UNITARY MULTIPLE SPARK-GAP DEVICE

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

INVENTORS
E.G.F. ARNOTT
C.E. DAWLEY.

ATTORNEY
UNITED STATES PATENT OFFICE

2,456,855

UNITARY MULTIPLE SPARK-GAP DEVICE

Edward G. F. Arnott, Upper Montclair, and Clara-
ence E. Dawley, Bloomfield, N. J., assignors to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

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6 Claims. (Cl. 315—220)

1. The present invention relates to spark-gap de-
vices and more particularly to such devices
which are operable at high voltage for the pulsing
of electrical energy.

Devices of this type are now commonly em-
ployed for controlling the current in radar mod-
lator circuits and have heretofore required from
two or three or more such spark-gaps in series.
This has necessitated the occupation of consider-
ably more space than desired, thus increasing the
total size and weight of the complete equipment.

It is accordingly an object of the present inven-
tion to provide a single spark-gap device having
a plurality of electrodes and which operates in
such manner that a plurality of spark-gap de-
vices connected in series is eliminated.

Another object of the present invention is the
provision of a unitary spark-gap device provided
with a plurality of electrodes between which two
or more are discharges occur in series, thus elimi-
inating the necessity for the employment of a
plurality of individual spark-gaps in a modulator
circuit.

A further object of the present invention is the
provision of a unitary spark-gap device which
will replace a plurality of individual spark-gap
devices connected in series.

Still further objects of the present invention
will become obvious to those skilled in the art by
reference to the accompanying drawing wherein:
Figure 1 is a sectional view of a multiple spark-
gap device constructed in accordance with the
present invention;

Figure 2 is a sectional view on the line
II—II of Fig. 1;

Figure 3 is a sectional view of a slight modifi-
cation which the spark-gap device of the present
invention may take;

Figure 4 is a schematic diagram showing the
connections to the various electrodes of the struc-
ture of Fig. 1 so that the unitary gap operates to
eliminate the necessity for a plurality of series
connected spark-gaps.

Referring now to the drawing in detail, the
spark-gap device as shown in Fig. 1 comprises
an envelope shown generally at 5 provided with
a plurality of electrodes therein. For example,
one such electrode 6 is formed as a cylinder of
suitable metal, such as aluminum or the like,
surrounded by a collar 7, formed of suitable metal
having a coefficient of expansion similar to that
of glass, such as the alloy known to the art as
“Kovar” and soldered or welded to the cylindrical
electrode 6. As shown, this collar 7 is slightly
less in cross-section than that of the cylindrical
electrode 6, and the ends of this collar forms an
hermetic seal with a vitreous sleeve 8, while the
other end of the collar is similarly sealed to a
further vitreous sleeve 8. The vitreous sleeve 8
is in turn hermetically sealed to an annular
“Kovar” collar 16 provided with a flanged por-
tion 12 of slightly reduced diameter to which a
cylindrical metallic electrode 13 of aluminum or
the like is rigidly secured in any suitable manner,
such as by soldering, welding or the like.

A header member 14 is also similarly secured to the
interior surface of the flanged portion 12, which
thus forms a closure for this end of the device
and an exhaust tubing 15 is provided in the
header member 14 for the purpose of evacuating
the device and filling with the desired gas, such
as a mixture of 80% hydrogen and 20% argon at
substantially atmospheric pressure.

The vitreous sleeve 8 is likewise hermetically
sealed to an annular “Kovar” collar 16 having a
flanged portion 17, the latter of which is of slightly
less diameter than the flanged portion 12 of the
collar 16, with this collar 16 likewise rigidly sup-
porting a cylindrical metallic electrode 18, of
aluminum or the like, in the same manner that
the collar 16 supports the electrode 13. The
peripheral surface of the collar 16 is in turn
hermetically sealed to a vitreous insulating sleeve
19 with such sleeve being closed at its other end
by a “Kovar” cup or the like 20, which thus also
closes the end of the hermetically sealed device 5.

An anode electrode 22 formed of steel rod or
the like, which for all intents and purposes may
also be considered as “cylindrical” is welded,
brazed, or soldered to the “Kovar” cup 20. The
structure of this anode electrode 22 is shown and
described in our previously issued Patent No.
2,411,241, granted November 19, 1946, and further
detailed description herein is believed unnecessary
except to state that because of its configuration
the potential gradient at the anode is more uni-
formly distributed over the anode surface, thus
eliminating concentration of the arc discharge
during operation of the device.

By reference now to Fig. 4 the manner in which
a potential is supplied to the device of Fig. 1 is
therein shown and which eliminates the necessity
for employing a plurality of individual spark-gap
devices. The spacing between the various elec-
trodes is such that the same definite minimum
voltage is required to break down the gap between
each pair. For example, assuming a potential of
12 kilovolts is applied from a suitable source L1
to L2 between the electrodes 6 and 22, and such
potential is divided in any suitable manner, with
4 kv. being impressed across the electrodes 22 and 18, 4 kv. between the electrodes 18 and 13, and 4 kv. between the electrodes 13 and 6, as shown in Fig. 4. These kilovoltages are arbitrary figures selected solely for illustrative purposes and may be varied to suit conditions by altering the electrode spacings. In the example shown, the kilovoltage applied is insufficient to break down any one of the gaps which may require say a minimum of 6 kv. If now a triggering voltage of more than 4 kv. is applied from a separate triggering source of opposite sign to that of L, as indicated by the legend (the opposite side of the trigger source being grounded and hence connected to electrode 22), at the electrode 18, this voltage is added to the 4 kv. already across the upper two gaps and is sufficient to break them down with an attendant discharge between the electrodes 18—13 and 13—6. The electrode 18 then immediately assumes the same potential as that of the electrode 6 with respect to the electrode 22 giving 12 kv. thereacross causing substantially simultaneous breakdown of the gap between the electrodes 18 and 22 and a discharge thereacross.

Accordingly by triggering the upper gaps in the series between the electrodes 18—13 and 13—6, the entire device breaks down almost instantaneously by the occurrence of an arc discharge across the gap between each pair of electrodes, thus enabling the unitary device to supply a current therethrough to a load from the electrode 6 to the opposite end electrode 22 of the series.

In Fig. 3 a structure is shown which is identical to the spark-gap device as shown in Figs. 1, 2 and 4, except that it provides only two gaps instead of three as in these latter figures. To this end the electrode 6 is entirely dispensed with and the vitreous sleeves 5 and 8 are formed into a single sleeve 23 but in all other respects the structure of Fig. 3 is identical to that described relative to Fig. 1 and operates in the same manner.

From the foregoing it is believed to be obvious to one skilled in the art that a unitary spark-gap device is herein provided which eliminates the necessity for a plurality of series connected individual devices as formerly required, with material reduction in the space and weight of the equipment with such devices are employed. Moreover, since the electrodes are concentrically disposed with respect to each other and the cathode electrodes being of cylindrical configuration provide ample surface area for the accumulation of sputtered material thereon without materially affecting the electrode spacing and hence the breakdown voltage of the device during its entire useful life. In addition, the employment of "Kovar" cups of relatively large diameter allows the device to be readily assembled and the parts to be accurately aligned and sealed in the manner shown and claimed in the pending application of Ward W. Watrous, Jr., Serial No. 521,807, filed February 10, 1944, issued June 17, 1947, as U. S. Patent No. 2,422,324, and assigned to the same assignee as the present invention.

Although several embodiments of the present invention have been herein shown and described, it is to be understood that still further modifications of the device may be made without departing from the spirit and scope of the appended claims.

We claim:
1. A unitary high voltage spark-gap device for supporting a plurality of high voltage arc discharges in series relationship comprising a sealed envelope provided with an ionizable gas therein at relatively high pressure, and a plurality of concentrically disposed metallic electrodes in said envelope having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths to cause the arc initiating voltage between adjacent electrodes to remain uniform throughout the useful life of said device.
2. A unitary high voltage spark-gap device for supporting a plurality of high voltage arc discharges in series relationship comprising a sealed envelope provided with an ionizable gas therein at substantially atmospheric pressure, a metallic rod-like electrode disposed coaxially with respect to the longitudinal axis of said device, a plurality of cylindrical metallic electrodes concentrically and telescopically disposed relative to each other and to said rod-like metallic electrode with said electrodes having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths to cause the arc initiating voltage between adjacent electrodes to remain uniform throughout the useful life of said device.
3. A unitary high voltage spark-gap device for supporting a plurality of arc discharges in series relationship comprising a sealed envelope, a plurality of concentrically disposed metallic electrodes in said envelope having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths, an ionizable gas at relatively high pressure in said envelope, means for applying a potential between each pair of electrodes of insufficient magnitude to cause a discharge therebetween, and means for applying a supplemental potential between one pair of electrodes of sufficient magnitude to cause an arc discharge with an attendant substantially simultaneous series of arc discharges of uniform voltage between the remaining adjacent electrodes of said device.
4. A unitary high voltage spark-gap device for supporting a rod-like plurality of high voltage arc discharges in series relationship comprising a sealed envelope provided with an ionizable gas therein at relatively high pressure, a rod-like metallic electrode coaxially disposed with respect to the longitudinal axis of said device, a plurality of cylindrical metallic electrodes concentrically and telescopically disposed relative to each other and to said rod-like metallic electrode with said electrodes having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths, means for applying a potential between each pair of electrodes of insufficient magnitude to cause a discharge therebetween, and means for applying a supplemental potential between one pair of electrodes of sufficient magnitude to cause an arc discharge with an attendant substantially simultaneous series of arc discharge between the remaining electrodes of said device.
5. A unitary high voltage spark-gap device for supporting a plurality of high voltage arc discharges in series relationship comprising a sealed envelope provided with an ionizable gas therein at substantially atmospheric pressure, a rod-like metallic electrode coaxially disposed with respect to the longitudinal axis of said device, a plurality of cylindrical metallic electrodes concentrically and telescopically disposed relative to each other and to said rod-like metallic electrode with said
electrodes having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths to cause a uniform voltage drop between the latter, and a support for each of said electrodes and forming an hermetic seal with said envelope.

6. A unitary high voltage spark-gap device for supporting a plurality of high voltage arc discharges in series relationship comprising a sealed envelope formed in part of vitreous material and provided with an ionizable gas therein at relatively high pressure, a rod-like metallic electrode coaxially disposed with respect to the longitudinal axis of said device, a plurality of cylindrical metallic electrodes concentrically and telescopically disposed relative to each other and to said rod-like metallic electrode with said electrodes having their parallel adjacent surfaces spaced equi-distant from each other throughout substantially their entire respective lengths to cause a uniform voltage drop between the latter, and a metallic support for each of said electrodes having a coefficient of expansion simulating that of the vitreous part of said envelope and forming an hermetic seal therewith.

EDWARD G. F. ARNOTT.
CLARENCE B. DAWLEY.

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