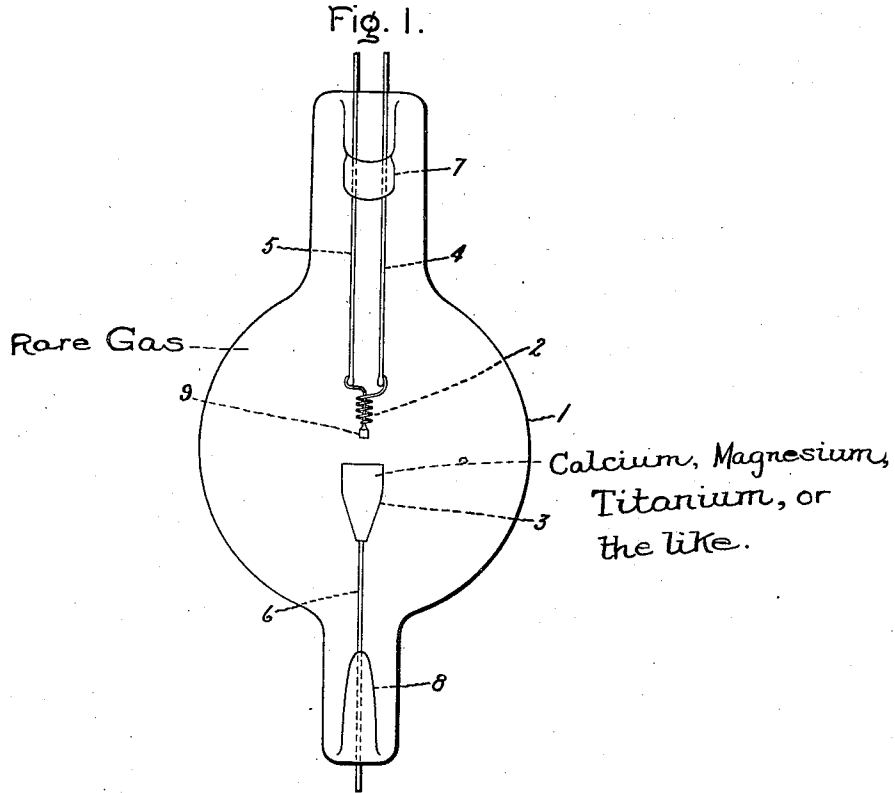
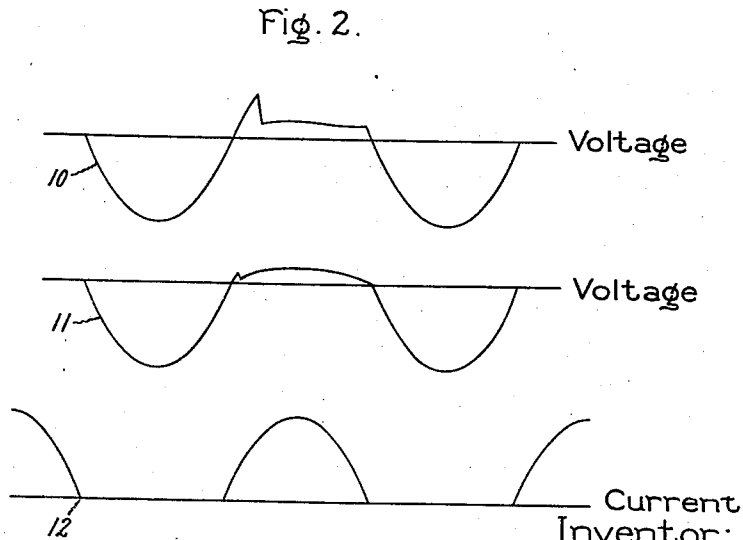


J. H. CLOUGH.
 INCLOSED ARC DEVICE.
 APPLICATION FILED OCT. 30, 1915.

1,246,054.

Patented Nov. 13, 1917.



Inventor:
 John H. Clough,
 by *Alfred J. Daniels*
 His Attorney.

UNITED STATES PATENT OFFICE.

JOHN H. CLOUGH, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INCLOSED-ARC DEVICE.

1,246,054.

Specification of Letters Patent.

Patented Nov. 13, 1917.

Application filed October 30, 1915. Serial No. 58,902.

To all whom it may concern:

Be it known that I, JOHN H. CLOUGH, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Inclosed-Arc Devices, of which the following is a specification.

The present invention relates to inclosed arc devices having a cathode consisting of highly refractory material, operating at incandescence in a gaseous atmosphere.

Formerly in arc devices of this type the anode has been constituted of either a refractory material, such, for example, as tungsten, carbon, tantalum or the like, or of mercury.

I have discovered that when the anode is constituted in part or entirely of a highly chemically reactive metal such, for example, as calcium, magnesium or titanium, the gaseous atmosphere surrounding the arc consists of a monatomic gas such as argon, neon, xenon, krypton, helium or the like, that a voltage drop in the arc of a hitherto unattainable low value is obtained.

My improvement will be more fully understood and appreciated by reference to the following description of several specific embodiments of my invention.

In connection with this description I have shown diagrammatically in Figure 1 of the accompanying drawing an incandescent cathode rectifier, as illustrating one form of apparatus to which my invention is applicable, and Fig. 2 illustrates by curves the improvement in the voltage characteristic on an arc in a device embodying my invention.

The device comprises an envelop 1 consisting of glass, such as low expansion or sodium-magnesium boro-silicate glass. The cathode 2 consists of highly refractory material, such for example, as tungsten, tantalum, carbon or the like.

The anode 3 comprises metallic calcium, magnesium, titanium or other metal highly reactive chemically to gases other than the inert so-called rare or monatomic gases. The cathode current supply wires 4, 5 and the anode conductor 6 are sealed into the stems 7, 8 in the usual manner. The cathode is preferably provided with a tip 9 having a somewhat greater diameter than

the adjoining sections as described and claimed in a co-pending application filed on September 20, 1915, by Charles V. Ferguson, Serial No. 51,661.

The globe is first evacuated and then filled with a monatomic gas at considerable pressure. The action of the anode material makes it unnecessary to use such great care in exhaust as has been necessary formerly. The pressure will vary with the nature of the device and the service required of it. I may say that it should be above a pressure of several millimeters of mercury and will more usually approach the order of magnitude of atmospheric pressure.

When arc devices such as described above are operated in series with an external resistance or load, part of the impressed voltage is consumed in the arc itself, known ordinarily as the arc drop. This voltage drop is in the neighborhood of about twenty volts in a device such as described above when the anode or anodes consist of a metal such, for example, as tungsten, which is not highly chemically reactive with respect to impurities in the atmosphere of inert gas. In a device provided in accordance with my invention with an anode consisting wholly or in part of calcium or other highly chemically active metal, the arc voltage drop is as low as about four to five volts.

In the former type of device at the beginning of the half wave of current which is negative with respect to the cathode, the voltage must rise to a value about double or more the value required to maintain the arc before the arc will start and current begin to be transmitted. As soon as the arc starts the voltage quickly drops to a lower value and then remains nearly steady until near the end of the half wave when the arc again goes out as the voltage approaches the zero value. This condition is illustrated in the curve 10, Fig. 2. In my improved device the voltage at the beginning of the wave during which the arc is operating does not rise to a value higher than the operating voltage of the arc. This result as far as I am aware is entirely new. As illustrated by the curve 11, the voltage wave rises from zero to a value high enough to operate an arc, then as the arc starts the voltage drops to a slightly lower value for an instant and again rises to approximately the value at

which the arc started and after rising slightly falls to zero while the current as shown in curve 12 rises from zero to a maximum value and falls again to zero.

5 The high initial voltage peak observable in curve 10 is lacking.

The improvement effected by my invention may be illustrated by the following specific example. Argon was introduced
10 into a device, such as above described, at a pressure of about 5 to 12 c. m. of mercury. An eight ampere arc was produced in the device with the cathode at bright incandescence having an arc voltage drop of 10.4
15 volts. After three hours with a calcium anode the voltage drop had decreased to 7.8 volts. With a twenty ampere arc an initial arc drop of 6.9 volts was observed which in three hours of operation had decreased
20 to 4.5 volts. In a neon atmosphere of about $\frac{1}{4}$ atmospheric pressure, purified by the usual chemical methods, a ten ampere arc was found initially to have a voltage drop of about 58 volts. The chemical effect of
25 a calcium anode reduced the voltage drop to about 12.5 volts in about forty minutes.

Another advantage gained by the use of electrodes of highly reactive metal is the remarkably low voltage required to start the
30 arc. For example, a fifteen ampere arc may be started with a potential as low as 14 volts with the cathode at a temperature of 2500° C.

What I claim as new and desire to secure by Letters Patent of the United States, is:— 35

1. The combination of a sealed envelop, a cathode of highly refractory material proportioned to operate at incandescence, an anode consisting in part at least of highly chemically active metal and a filling of rare
40 gas having a pressure high enough to substantially prevent electrical disintegration of said cathode by an arc.

2. The combination of a sealed envelop, an incandescent cathode, an anode consisting of alkaline earth metal, and a filling of argon at a pressure exceeding several millimeters of mercury. 45

3. The combination of a sealed envelop, an incandescent cathode, an anode consisting of calcium, and a filling of argon. 50

4. The combination of a sealed envelop, a cathode of tungsten proportioned to operate at incandescence, an anode formed in part at least of metallic calcium and a filling
55 of gas of the argon group at a pressure exceeding several millimeters of mercury.

5. The combination of a sealed envelop, a cathode of tungsten proportioned to operate at incandescence, an anode consisting in
60 part at least of a highly chemically active metal and a filling of argon gas at a pressure of about 5 to 12 centimeters of mercury.

In witness whereof, I have hereunto set my hand this 29th day of October, 1915. 65

JOHN H. CLOUGH.