

April 6, 1954

D. E. WILLIAMSON

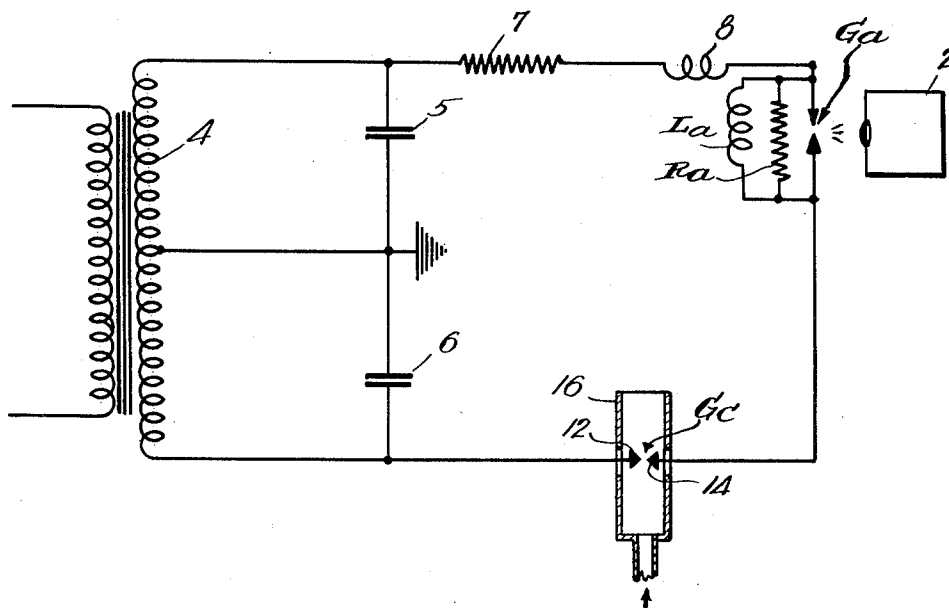
2,674,703

GAP CONTROL MEANS

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2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

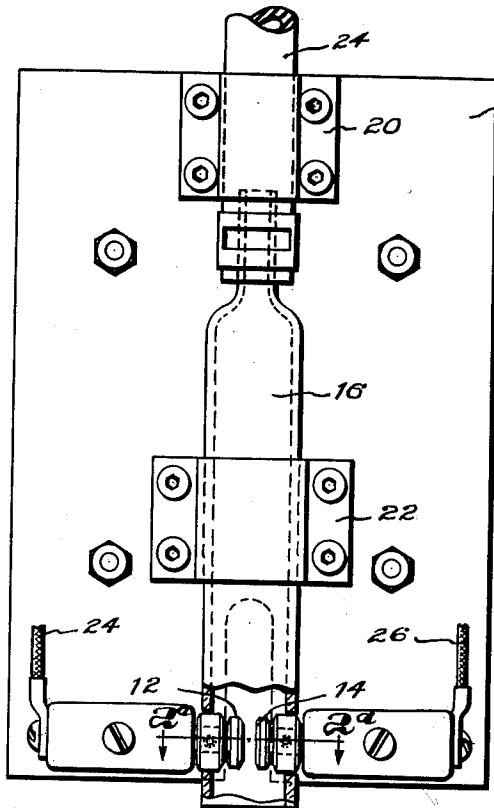


Fig. 4.

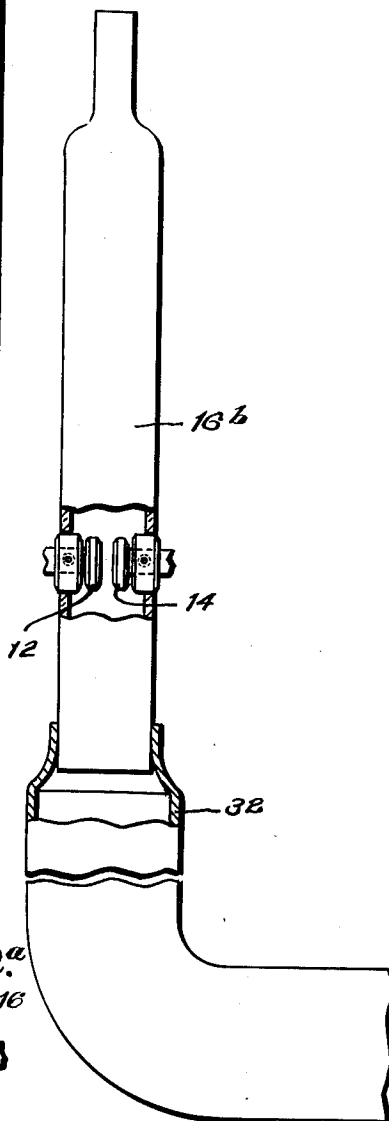


Fig. 3.

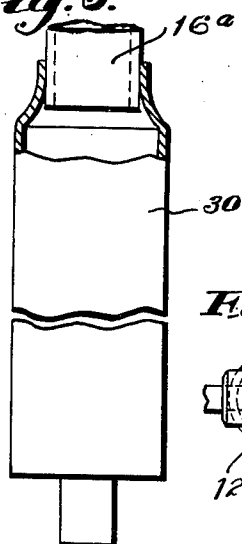
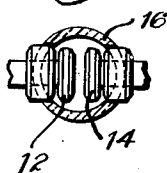


Fig. 2a.



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UNITED STATES PATENT OFFICE

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GAP CONTROL MEANS

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2 Claims. (Cl. 313—231)

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This invention relates to an auxiliary spark gap construction of the type commonly employed in conjunction with an analytical spark gap in optical instruments for spectro-chemical analyses, as illustrative of which there may be cited instruments such as a spectrometer, a spectrograph, or a direct reading spectrometer, and the like.

In electrical devices of this general class there arises the possibility of ionized particles, resulting from operation of the auxiliary spark gap, collecting on the electrodes with a strong tendency for the particles to undesirably affect and vary the break-down potential between the electrodes. Such variation in break-down potential may seriously impair the accuracy of spectro-chemical determination based on the spark gap operation.

I am aware that attempts have been made to deal with this problem in earlier devices wherein it has been proposed that an unconfined flow of air be directed from a point located externally of a pair of electrodes and caused to move over the electrodes in such a manner as to produce a non-turbulent stream of air. Such devices are, in practice, found to be of limited scope and, in some instances, fail to furnish a satisfactory constant break-down potential for measurements required in spectro-chemical determinations.

The present invention aims to improve methods and apparatus for controlling the operation of spark gap members in connection with spectro-chemical analyses, and to provide especially for a relatively higher degree of accuracy in fields of precise spectro-chemical determinations. It is also an object of the invention to devise a method and means for eliminating or substantially dissipating obnoxious odors arising out of the operation of spark gap members in spectro-chemical analyses, reference being had especially to the production of ozone. Still another object is to devise a means for absorbing, or substantially reducing, objectionable sounds developing in the course of spark gap operation.

These and other objects and novel features will be more fully understood and appreciated from the following description of a preferred embodiment of the invention selected for purposes of illustration and shown in the accompanying drawings, in which

Fig. 1 is a schematic wiring diagram showing the spark gap construction of the invention embodied therein;

Fig. 2 is a plan view further illustrating the

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spark gap construction of the invention in one preferred form;

Fig. 2a is a cross-section taken on the line 2a—2a of Fig. 2;

Fig. 3 is an elevational view showing a modified form of the invention in which is included a muffler element; and

Fig. 4 is an elevational view illustrating another modification of the invention including special exhaust conduit means.

The present invention is based upon the novel concept of utilizing a highly turbulent flow of gas, such as air, in place of a stream of non-turbulent air, as has heretofore been employed, to remove or scavenge ionized gas particles from the surfaces of a pair of electrodes of a spark gap construction. This concept has developed out of a recognition of the fact that at least some of the ionized gas particles very definitely arrange themselves on the surfaces of the electrodes in the form of very thin layers which are not easily broken up and, therefore, tend to adhere relatively tenaciously to the electrodes.

I have discovered that substantially complete removal of such surface layers of ionized particles can be achieved by breaking up the layers with a stream of air nitrogen or other gas of highly turbulent character and simultaneously carrying away the particles in a direction normal to the axes of the electrodes.

Attention is directed to Fig. 1 of the drawings wherein I have shown diagrammatically one typical apparatus of the class employed in making a spectro-chemical analysis. Included in this apparatus is an optical instrument indicated in block diagram form at 2 with which is associated the exciter circuit, as shown. The circuit includes a transformer 4, capacitors 5 and 6, a resistance 7, an inductance 8, and an analytical gap Ga. With the analytical gap Ga is an analytical gap shunt inductance La and an analytical gap shunt resistance Ra.

Connected in series with the analytical gap Ga is a control or auxiliary gap Gc. The latter gap includes a pair of spaced-apart sparking electrodes 12 and 14. The circuit operates as a charging circuit in a manner well known to the art and requires no further description here other than to point out that the control gap Gc operates to stabilize the light source at the analytical gap Ga.

In accordance with the invention I combine with the electrodes 12 and 14 of air gap Gc an air conduit member 16 of a suitable insulating

material which is arranged to surround and enclose the electrodes in some suitable manner, such as that shown in greater detail in Fig. 2. The air conduit 16 preferably comprises a tubular body which may, for example, be conveniently supported on a base plate 18 by means of brackets, as 20 and 22. It will be understood that the base plate may be located in any desired position with reference to other parts of the apparatus shown in Fig. 1.

At one end of the air conduit 16 openings have been formed through two opposite side wall portions and the electrodes 12 and 14 are transversely mounted in these openings projecting inwardly in spaced-apart relation, as shown in Fig. 2. Suitable electrical conductors 24 and 26, fragmentarily indicated, are provided for energizing the electrodes.

A stream of air is led into the air conduit 16 by suitable means, such as an air hose member 24 which is, in turn, connected to a source of compressed air. It will be observed that by means of the arrangement described the stream of air which is led through the air conduit member 16 is caused to pass over the electrodes 12 and 14, moving in a direction substantially normal to the longitudinal axis of the electrodes.

In utilizing the apparatus described to scavenge the electrodes in accordance with the method of the invention, it is essential to control the operating conditions so as to ensure that the air stream will be in a state of turbulence at the point where it passes over and around the electrodes in the air conduit 16. As an example of one satisfactory operation in which turbulence is produced, there may be cited the use of an air conduit having an inner diameter of, for example, one centimeter, and through this air conduit a stream of air having a velocity of approximately 3000 centimeters per second, may be passed.

It is pointed out that the initiation of turbulence in an air stream is known to be determined by the value of a dimensionless quantity, called Reynolds number. As set forth in the literature on this subject matter, the dimensionless quantity, known as Reynolds number, for a circular cross-section tube of radius A is given by the equation

$$R = \frac{2\rho AV}{\mu}$$

where ρ is the density of the fluid, V is the velocity, and μ is the viscosity of the fluid.

There is known to be a rather definite lower limit of the value of R corresponding to the beginning or initiation of turbulence, and turbulence of any appreciable character, such as is useful in the present invention, is not produced for values of R below about 2200. In the present invention it has been discovered that good results are obtained by using highly turbulent air streams where the value of Reynolds number for the air velocities above noted may be very much larger as, for example, in the vicinity of 27,000. Relatively highly turbulent air streams, where other values of Reynolds number occurs, may be utilized, also.

It is believed that the matter of inducing turbulence in the air stream is extremely pertinent to the problem of breaking up a layer of ionized gas particles for the reason that it is known turbulence occurs more or less at right angles to the axis of a tube in which the stream of air is confined and cannot occur as a variation in the forward

ward velocity of the air. It is thought that by arranging a tubular body transversely with respect to the longitudinal axis of a pair of spaced-apart electrodes, the turbulence occurs in one direction with respect to the electrodes, while the forward velocity of the air in the tube occurs in another direction which is at right angles to the axis of the electrodes, and may thus carry away particles dislodged by turbulence acting longitudinally of the electrode surfaces. The reason for improvement based upon the foregoing explanation is given by way of opinion only and is not to be taken as limiting the invention in any way thereto.

Whatever may be the correct explanation of the theory of operation of the gap construction and method of the invention, it has been found that by utilizing this method and apparatus a very marked improvement can be realized in stabilizing the light output of the analytical gap. As evidence of this, applicant has carried out comparative tests of samples of various materials to determine the standard deviation. In one case there was used a control gap of the type known in the art, and which may be conveniently referred to as a "tank type" control jet wherein the stream of non-turbulent character was directed from a point outside the gap. In the other case the turbulent flow of the invention was employed.

Based on these tests percentage figures reflecting improved reproducibility of the light output of the analytical gap have been derived. The results indicated all the way from 10% improvement in reproducibility up to as high as several hundred percent. A table of standard deviation for several components of the material analyzed, using the two types of control gaps, is noted below.

Standard deviation

	Tank type control gap	Tube type control gap
Cr.....	.0821	.0587
Cu.....	.419	.410
Si.....	1.77	.964
Ni.....	.0789	.0374
Mn.....	3.27	1.186

In all of the tests noted the oscilloscope patterns showed marked improvements which makes possible a greatly superior and more accurate method of spectro-chemical analysis.

In Fig. 3 I have illustrated a modification of the invention comprising a means of dealing with the problem of eliminating objectionable sound which develops in the course of operation of sparking electrodes. As is well known, the actual sparking operation and discharge is accompanied by a rather sharp continuous crackling sound which, when continued for any considerable length of time, becomes highly objectionable.

In accordance with the invention I have found that I may combine with the tubular member 16a, fragmentarily indicated in Fig. 3, a muffler member 30 which can be conveniently secured at the outlet end of the air conduit member and which may be constructed of a well known enlarged diameter to comprise an efficient sound absorbing means. With the aid of this combination of elements a substantial sound absorbing action is realized and the operation of the sparking electrodes is thereby rendered much

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quieter and more satisfactory to use for extended periods.

Still another modification has been illustrated in Fig. 4 of the drawings wherein a tubular member 16b, corresponding to the air conduit 16 of Fig. 2, is connected to a conduit member 32. The conduit member comprises any desirable type of tubing material and is preferably extended to a discharge outlet point which may be located, for example, at an outer wall of a building in which the equipment is installed. The purpose of the conduit 32 is to conduct away obnoxious odors arising out of the operation of the spark gap, particularly the odor from the gas ozone which commonly develops during the sparking operation.

It may also be desired to combine both the muffler unit and the conduit member 32 in a single line, arranged in series with one another, so that both sound absorbing and elimination of odors can be carried out in connection with the use of the air conduit member for the electrodes.

While I have shown a preferred method of the invention, it is intended that various changes and modifications may be resorted to in keeping with the scope of the invention as defined by the appended claims.

I claim:

1. An auxiliary spark gap construction for

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spectro-graphic analysis, comprising a pair of spaced sparking electrodes, an air conduit member constructed and arranged to receive the opposed ends of the electrodes in substantially embedded relationship therein, said air conduit member comprising a tubular body extending transversely with respect to the axes of the electrodes at either side thereof so as to provide a passageway in which a highly turbulent flow of air may be induced.

2. An auxiliary spark gap construction for spectrographic analysis, comprising a pair of spaced spark electrodes, a tubular air conduit member constructed and arranged to enclose the spark electrodes and to receive them in a position of embedded relationship so chosen that substantially all of the available gas which passes through the tubular air conduit is caused to be directed between the sparking surfaces of the electrodes at a high velocity.

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