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CONTINUOUS AND AUTOMATIC FALLOUT SAMPLER

Filed March 1, 1968

2 Sheets-Sheet 1

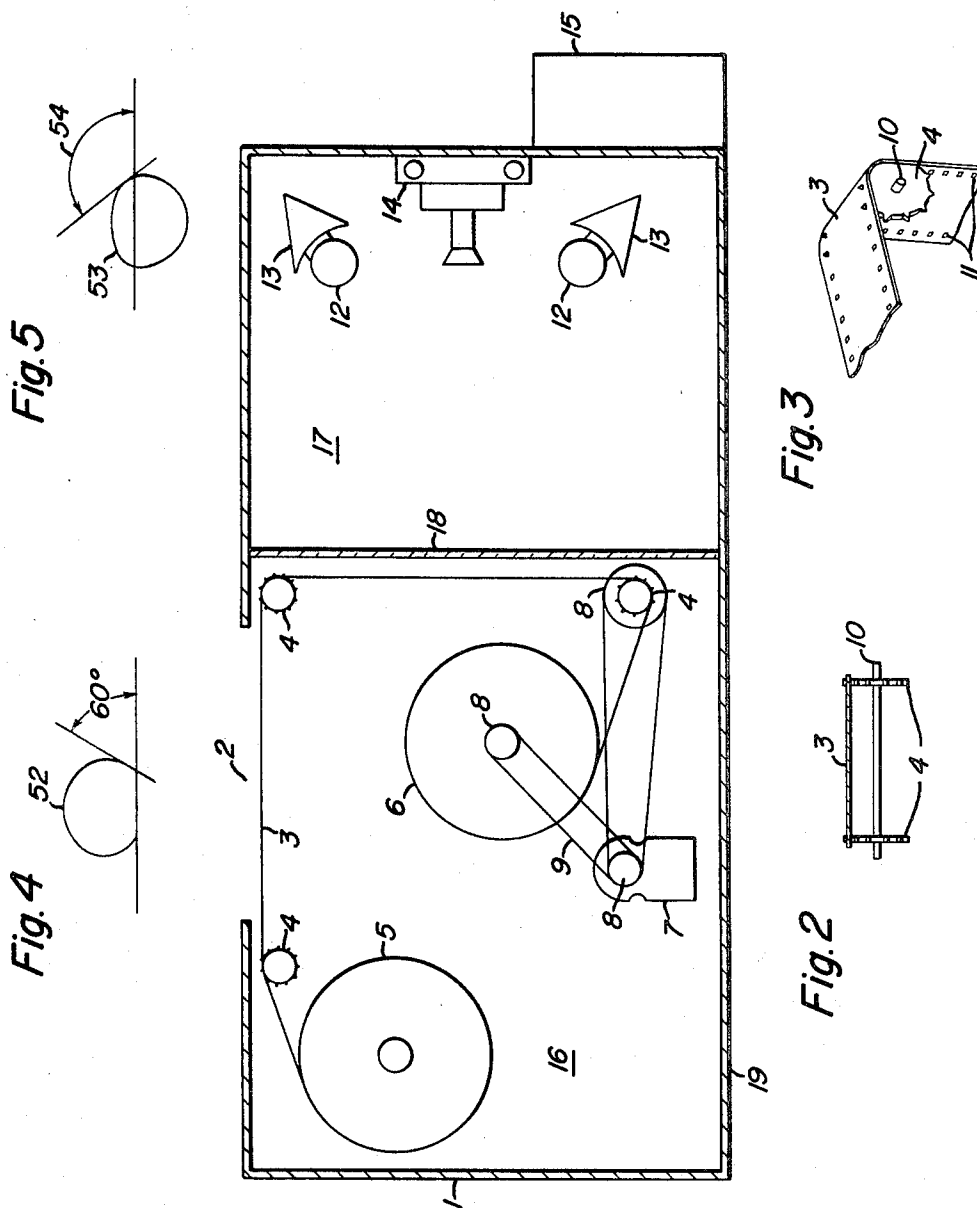


Fig. 5

Fig. 4

Fig. 1

Fig. 3

Fig. 2

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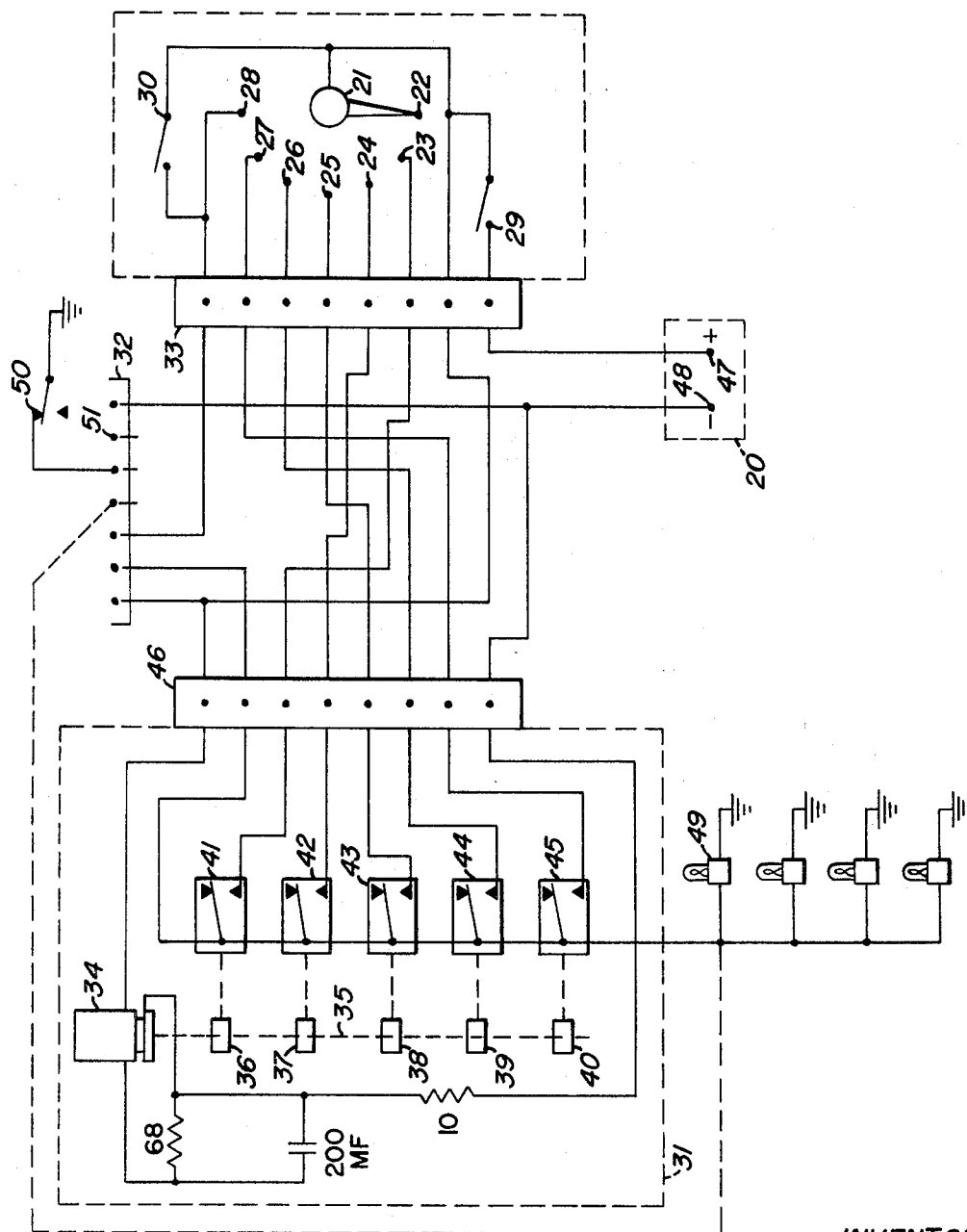


Fig. 6

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CONTINUOUS AND AUTOMATIC FALLOUT SAMPLER

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18 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and method of operation thereof for monitoring atmosphere contaminated by toxic spray comprising a water-proofed collecting tape, means for activating said collecting tape, photographic means, and electric circuit means to activate said photographic means.

DEDICATORY CLAUSE

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to us of any royalty thereon.

SPECIFICATION

Our invention relates to an apparatus and method for classifying particles, resulting from toxic sprays, which are produced at a given time according to the particle rate of fallout in air. This apparatus and method is utilized to determine the particle size distribution of droplets deposited as a result of some means of dissemination, such as an explosive or a spray means.

The prior art devices and methods all utilized a non-continuous series of slides, such as disclosed in U.S. Patent No. 3,222,925, as the sample collecting surface. Such a collecting surface presents the problem of only being able to determine all the droplets depositing at a given point without being able to determine the deposit at a given time after the initial dissemination. Associated with the problem of not being able to determine a given droplet at a given time was the problem of oversampling; that is, due to the failure to remove the sampling surface from the deposit area quickly enough, one sample overlapped another and obscured previous samples. Further, prior art devices utilized collecting surfaces such as printflex paper, magnesium oxide coated slides, or paper painted with indicating paint. Each of the aforementioned prior art collecting surfaces presented the problem that the surfaces were affected by undue amounts of precipitation and prevented any atmospheric particles from spreading and staining the surface uniformly, a prerequisite to evaluation of droplet fallout. Also, the prior art devices all presented the problem of utilizing tedious counting systems for evaluating droplet distribution. It was these problems which resulted in the conception of our invention and reduction to practice thereof.

A principal object of our invention is to provide a reliable apparatus and method for sampling air and evaluating any droplet fallout therein to determine a given particle size droplet deposit at a given time and to provide a permanent record thereof for comparison with calibration charts to eliminate tedious counting procedures.

A further object of our invention is to provide a reliable apparatus and method for sampling air and evaluating any droplet fallout therein during all conditions irrespective of any degree or concentration of precipitation.

Another object of our invention is to provide a reliable apparatus and method for sampling air and evaluating any droplet fallout therein wherein a continuously fresh sam-

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pling surface is presented to minimize the problem of oversampling.

Other objects of our invention will be obvious or will appear from the specification hereinafter set forth.

FIGURE 1 is a schematic diagram of our air sampling and recording apparatus.

FIGURE 2 is a view showing the tape, on which toxic spray droplet fallout is deposited, collecting surface being fed over a pair of sprockets.

FIGURE 3 is a view similar to FIGURE 2 but showing the tape collecting surface in perspective.

FIGURE 4 is a view showing the measurement of water droplets to determine the physical characteristic necessary for our waterproofed collecting tape.

FIGURE 5 is a view similar to FIGURE 4, but showing a paper tape which isn't suitable for our invention.

FIGURE 6 is a schematic wiring diagram of the electrical system for operating the recording camera.

FIGURE 7 is a schematic diagram showing circuitry for the frame counter and data lamp operation.

Our invention and FIGURES 1 to 7 will now be described in detail as follows.

As shown in FIGURE 1, the component subcombinations of our invention are contained in housing 1 which is made of stainless steel and comprises three separate compartments 15, 16, and 17. Compartment 16 is utilized to house the collection system and contains an opening 2 in the top of the compartment through which air toxic spray droplet contaminants pass to be deposited on tape 3. Holes are drilled in the base 19 of compartment 16 (not shown in the drawing) to permit the escape and to prevent a build-up within the compartment of any precipitation entering therein. The tape collecting surface 3 can be any paper tape which has been water-proofed to produce a finished paper tape having the physical characteristic of the contact angle, a tangent to a drop of water at the point of contact of the drop with the surface on which the drop rests as shown in respect to drop 52 in FIGURE 4, being 60° or less as measured from the horizontal plane counterclockwise to the tangent line and the angle not changing over a period of five minutes from the time of initial measurement. Any water-proofed paper meeting this test is suitable for our invention. FIGURE 5 shows paper which is not suitable for our invention wherein angle 54 measured counterclockwise from the horizontal to the tangent to drop 53 at the point of contact is greater than 60°. The angle of contact is determined by mounting a sample of the water-proofed paper to be tested on a microscope slide, placing a 0.01 milliliter drop of distilled water on the paper surface, and placing the slide having the paper mounted thereon on the stage of a microscope having a 15× eyepiece, which has a grid network therein, and a 1.3× objective lens (not shown in the drawing). A scale, or any straight edge, is placed across the microscope eyepiece in a manner to permit viewing through the eyepiece, and the scale is adjusted until it is tangent to the water drop at the point of contact with the paper as discussed above. The angle that the scale makes with the eyepiece grid as measured as described above and shown in FIGURE 4 is the contact angle. An alternative mode of measurement would be to place a hair line at an angle of 60° as measured counterclockwise from a horizontal line through the center of the microscope eyepiece and adjusting the stage with paper mounted thereon until the hair line becomes tangent to the drop of water as described above. A period of about one minute is permitted to elapse after placing the drop of water on the paper prior to taking the initial angular measurement in order to permit the drop to stabilize. The angular measurement and time of maintaining the angle is a measure of the degree of absorption of the paper. Collecting surface 3, as

shown in FIGURES 2 and 3, has two parallel rows of perforations along the edges of the surface to mesh over the prongs of sprockets 4, the perforations and sprocket system being utilized as the tape collector guide means. Sprockets 4 are mounted in pairs on a common axle 10, as shown in FIGURES 2 and 3, and the entire sprocket-axle assembly is mounted in the conventional manner by means of fixed mounts (not shown in the drawing) attached to housing 1 by any conventional fastening means such as screws, bolts, and nuts, etc. In operation, by means of the above described sprocket assemblies, tape collecting surface 3 is mechanically and continuously fed from feed reel 5 and stored on take-up reel 6. The continuous feed is actuated and kept in motion by means of motor 7 through belts 9 attached to pulleys 8. Compartment 17 is constructed to render the compartment moisture tight and to prevent moisture from getting therein utilizing conventional sealing techniques in order to avoid damage to the photographic equipment therein. Structure 18 is a panel of non-reflecting optical glass utilized to seal the photographic compartment 17 from the collection compartment 16 and to permit the collecting tape 3 to be photographed for a permanent comparison chart. Housed within compartment 17 are movie camera 14 which utilizes 35 mm. film and conventional photographic flood lights 12 and reflectors 13. The third compartment, 15, houses the circuitry shown in FIGURES 4 and 5 to automatically control the operation of camera 14.

The circuitry, as shown in FIGURE 4 is activated by a direct current power supply 20 in the range of 18-28 volts as shown. The speed at which pictures are to be taken is regulated by a seven position selector switch 21 wherein position 22 is the off position, position 23 operates the film in the camera at the rate of one frame every two seconds, position 24 at the rate of one frame per second, position 25 at the rate of two frames per second, position 26 at the rate of four frames per second, position 27 at the rate of eight frames per second, and position 28 at the rate of 16 frames per second. In order to start taking pictures, camera switch 29 must be closed. In the event that one would want to take only periodic pictures, the circuitry is provided with burst switch 30. When using the burst switch, camera switch 29 is closed, selector switch 21 is set at the off position, and burst switch 30 is closed to take pictures at the rate of 16 frames per second when such taking is desired. Burst switch 30 is a push button type of switch. Selector switch 21 is connected to a timing mechanism 31 and a seven prong camera connector 32 through eight prong connector 33. Timing mechanism 31 is operated by a constant speed direct current motor 34, which has a 25 watt input reduced to output of about $\frac{1}{3}$ the input value by means of a 68 ohm resistance in series therewith, connected to a timed shaft 35 having cams 36, 37, 38, 39, and 40 mounted thereon to control micro switches 41, 42, 43, 44, and 45. Switch 41 controls the camera speed at the rate of one frame per two seconds, switch 42 at the rate of one frame per second, switch 43 at the rate of two frames per second, switch 44 at the rate of four frames per second, and switch 45 at the rate of eight frames per second. The timing mechanism is connected to selector switch connector 33 and camera connector 32 through eight prong timing connector 46. Connector 32 is, of course, connected to a mating connector mounted on the camera (not shown in the drawing) for operation. Terminal 47 of supply 20 is positive and terminal 48 thereof is negative. Structure 50 is a frame counter; a low voltage device utilizing a grounding circuit as shown. This counter is automatically photographed by the camera during operation and the number of the frame appears in the margin of the film. Pin 51 in connector 32 is not now utilized, but it is available should it be desired to add another low voltage device to the circuit in the future. Twenty-eight volt direct current data lamps, 49, are used to illuminate the above frame counter, as well as a mechanically oper-

ated clock (not shown in the drawing, but located adjacent to the frame counter) for recording this information photographically on the edge of the film as mentioned above.

To monitor the toxic spray contamination of the atmosphere, the collecting tape 3 is started to operate as described above, droplet fallout generated by the toxic spray is deposited on the surface of the collecting tape, and a photograph is made of the droplet fallout contaminated collecting tape by the photographic system described above. The photograph is then compared to a family of photographs made from calibration runs which utilized known particle size distribution. Such comparison is possible due to the fact that toxic spray droplets in the absence of moisture stain the water-proofed tape. The size of the stain is a measure of the particle size; the larger the stain, the larger the particle size. The water-proofing of the tape eliminates the presence of moisture because beads of moisture simply roll off the paper tape. Since the photographic equipment is started simultaneously with the start-up of the collecting tape and the time shown on the mechanical clock, a twenty-four hour increment clock, and the frame number are photographed on the edge of the film, the given droplet particle size distribution at any instant of time is known through comparison with the above described calibration charts. Such comparison will show not only the droplet fallout particle size at any given point in time, but any increase or decrease in concentration over a period of time can also be ascertained. The continuous movement of the collecting tape, sequential photography, and calibration chart comparison as described above provides an accurate history of any toxic spray droplet size spectrum and of the droplet fallout contamination density as a function of time. Provisions can obviously be made for the remote control of the above described monitoring system.

We claim:

1. An apparatus for monitoring toxic spray in air and recording stain patterns produced by droplet fallout of said toxic spray comprising a housing means, a water-proofed collection tape means adapted to collect toxic droplet fallout deposited thereon and located within said housing, an opening in said housing means located above said tape means and adapted to allow toxic droplets to enter said housing and be deposited on said tape, feed means for said tape, take-up means for said tape, means for actuating and keeping said tape in motion adapted to continuously provide a new surface of said tape exposed to said opening for deposit of toxic spray droplets thereon, photographic means adapted to record said stain patterns, and electrical circuit means adapted to automatically control the operation of said photographic means.

2. The apparatus of claim 1 wherein the housing means is stainless steel.

3. The apparatus of claim 2 wherein the housing is provided with means to avoid precipitation build-up within said housing means.

4. The apparatus of claim 3 wherein the means to avoid precipitation build-up are holes located in the bottom of the housing means below the tape means.

5. The apparatus of claim 1 wherein the contact angle of the water-proofed tape has an upper limit of 60°.

6. The apparatus of claim 1 wherein the feed means is a reel adapted to have said tape wound thereon and fed therefrom.

7. The apparatus of claim 1 wherein said take-up means is a reel adapted to have said tape having said stain patterns wound thereon.

8. The apparatus of claim 1 wherein said guide means is a system comprising perforations located along each edge of the tape and sprockets adapted to engage said perforations, said sprockets being mounted in pairs on a common axle.

9. The apparatus of claim 1 wherein the actuating means is an electric motor.

10. The apparatus of claim 1 wherein the photographic means comprises a camera, photographic flood lights adapted to provide adequate light to take pictures, and photographic reflectors in combination with said flood lights adapted to reflect the light generated by said flood lights.

11. The apparatus of claim 1 wherein the electromechanical circuit means comprises a camera activation switch, a film speed selector switch, a burst switch adapted to activate film only at given times, a timing means, a first connection means adapted to connect said selector switch with said timing means, a second connection means adapted to connect said timing means and said selector switch with the camera, a third connection means adapted to connect said timing means with said second connection means, and a fourth connection means adapted to connect said selector switch with said second connection means.

12. The apparatus of claim 11 wherein the timing means comprises a motor, a timed shaft cooperating with said motor, a plurality of cams mounted on said shaft, a plurality of micro switches in cooperation with said cams, a plurality of resistance means in cooperation with said motor, and a capacitance means in cooperation with said motor.

13. A method of monitoring toxic spray in air and recording stain patterns produced by droplet fallout of said toxic spray for comparison with a calibration chart to evaluate the droplet particle size distribution at any given time comprising the steps of providing a water-proofed collection tape means, activating said tape means to continuously provide a new surface of said tape to the air being monitored, depositing toxic spray droplets on said tape by means of exposure to the air to produce droplet stain patterns on said tape, providing a photographic means to record the stain patterns on said tape, providing means to activate said photographic means, activating said photographic means, recording said stain patterns photographically, comparing the record stain patterns with a calibration chart means, and evaluating the droplet particle size distribution by means of the comparison.

14. The method of claim 13 wherein the tape means contact angle has an upper limit of 60°.

15. The method of claim 13 wherein the photographic means comprises a camera, photographic flood lights adapted to provide adequate light to take pictures, and photographic reflectors in combination with said flood lights adapted to reflect the light generated by said flood lights.

16. The method of claim 13 wherein the means to activate said photographic means is an electromechanical circuit comprising a camera activation switch, a film speed selector switch, a burst switch adapted to activate film only at given times, a timing means, a first connection means adapted to connect said selector switch with said timing means, a second connection means adapted to connect said timing means and said selector switch with the camera, a third connection means adapted to connect said timing means with said second connection means, and a fourth connection means adapted to connect said selector switch with said second connection means.

17. The method of claim 16 wherein the timing means comprises a motor, a timed shaft cooperating with said motor, a plurality of cams mounted on said shaft, a plurality of micro switches in cooperation with said cams, a plurality of resistance means in cooperation with said motor, and a capacitance means in cooperation with said motor.

18. The method of claim 13 wherein the chart means is prepared by photographing stains produced from droplets of known particle size.

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