R. B. WALLING.

METHOD AND APPARATUS FOR SINTERING METAL.

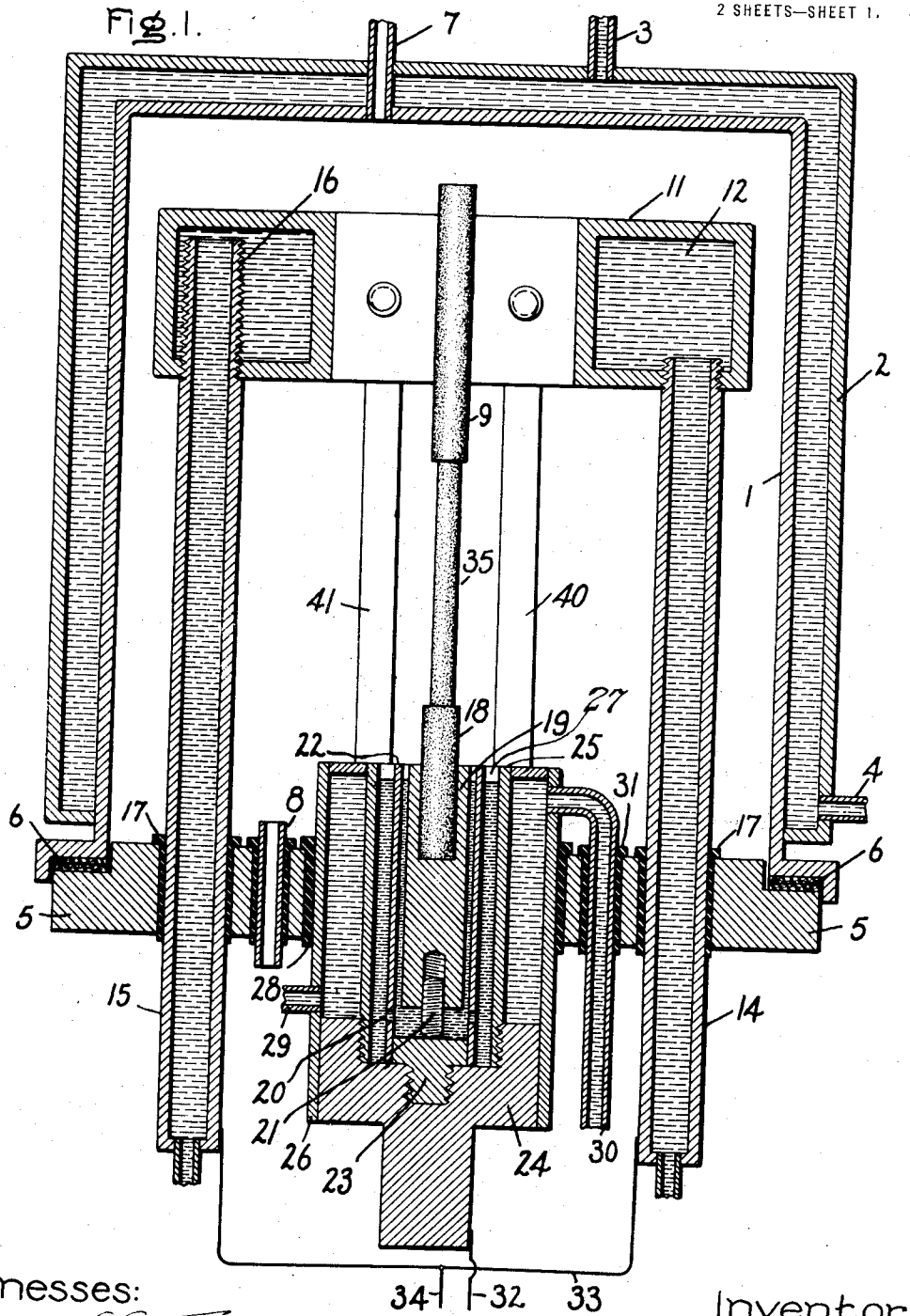
APPLICATION FILED OCT. 7, 1912.

1,194,906.

Patented Aug. 15, 1916.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

Irving E. Steers.

J. Ellis Glen.

Inventor

Raymond B. Walling,

by Albert G. Davis

His Attorney.

R. B. WALLING.

METHOD AND APPARATUS FOR SINTERING METAL.

APPLICATION FILED OCT. 7, 1912.

1,194,906.

Patented Aug. 15, 1916.

2 SHEETS—SHEET 2.

Fig. 2.

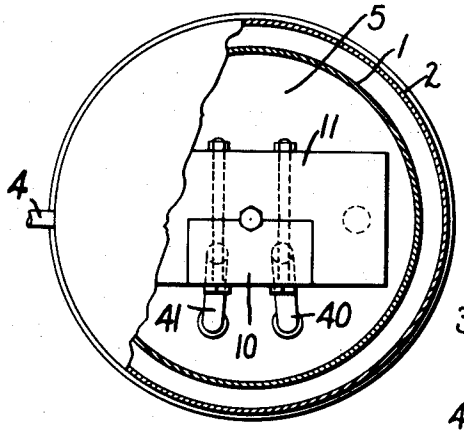


Fig. 3.

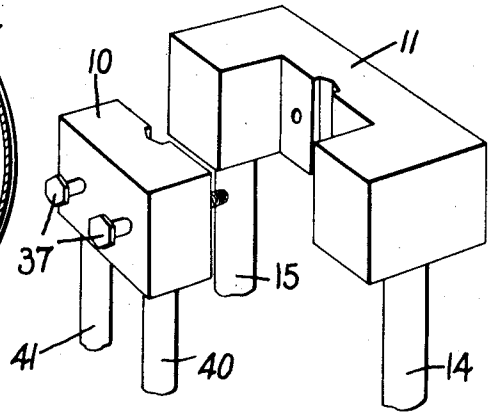
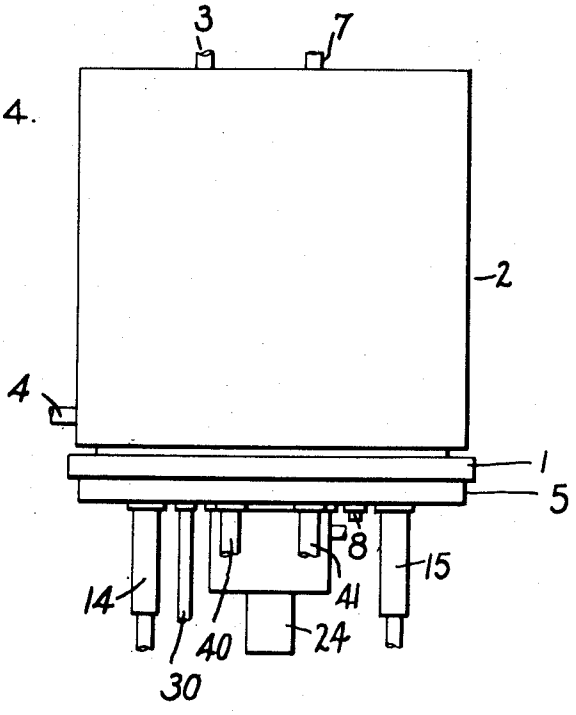


Fig. 4.



Witnesses:
Irving E. Steers.
J. Ellis Glen

Inventor
Raymond B. Walling,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

RAYMOND B. WALLING, OF NEWARK, NEW JERSEY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD AND APPARATUS FOR SINTERING METAL.

1,194,906. Specification of Letters Patent. Patented Aug. 15, 1916.

Application filed October 7, 1912. Serial No. 724,306.

To all whom it may concern:

Be it known that I, RAYMOND B. WALLING, a citizen of the United States, residing at Newark, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods and Apparatus for Sintering Metal, of which the following is a specification.

The present invention relates to a method and apparatus for sintering metal such as the metal tungsten employed in the manufacture of filaments and for other purposes, but it is obvious that my invention is by no means limited to treatment of tungsten.

In the manufacture of ductile tungsten, the tungsten powder is pressed by very heavy hydraulic pressure into rods. These rods when removed from the mold in which they are pressed cannot readily be handled at this stage. In order to render them stronger, they are placed in a furnace, in a hydrogen atmosphere and fired for a short time at a temperature in the neighborhood of 1000 degrees C. They are then removed and subjected to the sintering process, during which the metal contracts and becomes very dense and coherent. Heretofore this sintering was done by clamping each end of the fired rod in a heavy clamp and sending current through the rod while in an inert environment. This method of making electrical connection with the rod is objectionable because the metal which is in the clamp at each end is not heated sufficiently to become sintered and must be broken off and thereby wasted.

By the present invention there is no waste whatever, as the rod is perfectly sintered through its entire length.

My invention will be best understood by reference to the following specification taken in connection with the accompanying drawing, in which—

Figure 1 shows a section of the apparatus with a rod in position; Fig. 2 shows a plan partly in section; Fig. 3 shows a perspective of the upper contact holder; and Fig. 4 shows an elevation.

The apparatus is inclosed in a cylindrical treating bottle 1 which is preferably made of copper. The bottle is provided with a jacket 2 and between the jacket and bottle is a space so arranged that a cooling medium may be circulated therein. The cooling medium, such as water, enters through the pipe 4 and is discharged at the pipe 3 by which means the treating bottle is kept cool and the copper is not injured. The bottle rests on a circular base plate 5 when in its lowered position and is rendered gas tight by the use of gaskets 6. During the sintering operation hydrogen or other inert gas enters through the pipe 7 and is discharged through the pipe 8, so that a stream of gas is sent through the apparatus when in operation.

The upper electrode or contact 9 is, in the present instance, made of tungsten and is securely clamped between the copper castings 10 and 11. The two castings are bolted together by bolts 37. The member 10 is provided with a pipe 40 through which water or other cooling medium may be supplied and a pipe 41 by which the cooling medium is discharged. The pipes 14, 15, 40 and 41 are joined to the contact apparatus in such a manner that none of the cooling liquid can escape into the heating chamber. The member 11 is provided with a space 12 through which a cooling medium may be circulated in order to cool the contact. The cooling medium may enter through the pipe 14 and discharge through pipe 15. The pipe 15 is provided with an extension 16 which extends within a short distance of the top of the member 11 so that the chamber 12 may be kept substantially full of water which cannot escape until it has filled the chamber 12 to the top of the extension 16. The tubes 14, 15, 40 and 41, pass through the circular base plate 5, and are insulated therefrom by the insulating bushing 17, but tubes 14 and 15 are in good electrical connection with the upper contact 9. There is a rigid mechanical connection between tubes 14 and 15 and the base plate, whereby the upper contact and its associated members are supported. The tubes 40 and

41 may be flexible so that the contact may be removed and replaced.

The lower electrode or contact 18 is firmly set in the copper casting 19 which is floated in a mercury bath 20. In the end of the casting 19 is an adjustable screw 21 which is so adjusted that when the casting 19 is in its lowermost position the mercury will all but fill its container 22. The downward motion of the contact 18 is regulated by the screw 21, *i. e.*, the effective length of the member 19 is adjusted by the screw 21. As indicated the faces of the electrodes are substantially flat and horizontal so as to contact only with the butt ends of the rods to be sintered.

The mercury container 22 is firmly connected with a screw plug 23 which is screwed into the casting 24. The casting 24 is screwed onto a cylindrical member 25. The member 25 is provided with a jacket 26 which is insulated from the base plate 5 by the bushing 28, leaving a space whereby water may be circulated between the cylinders 25 and 26. The cooling medium is admitted to the lower contact apparatus through the pipe 29 and is discharged through the pipe 30 which is insulated from the base plate by bushing 31.

The electric current is supplied by any suitable source, not shown. It is conducted to the lower contact by conductor 32 which is shown conventionally as connected to the casting 24. The space 27 between container 22 and the cylinder 25 may be, and preferably is, filled with mercury in order to get the best possible contact. This may be accomplished by putting openings in the container 22, as shown in the drawings. The current is conducted to the upper electrode by means of the two tubes 14 and 15, which also convey the cooling fluid for the upper contact. These tubes are connected by the conductor 33 which is connected to the other side of the source by lead 34. The current divides and goes up these tubes substantially equally so that the electrodynamic action of the current in one tube on the rod 35 is counteracted by that of the other, whereby bending of the rod is prevented.

The operation of the above is as follows: The lower electrode 18 is depressed and the rod 35 is placed between it and the electrode 9, thus making a butt connection at each end. The rod is held by the pressure which is exerted by the lower electrode in an upward direction. The bottle 1 is then lowered and the inert gas turned on. The current is admitted to the rod gradually and is increased until the rod is brought to the sintering heat. The buoyancy of the lower contact in the mercury exerts an upward pressure which is continuous during the shrinking of the rod. The rod is kept at this temperature until it is sintered, and after sintering the current is reduced gradually to zero and the rod is removed. It is then in a sintered condition throughout its entire length.

It will be understood that many modifications of the above described apparatus may be made without departing from the spirit of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In apparatus for sintering rods, a fixed contact set in a water cooled member, a movable contact floated in mercury and water cooled, said floating contact exerting a pressure on said rods by which a firm electrical contact is made and maintained during the contraction of the rods in the sintering operation.

2. In a sintering apparatus, a container, a conductive liquid in said container, a metallic contacting member floated in said liquid, and means for adjusting the effective length of the metallic member.

3. In a sintering apparatus, a container, a conductive liquid in said container, a metallic contacting member having refractory metal firmly mounted in one end, and adjustable means on the other end thereof, said member being floated in said liquid.

4. In apparatus for sintering rods, the combination of an upper and a lower contact for the ends of the rods, conductors for supplying current to said contacts, the conductors for the upper contact being symmetrically arranged to the rods to prevent bending of the rods during sintering.

5. In apparatus for sintering rods, the combination of an upper and a lower contact for the ends of the rods, conductors for supplying current to said contacts, said conductors being so arranged as to prevent bending of the rod during sintering.

6. In apparatus for sintering rods, the combination of relatively movable upper and lower contacts for engaging the ends of the rod to hold it vertically and to supply current for sintering it, and means for automatically decreasing the vertical distance between said contacts in response to the shrinkage of said rod to exert pressure in a vertical direction upon said rod and to maintain current carrying contact therewith during sintering.

7. In apparatus for sintering rods, the combination of a fixed upper contact and a vertically movable lower contact for engaging the ends of the rod, conductors for supplying current to said contacts, and means responsive to the shrinkage of said rod during sintering for automatically raising said lower contact.

8. The method of sintering rods of loosely coherent refractory metal which consists in

supplying a heating current to said rods while in a vertical position through butt connections whereby the rods are heated to a sintering temperature throughout their entire length.

9. An apparatus for sintering rods of loosely coherent metal comprising relatively movable upper and lower electrodes having substantially flat horizontal contact faces for engaging the butt ends of the rods to be sintered.

In witness whereof, I have hereunto set my hand this fourth day of October, 1912.

RAYMOND B. WALLING.

Witnesses:
S. N. WHITEHEAD,
J. H. ELKINS.