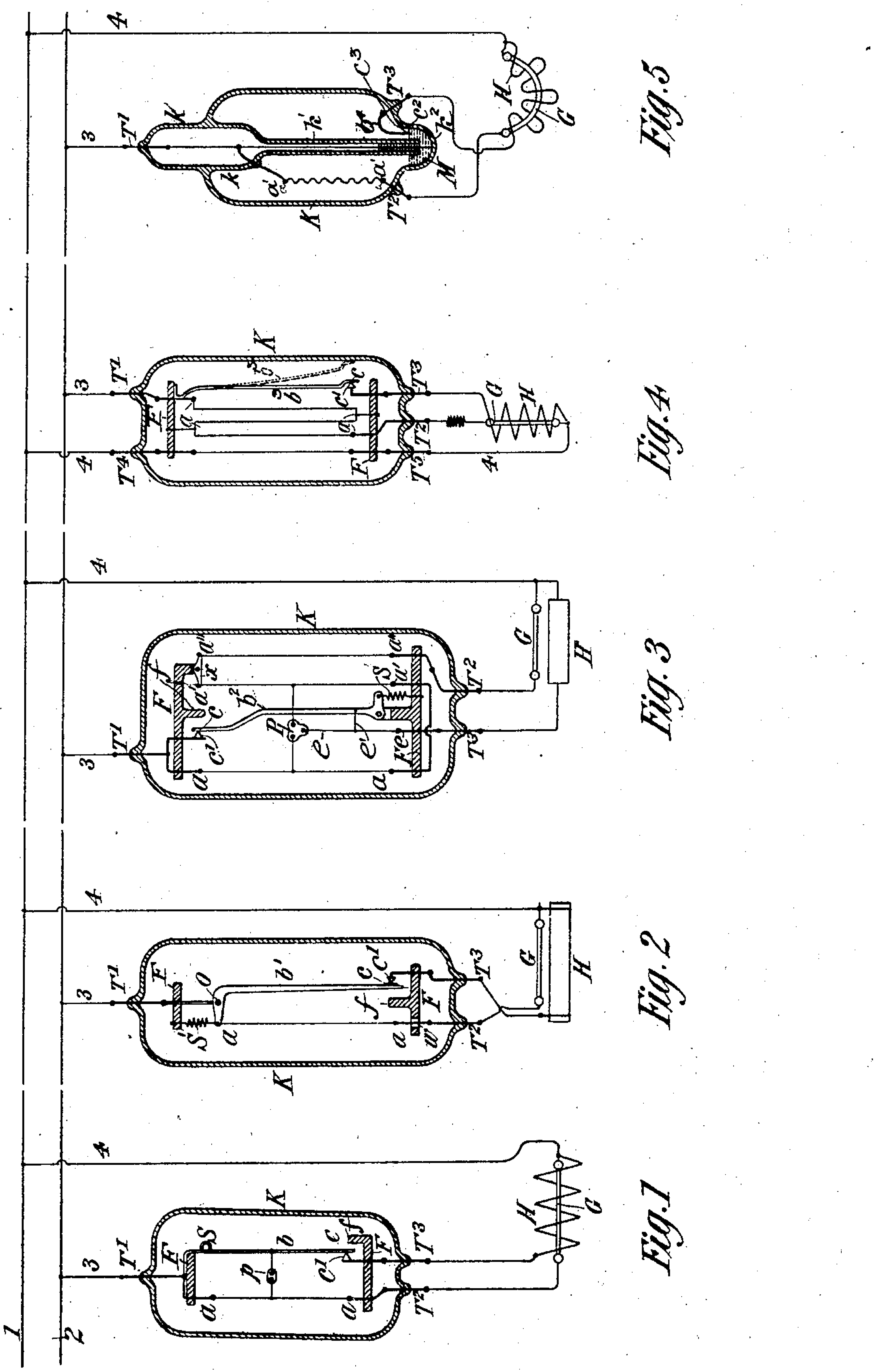
No. 721,387. PATENTED FEB. 24, 1903.

H. N. POTTER.

HEATER CUT-OUT FOR ELECTRIC LAMPS.

APPLICATION FILED SEPT. 2, 1899.

NO MODEL. 3 SHEETS—SHEET 1.



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

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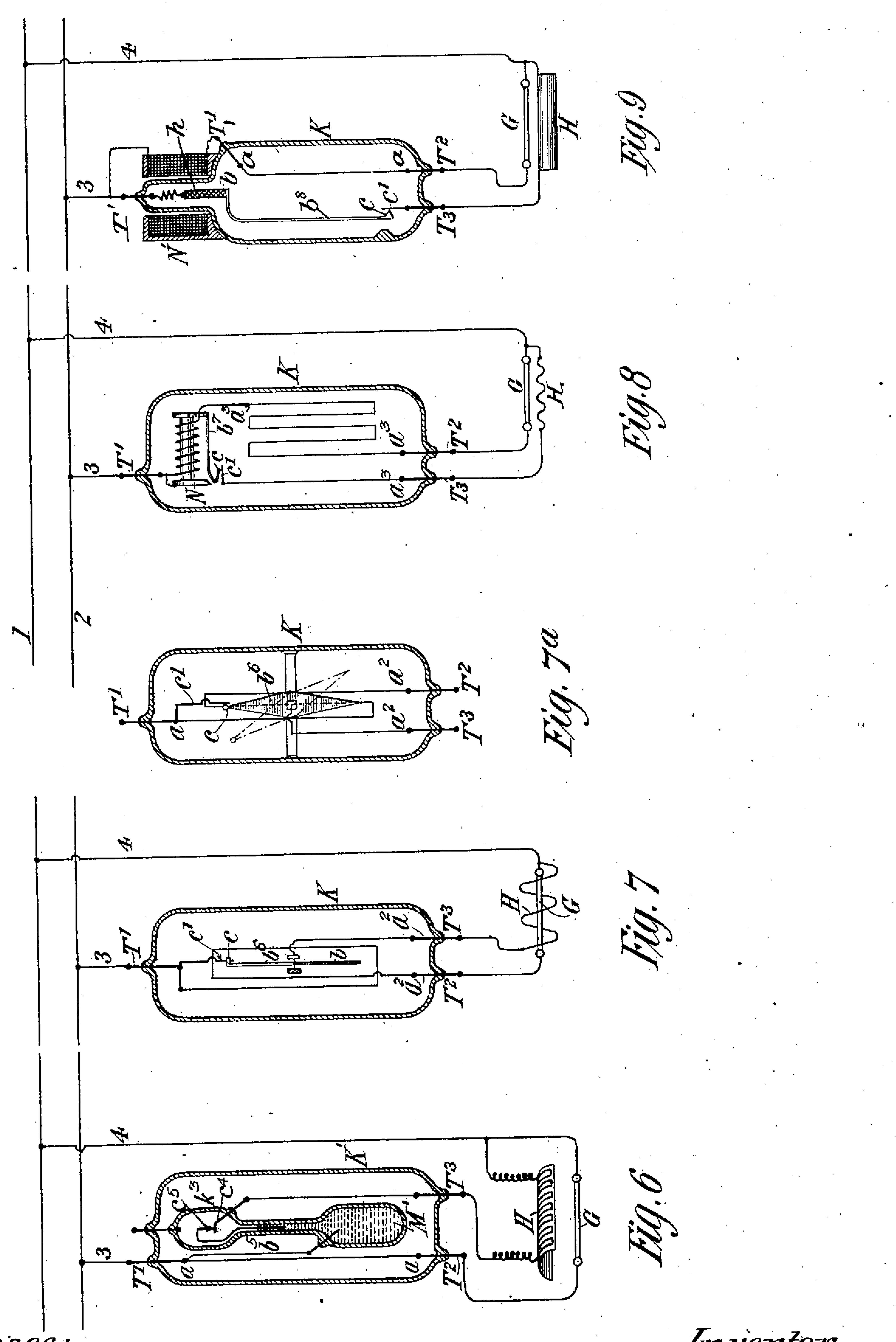

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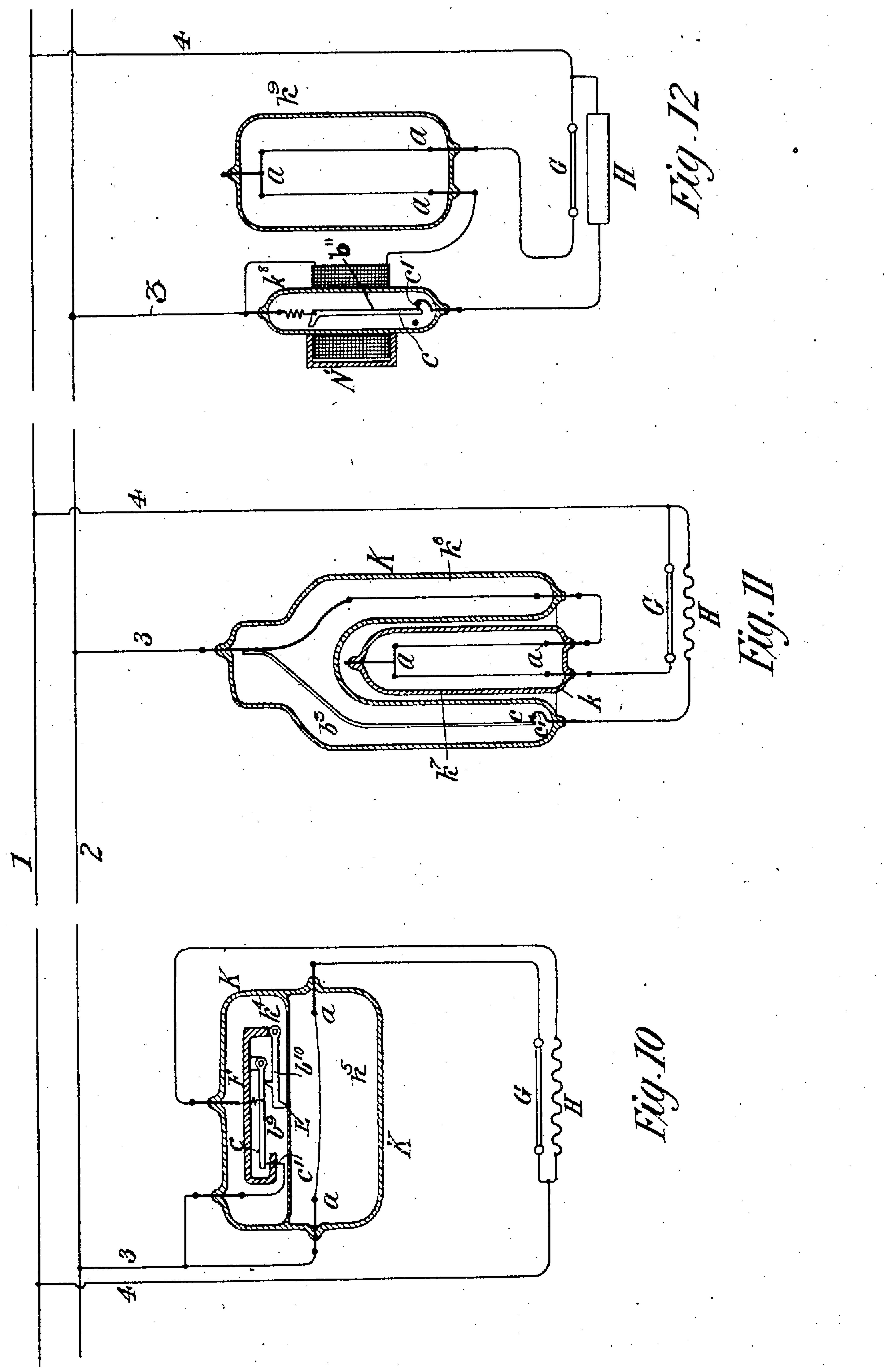

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UNITED STATES PATENT OFFICE.

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HEATER CUT-OUT FOR ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 721,387, dated February 24, 1903.

Application filed September 2, 1899. Serial No. 729,277. (No model.)

To all whom it may concern:

Be it known that I, HENRY NOEL POTTER, a citizen of the United States of America, and a resident at Göttingen, Germany, have invented certain new and useful Improvements in Heater Cut-Outs for Electric Lamps, of which the following is a specification.

The invention relates to the class of devices employed for cutting out of circuit the electric heating devices employed for heating to conducting temperature the light-giving members of electric lamps.

The object of the invention is to provide a simple and efficient device for automatically cutting the heating device out of circuit when the glower or illuminant of the lamp has been heated to a conducting temperature. It has been heretofore proposed to employ a magnetic or thermostatic cut-out device for this purpose, having an actuating element in series with the glower and separable contacts actuated thereby in the heater-circuit. I have found that usually thermostatic devices are very troublesome owing to their slowness of action if made massive enough to withstand use and transportation and owing to their extreme delicacy if made rapid in action. I have found the magnetic devices undesirable to a certain extent, owing to the waste of energy in the coils, which contributes but very little to steadying the current in the glower, and owing also to the necessity of keeping the necessary insulation below the charring temperature, which precludes the use of such coils in the immediate neighborhood of the glower. I have now devised cut-out devices which avoid these difficulties partially or entirely. In another application, Serial No. 726,617, filed August 9, 1899, I have described a special form of steadying resistance or ballast to be employed in series with the glower of this form of lamp. This ballast consists of an iron conductor in an atmosphere of inert gas—such, for instance, as hydrogen—and my present invention relates particularly to the utilization of this form of ballast device in operative connection with an automatic cut-out for the heater-circuit; but certain features of the invention have a wider application. The ballast-wire consists usually of a comparatively short length of iron wire, varied in length, diameter, &c., to suit the various characteristics of the different lamps with which it is to be employed and the degree of irregularity of voltage on which such lamps are run. This wire, when current is traversing the glower, is heated to a temperature just below a red heat or a trifle hotter, and when so heated expands somewhat in length and heats the surrounding gas, the inclosing-chamber, and any foreign bodies placed within the chamber. In short, within the said chamber occurs a variety of heat phenomena which can be made use of to operate a circuit-breaker through which the circuit to the heater is closed when the glower is not in operation. Various different forms of circuit-breakers thus operated may be employed.

In Figure 1 of the drawings I have illustrated one form and in Figs. 2, 3, 4, 5, 6, 7, 7ᵃ, 8, 9, 10, 11, and 12 modifications of the invention.

Referring to the drawings, in Fig. 1, G is the glower, surrounded by the heater H. K is the ballast-chamber. *a a* denote the ballast-wire; *b*, a conducting-arm carrying the contact *c*, which is held in engagement with contact *c'* by the tension of the wire *a a*, through the insulated connection *p*, against the tension of the spring S. F is a frame for supporting the ballast-wire and the circuit-breaker. T' T^2 T^3 are platinum terminals sealed in. The current enters the ballast-chamber from the main 2 at 3 by terminal T' and passes, by arm *b*, contacts *c* and *c'*, and terminals T^3, to heater H, thence by conductor 4 to main 1. This condition lasts until the glower G becomes conductive, when current passes to the glower from terminal T', through ballast-wire and terminal T^2, and thence by conductor 4 to main 1. The passage of current through ballast-wire *a a* heats it in the manner described, and this heat causes it to expand sufficiently to release the tension on arm *b*, whereupon the spring S moves the arm *b* and its contact *c* out of engagement with the contact *c'*, thereby interrupting further flow of current to the heater so long as current to the glower keeps the wire *a a* slack. Upon current to the glower being interrupted by a switch—in conductor 4, for example—the wire *a a* cools, contracts, and reëstablishes contact between contacts *c* and *c'*, and the lamp is ready to automatically start again. As the atmosphere within the ballast-chamber K is inert, the contacts need not be of platinum or other non-oxidizable metal, but may be of iron, nickel, brass, or other suitable material.

In Fig. 2 another method of securing the necessary movement of the circuit-interrupting arm is shown. As here shown the arm *b'* is a lever pivoted at *o*, and the tensions of the ballast *a a* and of the spring S' oppose each other, as before. An expansion of ballast *a a* results in a movement of arm *b'*, a separation of contacts *c* and *c'*, and interruption of the heater-circuit. In every case the motion of the circuit-breaker arm is limited by a stop, which may be a part of the frame F, as indicated at *f* in Figs. 1, 2, and 3, or in certain cases the containing-case itself. The stop is provided in order to relieve the wire *a a* of the tension of the spring *s* when the heater-circuit is interrupted, the strength of the wire being so small that any tension beyond that of its own weight is liable to stretch it permanently to such an extent as to prevent reëngagement of contacts *c* and *c'*. In practice the terminal-wire T^2 will usually extend loosely through the frame at *w* and be connected directly to one end of wire *a a*. This permits the contact at *c c'* to be adjusted after the insertion of the mechanism in the case K by heating the glass of the case adjacent to the terminal-wire T^2, pulling the wire *a a* taut and then allowing the glass to cool before releasing wire T^2.

In Fig. 3 a modification is shown which is designed to so operate as to open the heater-circuit when the glower-current is but a fraction of its normal strength. This arrangement embodies the principle illustrated in Fig. 1, but includes a second bending-wire *e e* between the insulating connecting-piece P and the frame F. In this modification two additional ballast-wires *a' a'* and *a'' a''* are connected in series with each other and with wire *a a*, though the wire *a'' a''* is not necessarily of such diameter as to take part in the steadying action. A slight expansion of wires *a a* and *a' a'* permits the part P to sink considerably, and this movement is imparted to the wire *e e*, which is electrically and mechanically connected to arm b^2 by a wire *e'*. The consequent movement of arm b^2 under the action of spring S' is considerably in excess of the amount of flexion of wire *a a*. The arm *x*, connecting wires *a' a'* and *a'' a''*, may be a rocker-arm pivotally mounted in the frame F to permit adjustment of the contacts *c c'* through terminal wire T^2, as described in connection with Fig. 2, and also to permit wire *a'' a''* to be made a part of the steadying resistance (instead of merely a return-conductor) and to participate in controlling the motion of the arm b^2.

In Fig. 4 I show a modification of my invention which departs from the idea of the direct use of the expansion and contraction of the ballast-wire to separate the circuit-breaker contacts. In this figure the arm b^3 instead of being mechanically moved by wire *a a* is composed of two metals of different expansion coefficients, as is common in thermostats. The arm is caused to bend, as shown by the dotted lines, by the heat of the steadying resistance *a a*, and thus to separate the contacts *c c'*, as before, I sometimes blacken the side of the thermostatic arm b^3 on the side adjacent the ballast-wire to increase its power of absorbing radiant heat, and in this way I render the operation of the cut-out more rapid.

In Fig. 5 I show an air thermostatic device consisting of a case K and an inner case *k*, having a narrow portion *k'* projecting into a depression k^2 in the larger case K, as shown. Covering the opening in the lower end of the part *k'* and filling the said depression k^2 in case K is a small quantity of mercury M, which is connected to the circuit by the conductor b^4, the separable contacts c^2 and c^3 being respectively the end of wire b^4 and the surface of the mercury M. When wire *a' a'* heats up, it warms and expands the air in case K, and the expansion of the air forces more mercury into the part *k'*, thus lowering the mercury in case K and separating the contacts c^2 and c^3. This modification is operative only in substantially the position shown; but the substitution of an aneroid barometer construction for the mercury would render it operative in all positions.

In Fig. 6 is shown a modification in which a body of mercury M' in a tube k^3 supports the movable member b^5 of the circuit-breaker. The heat generated by the current flowing through the wire *a a* is transmitted by the gas in the chamber K' to the mercury M', which is thereby expanded and separates the contact-points c^4 and c^5. I have now shown how the heat of the ballast-chamber may be utilized to effect the interruption of the heater-circuit by means of the expansion of solids, liquids, and gases. The ballast-wire, however, has not only a thermic action, but also a weak magnetic action, and the conditions within the ballast-chamber are so favorable to the use of extremely-delicate mechanism (due to the complete absence of the usual disturbing action of the oxygen of air and of dust-particles, rust, &c.) that the very delicate magnetic forces present may be rendered available. I have diagrammatically shown arrangements for accomplishing this in Figs. 7 and 7^a, 8 and 9.

In Figs. 7 and 7^a the ballast-wire a^2 a^2 makes one and one-half turns about the pivoted compass-needle b^6, having the contact *c*, which touches contact *c'*. Fig. 7^a shows a side view of the same. In action the current in wire a^2 a^2 moves the needle to the position indicated by the dotted lines in Fig. 7^a. This device can only be used in connection with direct currents. In Fig. 8 a new element is introduced, namely—a coil N within the ballast-chamber, in series with the ballast a^3 a^3 for operating the movable arm b^7, having the contact c. This introduces the undesirable element of a length of conductor having an appreciable resistance, which is, so to speak, "dead"—that is, it can take no part in actively steadying the glower-current, since its changes in resistance are too slight and too gradual to be useful. However, the amount of this dead wire may be made very small, as the movement of the arm b^7 may be made more delicate and easily affected than if it were free in air. The number of turns become so few, in fact, that they may be insulately embedded in a fireproof or heat-resisting substance and run very hot.

In Fig. 9 the coil N′ is placed outside the ballast-chamber, the moving arm b^8 and contacts c and c' remaining within. The upper end of the arm b^8 is provided with a magnetizable core b for the coil N′. This form requires an extra leading-in wire, which is marked T′, as it discharges a portion of the duties of terminal T′ in the foregoing drawings. The action of these devices is too obvious from the foregoing to require special explanation.

In Fig. 10 the case K is divided in two portions or subchambers k^4 and k^5 by a glass diaphragm L, similar in thickness and elasticity to a phonograph-diaphragm. The expansion of the gas in the ballast-subchamber k^5 operates the cut-out mechanism in the other subchamber by the movement of the diaphragm L and the multiplying action of the levers b^9 and b^{10}, which separate the contacts c and c', as required.

In Fig. 11 the subchambers of Fig. 10 become two distinct chambers k^6 and k^7, the interaction being brought about thermally instead of mechanically, as in the modification shown in Fig. 4. This device permits renewal of ballast and cut-out devices independently.

In Fig. 12 the subchambers of Fig. 10 not only become separate chambers k^8 and k^9, but the interaction between the chambers ceases, the cut-out arm b^{11} being moved by an actuating-coil N′ to separate the contacts c and c' and its chamber k^8 being filled with an inert gas.

It will be observed that the leading idea of placing the cut-out contacts out of the way of mechanical and chemical injury by inclosing them in a chamber filled with an inert gas (preferably hydrogen) is carried through all the devices and forms the main feature of the invention.

The subordinate idea of combining the cut-out and ballast in a single chamber is represented in all devices except those shown in Figs. 10, 11, and 12, that of Fig. 10 being a transition device representing diagrammatically the aneroid barometer construction referred to in connection with Fig. 5. In Figs. 11 and 12 the feature of separate chambers for the ballast and the cut-out is introduced. The subordinate idea of deriving the movement of the contact c from the action of the ballast is represented in all devices save those of Figs. 8, 9, and 12, where it is sacrificed to secure a more powerful action of the cut-out and in Fig. 12 to secure also separate chambers for the ballast and the cut-out. The arrangement shown in Fig. 12 alone permits the two devices to be indefinitely separated, which is in some cases desirable.

The subordinate idea of utilizing the expansion and contraction of the ballast-wire to move the cut-out arm is shown only in Figs. 1, 2, and 3; but its extreme cheapness of construction and rapidity of action render its use desirable in many cases.

In making my ballast and cut-out devices I have used generally an atmosphere of hydrogen, which is distinguished from other inert gases, such as nitrogen or ammonia, in a variety of ways—such, for example, as ease of preparation and purifaction, but principally by its enormously-superior heat conductivity. In a steadying resistance it is desirable that heat energy may be dissipated as rapidly as possible, so that a given current may be carried by a wire of the highest resistance per millimeter—in other words, smallest diameter, and consequently shortest length and mass possible.

Hydrogen under a pressure of but one-fifteenth atmosphere conducts heat much better than nitrogen under full atmospheric pressure.

Mixtures of hydrogen and nitrogen do not conduct heat essentially better than nitrogen unless but very small percentages of nitrogen be used. Owing to the explosibility of mixtures of hydrogen and ordinary air I sometimes reduce the pressure of hydrogen in my ballast-chambers to one-fifteenth atmospheric or lower. At such pressures no explosion can be produced by reason of the admission of air through a crack or opening in the inclosing-chamber, as the hydrogen is too dilute to burn explosively. Owing, however, to the better heat conductivity of hydrogen at full atmospheric pressure over that at one-fifteenth atmospheric, which amounts, roughly, to one and four-fifths times, I prefer to use full pressure where the ballast device or cut-out is so situated in a hood or elsewhere that an occasional explosion can do no harm. These features are in the nature of variations, and I do not bind myself to the use of any one gas or any particular pressure. In certain cases a vacuum may with advantage be substituted for the inert gas, a vacuum being merely an atmosphere under great rarefaction, but often having peculiar properties of electrical conduction which may or may not unfit it for use in my devices. I therefore include the case of a vacuum under the general head of inert gases, leaving the choice of gas and pressure to be decided by practical considerations.

I claim as my invention—

1. In an electric lamp of the type described, having a heater, a glower and a steadying resistance for the glower, a controller for the heater-circuit having separable contacts the relative positions of which are controlled by energy derived from the steadying resistance, and a sealed chamber in which said contacts are located.

2. An electric lamp of the class described consisting of a glower, a steadying resistance therefor inclosed in an inert gas, a heater, and a controlling device therefor having its contacts in an inert gas.

3. In an electric lamp of the class described having a glower, a heater and a steadying resistance for the glower, a controlling device for the heater-circuit the operation of which is dependent upon energy derived in whole or in part from the steadying resistance.

4. An electric lamp of the class described consisting of a glower, a ballast therefor located in a sealed chamber, a heater, and a controlling device therefor having its contacts within the said sealed chamber.

5. In an electric lamp, a ballast-chamber containing an inert gas, a steadying resistance and a heater cut-out located within said chamber, and circuits leading from the inclosed devices to a heater and a glower located outside the chamber.

6. In an electric lamp, a sealed chamber containing an inert gas, a steadying resistance within said chamber, a heater-controlling device also within said chamber and operated by energy derived from the said steadying resistance, and conductors leading from the inclosed devices to a heater and a glower located outside the chamber.

7. In an electric lamp, the combination of a glower, a heater, a steadying resistance in series with said glower and a thermostatic cut-out having circuit-interrupting contacts in series with said heater and operated through the action of heat generated in said steadying resistance.

8. The combination, in an electric lamp, of a steadying resistance for the glower and a thermostatic cut-out for the heater both inclosed within a single chamber containing an inert gas.

9. In an electric lamp of the type described having a glower, a heater and a ballast-wire for the glower, a controller for the heater-circuit comprising a movable arm actuated in whole or in part by energy derived from the ballast-wire and a stop for limiting the movement of the arm in the open-circuit direction.

10. In an electric lamp having a glower which requires the application of heat to render it conductive, the combination with such glower, of a heater in proximity thereto, a current-restraining device in series with the glower, a making and breaking device for the heater-circuit, and an inclosing-chamber for said current-restraining and circuit making and breaking device containing hydrogen.

11. In an electric lamp of the type described, the combination with the glower and a current-restraining device in series therewith, of a heater in proximity to the glower, a thermostatic interrupter for the heater-circuit and an inclosing-chamber for said current-restraining device and said interrupter containing an inert gas such as hydrogen.

12. A "ballast cut-out" for heaters of lamps of the class described comprising a conductor attached to a support at each end, a flexible wire attached to an intermediate point in said conductor at one end and at the other end to an intermediate point in a second conductor similar to the first, a second flexible wire attached to an intermediate point in the first flexible wire at one end and at the other to a stationary support, and a contact-arm controlled by the movements of the second flexible wire and carrying a contact which coacts with a stationary contact, substantially as described.

13. In an electric lamp of the type described, the combination with a glower and a heater, of a ballast-wire comprising a plurality of sections, a rocker-arm connecting corresponding ends of a plurality of said sections and a movable cut-out member connected to one of said sections.

14. In a ballast-cut-out device for heaters of electric lamps controlled by the expansion of a ballast-wire in an inclosing chamber, the combination with said wire, of a terminal therefor passing through the wall of the inclosing chamber, whereby the tension of the said inclosed wire may be regulated from without the chamber, substantially as described.

15. In an electric lamp of the type described, the combination with the glower, of a ballast-conductor in series therewith, a heating-conductor for imparting the initial temperature to the glower, and a cut-out for the heater controlled by the expansion and contraction of the ballast-conductor.

In witness whereof I have hereunto signed my name, this 5th day of August, 1899, in the presence of two subscribing witnesses.

HENRY NOEL POTTER.

Witnesses:

HENRY HASPER,

WOLDEMAR HAUPT.