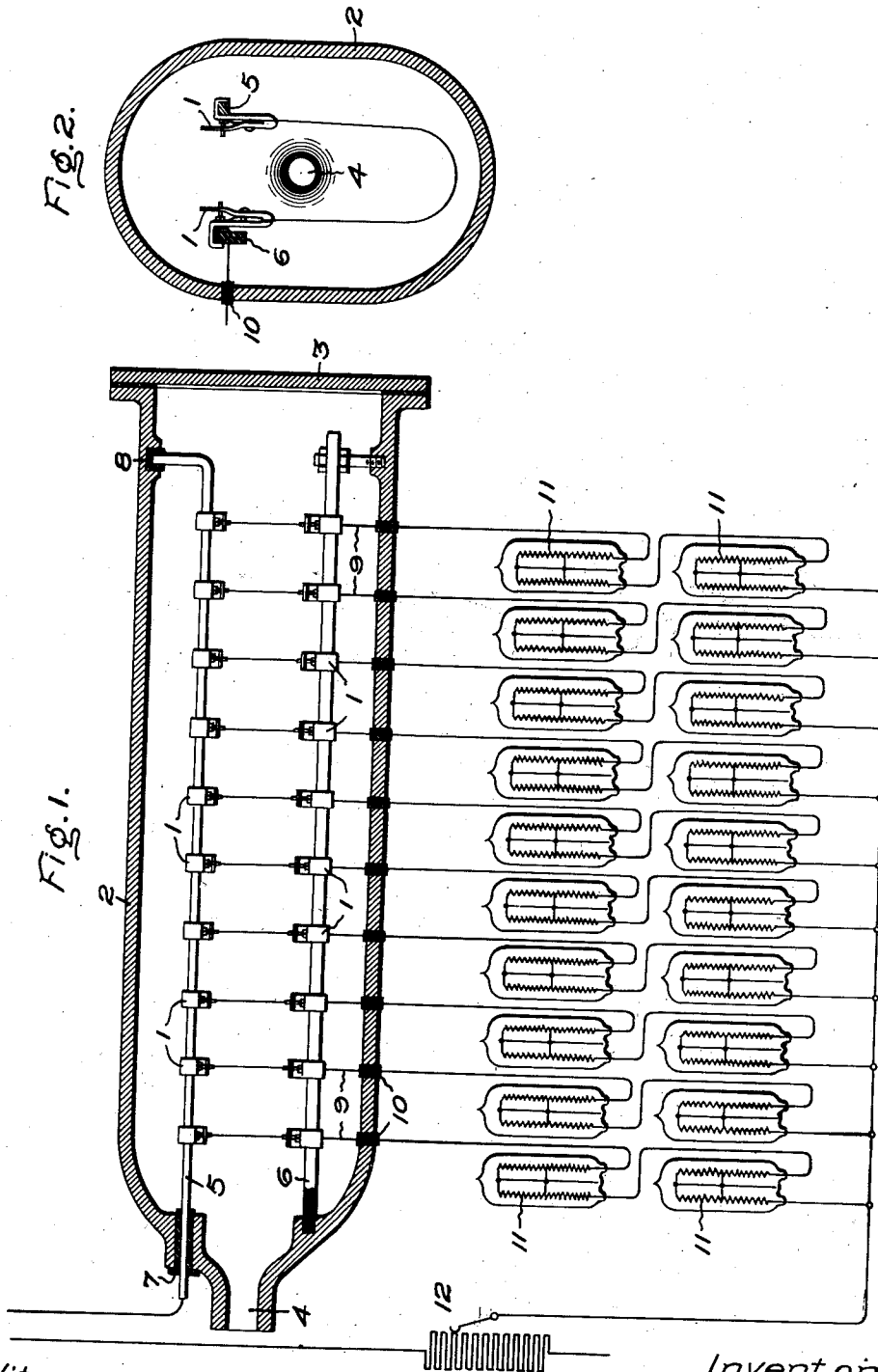


W. D. COOLIDGE.
ART OF MANUFACTURING LAMP FILAMENTS.
APPLICATION FILED AUG. 24, 1907.

1,047,502.

Patented Dec. 17, 1912.

2 SHEETS—SHEET 1.



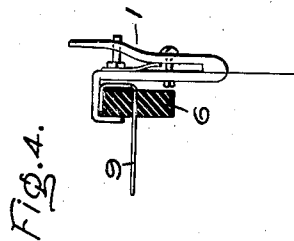
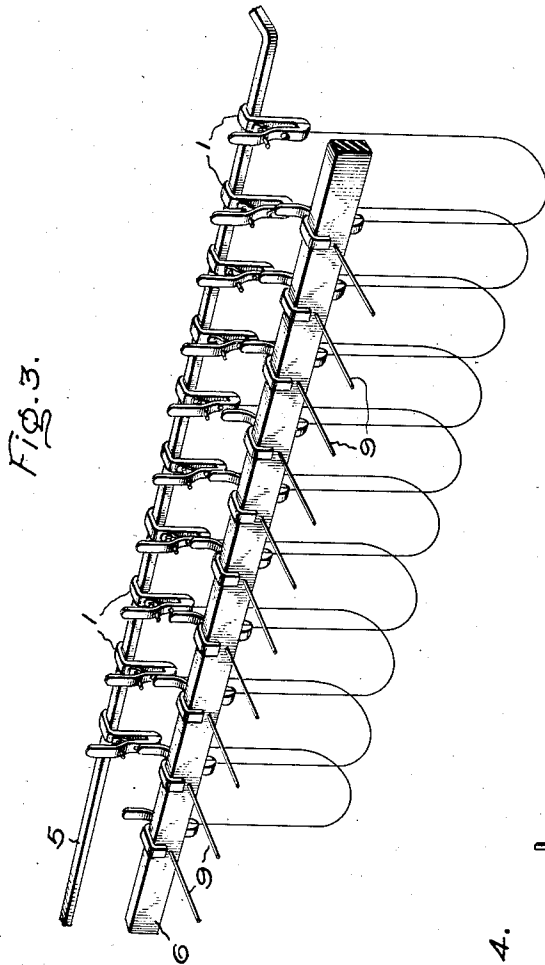
Witnesses:
Marcus S. Byng.
J. Ellis Allen.

Inventor:
William D. Coolidge,
by *Albert H. Davis*
Att'y.

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UNITED STATES PATENT OFFICE.

WILLIAM D. COOLIDGE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ART OF MANUFACTURING LAMP-FILAMENTS.

1,047,502.

Specification of Letters Patent.

Patented Dec. 17, 1912.

Application filed August 24, 1907. Serial No. 390,037.

To all whom it may concern:

Be it known that I, WILLIAM D. COOLIDGE, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in the Art of Manufacturing Lamp-Filaments, of which the following is a specification.

My invention relates to filament manufacture and comprises an apparatus whereby filaments may be advantageously subjected to treatment involving passage of current through them.

A number of processes for the manufacture of incandescent lamp filaments of tungsten, molybdenum, and other refractory materials involve heat treatment of the filamentary conductors, which may be carried out by current passed through them. Whatever the specific character of the change in the filaments produced by this treatment, it results in a material alteration of their electrical conductivity, so that it has been found necessary to treat each individual filament separately,—to which fact a large proportion of the cost of a completed filament made by a procedure including such treatment is probably due.

According to the present invention, filamentary conductors, subject to change in conductivity during treatment, are treated simultaneously in a single treating vessel by means of current passed through the conductors. Furthermore, the proper current strength is at all times maintained in the conductors by the action of automatic regulating means.

The apparatus by which the above-mentioned treatment can be applied is illustrated in the accompanying drawings, in which—

Figure 1 is a sectional view of a treating vessel and a diagrammatic representation of the electrical circuits connected to said vessel; Fig. 2 is a transverse section of said treating vessel; Fig. 3 is a perspective view of the filaments and the clips by which they are supported; and Fig. 4 is a detail of a single clip.

My invention may be used in the manufacture of filaments by a procedure involving passage of current therethrough irrespective of the particular process of manufacture employed. Thus the treatment with current may produce chemical changes in

the conductor or merely drive out vaporizable components and sinter together the refractory residue.

According to my invention, the conductors which are to be subjected to treatment with current are attached at either end to spring clips 1 illustrated in the accompanying drawing, and are then suspended in a treating vessel 2 of glass or metal having a removable closure 3 for one end and a constricted opening 4 at the other end whereby the vessel may be connected with an air pump and maintained in a more or less completely exhausted condition.

As shown in the drawings, the plurality of filaments are mounted in a single treating vessel and the spring clips 1 are carried by supporting rails 5 and 6 arranged on opposite sides of the treating vessel. The rail 5 is of conductive material and is insulated from the wall of the vessel by suitable non-conductive bushings 7 and 8. Rail 6 is of insulating material but is pierced with a plurality of wires 9, equal in number to the filaments to be treated and serving as independent supply wires for the several filaments. These conductors 9 after passing through the non-conductive rail, are bent upward and then backward over the surface of the rail, as shown in Fig. 4, and thus serve to establish electrical connection with their respective filament clips. The wires 9 pass out through the side of the vessel 2 and are insulated therefrom by bushings 10. Each filament is connected in series with a regulating resistance having a pronounced positive temperature coefficient, which may advantageously consist of a plurality of iron wire ballasts 11 of the type heretofore commonly used in conjunction with Nernst lamp glowers. Each filament under treatment has its separate group of ballasts but the ballasts are connected together at their other ends and are supplied with current through an adjustable resistance 12. With this arrangement of filaments, ballasts, and adjustable resistance, the voltage on the filaments may be gradually raised, and the proper heating current may be produced therein without danger that any one filament will "run away" and take more than its proper proportion of treating current. If one filament starts to increase in conductivity more rapidly than the others, it is automatically held in check by its ballast, and must of ne-

cessity hold on at the proper current until the other filaments of the group have attained the same degree of conductivity and until the adjustable resistance 12 is shifted over by the operator. After the treating is completed, the spring clips and their supporting filaments may be taken out through the end of the treating vessel and a new supply be introduced for a repetition of the operation. This simultaneous treatment is a material advance over individual treatment, not only because a single operator can take care of a group of filaments instead of a single filament, but also because the treating vessel need be evacuated only once for an entire group of filaments, whereas in the single treatment it must be evacuated for each filament. Furthermore, the filaments are perfectly uniform and require no sorting or measuring.

I do not consider that my invention is limited to use in any particular process. On the other hand, I consider it generally applicable as a step in those processes of filament production which have heretofore necessitated individual treatment of the filament whether as a step in the production of pure refractory metal, or as a step in the shrinkage or consolidation of the refractory metal, or in fact, as any other step in which the unfinished filament undergoes a change in conductivity during treatment.

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

1. The combination of a treating vessel, means for supporting a plurality of unfinished filaments in said vessel, a ballast for each filament, a source of current for said filaments, and regulating means between said source and said ballasts.

2. The combination of a treating vessel, means for supplying current to a plurality of filaments in said vessel, and automatic means for distributing said current equally among said filaments and for maintaining proper distribution while the filaments are changing in conductivity.

3. The combination of a closed vessel, suitable connections and means for supporting a plurality of filaments therein, a source of current for supplying energy to said filaments, resistance means in circuit with each filament, and means for adjusting the voltage impressed across the filaments and their respective resistance means.

4. The combination of a treating vessel, suitable connections and means for supporting a plurality of filaments therein, a resistance in series with each filament and having a pronounced positive temperature coefficient, and a source of current supply common to all said filaments.

5. The combination of a treating vessel, supporting rails mounted therein, and clips resting on said rails adapted to carry a plurality of filamentary conductors.

6. The combination of a treating chamber, a conductive rail mounted therein, a non-conductive rail also mounted therein, a plurality of filament supporting clips resting on said rails, and separate connections for those clips which rest on the non-conducting rail.

7. The combination of a treating vessel, a plurality of conductors entering said vessel, means for temporarily connecting an unfinished filament with each of said conductors, and automatic means for equalizing the voltage across said filaments irrespective of changes in their conductivity.

8. In an apparatus for subjecting a plurality of filamentary conductors to uniform heat treatment, the combination of a constant potential circuit and a plurality of normally-open multiple branches derived from said circuit each adapted to be closed by a filamentary conductor constituting a relatively small portion of the resistance of the closed branch.

9. In an apparatus for subjecting a plurality of filamentary conductors to uniform heat treatment, the combination with a suitably controlled circuit of means for connecting said filamentary conductors in parallel therein so that the amount of current passing through each of them will be relatively independent of differences and changes in their conductivity.

10. In an apparatus for subjecting a plurality of filamentary conductors to uniform heat treatment, the combination with a circuit including a source of difference of potential of means for connecting said filamentary conductors in parallel in said circuit and causing the passage of current through them in amounts relatively independent of differences and changes in their individual conductivity.

11. In an apparatus for subjecting a plurality of filamentary conductors to uniform heat treatment simultaneously, a plurality of ballast resistances, means for connecting each filament in series with one of said resistances, means for connecting a plurality of said circuits in parallel across a supply circuit, and a variable resistance in series with said parallel circuits.

In witness whereof, I have hereunto set my hand this 23rd day of August, 1907.

WILLIAM D. COOLIDGE.

Witnesses:

HELEN ORFORD,
ARBA B. MARVIN, Jr.