters Patent. Patented Aug. 5, 1913.

Application filed September 20, 1909, Serial No. 518,529. Renewed December 27, 1912. Serial No. 738,966.

To all whom it may concern:

Be it known that I, WOOLSEY McA. JOHNSON, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Metallurgical Apparatus, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to metallurgical apparatus such as that having the capacity of condensing metallic vapors at carefully controlled temperatures, but inasmuch as certain advantages characteristic of this invention prominently appear in its more intense aspect as a means instrumental in continuously condensing vapors of zinc such as those obtained from a gas, electric, or other zinc furnace, it will be conducive to clearness to disclose this invention by way of such embodiment thereof.

This invention has in objective an apparatus capable of being built at low cost, from the standpoint of commercial efficiency, so constructed and designed as to enable a skilled workman to readily handle and operate the same, and of such nature as will not only very efficiently condense the zinc vapors, but also enable the temperatures to be controlled within commercially close limits.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the following claims.

In order that this invention may be the more fully disclosed and otherwise made comprehensible to those skilled in this art, drawings of one of the many possible embodiments thereof have been appended as a part of this disclosure, and in such drawings like characters of reference denote corresponding parts throughout the several views, of which—

Figure 1 is a longitudinal, vertical section showing many of the details of construction which may be employed; Fig. 2 is a cross, vertical section taken along line 2—2 of Fig. 1; Fig. 3 is an enlarged section showing one of several available devices arranged within one of the condensing tubes and which devices present a corrugated or recessed surface for the reception of the multiplicity of pools of liquid, metallic zinc, the presence of which accelerates and otherwise facilitates the condensation of vapors; Fig. 4 is a top plan view of the device shown by Fig. 3; Fig. 5 is a diagrammatic representation of a system of radiators adapted to be variably rendered operative according to the selection of the workman, so as to control the temperature of the furnace within very close limits, speaking from a commercial standpoint.

Continuing now by way of a more detailed description of this embodiment of my invention, making such occasional references to the drawings as may be indicated by the reference characters, A indicates a zinc furnace of suitable construction capable of producing in the chamber 1 vapors of metallic zinc. While, perhaps, other forms of zinc furnaces are available in this connection, I prefer to use the gas or electric zinc furnace. The gases are educted from such furnace at the temperature of zinc reduction, *i. e.*, 1020° to 1100°, and consists chiefly of zinc vapor and carbon monoxid in molecularly equal parts. This gas is received by the openings 2 of the condensing pipes or vessels B, which are constructed of some suitable material, as of iron or otherwise, capable of withstanding the temperature at which the condensation of zinc vapor takes place. These pipes may be fastened tightly at their openings 2 into the wall 3 of the zinc reduction furnace so as to maintain a vapor-tight connection therewith. At their ends, however, these pipes preferably pass through sleeves 4 so that they may slip therethrough when expanded under temperature elevations and thus prevent the wall 5 of the condenser from being bulged or otherwise broken. Inasmuch as these condenser pipes are preferably quite long and maintained at a fairly high temperature, they are preferably supported at intermediate points by walls or partitions 6 and 7, which partitions carry perforations 8 and 9 for permitting the circulation of the temperature controlling gases.

In order that the condensing pipes may be kept at the proper temperature for condensing zinc vapor, which enters from the reduction furnace, a fire-box D is provided having a grate 10 and the usual fire-door 11, so that coal may be burned if desired to initially bring the apparatus to the desired temperature. In lieu of such fire-box or auxiliary thereto, there may be provided a gas-pipe 12 leading to any suitable gas burner, so that the initial temperature may be obtained from the combustion of gaseous or liquid fuel, if desired, which in certain instances would be of advantage in view of the greater readiness with which perfect regulation of the temperatures may be obtained under these conditions. Overlying the fire-box D there is preferably a perforated fire-brick arch 13 which assists the regular generation and distribution of the heated gases. These gases for initially heating the condenser pipes pass upwardly into a chamber E, thence into chamber F through the opening 8, then into chamber G through the opening 9, and finally pass out through the discharge pipe H. In this connection, it may be stated that the heating and temperature confining structure has its inner walls preferably made of fire-brick and its outer walls 14 may be made of sheet iron supported by the skeleton framework of structural steel, and between the inner and outer walls there may be used a thick packing 15 of asbestos, infusorial earth, or mineral wool. The object of this arrangement is to make the interior of the condenser efficiently and practically thermally insulated from the surrounding atmosphere. With this construction the heat abstracted by eduction, radiation, or convection is negligible with regard to the total heat evolved in the condensation.

In starting up the apparatus combustion will first be inaugurated in the fire-box D, and the heat thereof is carried to all parts of the pipes by increasing or decreasing the draft of the fire or opening the furnace door. It is possible to bring and keep the temperature of the pipes low enough to carry off the heated condensation and high enough to insure the condensation of metal, and also high enough to prevent the formation of what is known as "flue powder" or zinc snow. Initially, the heat condensing pipe is preferably raised to a temperature above the melting point of zinc, *i. e.*, 450° C., so as to prevent the formation of zinc dust or "flue powder" which would otherwise rapidly choke up the pipes. The gases from the zinc reduction furnace are then passed into the open ends of the pipes B and thereupon condensation follows. This condensation is aided by means of a number of members K supported in some suitable manner within the condenser pipes and which present surfaces 16 providing a multiplicity of shallow recesses 17 in which the condensed zinc may collect in the form of pools of molten metal. These pools in the aggregate present a large surface of molten metal, and the vapors are very helpful in bringing about a proper condensation. The zinc forms in these pools and on the inside walls of the condenser as small drops, which gradually coalesce and run to the bottom of these pipes. As such pipes are inclined the molten metal trickles downward toward the front of the condenser furnace near which is a transverse pipe M connected by vertical pipes 18 to all of the overlying inclined condenser pipes. This transverse pipe is the collector and one end of it 19 projects through the side of the wall, as shown in Fig. 2, and the cap is preferably provided with a small hole near the bottom at a point indicated by 20, which may be closed with a plug of fire-clay so that when sufficient metal is collected in this receiver it may be tapped in the usual manner and the molten metal caught in a ladle, the hole again replugged when the said ladle is full.

It will be understood that some provision must be made for the escape of the vapors of carbon monoxid which accompany the zinc vapors, and to this end the protruding forward ends of the inclined condenser pipes B are preferably provided with caps 21 bolted or otherwise secured to the said pipes. Near the top of each of these caps there is provided a small vent 22 of about $\frac{3}{4}$ of an inch, more or less, in diameter, so that the carbon monoxid may escape and burn underneath the hood N which leads to suitable condensing chamber or bag indicated by O. The carbon monoxid which escapes through this vent, together with a similar residue of zinc vapor is ignited and burns to carbon dioxid and zinc oxid, which latter will be collected in the condensing chamber or bag-house similarly to the ordinary operation, and the zinc vapor thus saved in the form of solid zinc oxid or "flue powder." In case the inclined condensing pipes should for any reason or other stuff up by reason of an imperfect condensation, with the resultant formation of "flue powder," the removable plugs at the ends of the condensing pipes may be taken down, the trays, of which there may be several in each condensing pipe, arranged in overlying relationship, may be pulled out by means of tongs or other suitable tools, and the pipes may then be cleaned by a rabble or similar tool. It will thus be perceived that in this apparatus it is impossible for the metal to flow back into the reduction furnace and be rapidly vaporized with a loss of zinc and danger to the workmen, because the condensing pipes are inclined away and at the same time it is comparatively easy to clean out these pipes whenever occasion demands. Moreover, the pipes may be separately

tapped if desired, and the metal taken out of each one separately.

As has been implied in the foregoing, condensation depends upon temperature, on the surface to which the minute drops can cling, and on the presence of the liquid to which the vapor condenses. The temperature regulation in our condenser may be provided as above described by the furnace and by opening the doors or closing the draft thereof, and in this manner it is possible to control the temperature to within very close limits, especially if the furnace be intermittently employed at such times as the supply of heat evolved by the process of condensation may be lowered. In the normal operation, however, there will be an excess of heat due to the condensation of zinc vapor to metallic zinc, and for the purpose of absorbing this excess heat the radiating system set forth in Fig. 5 may be employed. In this instance the heat of condensation is carried off by rapidly circulating the gases outside the pipes by means of a fan with water cooled bearings and thin radiators of cast iron in which the amount of radiating surface is controlled independently by suitable valves. The cooled gases from the radiating system enter the condensing apparatus at the furnace end, where they abstract the heat from the pipes heated by the hot gases of reduction, and, being slightly heated, are rapidly circulated with an increase of temperature of only a few degrees to the cooler end. By this rapid countercurrent of heat flow the entire number of condensing pipes are kept at precisely the right temperature for condensing at a maximum rate and with the minimum formation of "flue powder."

I have ascertained that it is of great importance that the temperature of the zinc condenser be maintained very accurately at the predetermined temperature and to this end I have devised a system whereby the operator can control very slight fluctuations in temperature with a minimum of effort. It should here be stated that when zinc condenses considerable heat is evolved and this heat should be withdrawn or extracted at a rate bearing a proportion to the rate at which such heat is evolved, as well as to the amount of heat extracted from the hot vapors from the reduction furnace, so that the temperature may not unduly rise in the condenser, nor fall too low therein. Turning, now, to Fig. 5, A indicates diagrammatically the zinc condenser, and P indicates a heat radiator which is connected therewith by means of pipes 25 and 26. In pipe 25 there is interposed a motor driven fan R which operates to withdraw the hot air through pipe 25 and force the same through the system of radiators. The bearings of this fan are preferably water cooled so as not to become unduly heated. The radiator S is constructed in a characteristic manner, that is to say, it comprises a series of units of diverse capacities which are capable of being thrown in and out, so as to vary the sum total of the radiating surface within closely determined limits. These units, as to their capacity and number, are preferably arranged somewhat after the fashion of a set of weights for a balance, so that while it is only necessary to use the minimum number of units, nevertheless the widest latitude in variations of radiating surface is permitted. Thus, 27 indicates the smallest radiator which has what may be regarded as the unitary capacity. 28 and 29, respectively, represent two additional radiators each having twice the capacity or radiating surface of No. 27. 30 shows a larger radiator having a capacity of five times that represented by the unitary radiator 27. 31 represents a radiator having a capacity of ten. 32 and 33, respectively, represent radiators having each a capacity of twenty; and 34 represents a radiator having a capacity of fifty. Each of these radiators, which may be of any usual construction, are by means of hand valves 35 interposed between the pipes 25 and 26 so that the operator by merely turning one of the valves can throw in as many radiators as he desires, and in such assortment or arrangement as would give the sought-for result. By this system and arrangement in capacity radiators, it is possible to very readily obtain any radiating surface which may be desired, and therefore it is in like manner possible to control the temperature of the zinc condensing chamber to within very exact limits.

It will thus be seen that I have devised an apparatus exceedingly well adapted for the condensation of zinc vapor. By means of the circulating gases, which are at a temperature of a little less than 415° C., the amount of heat given out to such gas, plus the small amount lost by the condenser, is exactly equal to the amount of heat necessary to cool the gases of reduction to bring about the proper condensation of the zinc content.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of

the invention which as a matter of language might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, an elongated vessel communicating at one end with said source, and having an opening to permit the escape of accumulating gases, a cover member movably arranged on said vessel whereby access may be gained to the interior thereof, means independent of the source of vapors arranged in conjunction with said vessel whereby the same may be maintained at a closely controlled predetermined condensing temperature, and means for enabling the molten metal condensed within said vessel to be withdrawn.

2. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, an elongated pipe bonded at one end in a wall of said receptacle and having its interior in free communication with the interior of said receptacle, said pipe having an aperture permitting the escape of gases accumulating therein, a cover member mounted on said pipe to enable access to be had to the interior thereof, an inclosure circumscribing imperforate portions of said pipe and having passages for the circulation of heating gases, and a furnace adapted to discharge gases free from zinc vapors at an elevated temperature into said receptacle whereby portions of said pipe may be uniformly maintained at a predetermined condensing temperature.

3. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, a plurality of elongated inclined vessels communicating at one end with said source and having an aperture permitting the escape of gases accumulating therein, cover members mounted on said vessels to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said vessels and having a wall in which said vessels are slidably mounted at their ends, and a furnace independent of said source of vapors adapted to discharge heated gases into said receptacle whereby said vessels may be maintained at a predetermined uniform temperature.

4. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, a plurality of elongated inclined pipes bonded at one end in a wall of said receptacle and having their interiors in free communication with the interior of said receptacle, said pipes provided with vents permitting the escape of gases accumulating therein, a cover member mounted on one or more of said pipes to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said pipes and having a wall through which said pipes slidably protrude at their ends, and a furnace adapted to discharge heated gases free from zinc vapors into said receptacle whereby said pipes may be maintained at a predetermined uniform temperature.

5. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, an elongated vessel communicating at one end with said source and having an opening to permit the escape of accumulating gases, means for collecting the valuable products contained in said escaping gases, a cover member movably arranged on said vessel whereby access may be gained to the interior thereof, heat absorbing means arranged in conjunction with said vessel whereby the same may be maintained at a predetermined condensing temperature, and means for enabling the molten metal within said vessel to be withdrawn.

6. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, an elongated pipe bonded at one end in a wall of said receptacle and having its interior in free communication with the interior of said vapor containing receptacle, said pipe having an aperture permitting the escape and combustion of gases accumulating therein, a hood arranged adjacent said aperture for collecting the solid valuable products of combustion, a cover member mounted on said pipe to enable access to be had to the interior thereof, an inclosure circumscribing portions of said pipe and having passages for the circulation of heating gases, and a furnace adapted to discharge gases free from zinc vapors at an elevated temperature into said receptacle whereby portions of said pipe may be uniformly maintained at a predetermined temperature.

7. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, a plurality of elongated inclined vessels communicating at one end with said source and having an aperture permitting the escape of gases accumulating therein, a hood arranged adjacent said aperture for collecting the valuable products thereof, cover members mounted on said vessels to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said vessels and having a wall in which said vessels are slidably mounted at their ends, and a furnace independent of said source of vapors adapted to

discharge heated gases into said receptacle whereby said vessels may be maintained at a predetermined uniform temperature.

8. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, a plurality of elongated inclined pipes bonded at one end in a wall of said receptacle and having their interiors in free communication with the interior of said receptacle, said pipes providing vents permitting the escape and combustion of gases accumulating therein, means arranged adjacent said vents for collecting the solid products of combustion, a cover member mounted on one or more of said pipes to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said pipes and having a wall through which said pipes slidably protrude at their ends, and a furnace independent of the source of metallic vapors adapted to discharge heated gases into said receptacle whereby said pipes may be maintained at a predetermined uniform temperature.

9. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, an elongated vessel communicating at one end with said source and having an opening to permit the escape of accumulating gases, said vessel having in its interior a surface providing a plurality of shallow recesses in which pools of condensed metal may collect, a cover member movably arranged on said vessel whereby access may be had to the interior thereof, heat absorbing means arranged in conjunction with said vessel whereby the same may be maintained at a predetermined condensing temperature, and means for enabling the molten metal condensed within said vessel to be withdrawn.

10. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, an elongated pipe bonded at one end in a wall of said receptacle and having its interior in free communication with the interior of said receptacle, said pipe having an aperture permitting the escape of gases accumulating therein, and also provided with an interior surface having a multiplicity of shallow recesses in which pools of condensed metal may collect, a cover member mounted on said pipe to enable access to be had to the interior thereof, an inclosure circumscribing portions of said pipe and having passages for the circulation of heating gases, and a furnace adapted to discharge gases at an elevated temperature into said receptacle whereby portions of said pipe may be uniformly maintained at a predetermined condensing temperature.

11. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, a plurality of elongated inclined vessels communicating at one end with said source and having an aperture permitting the escape of gases accumulating therein, members provided with surfaces having numerous shallow recesses contained within said vessels, an aperture permitting the escape of gases accumulating therein, cover members mounted on said vessels to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said vessels and having a wall in which said vessels are slidably mounted at their ends, and a furnace adapted to discharge heated gases into said receptacle whereby said vessels may be maintained at a predetermined uniform temperature.

12. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, a plurality of elongated inclined pipes bonded at one end in a wall of said receptacle and having their interiors in free communication with the interior of said receptacle, members movably contained within said pipes provided with surfaces having a multiplicity of shallow recesses, said pipes providing vents permitting the escape of gases accumulating therein, cover members mounted on said pipes to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said pipes and having a wall through which said pipes slidably protrude at their ends, and a furnace adapted to discharge heated gases into said receptacle whereby said pipes may be maintained at a predetermined uniform temperature.

13. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, an elongated vessel communicating at one end of said source and having an opening to permit the escape of accumulating gases, a cover member movably arranged on said vessel whereby access may be gained to the interior thereof, a fire-box comprising means for introducing and burning gases arranged in conjunction with said vessel whereby the same may be maintained at a predetermined condensing temperature, and means for enabling the molten metal condensed within said vessel to be withdrawn.

14. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, an elongated pipe bonded at one end in a wall of said receptacle having its interior in free communication with the interior of said receptacle, said pipe having an aperture permitting the es-

cape of gases accumulating therein, a cover member mounted on said pipe to enable access to be had to the interior thereof, an inclosure circumscribing portions of said pipe and having passages for the circulation of heating gases, and a furnace for burning either solid fuel or combustible gases, or both, adapted to discharge products of combustion at an elevated temperature into said receptacle whereby portions of said pipe may be uniformly maintained at a predetermined condensing temperature.

15. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a source of metallic vapors, a plurality of elongated inclined vessels communicating at one end with said source and having an aperture permitting the escape of gases accumulating therein, cover members mounted on said vessels to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said vessels and having a wall through which said vessels are slidably mounted on their ends, and a furnace adapted to burn either solid fuel or combustible gases, or both, for discharging heated products of combustion into said receptacle whereby said vessels may be maintained at predetermined uniform temperature.

16. An apparatus of the nature disclosed for condensing metallic vapors to regulus comprising in combination, a receptacle containing metallic vapors, a plurality of elongated inclined pipes bonded at one end in a wall of said receptacle and having their interiors in free communication with the interior of said receptacle, said pipes providing vents permitting the escape of gases accumulating therein, a cover member mounted on one or more of said pipes to enable access to be had to the interior thereof, an inclosure circumscribing the major portions of said pipes and having a wall through which said pipes slidably protrude at their ends, and a furnace adapted to burn either solid fuel or combustible gases, or both, for discharging heated products of combustion into said receptacle whereby said pipes may be maintained at a predetermined uniform temperature.

17. An apparatus of the nature disclosed comprising, in combination, a condenser, a radiator consisting of a plurality of sections, and means for connecting one or more of said sections with said condenser whereby a fluid may be continuously passed from said condenser through said radiators and returned to said condenser and thus maintain the latter at a predetermined temperature.

18. An apparatus of the nature disclosed comprising, in combination, a zinc condenser having a jacket, a heat radiator, a pipe leading from said radiator to said jacket, means for causing gases to flow through said pipe into said radiator and return to said condenser, and means for varying the radiating surface of said radiator.

In testimony whereof I affix my signature, in the presence of two witnesses.

WOOLSEY McA. JOHNSON.

Witnesses:
HARRY H. HOWARD,
CHARLES M. STARKWEATHER.