

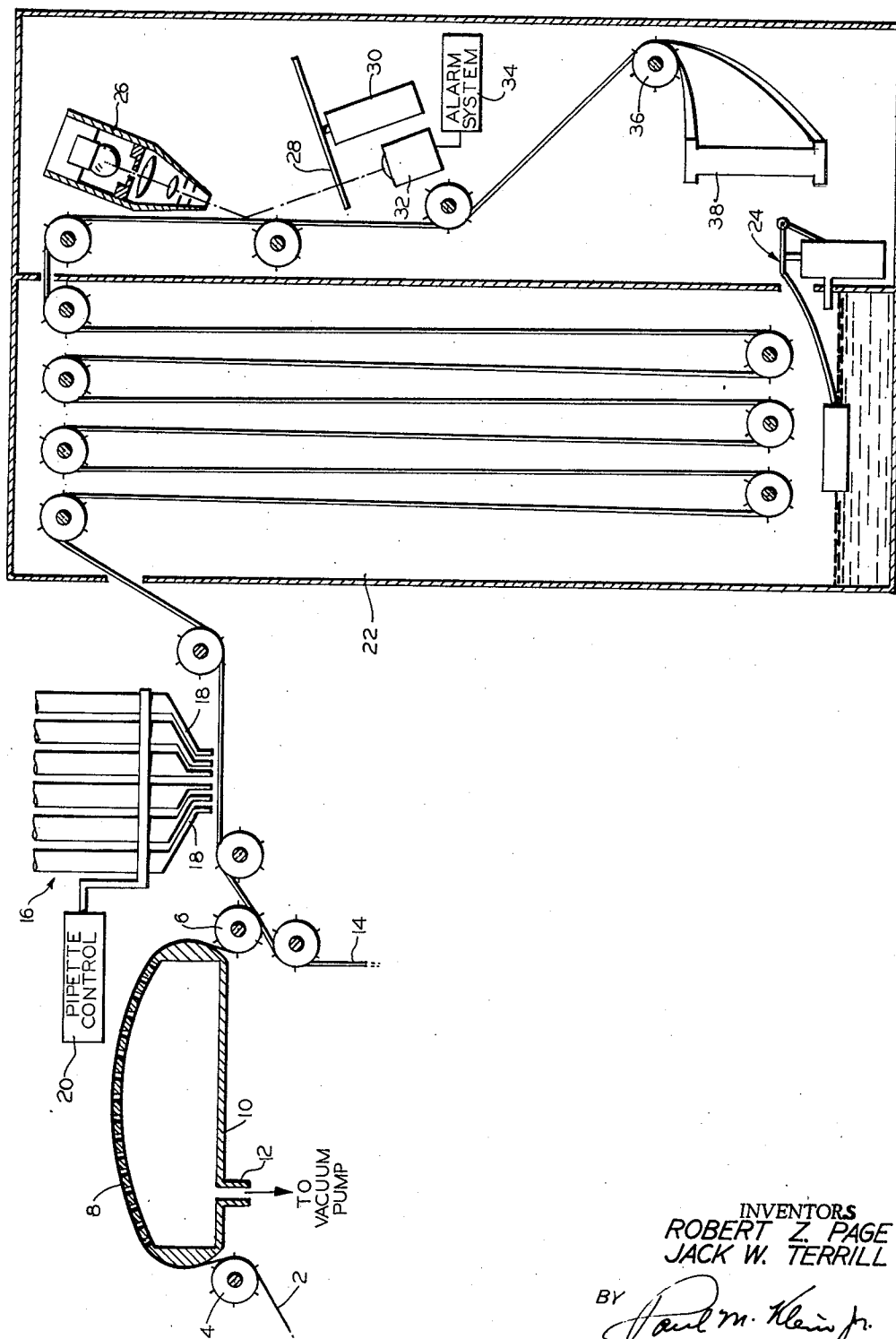
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R. Z. PAGE ETAL

3,129,144

BIOLOGICAL DETECTION EQUIPMENT

Filed June 29, 1962



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3,129,144

BIOLOGICAL DETECTION EQUIPMENT

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3 Claims. (Cl. 195-127)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention involves modifications of the invention of copending patent application entitled "Biological Detection Equipment," Serial No. 206,524, filed June 29, 1962, in the name of sole inventor Robert Z. Page, joint inventor of the present invention.

This invention relates to sampling equipment and more particularly to equipment which will automatically and continuously sample air (or water), which will automatically detect and identify biological warfare agents or other pathogenic organisms present in the fluid sampled, which will automatically determine the resistance of such pathogens to antibiotics, and which will activate an alarm system.

Old prior art devices for detecting and identifying pathogenic organisms involve typically the passage of air over culture plates or through nutrient solutions. The process involved was necessarily relatively slow. The more recent development of the millipore filter has permitted much more rapid reading of results. However, the millipore filter and nutrient pad associated with it are made in the prior art as disks which must be manually replaced after a period of exposure and then placed in a culture chamber for the period of development. The results must then be read by a well-trained technician. "Early" reading requires the use of a microscope. Subculturing is required for determination of resistance to antibiotics. Answers to subculturing would not be available until after many human deaths could have occurred following exposure to pathogens. The chances for both negligence and human error in these prior art techniques are great. Requirements for trained technicians preclude wide use of this prior art system as an effective warning procedure.

An object of the present invention is to provide apparatus which will sample a fluid and which will automatically detect and identify biological warfare agents or other pathogenic organisms in the fluid and which will automatically activate an alarm system upon identification of particular organisms.

Another object of the invention is to provide an apparatus which will automatically sample a fluid and will automatically detect and identify biological warfare agents or other pathogenic organisms present in the fluid and will automatically determine the resistance of such pathogens to antibiotics.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein the single figure is a schematic diagram of one preferred embodiment of the invention.

The operation of the apparatus of this invention is based upon the use of a filter developed in recent years and known as the molecular filter (described by Goetz, the patentee of pertinent U.S. Patents 2,761,813, 2,672,432 and 2,672,431), the membrane filter (described by Clark) and the millipore filter (manufactured by the Lovell Chemical Company, assignee of pertinent Patent

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2,677,646). The porosity of the filters is such that bacteria and other microorganisms are entrapped on the upper surface of the filters. The millipore filter is available as an aerosol assay type for use with air or other gases and the hydrosol assay type for use with liquids. In some forms these filters are used with an absorbent pad which has previously been impregnated with nutrients. The absorbent pads can also be treated with dyes and dye activators which aid in the early definitive chromatic detection and identification of the pathogens. The moistening of the absorbent pad with water permits the moistening of the filter and entrapped organisms with solutions of the materials contained in the pads. In the prior art these filters and the absorbent pads are normally provided as disks which fit specially designed filtering equipment. After filtration, the filters are placed on the moistened absorbent pads and held at elevated temperatures for incubation. The pathogens present are identified by the color of the small colonies developing during incubation.

According to this invention apparatus is provided which by fabricating the filters and absorbent pads of the prior art in the form of tape, insures continuous automatic sampling and culturing, with determination of resistance to antibiotics, and with an automatic warning device so that information is provided by the time the first clinical symptoms begin to appear in populations subject to attack. A trained technician is needed for only a few minutes every few days to check operation and replace filter and absorbent tapes.

Reference is now made to the drawing. The molecular (or membrane or millipore) filter used in the invention is in the form of rolls of sterile tape. The filter tape 2 is reinforced along its edges and perforated to permit handling by sprockets 4, 6, etc. The filter tape is passed over a perforated surface 8 of glazed enamel, the underside of which forms the top of a chamber 10 connected as at 12 to a vacuum pump. In passage over the perforated enamel surface 8, the filter tape 2 is held securely against it by the sprockets 4 and 6 or any other suitable means such as that shown in the aforementioned copending related patent application.

A treated absorbent tape 14 is moved to a position directly beneath the filter tape 2 after the filter tape leaves the perforated surface 8. The two tapes are moved together beneath a moistening unit, generally indicated at 16, made a plurality of pipettes 18, which can be used to treat the tapes with a "universal" nutrient or serially with several nutrients. Antibiotics can be added to the series to provide further information indicating the resistance of microorganisms to various antibiotics. Each pipette can dispense, for example, a different nutrient containing a particular dye and dye activator. A pipette control 20 is used to control the release of fluid from the pipettes and can be operated periodically, synchronized with the passage of the tapes beneath the moistener. Details of the pipette control are not shown since they are not part of this invention and are readily available to those skilled in the art. Many timed valving arrangements are known and suitable for use in the invention. Various sequences of operations can be used. For example, if each pipette contains all the ingredients (nutrient, dye, dye activator, antibiotic, etc.) specific to a different microorganism and adequate to culture it and visualize it, then a valving timer can be set to dispense periodically the respective mixtures from all pipettes simultaneously with the period so related to the rate of travel of the tapes (which may be of the order of $\frac{1}{10}$ inch per minute) that there is no overlapping impregnation of the tapes with effluent from two pipettes. On the other hand, if it is desired to dispense separately from more than one pipette onto the same area of the tapes, this can be accomplished by so setting the pipette control that the valves of several

pipettes are timed to dispense effluent serially in time on the same area of the tapes as that area passes in turn beneath each pipette.

From the moistening unit 16, the two tapes are moved together into an incubation chamber 22 of high humidity. Water level in the chamber 22 is controlled by a float valve 24. The elevated temperature in the chamber 22 is maintained by a heating unit and thermostat not shown. From the incubation chamber, the tapes are moved past a light source 26 which illuminates the filter tape. Light reflected from the tape passes through a revolving optical filter disk 28, driven by motor means 30 in synchronism with the movement of the tapes and therefore with the action of the pipette moistener or with impregnations on the tape, and thence the light impinges on a photoelectric pickup 32. The use of the optical filters permits actuation of the photoelectric cells by a predetermined segment of the spectrum. The output of the photoelectric pickup means is fed to an alarm system 34 and, if desired, to a recording device for recording the data and which can be embodied, if desired, in the alarm system.

The tapes move from the optical observation station over sprockets 36 and 38 to either discard or to a "filing" area where they can be "filed" for future study in a second culture, chamber, if desired.

Details of such items as motors and mechanical drives for driving the sprockets, vacuum pumps, recording devices, alarm systems and the like, are not shown since they are readily available to those skilled in the art and do not constitute a part of this invention. The choice of alarm systems is, for example, rather obvious and may include such warning devices as flashing lights, ringing bells, etc., set off by receipt by the photoelectric means of predetermined wavelengths of light. Similarly the details of the optical filters and photoelectric pickup means are not shown for the same reason. Many various designs are available to those skilled in the art and their details will vary according to the chromatic pictures produced upon the filter. This factor in turn is determined by the organisms cultured and by the media, dyes, and dye activators used.

Many modifications of this apparatus are possible within the concept of the invention. For example, the absorbent tape can be a single layer tape in the form of a single strip. However, multiple layers and, particularly, parallel strips can be used and under certain monitoring conditions prove highly advantageous. The illumination and detection, as illustrated, involve reflected light. Transmitted light can be used and in such a case the two tapes are separated after incubation and the filter tape is treated with clear mineral oil.

Obviously many other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Apparatus comprising filter tape made of material capable of filtering out from a suspending fluid medium and retaining microorganisms; a vacuum chamber having a perforated wall and means for subjecting said chamber to vacuum; means for moving said filter tape continuously past said wall in intimate contact with the exterior surface of said wall whereby, when a vacuum is applied to said vacuum chamber, the fluid medium surrounding said chamber is caused to flow through said filter tape to deposit microorganisms from said medium on said filter tape; means for bringing absorbent tape into intimate contact with said filter tape after said filter tape has passed said chamber; means for causing said absorbent tape and said filter tape, while remaining in intimate contact, to move together continuously to a moistening unit for moistening said absorbent tape to produce therein a

plurality of moist region, each containing, for supply to said filter tape, nutrient, dye, and dye activator for a particular microorganism, there being separate regions adapted to culture different microorganisms; an incubation chamber; means for feeding said tapes into said incubation chamber, the rate of travel of the tapes being such that they remain in said incubation chamber for an incubation period long enough to develop observable colonies of microorganisms; a light source to produce light to illuminate microorganism colonies which produce characteristic colors in the presence of their associated dyes and dye activators; means for passing said tapes after said incubation period into the path of light from said light source; photoelectric pickup means which respond to selected wavelengths of light characteristic of particular microorganisms, located to receive light from said light source after impingement on said tapes; optical filter means associated with said light source and photoelectric pickup means to facilitate transmission to said photoelectric pickup means of selected wavelengths of light characteristic of particular microorganisms; and an alarm system connected to said photoelectric pickup means to signal an alarm upon receipt from said photoelectric pickup means of a signal indicative of light characteristic of a particular microorganism; said moistening unit comprising a plurality of adjacent dispensers, each for dispensing its own solution containing particular nutrient, dye, and dye activator components; and means for controlling operation of said dispensers in synchronism with the travel of said tapes, whereby separate regions of said tapes are impregnated separately with the effluent from each dispenser.

2. Apparatus comprising filter tape made of material capable of filtering out from a suspending medium and retaining microorganisms; a vacuum chamber having a perforated wall and means for subjecting said chamber to vacuum; means for moving said filter tape continuously past said wall in intimate contact with the exterior surface of said wall whereby, when a vacuum is applied to said vacuum chamber, the fluid medium surrounding said chamber is caused to flow through said filter tape to deposit microorganisms from said medium on said filter tape; means for bringing absorbent tape into intimate contact with said filter tape after said filter tape has passed said chamber; means for causing said absorbent tape and said filter tape, while remaining in intimate contact, to move together continuously to a moistening unit for moistening said absorbent tape to produce therein a plurality of moist regions, each containing, for supply to said filter tape, nutrient, dye, and dye activator for a particular microorganism, there being separate regions adapted to culture different microorganisms; an incubation chamber, the rate of travel of the tapes being such that they remain in said incubation chamber for an incubation period long enough to develop observable colonies of microorganisms; a light source to produce light to illuminate microorganism colonies which produce characteristic colors in the presence of their associated dyes and dye activators; means for passing said tapes after said incubation period into the path of light from said light source; photoelectric pickup means which respond to selected wavelengths of light characteristic of particular microorganisms, located to receive light from said light source after impingement on said tapes; optical filter means associated with said light source and photoelectric pickup means to facilitate transmission to said photoelectric pickup means of selected wavelengths of light characteristic of particular microorganisms; and an alarm system connected to said photoelectric pickup means to signal an alarm upon receipt from said photoelectric pickup means of a signal indicative of light characteristic of a particular microorganism; said optical filter means including a rotatable disk having a plurality of optical filters for various selected wavelengths of light mounted to filter light entering said photoelectric

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pickup means from said microorganism colonies and means to rotate said disc in synchronism with the travel of said tapes whereby optically to filter with a particular optical filter light emanating from a particular colony of microorganisms.

3. The apparatus of claim 1 wherein said optical filter means includes a rotatable disk having a plurality of optical filters for various selected wavelengths of light mounted to filter light entering said photoelectric pickup means from said microorganism colonies; and means to

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rotate said disk in synchronism with the travel of said tapes whereby optically to filter with a particular optical filter light emanating from a particular colony of microorganisms.

References Cited in the file of this patent

UNITED STATES PATENTS

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2,761,813	Goetz	Sept. 4, 1956
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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,129,144

April 14, 1964

Robert Z. Page et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 22, after "continuous" insert -- and --;
line 46, after "made" insert -- of --; column 4, line 1, for
"region" read -- regions --.

Signed and sealed this 8th day of September 1964.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents