

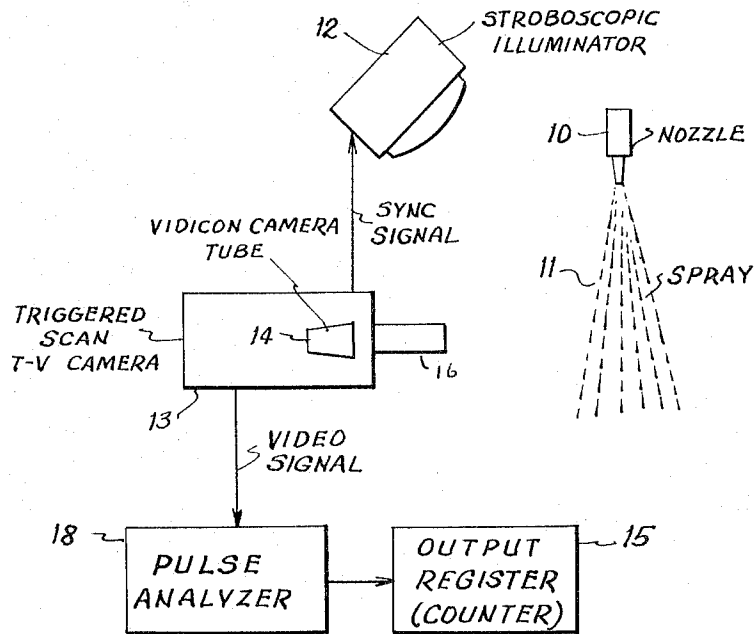
Sept. 27, 1966

V. E. DIETRICH

3,275,744

APPARATUS FOR SPRAY ANALYSIS

Filed Oct. 1, 1962



INVENTOR.

Verne E. Dietrich

BY

*Donna, Inc. Dougall and Herik
Attys*

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APPARATUS FOR SPRAY ANALYSIS

Verne E. Dietrich, Naperville, Ill., assignor to Spraying Systems Co., Bellwood, Ill., a corporation of Illinois
Filed Oct. 1, 1962, Ser. No. 227,190
5 Claims. (Cl. 178-6)

This invention relates to the field of spray analysis—i.e., to the determination of such factors as absolute particle size, numerical distribution of variously sized particles, spatial distribution of particles, and the like—in a spray of rapidly moving, finely divided particles. In many applications of my invention, the particles in the spray being analyzed may consist of liquid droplets; in other applications, the individual particles in the spray may be solid matter or a mixture of liquid droplets and solid matter. In nearly all cases, the particles comprising the spray will be suspended or immersed in a gaseous medium. Much time and thought by skilled persons have been devoted in years past to spray analysis, and many methods and types of apparatus have been proposed for doing such work. Among these, the commonest technique has involved making a high-speed photograph of the spray pattern, thus securing a photographic model of the particle distribution in the spray at a particular random instant of time. Analytical methods have then been applied to the photographic model thus obtained, the individual particles being counted, their relative sizes determined, and other information about the spray composition secured.

This prior-art approach to spray analysis has proved to be at best slow and burdensome. Particularly is this so when, as is usually the case, a large number of different spray samples must be analyzed to secure a statistically reliable picture of the spray composition as it exists, on the average, over a period of time.

In the present invention, I employ a novel technique which provides, almost instantaneously, as many separate spray "specimens" as may be needed for accurate statistical analysis and analyzes them rapidly by electronic methods already known by virtue of technological advances in other fields.

The heart of my invention consists in the cooperative use of stroboscopic illumination and a triggered-scan television camera, the mosaic of the camera tube functioning as a "memory" device for "freezing" momentarily the spatial pattern of spray particles while the scanning beam of the camera tube converts such spatial into a train of electrical pulses systematically separated in time. This train of electrical pulses is then analyzed by conventional electronic methods to yield information as to particle size, number, and distribution. Because the scanning beam of the television camera tube automatically "erases" the image on the camera-tube mosaic as it scans, the apparatus is capable of recording and analyzing new spray specimens at intervals only slightly greater than the time required for a single scan. Thus, it is possible within a few seconds to record and analyze a statistically reliable number of particle-distribution samples in the spray.

From the foregoing, it will be understood that the major object of the present invention is to provide a system of spray analysis wherein specimens of particle distribution in the spray are recorded in rapid succession and preserved in each instance only long enough to permit electronic analysis of the information contained in the specimens, thus permitting analysis in a short time, with a single sensing device, of any desired number of specimens of spray patterns.

A further object of the invention is to utilize for spray analysis the "memory" characteristic of a vidicon camera tube, in combination with synchronized stroboscopic il-

lumination to yield in a short time any desired number of spray specimens.

Other objects and advantages of the invention will be apparent from the following description of a typical embodiment thereof.

In the single figure of the drawing, I have shown in diagrammatic form an assembly of apparatus which comprises a typical embodiment of my invention.

I show therein a nozzle 10 from which is discharged the spray 11 to be analyzed. As previously noted, this spray may consist of liquid droplets, finely divided particles of solid material, or a mixture of both. In most cases, of course, the droplets or solid particles in the spray 11 will be carried or suspended in a gaseous medium such as air.

A television camera 13 comprising a conventional vidicon camera tube 14 is positioned in front of the spray in such manner that its lens system 16 focuses on the mosaic of camera tube 14 an image of a portion of the spray 11. (Normally, the optics of the lens system 16 will be so designed as to "look" only at a limited region of the spray, so as to permit independent analysis of the particle distribution in various parts of the spray.)

A stroboscopic light source 12 is placed adjacent the spray in a position where, when energized, it will illuminate brightly the portion of the spray being "seen" by the camera 13. Light source 12 may be of any conventional type which, on being triggered by successive electrical impulses, will produce corresponding short-duration light flashes of great intensity. Such devices are well known and utilize, in most cases, an electrical flash tube of the gaseous-discharge type.

Camera 13 is provided with a conventional scanning system of the triggered type—i.e., a scanning system which causes the electron beam generated by the electron gun in tube 14 to scan systematically the mosaic of the tube in response to timed trigger impulses, which may be derived from a timing generator in the camera itself or from some outside source. Such scanning circuits are conventional. Usually internal triggering is provided by a multivibrator or blocking oscillator.

Synchronizing impulses derived from the scanning system of camera 13 are fed to light source 12 and used to trigger its flashes, the timing being so arranged that light source 12 emits a brilliant short-duration flash just before the beginning of each scanning cycle. Alternatively, the master timing control may be a part of the circuitry of the light source 12, in which event the synchronizing signals will flow in the direction opposite to that indicated on the drawing, i.e., from the light source 12 to the camera 13, where they are used to initiate scanning cycles in the camera 13 following the respective flashes from light source 12.

In the manner conventional in television cameras, the spatial charge pattern on the mosaic of camera tube 14 is converted in the scanning process to a modulation envelope superimposed on the electron-beam current, and this modulation envelope is in turn amplified and fed from the camera output in the form of a video signal.

In the present invention, the successive images on the mosaic of vidicon tube 14 will consist of minute charged zones corresponding, in position, number, and size, to the particles in the spray at the instant of the last flash from light source 12, and the resulting video signal will constitute a train of corresponding electrical impulses.

The video-signal output of camera 13 is fed to a pulse analyzer 18 which classifies the video impulses according to duration, or magnitude or both, as the needs of the particular analysis may require, and the classified impulses are then fed to an output register 15 which counts and records the number of video impulses in each classification. Pulse analyzers and electronic counters of this type

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are well known, being extensively used in radiation detectors and electronic computers.

If the requirements of a particular application do not require classification of the video impulses to yield specific information as to particle size or spatial distribution, the analyzer 18 may be eliminated and the video impulses fed directly to the counter 15, thus yielding a simple count of the spray particles "seen" by the camera tube during successive scans.

In the normal operation of my invention, successive light flashes from source 12 will normally follow one another at frequent intervals, each flash being followed by a scanning cycle in camera 13. As skilled readers will understand, each short-duration flash will impress on the mosaic of the vidicon tube a charge image representing the spatial distribution of particles in the spray at the particular instant that the flash occurs, and the particle images will in general be quite sharply defined because the particles will, for all practical purposes, have remained stationary during the short duration of the flash. Thus, by having successive flashes and corresponding scanning cycles my invention will provide, in a short time interval, as many specimen images of the spray pattern as may be needed to achieve statistically significant data.

In some special situations, it may be desirable to record and analyze single spray patterns, in which event the synchronized flash and scanning sequence may be initiated by a suitable manual control means, rather than being repeated periodically under the control of a master timing circuit such as a blocking oscillator.

As will be appreciated from the foregoing description of my invention, the particular units of apparatus employed may be conventional and do not, per se, form a part of my invention. My inventive contribution consists in combining a television camera, a synchronized stroboscopic light source, and electronic pulse-analyzing means to provide a spray-analysis system of extraordinary speed and versatility.

While I have in this specification described in considerable detail a typical embodiment of my invention, it should be understood that such description is merely illustrative, and the scope of my invention is to be determined primarily by reference to the appended claims.

I claim:

1. Apparatus for spray analysis comprising a television camera having a camera tube and a scanning system therefor, said camera being positioned to view at least a portion of the spray to be analyzed, a stroboscopic light source operative when triggered to emit a short-duration light flash momentarily illuminating said spray portion, means interconnecting said scanning system and said light

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source operative to synchronize the triggering of said source and the initiation of a scanning cycle in said camera, means for triggering said light source and initiating a scanning cycle in synchronism therewith, whereby an image representing the spray pattern at the instant of said flash is recorded by said camera tube and then converted to a video signal by said camera, and means fed by the camera for analyzing said video signal and thereby recovering information concerning said spray pattern.

2. The apparatus defined in claim 1 wherein said triggering and scan-initiating means is automatically operative to trigger said light source and initiate a corresponding scanning cycle at regular, predetermined intervals.

3. The apparatus defined in claim 2 wherein said video signal comprises a train of electrical impulses corresponding to particles in said spray, and said video-signal analyzing means comprises means for counting the individual impulses in said video signal.

4. The apparatus defined in claim 2 wherein said video signal comprises a train of electrical impulses corresponding to particles in said spray, and said video-signal analyzing means comprises means for classifying the individual impulses in said video signal according to some characteristic thereof and then separately counting the number of impulses in each class.

5. In a television system for spray analysis including a television camera having a screen and deflection means for causing a cathode ray beam spot to traverse said screen in a certain pattern to produce a video signal,

a spray nozzle,

means for flash illumination of said spray from said nozzle,

means for producing images of spray particles on said screen to produce pulses in said video signal in response to traverses of said image by said spot,

a pulse counter,

and means for applying a pulse to said counter in response to each traverse of a spray particle image by said spot.

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DAVID G. REDINBAUGH, *Primary Examiner*.

R. M. HESSIN, T. G. KEOUGH, R. RICHARDSON,
Assistant Examiners.