

March 6, 1928.

1,661,579

E. H. ROLLINSON

BULB RECTIFIER

Filed July 28, 1922

2 Sheets-Sheet 1

Fig. 1.

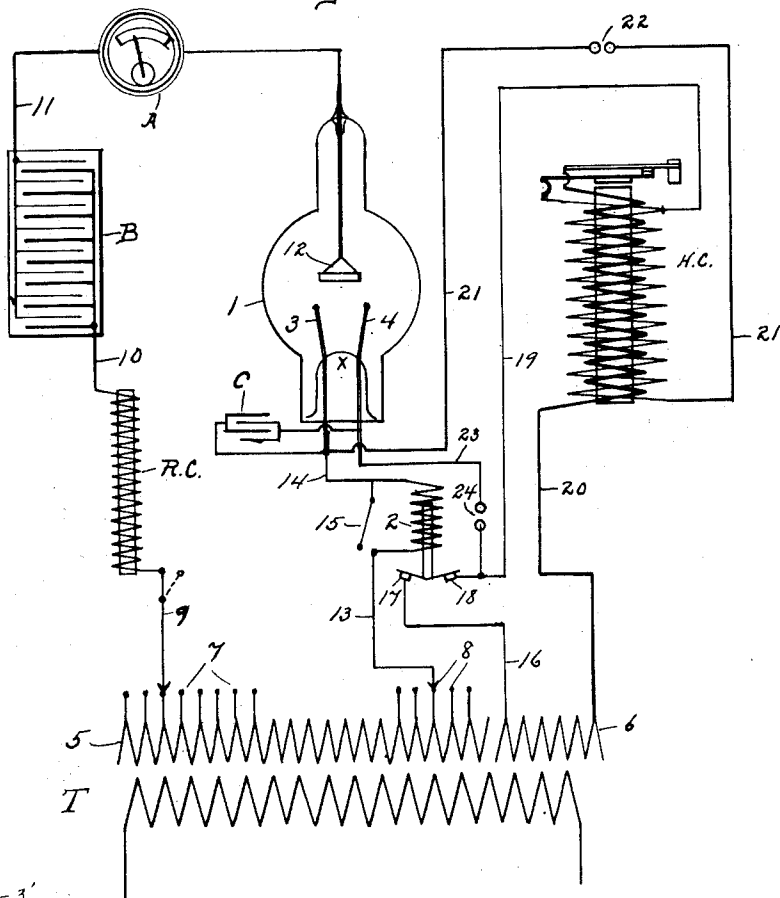
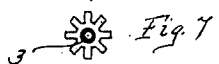
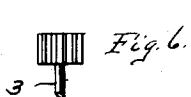
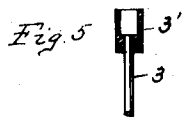


Fig. 4. (3')



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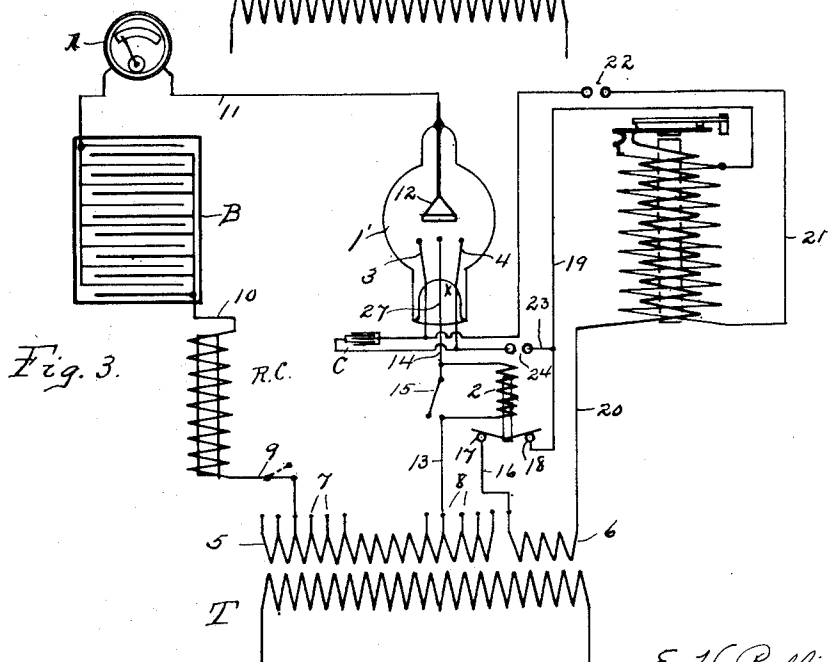
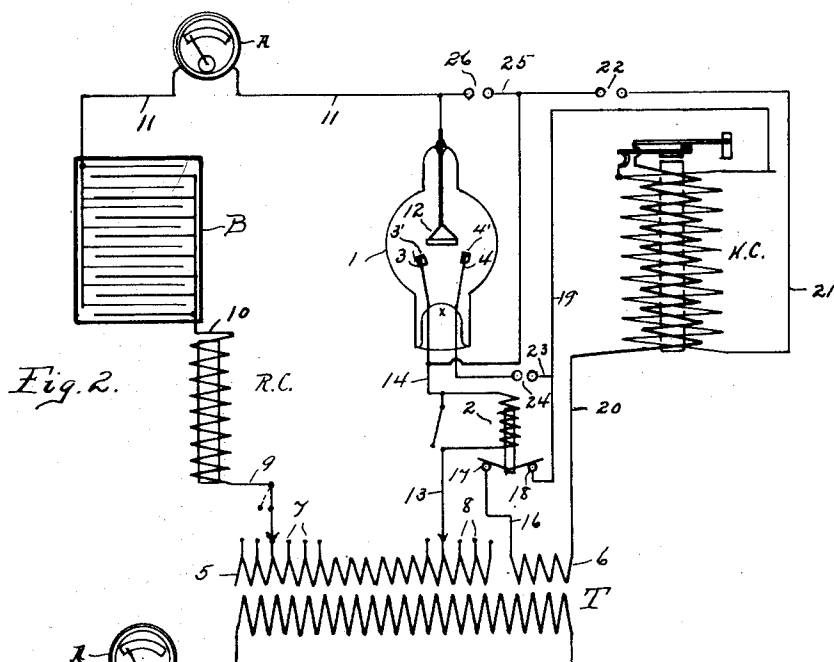
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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BULB RECTIFIER.

Application filed July 28, 1922. Serial No. 578,131.

In my prior application, Serial No. 461,-
886, now Patent 1,591,185, filed April 16,
1921, I have described an improved arc
rectifier with a rectifier bulb, wherein the
5 cathode is formed from a closely coiled
filament of tungsten, from which various
leads are described as carrying A. C. to be
rectified. The bulb is exhausted of air and
usually filled with some gas of the argon
10 group. In the development and use of the
rectifier described in said application, the
tungsten filament has frequently burned
out. In experimenting with bulbs of this
type, I have discovered that the tungsten
15 filament is not essential to the working of
the rectifier; indeed I am able to operate the
bulb after the filament has been completely
ruptured equally as well as when the fila-
ment is intact. I am therefore able to use
20 bulbs in which the filament has broken down
by the system which I will fully describe
in the following specification.

The object of my invention, therefore, is
to construct a rectifier system wherein the
25 cathode rods are unconnected and a high
potential spark between them serves as the
initial ionizing agent, and thereafter the
operation of the system continues either with
or without the high potential spark.

30 A further object of my invention is to
utilize exhausted rectifier bulbs, i. e. bulbs
in which the tungsten filament is ruptured,
which under the system which I have de-
vised, last almost indefinitely, and when the
35 cathode rods have been burned down to mere
stubs, they may be readily renewed by open-
ing up the bulb. Since the ionizing of the
gas within the bulb is produced by the spark
between the cathode rods, I prefer to protect
40 them by covering their free ends with small
carbon caps which have sufficient area to dis-
sipate any destructive heat which may de-
velop from the spark. A further object of
my invention is to construct new bulbs with
45 a supplemental or service cathode and uti-
lize, what has been hitherto considered the
service cathode rods merely, as a heating
device, to start the rectification.

In the accompanying drawings illustrat-
50 ing my improved arc rectifier,

Fig. 1 illustrates the diagrammatic ar-
rangement of the system, showing the usual
bulb with the tungsten filament omitted.

Fig. 2 illustrates a modified form of bulb
55 and a slightly modified wiring diagram.

Fig. 3 illustrates a still further slightly
modified wiring diagram.

Figs. 4 and 5 illustrate in plan and sec-
tion respectively, the carbon cathode cap.

Figs. 6 and 7 illustrate a slight modifica- 60
tion of the same.

Similar reference numerals refer to like
parts throughout the specification and draw-
ing.

As set forth in my above named prior ap- 65
plication, the life of the rectifier bulb above,
using the tungsten filament had theretofore
been limited to about 800 hours, but with
the improvements set forth in the said ap-
plication, the life of the bulb is lengthened 70
to about 1200 hours and in some cases con-
siderably longer. By the improvements of
my present invention, I am able to prolong
the life of the bulb almost indefinitely, by
reason of the fact that the perishable part 75
or element which has hitherto been con-
sidered as necessary to the rectification of
A. C. is omitted and the system of wiring
slightly modified to correspond; also a high
80 frequency spark coil is introduced into the
wiring system for the purpose of starting
its operation.

In Fig. 1, the transformer T, rectifier
bulb 1, high frequency coil H. C., reactance
coil R. C., storage battery B, ammeter A, 85
and solenoid circuit breaker 2 are of the
usual type with the exception that in the
bulb 1, the usual tungsten filament connect-
ing the cathode leads 3, 4 is omitted and
carbon caps 3', 4' are mounted thereon. The 90
leads 3, 4 together constitute a cathode ele-
ment which is introduced into the tube by
a re-entrant stem α , in which they are sealed
in substantially parallel alignment with
each other. Because of this parallel mount- 95
ing, the spark distance between the leads re-
mains approximately constant in length, as
they burn down in use. The bulb may be
originally constructed without the filament,
or bulbs in which such filament has broken 100
down and which have hitherto been dis-
carded as useless may be used. The trans-
former T has the usual secondary 5 and a
tertiary winding 6; the first being provided
with a number of taps 7, 8 at each end for 105
current regulation, while the tertiary 6 is
of small capacity usually about 10 volts,
and is utilized only as a starting means.

The wiring diagram may be described as
follows: Starting from one of the taps 7. 110

the wire 9 leads to the reactance coil R. C., thence wire 10 leads to a terminal of the battery B, from the other terminal of which the wire 11 leads through the ammeter A to the bulb anode 12. From one of the taps 8 at the other end of the secondary 5, the wire 13 leads to the coil of the circuit breaker 2, from which the wire 14 leads to the cathode lead 3. If desired a small switch 15 may be located between the wires 13 and 14 in order to short circuit the circuit breaker 2. The carbon caps 3', 4' are mounted upon the free ends of the cathode rods 3, 4 and by their large surface, serve to dissipate any destructive heat which might develop in the rods due to the spark.

The diagram for the starting or high frequency coil may be described as follows:—

The wire 16 leads from one end of the tertiary winding 6 to one of the contacts 17 of the circuit breaker 2; from the other contact 18 of which the wire 19 leads to and is connected with the armature side of the high frequency coil H. C., from the primary of which the wire 20 leads back to the other end of the transformer tertiary winding 6. The secondary of the high frequency coil H. C. is connected by the wire 21 through the spark gap 22 to the cathode lead 3, and the wire 23 connects the other cathode lead 4 through a spark gap 24 with the wire 19.

A comparison of the diagram shown in Fig. 2 will show that it is identical in all respects with that shown in Fig. 1 with the single exception that the wire 25 connects the wires 11 and 21, through the spark gap 26; the diagram shown in Fig. 3 is identical in all respects with Fig. 1 except that the cathode rods 3, 4 are connected solely into the secondary circuit of the high tension coil, H. C. while a main cathode 27 is located directly between the rods or leads 3, 4 and connected by wire 14 with the coil of the circuit breaker 2. This amounts structurally, only to the dividing of the cathode lead 3 into two elements one of which is connected to the transformer secondary and the other to the high frequency coil secondary whereas in the other diagrams both of those secondaries are connected to a single cathode lead.

The operation of the device is as follows:

Upon closing the primary of the transformer T into the main or supply circuit, the high frequency coil H. C. is immediately supplied with current coming from the tertiary winding 6. The current therefrom taking the following path: by way of the wire 21, spark gap 22, cathode rod 3 across the cathode rod 4, thence by wire 23, spark gap 24 and wire 19 back to the high frequency coil secondary. The high potential thus produced in the high frequency coil, will produce sparking at the gaps 22 and 24 and between the cathode rods 3 and 4, which

latter will result in ionizing the gas within the bulb 1. It may be stated at this point that the gaps 22 and 24 not only intensify the ionizing spark between the cathode rods 3 and 4, but serve also to insulate the high frequency coil H. C. from the transformer secondary 5. A peculiar phenomenon develops as the spark is produced across the gap between the cathode rods 3 and 4. The spark first appears at the base of said leads, that is, at the points where they emerge from the glass support X, and when potential is supplied between the anode 12 and the rods 3 or 4, the spark creeps up to the free ends of said rods where it remains. The spark thus produced, between the cathode leads or rods 3 and 4, ionizes the inert gas within the bulb and immediately electrons begin to flow across between the anode 12 and the cathode 3, thereby establishing the rectifying circuit through the battery B by way of the wires 9, 10, 11, 13 and 14. Thereafter the rectification proceeds continuously until the battery B is charged.

It should be noted that the rectifying circuit just described, includes the small circuit breaker 2; immediately upon the starting of the rectifying current, this circuit breaker is opened at the points 17, 18, thereby cutting out the high frequency coil H. C. It may be thought, at first glance, that the opening of this circuit, eliminating as it does the spark between the points of the cathode rods 3 and 4 would immediately stop the operation of the rectifying circuit. Such, however, is not the case for it is only necessary to start the rectification by producing the spark across the cathode leads 3 and 4, whereupon the point of the cathode rod 3 is heated, by the bombardment of the electrons flowing, and the rectifying current, whereby the gas within the bulb becomes ionized; thereafter this bombardment of electrons between the point of the rod 3 and the anode 12 will be sufficient to maintain the ionizing effect which is all that is necessary for continuous rectification.

If, for any reason, the rectifying current to the battery B should cease temporarily as by the opening of the circuit, the solenoid circuit breaker 2 would be immediately deenergized, its core would drop, and the high frequency coil primary would at once be thrown into circuit with the tertiary winding 6, when of course, the spark between cathode rods 3 and 4 would again be produced and rectification would again start upon the reclosing of the open circuit. This renders the device automatic and self-starting so long as the supply circuit through the primary of the transformer T is closed.

It is not essential that the high frequency coil H. C. be cut out of operation by the circuit breaker 2, since rectification would proceed just the same if said circuit breaker

were omitted from the system and the wires 16 and 19 directly connected. I may accomplish such a result by closing the switch 15, thereby short circuiting the circuit breaker 2.

It will be noted that the diagram shown in Fig. 2 is identical with that shown in Fig. 1 in all of its parts, with the single exception that the wire 25 connects the wires 21 and 11 with the spark gap 26 interposed therein. By this slight modification, I am able to produce ionization between the anode 12 and cathode 3 as well as between the cathode rods 3 and 4.

With the rectifier as thus far described, I am able to use exhausted bulbs in which the usual tungsten filament has broken down in use, inasmuch as I produce the ionizing effect not by heat generated in any such filament or even in the cathode rods, but by the spark produced between the cathode rods. In this manner, ionization is only initiated by the spark produced between said rods, but such ionization is maintained by the arc produced between the cathode 3 and anode 12, and this whether or not the spark between the cathode rods 3 and 4 is maintained. The means described effectively produces the spark between the cathode rods and after ionization begins, the maintenance of said spark is no longer essential. Since the ionization is continued by the arc spanning the gap between the anode 12 and the cathode rod 3, this feature naturally leads to the development of the form of bulb illustrated in Fig. 3. Here, the two rods 3 and 4 are connected up in circuit with the secondary of the high frequency coil and the spark is produced between said rods in the manner as above described. Interposed between the two rods 3 and 4, is the service cathode rod 27, which is connected up by the wire 14 in exactly the same manner as above described in connection with Figs. 1 and 2. The point of this cathode rod 27 is located directly in the path of the spark between the points of the rods 3 and 4 and when potential is applied between the anode 12 and cathode rod 27, the

ionization produced causes current to flow to the service cathode rod 27, whereas, in Figs. 1 and 2 the rod 3 serves the double purpose, that is to say, as a cathode rod and also as a spark gap terminal. After rectification begins, the operation will be continuous, whether the high frequency coil H. C. is kept in circuit by closing the switch 15 or automatically cut out by the opening of said switch. In order to still further intensify the spark between the rods 3 and 4, I may insert a condenser C across the terminals of said cathode rods as shown in Figs. 1 and 3.

While it has been the custom to fill glass rectifier bulbs with argon gas, yet I find that any of the inert gases such as neon gas or nitrogen gas will serve the purpose equally well.

In connection with Fig. 2, I have described the wire 21 and the wire 11 as spanned by the wire 25 and spark gap 26. With this form, a spark may be produced between the anode 12 and the electrode 4, as the initial ionizing agent.

The cathode caps 3' and 4' shown in Figs. 4 to 7 which are mounted upon the free ends of the cathode rods 3, 4 are made of carbon and as above indicated they serve to dissipate the heat due to the arc between said cathodes and the anode 12. They also enable me to utilize other materials for cathode rods than the usual tungsten, as for example, molybdenum, tantalum, or some of the other less refractory of the metals. In Figs. 4 and 5, I have shown the caps as of a cup shape, while in Figs. 6 and 7 they are shown as fluted resembling a small pinion. The form or shape however, is quite immaterial so long as a suitable radiating surface is afforded.

I claim:

A thermionic rectifier comprising a tube provided with a re-entrant stem, an anode and a cathode element, the latter comprising spaced, substantially parallel conductors mounted on said stem and designed to establish an exciting arc from one to the other.

EARL H. ROLLINSON.