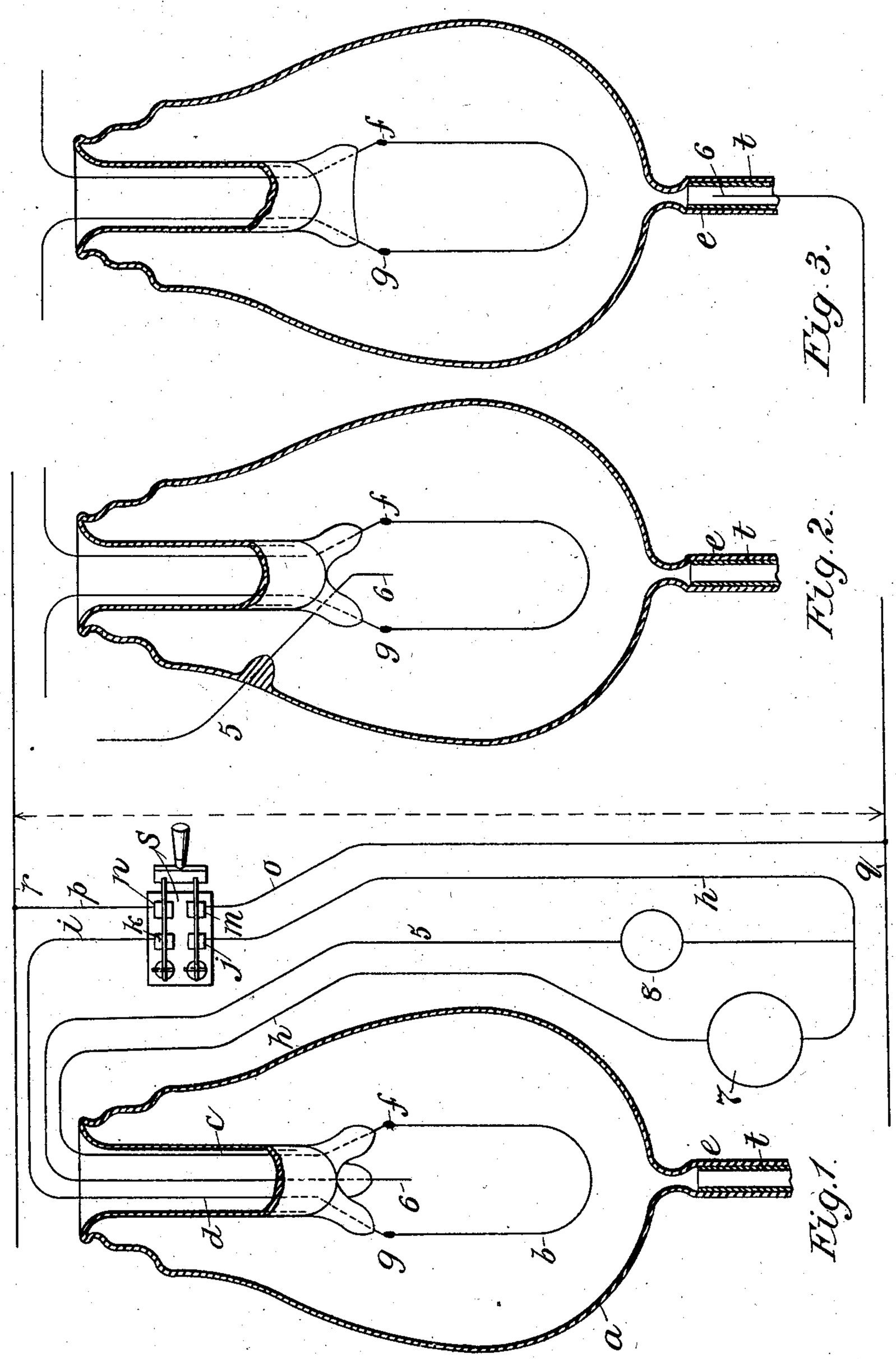
No. 710,099. Patented Sept. 30, 1902.

S. E. DOANE.

METHOD OF EXHAUSTING INCANDESCENT ELECTRIC LAMPS OF RELATIVELY LOW VOLTAGE.

(No Model.) (Application filed Feb. 7, 1902.) 2 Sheets—Sheet 1.



Witnesses
Edward C. Rowland.
M. F. Keating

Inventor
Samuel Everett Doane
By his Attorney
Charles J. Kintner

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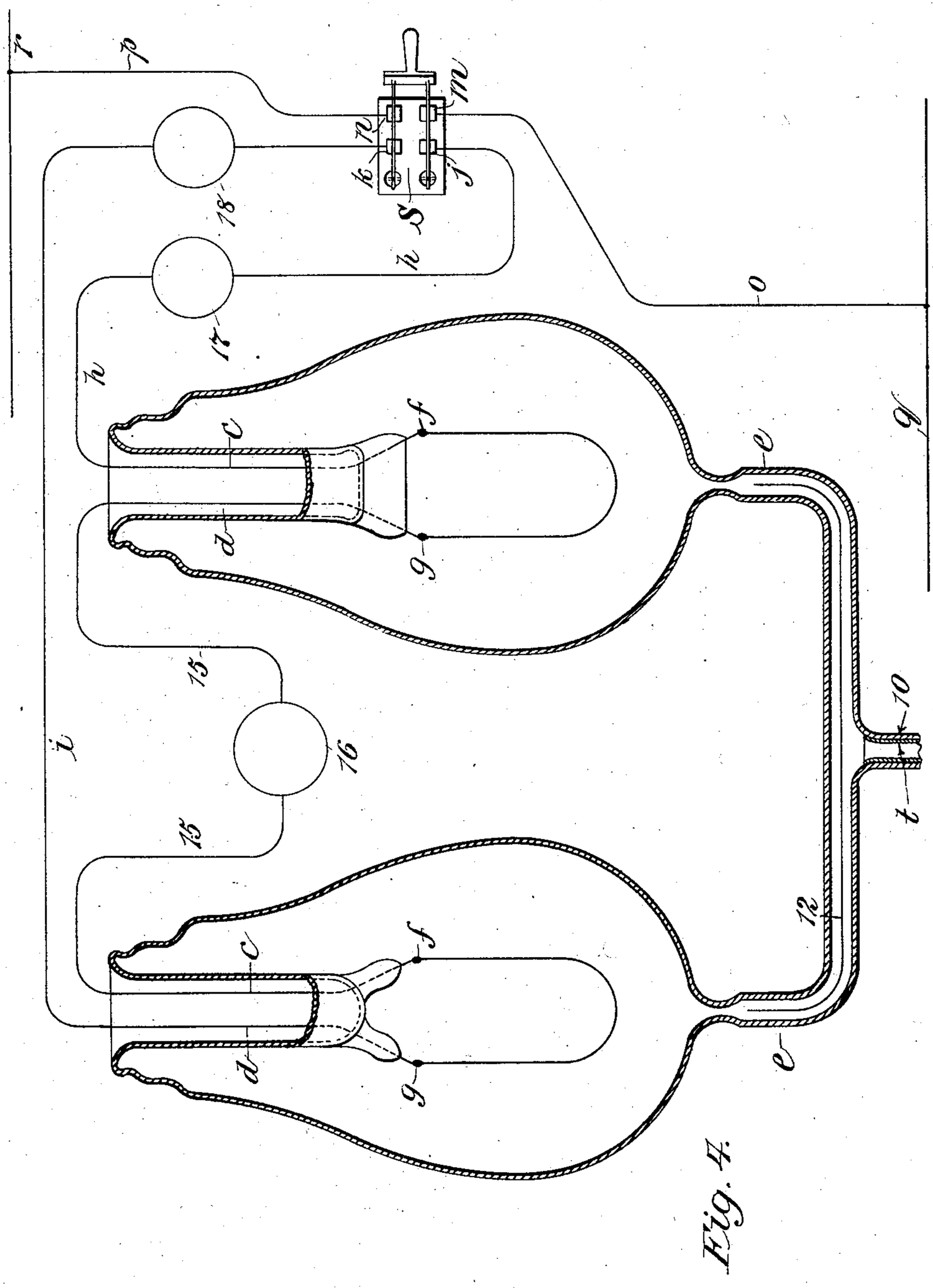

Fig.

Witnesses
Edward Rowland.
M. F. Keating

Inventor
Samuel Everett Doane
By his Attorney
Charles J. Kintner

UNITED STATES PATENT OFFICE.

SAMUEL EVERETT DOANE, OF MARLBORO, MASSACHUSETTS, ASSIGNOR TO THE BRYAN-MARSH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

METHOD OF EXHAUSTING INCANDESCENT ELECTRIC LAMPS OF RELATIVELY LOW VOLTAGE.

SPECIFICATION forming part of Letters Patent No. 710,099, dated September 30, 1902.

Application filed February 7, 1902. Serial No. 93,049. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL EVERETT DOANE, a citizen of the United States, residing at Marlboro, county of Middlesex, and State of Massachusetts, have made a new and useful Invention in Methods of Exhausting Incandescent Electric Lamps of Relatively Low Voltage, of which the following is a specification.

My invention has for its especial object to facilitate the manufacture of low-voltage electric lamps, and will be fully understood by referring to the accompanying drawings, which are all diagrammatic views illustrating modified means for effecting the practice of the method hereinafter claimed.

During the process of manufacturing incandescent electric lamps as ordinarily practiced when a lamp, say, of normally one hundred and ten volts is caused to glow during exhaustion at approximately one hundred and fifty volts after the vacuum-pump has established a vacuum which can be indicated by a column of three millimeters or less of mercury the whole of the bulb of the lamp is filled with a blue-flame-like appearance. While this blue flame in the bulb is not entirely caused by the electromotive force of the generator, it is largely dependent upon it. This blue flame will not fill the bulb of the lamp no matter how much the filament is made to glow or how high the vacuum may be unless there is sufficient electromotive force (or difference of potential) so applied to the vacuous space as to cause a current to pass through the heated gases contained in the bulb; nor will this blue-flame-like appearance occur, no matter what the electromotive force may be, until the filament has raised the gas in the bulb to a sufficiently high temperature.

In the manufacture of ordinary incandescent electric lamps of about one hundred and ten volts the voltage which raises the filament to the necessary temperature to heat these gases is also sufficient to cause the currents to flow through them, and though these different conditions have been produced heretofore no one has fully appreciated the fact that they may be utilized for the purpose of completing the exhaustion of low-voltage incandescent electric lamps. I have found why this blue flame does not appear in low-voltage lamps under ordinary treatment, and the essence of my invention lies in the practice of the method hereinafter described and claimed whereby more perfect exhaustion of low-voltage lamps is effected by the independent passage of electrical currents through the vacuous space and the gases in the lamp simultaneously with the passage of the current through the filament proper.

In some of the processes of manufacturing incandescent electric lamps now in use chemicals are employed to perfect the vacuum, and in these processes it is necessary that a sufficient difference of voltage be maintained in the lamp-bulb during some portion of the process to cause a flow of current across the vacuous space to bring about an electrochemical action between the residual gases from the preliminary exhaustion and the gases, vapors, or solids introduced for this purpose. As now usually practiced and known to me, an electric current is passed through the filament while the lamp is being exhausted in order to heat the said filament very hot.

In lamps, say, for instance, of fifty volts and upward the current referred to flows for a portion of the time at least by two paths. The greater portion flows along the filament to heat the same, while a small portion passes across the vacuous space and further heats the joints between the filament and the leading-in wires and in chemical processes of exhaustion brings about the electrochemical actions desired and above mentioned. In manufacturing lamps of lower voltages, however, difficulty is experienced in bringing about either a sufficient joint heating or the chemical combinations, as the relatively high voltage required to effect the discharge across the vacuous space, which is desirable for the joint heating and necessary for the electrochemical action, is so much higher than the normal voltage of substantially low-voltage lamps that if applied to the leading-in wires it causes so much current to flow through the filament that the said filament is immediately injured or destroyed. The exact voltage below which the "cross-currents" in the vacuous spaces do

not exist depends upon circumstances; but ordinarily they cannot be produced by much under thirty volts.

My invention brings about in low-voltage lamps the conditions present in lamps of high voltages, whereby the former may be exhausted with equal facility and with equally effective joint heating and electrochemical action without detrimental action to the filament of such lamps, and I accomplish this result by separately and simultaneously introducing into the low-voltage lamp during exhaustion two currents, one of which flows through the filament and heats it and the surrounding gases, as in the high-voltage lamp, and the other of which flows across through the gases in the vacuous space. The current which flows across the vacuous space completes its circuit through other wires as well as the leading-in wires, and therefore it may be of any voltage necessary to effect the joint heating and the electrochemical action upon the gases, so as to dissipate them as desired without destroying or injuring the filament of the lamp.

My method of exhausting low-voltage lamps contemplates, first, the preliminary exhaustion of the bulb by any of the well-known processes—such, for instance, as the vacuum-pump; second, the generation of gases within the bulb in a well-known manner for the electrochemical reaction described later, and, third, the simultaneous passage of two independent electric currents through the lamp, one through the filament itself for the purpose of heating it and the surrounding gases and the other of higher voltage directly through the gases themselves for the purpose of acting chemically therewith and in such manner as to dissipate them and still further perfect the vacuum. This method may be carried out with many different arrangements of circuits and terminals, and the latter can be placed in various portions of the exhausting apparatus outside of the lamp proper. It is also possible to use various combinations of generators and to use either direct or alternating currents, or both.

Referring to Figure 1, *a* represents an incandescent electric-lamp bulb provided with a filament *b* and leading-in wires *c d*. The bulb *a* is provided with a tube *e*, through which it is preliminarily exhausted in the usual or well-known manner, *t* being an interior coating of amorphous, phosphorous, or such other equivalent material as is ordinarily used for the purpose of generating gases within the bulbs of incandescent lamps, said gases being generated, as is well known, by heating the tube *e* by a blowpipe or otherwise. The filament *b* is connected with the lead-in wires *c d* by joints *f g*, and, as shown in Fig. 1, the leading-in wires *c d* are connected by wires *h i* with one set of poles *j k* of a double-pole switch S, which has its other set of poles *m n* connected by wires *o p* with main line-wires *q r*, between which one hundred volts are sufficient for effecting the results desired with the arrangement shown in Fig. 1. The wire *h* has connected to it a branch wire 5, connected with a third wire 6, which is commonly sealed in the bulb *a* between the leading-in wires *c d*. The wire *h* includes a rheostat 7 for controlling the voltage of the current passing through the filament to heat the same while the lamp is being exhausted, and the wire 5 includes a resistance 8, which is in series with the third wire 6 to prevent too great a flow of current.

With the arrangement shown in Fig. 1 it will be noticed that two currents are introduced into the lamp while it is being exhausted, one flowing through the leading-in wires and the filament *b* and the other flowing from the third wire 6 across the gases in the vacuous space between the said third wire and the filament and joints. The voltage introduced into the lamp by the third wire 6 should be materially higher than the voltage passing through the filament, and as a result the joints *f g* are effectively heated and the electrochemical action upon the gases above referred to is obtained without deleterious action on the filament of the lamp.

In Fig. 2 the third wire 6 is shown as passed through the side of the lamp, and in Fig. 3 the said wire is extended into the tube *e*.

In Fig. 4 I have shown two lamps with their tubes *e* connected together and provided with a branch 10, leading to the exhausting apparatus. (Not shown.) In the arrangement shown in this figure of the drawings the connected tubes *e* contain a wire 12 to increase the conductivity of the vacuum-tube circuit, and the lamps are connected in series, the leading-in wire *c* of one lamp being connected by wire 15 with the leading-in wire *d* of the other lamp. The wire 15 includes a rheostat 16 for causing a difference of electrical potential between the lamps sufficient to bring about the discharge from lamp to lamp through the attenuated gases in the connected tubes *e*. The wires *h i* include rheostats 17 18 to govern the voltages on the two lamps being exhausted in series and also to limit the rise in current due to the extra current traversing the vacuum-space from lamp to lamp through the connected tubes *e*. The lamps may be connected in multiple, and in this case the rheostat 16 would not be necessary. The arrangements shown in Figs. 3 and 4 are not deemed by me as desirable as those shown in Figs. 1 and 2 owing to the resistance introduced into the gaseous circuit by its contraction in the tube *e*.

It will be understood that I do not limit my invention to the particular arrangements shown by which the method may be practiced, but consider them simple, operative, and sufficient to enable the invention to be understood.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

The described method or process of exhausting an incandescent electric lamp of relatively low voltage, consisting in first, producing a partial vacuum within the bulb thereof; second, generating a gas therein; third, passing a current of electricity through the filament of the lamp sufficient to heat it to incandescence and finally, passing an additional current of electricity of higher voltage directly through the gases in the vacuous space so as to act upon said gases in such manner as to dissipate them.

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

SAMUEL EVERETT DOANE.

Witnesses:
THEO. W. FRECH, Jr.,
GEO. G. LOCKWOOD.