NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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REPLY TO ATTN OF: GP

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,841,973

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : ~

NASA Patent Case No. : LAR-11,069-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES ☐ NO ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

Bonnie L. Woerner

Bonnie L. Woerner
Enclosure

Oct. 15, 1974 J. R. WILKINS ET AL 3,841,973

APPARATUS FOR MICROBIOLOGICAL SAMPLING

Filed Jan. 24, 1973

2 Sheets-Sheet 1

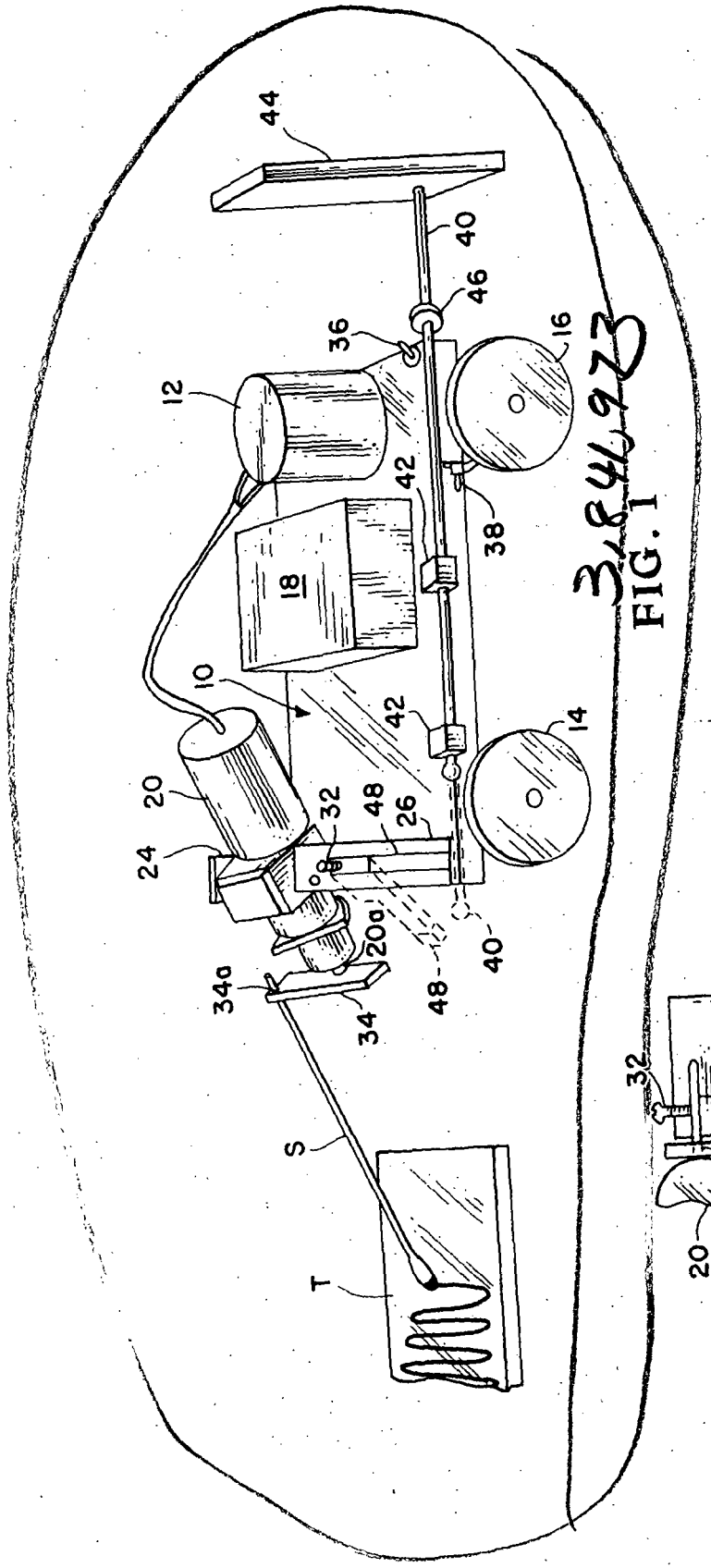

FIG. 1

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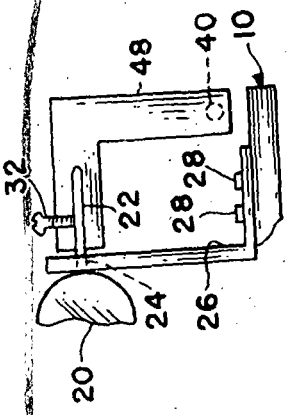

FIG. 2

APPARATUS FOR MICROBIOLOGICAL SAMPLING

Filed Jan. 24, 1973 2 Sheets-Sheet 2

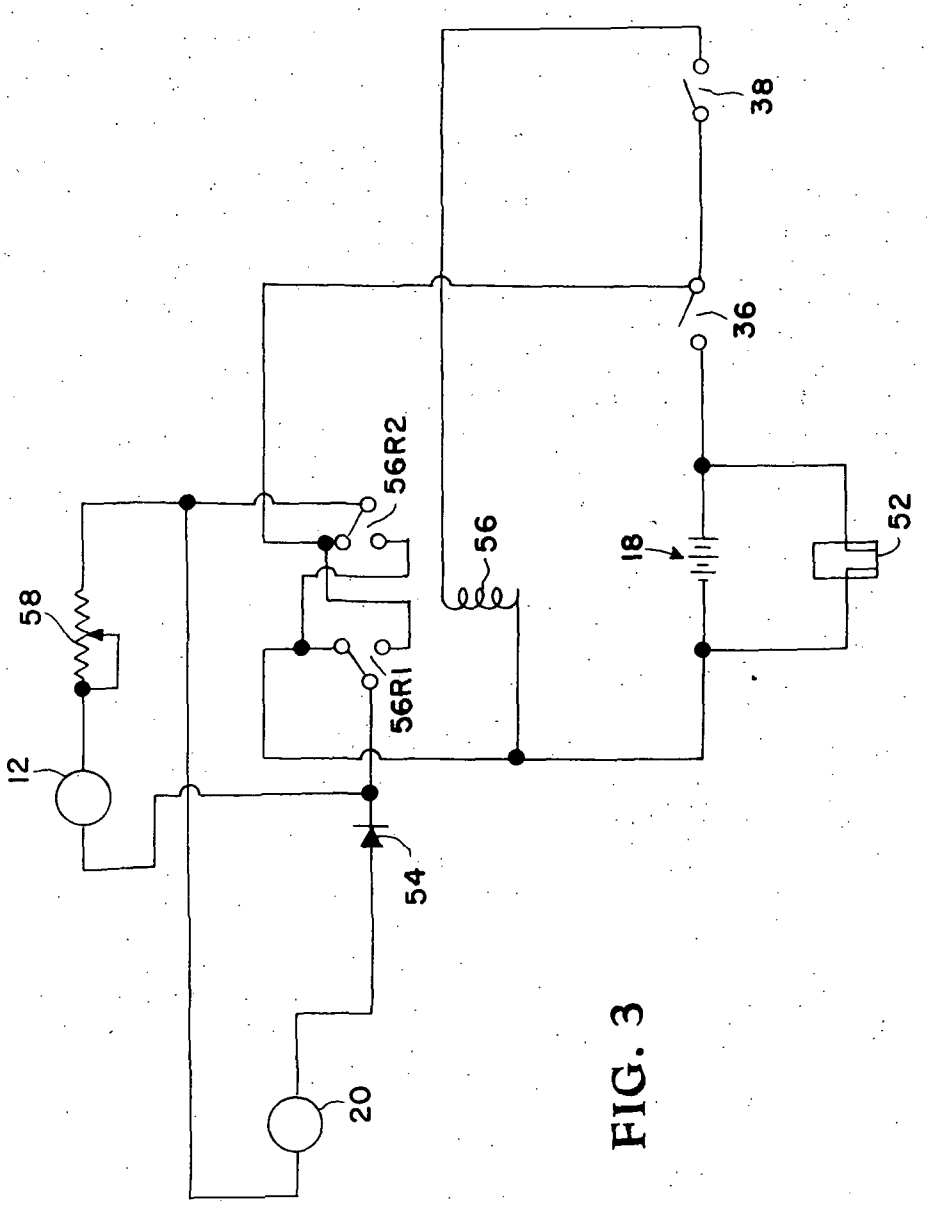

FIG. 3

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3,841,973

APPARATUS FOR MICROBIOLOGICAL SAMPLING

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Filed Jan. 24, 1973, Ser. No. 326,198
Int. Cl. C12k 1/10
U.S. Cl. 195—127 10 Claims

ABSTRACT OF THE DISCLOSURE

An automatic apparatus for microbiologically sampling surfaces using a cotton swab is provided which eliminates human error normally associated with this process. The apparatus includes a self-powered transport device, such as a motor-driven wheeled cart, which mounts a swabbing motor drive for a crank arm which supports a swab in the free end thereof. The swabbing motor is pivotably mounted and an actuator rod movable responsive to the cart traveling a predetermined distance provides lifting of the swab from the surface being sampled and reversal of the direction of travel of the cart.

ORIGIN OF THE INVENTION

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

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for microbiologically sampling surfaces using cotton swabs.

BACKGROUND OF THE INVENTION

A number of techniques are available for sampling or enumerating micro-organisms on surfaces. These include the swab-rinse method, rinse tests, the agar contact technique, direct agar surface plating and vacuum probe techniques. The advantages and disadvantages of these techniques are discussed in the literature and reference is made to Favero et al., "Microbiological Sampling of Surfaces," of Appl. Bact., Vol. 31, 1968, pages 336–343; Petersen et al., "Michrobiological Evaluation of the Vacuum Probe Sampler," Appl. Microbiol., Vol. 18, 1969, pages 1002–1006; Vesley, "Survey of Microbiological Techniques for Recovery from Surfaces," "Proceedings of Spacecraft Sterilization Technology" meeting, NASA SP–108, 1965, pages 147–153; and Walter, "Symposium of Methods for Determining Bacterial Contamination on Surfaces," Bact. Rev. Vol. 19, 1955, pages 284 to 287.

It is generally agreed that of all of these techniques, those utilizing swabbing and, in particular, those in which a surface is swabbed with a moist cotton swab and then rolled over an agar medium yields the quantitative information, especially from surfaces with known concentrations of contaminants. A primary reason for the ineffectiveness of this method stems from the manner in which the surface in question is sampled. Before exploring this point further, it should be noted that the general practice in sampling of this kind involves hand swabbing, in orthogonal directions, of the surface under a sterile template or a marked-off area, the surface being swabbed in a first direction and then being swabbed at right angles to this direction. Reference is made to Angelotti et al., "Comparative Evaluation of the Cotton Swab Rodac Methods for the Recovery of Bacillus Substilis Spore Contamination From Stainless-Steel Surfaces," Hlth. Lab. Sci., Vol. 1, 1964, pages 289–296, for an example of detailed instructions given for this procedure. In any event, as stated, it is generally accepted that swabbing techniques are subject to a number of inherent errors and actual experience has indicated a poor correlation between the amount of contamination present and that recovered by different investigators using swabbing techniques. As mentioned above, a primary source of error lies in the manner in which the swabbing is performed or, more particularly, in the fact that no two people use a swab in precisely the same way. For example, the swabbing techniques of two different investigators might differ as to speed as well as the angle and pressure applied to the swab. Because of the high precision necessary in the sampling procedure these differences can mean differences in results.

Because of the attractive features of the cotton swab method, and in particular, its ready availability, simplicity and low cost, the method is used extensively despite the limitations discussed above. Attempts to regularize the procedure using detailed instructions are perhaps of some help but the human factor, i.e., the fact that even the same investigator, much less two different investigators, will almost inevitably produce different results, has heretofore placed a severe handicap on this method particularly where a high degree of accuracy is required.

SUMMARY OF THE INVENTION

In accordance with the present invention, an automatic swabbing apparatus is provided which enables swabbing of a surface without human involvement and which thereby eliminates the human error factor normally associated with this technique. The apparatus enables control of swabbing speed, rotation of the swab, swab pressure and the swabbing angle while providing substantially uniform, complete coverage of the area to be sampled.

According to a preferred embodiment thereof, the apparatus comprises a self-powdered transport device, such as a motor-driven wheeled cart, on which an automatic swabbing device is mounted. The swabbing device preferably comprises a pivotably mounted swabbing motor which imparts a swabbing motion to an elongate crank arm in the free end of which a swab is mounted. With the motor pivoted so that the swab contacts the surface to be sampled, a combined side-to-side and spiraling motion is imparted to the swab.

An actuator bar mounted for axial movement on the cart cooperates with an obstacle placed in the path of the cart to limit the swabbing operation to a predetermined area. In accordance with a preferred embodiment, movement of the actuator bar a predetermined distance causes actuation of a limit microswitch which, in turn, causes a reversal of the direction of movement of the cart. The actuator bar is also arranged to contact a lift bar affixed to the pivot shaft for the swabbing motor so that the swab is lifted from the sampled surface at substantially the same time as the cart reverses direction.

Other features and advantages of the invention will be set forth in, or apparent from, the detailed description of a preferred embodiment found hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic perspective view of an automatic sampling apparatus in accordance with a presently preferred embodiment of the invention;

FIG. 2 is a front view, to an enlarged scale, of a detail of the apparatus of FIG. 1; and

FIG. 3 is a schematic circuit diagram of the electrical control system for the apparatus of FIG. 1.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to FIGS. 1 and 2, a presently preferred embodiment of the apparatus of the invention is shown. This apparatus includes a motor-driven cart **10** driven by a drive motor **12** mounted thereon. Cart **10** includes a pair of front wheels **14** and a pair of back wheels **16** which are interconnected by a drive shaft (not shown). A pair of bevel gears (not shown) mounted beneath cart **10** directly couple the drive shaft to motor **12**. In an exemplary embodiment, the cart **10** is 6 inches wide, 11 inches long and 6 inches high and motor **12** is a Model 41–26 electric motor manufactured by Hansen Manufacturing Company.

Motor **12** is powered from a power source comprising a battery pack **18** including two rechargeable nickel cadmium batteries which in accordance with the exemplary embodiment under consideration are of the type manufactured by the Gould Company and are rated at 10 volts D.C., 450 milliampere hours. The batteries are wired in parallel and hence provide a total capacity of 900 milliampere hours. The batteries can be held in place by a clip (not shown) secured to cart **10** by suitable means such as screws (not shown). In the exemplary embodiment being considered the 10 volts D.C. applied to motor **12** from battery pack **22** provides for a maximum drive speed of 1 inch of travel in 3.3 seconds. Lower speeds can be provided by adjusting the setting of a suitable potentiometer **58** shown in FIG. 3.

Cart **10** also mounts a second, swabbing motor **20**, motor **20** being pivotably mounted in a single gimbal **22** formed by a pair of gimbal shafts **24**, a portion of one of which is shown in FIG. 2. The gimbal shafts **24** are supporte by the upright flanges of a pair of L-shaped brackets **26**. The horizontal flanges of brackets **26** are secured to the upper surface of cart **10** by suitable means such as screws **28**. Motor **20** is mounted within ring or collar **30** from which gimbal shafts **24** extend and which has a central aperture through which motor **20** extends. The longitudinal position of motor **20** within collar **30** can be varied and a set screw **32** enables fixing of the position of motor **20** within collar **30** as desired. The armature **20***a* of motor **20** is connected to a laterally extending elongate crank arm **34**, crank arm **34** including a socket **34***a* in the free end thereof in which a swab S can be mounted. Socket **34***a* can simply be an aperture in arm **34** which provides a friction fit with the swab S. As can best be seen in FIG. 1, with motor **24** energized, crank arm **34** sweeps swab S back and forth in a predetermined pattern so as to cover or trace out a selected area. This pattern, as traced out in India Ink on sampling surface T, is shown in FIG. 1. The movement of the swab S as dictated by crank arm **34** is a combined side to side stroke plus a spiraling action in the Y–Z plane about the longitudinal X-axis. The swabbing motor **20** can be a model 6907 electric motor manufactured by Globe Industries.

An "on-off" switch **36** is mounted on the upper surface of cart **10** near the rear thereof for controlling energization of motors **12** and **20**. A reversing switch in the form of a micro-switch **38** located in advance of one of rear wheels **16** controls, in cooperation with an elongate actuating rod **40**, reversal of the direction of movement of the cart **10**. Rod **40** is mounted for longitudinal movement in spaced supports **42** and can be used in conjunction with an object or obstacle **44** deliberately placed in its path to control the size of the area being sampled. More specifically, actuator rod **40** includes an actuator cam **46** positioned at a predetermined location along the length thereof which controls actuation of micro-switch **38** which, in turn, as explained hereinbelow in connection with FIG. 3, controls reversing of the current through drive motor **12**. The location of object **44** will, of course, determine when switch **38** is actuated and, hence, the size of the area sampled.

In addition to the function described above, actuator rod **40** cooperates with a lift bar **48** to pivot swabbing motor **20** so that the swab S carried by crank arm **34** is lifted from the surface T. As can best be seen in FIG. 2, lift bar **48** is L-shaped and the horizontal leg thereof is secured to gimbal shaft **24**. More specifically, gimbal shaft **24** is received in a bore in this horizontal leg of bar **48** and a set screw **32** is used to rigidly affix lift bar **48** thereto. The vertical, downwardly depending leg of lift bar **48** is positioned such that the lower portion thereof lies in the path of actuator rod **40**. Thus, when rod **40** contacts an obstacle **44** placed in the path of movement of cart **10**, rod **40** will be moved rearwardly so that cam **46** actuates reverse switch **38** as described above and so that the end of rod **40** engages lift bar **48**, and, through the rigid connection to gimbal shaft **24**, causes pivoting of motor **20** so that swab S is lifted from the sampling surface T.

Referring to FIG. 3, the electrical control circuit for the apparatus of FIGS. 1 and 2 is shown. As illustrated, on-off switch **36** controls the connection of the power source, represented by battery **18** and corresponding to the battery pack described above, to drive motor **12** and swabbing motor **20**. A battery charging plug **52** can be used in re-charging battery **18**. Motors **12** and **20** are connected in parallel and a diode **54** permits current flow to swabbing motor **20** in one direction only. Reverse switch **38** controls energization of a relay **56** to provide switching of relay contacts **56R1** and **56R2**. As illustrated, with relay **56** energized the current through drive motor **12** is reversed so that the direction of movement of cart **10** is reversed.

It will be understood that while the invention has been described with reference to an exemplary embodiment, variations and modifications may be effected in the embodiment without departing from the scope and spirit of the invention.

What is claimed is:

1. An automatic mechanical swabbing apparatus for microbiologically sampling surfaces using cotton swabs comprising an independently movable transport device, drive means mounted on said device for propelling said device and swabbing means mounted on said device for imparting a predetermined controlled swabbing motion to a swab supported thereby during the movement of said transport device, said transport device comprising a wheeled cart and said drive means comprising a drive motor for propelling said cart.

2. A swabbing apparatus as claimed in Claim **1** wherein said swabbing means includes a movable crank arm including means for detachably supporting a swab, and a swabbing motor for driving said crank arm.

3. A swabbing apparatus as claimed in Claim **2** wherein said swabbing motor imparts a circular movement to said crank arm, said crank arm comprising an elongate crank member affixed at end of said motor and including an aperture for receiving a swab therein at the other, free end, said crank arm imparting a combined side to side and spiraling movement to a swab received thereby and in contact with a sampling surface.

4. A swabbing apparatus as claimed in Claim **2** further comprising pivot means for pivotably mounting said swabbing motor on said cart.

5. A swabbing apparatus as claimed in Claim **4** wherein said pivot means includes an annular collar for supporting said swabbing motor and through which said swabbing motor extends, gimbal shaft means secured to said collar providing a pivot axis for said swabbing motor, and bracket means for supporting said gimbal shaft means.

6. A swabbing apparatus as claimed in Claim **5** further comprising a self-contained power source mounted on said cart for powering said drive motor and said swabbing motor.

7. A swabbing apparatus as claimed in Claim **2** further comprising means for automatically reversing the direction of movement of said cart.

8. A swabbing apparatus as claimed in Claim 2 further comprising means for automatically lifting a swab from the surface being sampled responsive to said cart traveling a predetermined distance.

9. A swabbing apparatus as claimed in Claim 7 wherein said reversing means includes an actuator rod movable responsive to said cart traveling a predetermined distance and means, including a microswitch actuated by said actuator rod, for causing reversal of the direction of current flow through said drive motor when said microswitch is actuated.

10. A swabbing apparatus as claimed in Claim 9 further comprising a lift bar pivotable responsive to said actuator rod for lifting said swabbing motor from the

operative position thereof to an inoperative position so that a swab carried by said crank arm is removed from contact with the surface being sampled.

References Cited

UNITED STATES PATENTS

3,778,351 12/1973 Rosov ..... 195—127

ALVIN E. TANENHOLTZ, Primary Examiner

U.S. Cl. X.R.

195—120, 103.5 R