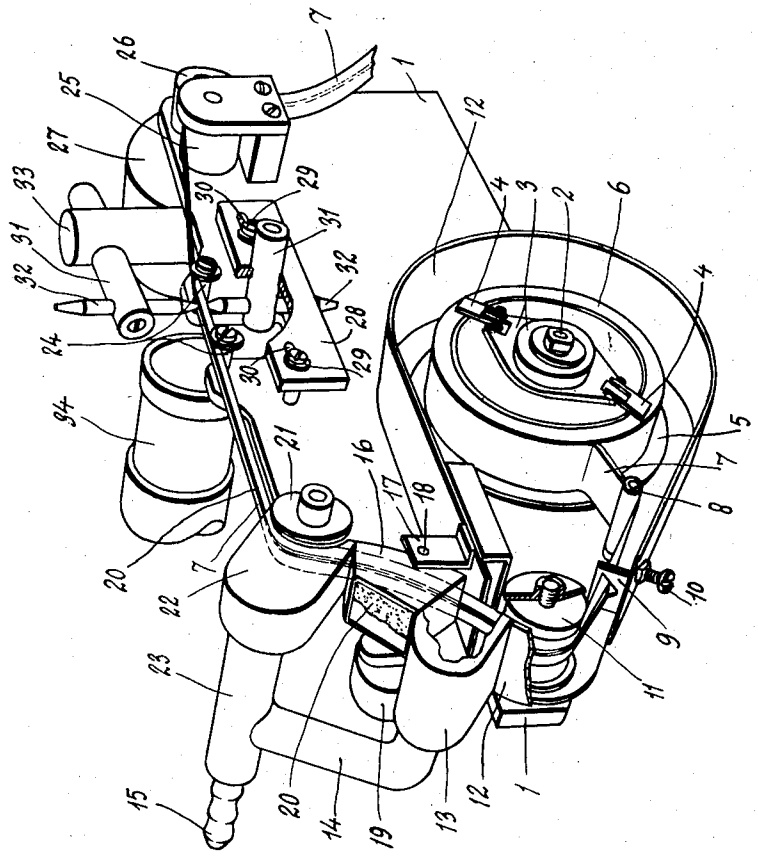
April 28, 1959 N. A. DANIELSSON 2,883,901

MEANS FOR MAKING SPECTRAL ANALYSIS ON PULVERIZED MATERIAL

Filed March 22, 1956



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United States Patent Office 2,883,901 Patented Apr. 28, 1959

2,883,901

MEANS FOR MAKING SPECTRAL ANALYSIS ON PULVERIZED MATERIAL

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Application March 22, 1956, Serial No. 573,178

Claims priority, application Sweden March 31, 1955

7 Claims. (Cl. 88—14)

This invention relates to a means for making spectral analysis, where the substance to be analyzed is entered into a discharge gap between two electrodes, between which discharge is caused so as to evaporate the substance to emit light, which then enters a spectral apparatus.

The quantitative spectral analysis is based upon the measuring so called flux ratios of spectral lines of the elements to be determined in relation to the flux ratios of a so called reference element. The flux is defined as the time integral of the instantaneous light intensities.

The working out of spectral analysis methods, besides attaining the required sensitivity, contemplates to make the flux ratio as far as possible independent of other parameters than the quantities of the elements in question.

According to the invention this is primarily attained by feeding a string of the substance through the electrode gap.

According to the invention the string may be fed continuously or intermittently. The string of the substance is further applied to a carrier, which in turn is fed through the electrode gap, and the substance can be applied to a wire or tape.

According to the invention the wire or tape may be provided with an adhesive film, onto which the substance may be applied, the tape used being a so called adhesive tape, i.e. a tape made of a plastic material, cellulose, cellulose compounds or derivatives, natural fibres or synthetic fibres.

The invention will now more closely be described in the following with reference to the diagrammatic view of an apparatus carrying out the method according to the invention.

In order to explain the problem more closely, it should be suitable to comment upon the factors influencing the intensity of a spectral line in a sequence of sparks. Thus, when a first spark is generated, the intensity of a certain spectral line depends upon the following factors, viz. the electrical parameters of the discharge circuit, the amount of the substance to be analyzed contained in the electrode material, and the further composition, the heat of melting and evaporation, the thermal conductivity and the heat capacity of the electrode material.

The electrical parameters determine the energy supplied to the electrode material, which energy among others is transferred into heat, evaporating the material. Said parameters also determine the time function of energy and have considerable influence upon the excitation of the gaseous phase, viz. for example the emission of light and ionization. Furthermore, other elements included have a particular influence upon said intensity.

Also the thermal properties of the sample are of some importance, since part of the electric energy is transferred into heat evaporating the substance. The amount of the substance evaporated by a single spark of a certain type depends upon the heat of melting and evaporation and

the manner of removing heat from the spark point or points.

If now another spark is regarded, which occurs later in a sequence of sparks, this one may impinge upon a point, which earlier was impinged by a spark, and moreover the temperature of the electrodes may be higher than the temperature at the discharge of an earlier spark. It is obvious, that the chemical composition and the metallographical structure of the point earlier impigned by the spark has changed. Thus, the composition of the evaporated substance is changed and the ratios between the intensities of the different spectral lines are influenced. The composition of the vapor may also indirectly influence the excitation process and the intensity of the lines by influencing the voltage and the distribution thereof in the discharge gap. The flux from a spark within a sequence of sparks is thus more or less influenced by the sparks occurring earlier in said sequence, and practically, for example upon analyzing metals, attempts have been made to remove the inconveniences, which this may have upon the reproducibility of the analysis by selecting a suitable preparatory spark discharge period, which should give the evaporation and excitation conditions of the spark sequence a stationary or constant course before the exposure (prearcing, preliminary sparking).

It should therefore be practical to make the flux of each particular spark independent of the preceding sparks of the sequence. This means that the spark gap should be supplied with fresh substance upon discharge of any spark of the sequence and that the spark gap should be normalized in the interval between the sparks. Sometimes it might, at least theoretically, be possible to displace the sample continuously, but in practice difficulties are met with to get a sufficiently large surface and displacement. Upon introducing a solution for spectral analysis in the spark gap by injection or the so called "porous cup" technique, where the solution diffuses into the spark gap through a graphite or carbon electrode, or by employing electrodes rotating in the solution, the substance is accumulated on the electrodes and the temperature of the electrodes will vary during the spark sequence, which involves a serious drawback.

In order to obtain ideal conditions and to avoid the above mentioned drawbacks and sources of errors the apparatus according to the fundamental principle of the invention could be used. With this apparatus the sample to be analyzed is shaped to form a string, which for example is applied to a tape, thread or similar device and entered into the discharge gap. The string is conveyed through the spark gap in such a way, that each spark always will impinge upon a fresh substance and no substance will accumulate on the electrodes. In this case the substance has to be uniformly distributed in a relatively simple and definite way. When the substance is carried by a tape, this requires that the substance be applied to the tape in a determined manner. A tape suited for use in conjunction with the invention must have a reasonably low dielectric strength against spark puncture, and it must facilitate a determined distribution of the substance to be analyzed. Furthermore the tape or the carrier must be very pure with regard to inorganic elements. For practical reasons the tape should be available in comparatively long continuous lengths, and if possible be commercially available and in any case sufficiently inexpensive. In addition to said requirements the tape should have such a mechanical strength as to allow pulling the tape upon feeding between the electrodes at the required rate.

Although a plurality of different carrier or tape materials may be selected within the scope of the invention, the common transparent, adhesive tape adapted for office

use has surprisingly proved to meet the above requirements to satisfaction. For example, a high voltage spark will easily puncture the tape. Moreover the tape is provided with an adhesive surface on which the substance may be charged in a determined manner. The composition of the tape is uniform, and the purity sufficient, and there are no economic reasons preventing the use thereof.

In certain cases it has proved desirable that the tape from the beginning be provided with some element which is uniformly distributed in or on the tape and which may be used as an element of reference for the analysis of the sample.

A preferred embodiment of the device of the invention is exemplified in the attached drawing, wherein 1 designates a frame. Secured to said frame 1 is a shaft 2 supporting a retaining disc 3. Said disc 3 is provided at both ends with stop members 4, and the shaft 2 has mounted thereon a reel 5 provided with a tape coil 6, preferably a coil of adhesive tape. From the tape coil 6 the tape is passed below a guide pulley 8 and further through a suitably shaped folding plate 9, preferably provided with a triangular recess. A set screw 10 is arranged for adjusting said folding plate 9. The tape 7 is further guided over a pulley 11, which is located within a protective casing 12. A dust exhausting casing 13 projects from the top of the cover 12 and this casing is connected via a suction pipe 14 to a nozzle 15, which may be connected to a suitable source of evacuation.

Arranged above the casing 13 is a box-shaped pocket 16 receiving the substance to be analyzed. This pocket is attached to a springy plate 17, which is attached to the shaft 18 of a vibrator 19 arranged at the opposite side of the pocket 16. The substance received in the pocket is designated by 20. Beyond the pocket 16 the tape is guided over an idler 21, which is located within a second dust exhaustion casing 22, which is connected by means of a suction pipe 23 to the above mentioned nozzle 15. The tape is further guided over two supporting shafts to the feeding wheels 25 and 26, which are driven by a motor 27.

A support plate 28 is secured to the frame 1 by means of screws 29, and said plate is provided with elongated setting holes. The support plate 28 carries an electrode clamp 31, which supports an electrode 32. In a similar way a support upright 33 is arranged to carry an electrode clamp 31 for an electrode 32. The electrodes are of course so arranged that a gap is formed between them, and a lens 34 is located in front of the gap. The purpose of this lens is to collect the light emitted by the sparks upon a discharge between the electrodes and to pass the light to a spectral apparatus of any suitable kind. According to the invention provision is further made for blowing of air and/or for suction in conjunction with the electrode gap and/or means for cooling the electrodes in a conventional manner.

The mode of operation of the apparatus according to the invention is as follows. When putting the apparatus into use, it is provided with a tape coil 6, which is placed on the shaft 2, and this is easily done by pushing the stops 4 aside. Then the tape is passed through the apparatus in the manner described above, and the tape can now be fed between the electrodes either continuously at a suitable speed or intermittently in a desired manner.

Since it is of great importance that the substance to be analyzed is uniformly distributed and that the consumption of the substance is as small as possible, the edges of the tape are folded inwardly against the adhesive surface. The edges are then completely turned down and caused to adhere to the remainder of the tape during the passage over the pulley 11, so that a central space remains between the edges for receiving the charged substance. The width of this space can be adjusted by means of the set screw 10. After leaving the pulley 11 the tape is passed through the dust extractor casing 12 wherein all the superfluous substance is removed, and it is to be noted that only the substance covering the exposed adhesive space will adhere to it, whereas the remainder of the substance is loose and can be removed. Thus, the charging of the space has become extremely uniform before the tape finally leaves the dust extractor casing 22 on its way to the electrodes 32. The tape has now received a very uniform string of suitable thickness of the substance to be analyzed, which is of great importance for obtaining a reliable result of the spectral analysis. The speed of the tape may be adjusted as desired by means of a suitable gearing means. Both electrodes are of course included in a suitable electric circuit comprising means for timing the spark discharge and/or controlling the discharge in some other way.

According to the invention it is of course possible to use a tape with a prefabricated space of the kind described. In this case the apparatus can be somewhat simplified, but usually the described apparatus is to be preferred owing to the desirability of getting the adhesive surface completely fresh during the charging operation, and this would not be the case with such a prefabricated tape.

Although the device is described and shown in conjunction with the use of adhesive tape of the common office type, there is nothing that prevents the use of other tape materials, provided this material will satisfy the requirements upon the dielectric strength and other factors, which must be put on it in this respect.

The invention is not limited to the embodiment shown and described, but may be varied in many respects within the scope of the claims.

The embodiments of the invention, in which an exclusive property or privilege is claimed, are defined as follows:

1. In an apparatus for performing spectral analysis of pulverized material, the combination of a web, provided with an adhesive layer, a source of said pulverized material, means for distributing the pulverized material to be analyzed onto said adhesive layer on said web, feeding means for moving said web in its longitudinal direction, means for removing surplus material from said web disposed after said distributing means, an electrode placed on either side of said web and included in an electric circuit, guiding means for causing the web to travel in a defined path between said electrodes, means for discharging sparks between said electrodes at desired intervals, and means to receive the light emitted from said sparks for the spectral analysis.

2. An apparatus as recited in claim 1 wherein said web is in the form of a coil and said coil is mounted for rotation in an uncoiling device.

3. An apparatus as recited in claim 2 wherein a folding device is provided after said uncoiling device and that this device acts to fold the edges of said web to leave uncovered only a central space on the web of the adhesive layer.

4. An apparatus as recited in claim 1 wherein the web carries a known substance serving as an element of reference when carrying out the spectral analysis.

5. In an apparatus for performing spectral analysis of pulverized material, the combination of means defining a surface, an adhesive layer on said surface, pulverized material to be analyzed distributed on said adhesive layer, means providing an electric arc, means for moving said surface continuously through said electric arc, and means for receiving the light produced by said arc for the spectral analysis.

6. In an apparatus for performing spectral analysis of pulverized material, the combination of a web with an adhesive layer, a source of pulverized material to be analyzed, means for distributing said material on said adhesive layer, means for producing an electric arc, and means for feeding said web first past said distributing means and then through said electric arc, and means for

receiving light produced by said arc for the spectral analysis.

7. In an apparatus for performing spectral analysis of pulverized material comprising means defining an adhesive surface, a source of pulverized material to be analyzed, means for distributing the said material on said adhesive surface, means for removing surplus material from said adhesive surface, means producing an electric arc, and means for moving said surface in a path first past said distributing means, then past said removing means, and then through said electric arc, and means for receiving the light produced by said electric arc for spectral analysis.

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