Aug. 1, 1972 S. NATELSON 3,681,030

HAND AUTOMATIC SAMPLER AND DILUTER

Filed Aug. 19, 1970 3 Sheets-Sheet 1

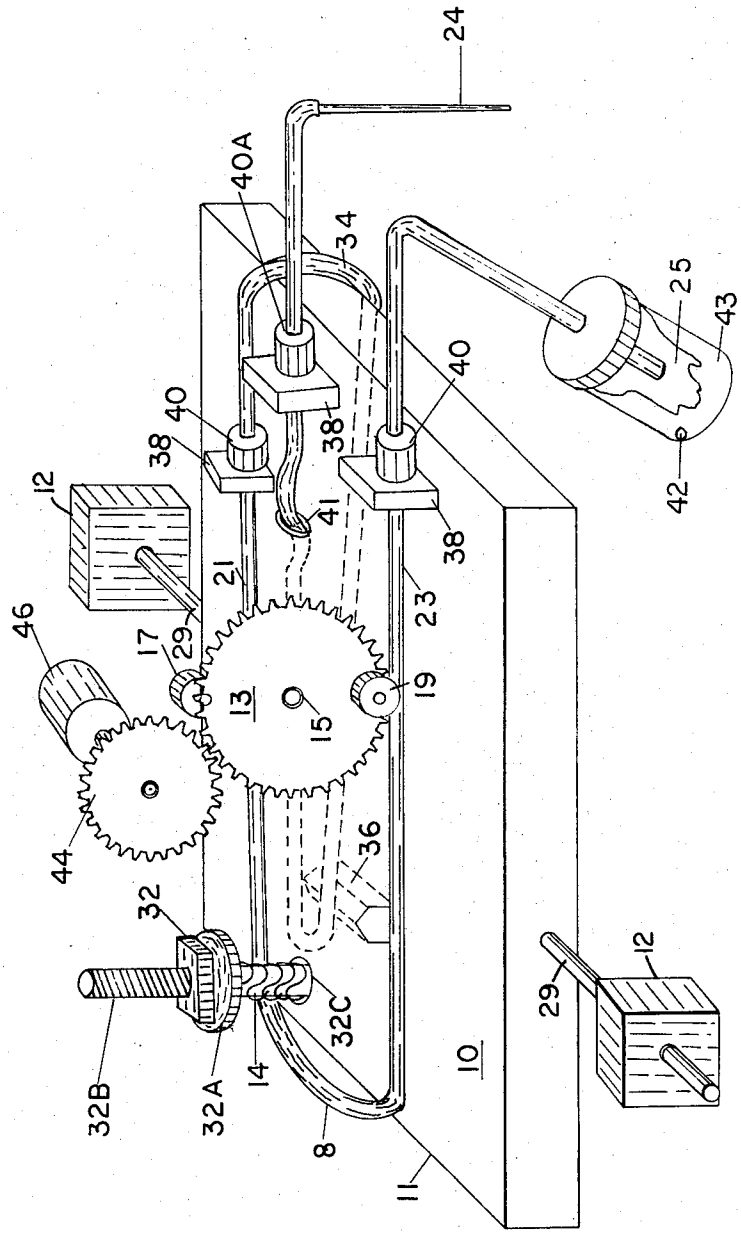


FIG. 1

SAMUEL NATELSON
INVENTOR.

BY George B. Oujevolk
ATTORNEY

HAND AUTOMATIC SAMPLER AND DILUTER

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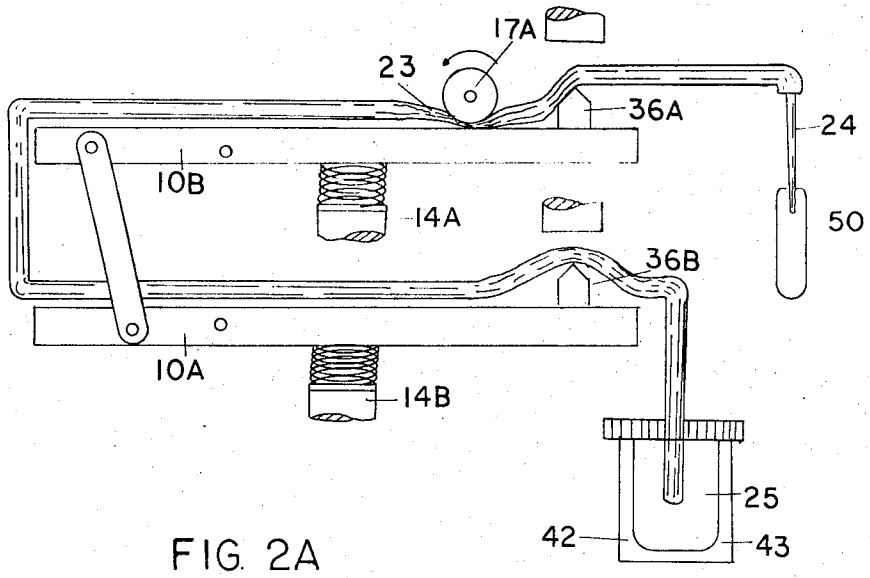


FIG. 2A

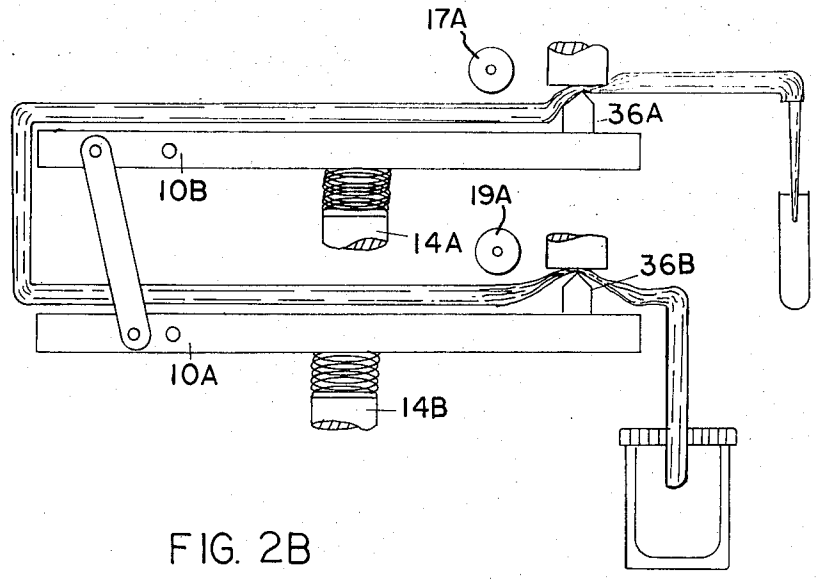


FIG. 2B

SAMUEL NATELSON
INVENTOR.

BY George B. Oujevolk
ATTORNEY

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HAND AUTOMATIC SAMPLER AND DILUTER

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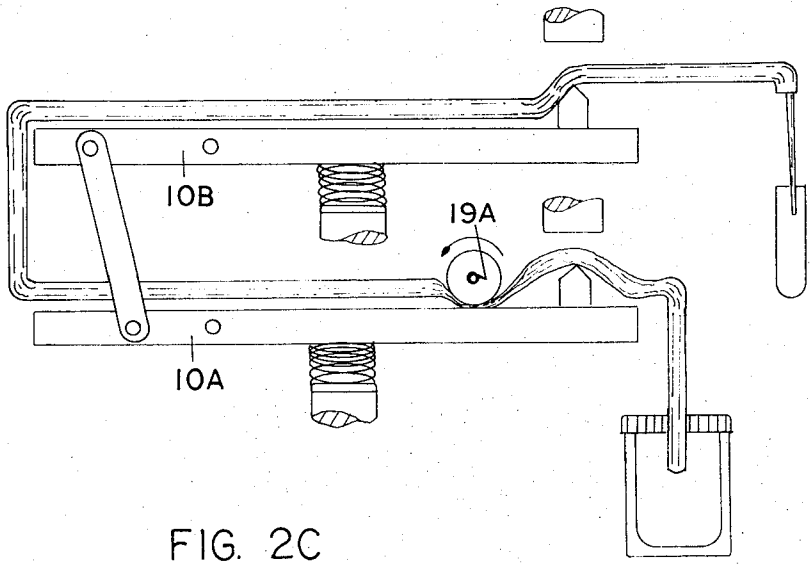


FIG. 2C

SAMUEL NATELSON
INVENTOR.

BY George B. Dujwalk
ATTORNEY

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3,681,030

HAND AUTOMATIC SAMPLER AND DILUTER

Samuel Natelson, 5508 Hyde Park Blvd., Chicago, Ill. 60616

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U.S. Cl. 23—259 2 Claims

ABSTRACT OF THE DISCLOSURE

A hand automatic sampler and diluter arrangement operable in any position and independent of gravity, comprising passing a roller over a first section of flexible tubing in order to aspirate a sample by peristalsis. A second roller passes over a second section of tubing of wider diameter to eject the sample plus some diluent. The two sections of tubes are connected, but the peristaltic action through the sections moves in opposite directions. In practice, a single wheel with two rollers on opposite sides serves to alternately pass over one and then the other tubing. The instrument is self-contained, readily portable, and hand operated. A valve arrangement permits the clamping of the tubing near the exit when neither roller is pressing the tubing.

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85–568 (72 Stat. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

The present invention relates to an automatic sampler and diluter for use with small quantities of a sample which could be contained in the hand and be hand operated, and more particularly, to an automatic sampler and diluter used to sample a specimen of blood from the fingertip and then expel the specimen with the aid of water or a reagent so as to hemolyze the blood and dilute it for analysis.

BRIEF DESCRIPTION OF THE PRIOR ART

The present instrument is useful with the arrangement described in the Samuel Natelson U.S. Patent No. 3,261,668. Automatic sampler and diluters available commercially operate by means of two sets of plungers. One plunger aspirates the specimen and the second ejects the specimen plus the diluent. These instruments generally require operation electrically by a motor and are too bulky and heavy to be used as a portable hand instrument.

SUMMARY OF THE INVENTION

The present instrument resembles a flashlight in appearance and size. The diluent is retained in the handle of the instrument. The volume of diluent in the handle is or the order to 100–200 ml. Since, usually 10–25 μl. is sampled and ejected with less than 100 μl. of diluent, as many as 1000 samples can be sampled before the instrument needs to be refilled with diluent. The thumb rotates a wheel to sample and continues rotation in the same direction to eject the sample and diluent.

Generally speaking, the present invention contemplates passing a roller over a first section of flexible tubing in order to aspirate a sample by peristalsis. A second roller passes over a second section of tubing of wider diameter to eject the sample plus some diluent. The two sections of tubes are connected but the peristaltic action through the sections moves in opposite directions. In practice, a single wheel with two rollers on opposite sides serve to alternately pass over one and then the other tubing. Means is provided to prevent the siphoning out of the

diluent when neither roller is pressing the tubing. Also there are means for providing a continuous flow of diluent without injecting air or creating a vacuum in the system.

The invention, as well as other objects and advantages thereof will become more apparent from the following detailed description when taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal perspective explanation of the apparatus contemplated herein;

FIG. 2A is a schematic explanation of the principles of operation of the apparatus shown in FIG. 1 illustrating the sampling procedure;

FIG. 2B again illustrates in schematic form similar to FIG. 2A, the situation when there is no flow of sample; and,

FIG. 2C like FIGS. 2A and 2B, shows schematically the ejection of the sample.

DETAILED DESCRIPTION

FIG. 1 shows a hand automatic sampler and diluter **11** with a gear wheel **13** which rotates on an axle **15**. On opposite sides of gear **13** are two rollers **17** and **19**. The tubing **8** rests on a platform **10** which is pivoted to the outer structure **12** of the hand held instrument and is spring loaded with a spring **14**. The rollers **17** and **19** pass over the tubing **8** and push back the platform. In this way, excessive pressure is not brought to bear on the tubing **8**. This movement of the platform **10** also serve a second function. When neither roller rests on the rubber tubing **8**, the liquid could siphon out. This is prevented because when the rollers are not on the tubing, the platform is in the up position, held there by spring **14**. This causes a piece of plastic to press on the exit tube preventing the siphoning of the fluid. The tubing is in a U-shape with two sections **21** and **23**. Section **21** is narrower than section **23** and the two sections are connected.

The rollers **17** and **19** pass alternately over rubber tubing sections **20** and **23**. When passing over tubing section **21**, the sample is aspirated at plastic tip **24** of the tubing. When passing over wider tubing **23**, diluent from a container **25** is pumped out so that the sample at the plastic tip **24** is delivered along with the diluent. The tubing rests on platform **10** which rocks on pivot **29**. Spring **14** whose tension is adjustable by nut **32**, pressing on washer **32A**, keeps the end **12** of the rocker platform **10** down, except when the rollers **17** and **19** press on the tubing. Threaded bolt **32B** which slides loosely through hole **32C**, and is bolted to an outside frame, (not shown) which remains stationary and rigid. The tubing passes under the instrument platform just before it leaves the instrument at **34**.

It then passes in a loop, one leg of the loop passing between a projection valve **36**, and the bottom of the platform. The projection valve is a solid piece of plastic anchored to the frame of the instrument and has an edge. The tubing then emerges from under the platform at **41** and goes on to the exit tip **24**.

When the rollers **17** and **19** are off the tubing, the spring **14** pushes down on the platform causing it to pivot at **29**. This serves to bring lower tubing segment **34** in contact with the rigid projection valve **36**, as shown in the drawing. This projection valve **36** presses on one leg of the tubing going below the platform **10** and acts to seal the tube. This prevents liquid flow when the rollers are off the tubing. Thus, along the travel path of the diluent from the container **25** are rollers **17** and **19** and then projection valve **36** formed by a rigid section. The outlet rubber tubing is held down and back and the projection valve **36** presses on the tubing before it acts as an outlet tube. Thus, unless the rollers **17** and **19** are acting on the tubing, the tubing outlet is blocked by the valve. In

order to keep tubing in place, stops **38** are placed around the tubing so that the tubing cannot be pulled beyond the stop points **40** and **40A**. The diluting fluid is retained in container **25** which is a plastic bag inside a plastic bottle **43** with a hole to the air. The bag collapses as diluent is removed. This occurs because the hole **42** permits air pressure to push on the outside of the plastic bag. This permits the operation of the instrument in any position and makes it independent of gravity.

Rotation of gear **13** is simplified by means of pinion gear **44** and knurled wheel **46** arrangement. Wheel **46** is operated by the thumb, while the technician holds the barrel of the instrument containing the container **25**.

The tubing **8** passes under the platform and back, so that a lower tubing segment **34** is underneath the platform. The platform moves up and down because of the pivot. When the rollers are off the tubing, the spring **14** pushes the platform. This causes the lower tubing exit segment **34** to be pressed against projection valve **36**. This acts to stop the flow of liquid. When the rollers are off the rubber tubing, the valve is thus closed. When one of the rollers presses on the tubing because of the rocker or lever action, the opposite side moves up. This releases the pressure on the loop of lower tubing exit segment **34** under the platform and the liquid may now flow. The valve is located just before the exit of the fluid so that no flow can take place when rollers are off the tubing.

The instrument may operate in any position. The reservoir of diluting fluid is kept in an inner plastic bag **25**. The plastic bag is protected by an outer plastic container **43** around it. This container has a hole **42** punched in it to equilibrate with ambient atmospheric pressure. As liquid is pumped out of the plastic bag, the plastic bag collapses. In this way, liquid will flow regardless of the orientation of the plastic bag or whether it is in a weightless environment.

The tubing in the hand automatic sampler and diluter may be replaced to change the volumes being sampled and ejected and the ratio of each to the other. For this purpose, Table I calculates the volume of fluid delivered per cm. of Tygon clear tubing. The color code is that of a readily available commercial tubing.

TABLE I

Tube selection for automatic sampler and diluter Values for volumes delivered by clear plastic Tygon tubing

Color (tubing code)	I.D. (inches)	I.D. (cm.)	Volume per cm. (μl.)
Orange-black	.005	.0064	0.13
Orange-red	.0075	.0095	0.28
Orange-blue	.010	.0127	0.51
Orange-green	.015	.0191	1.14
Orange-yellow	.020	.0254	2.03
Orange-white	.025	.0318	3.17
Black	.030	.0381	4.56
Orange	.035	.0445	6.20
White	.040	.0508	8.10
Red	.045	.0572	10.26
Grey	.051	.0648	13.17
Yellow	.056	.0711	15.88
Yellow-blue	.060	.0762	18.23
Blue	.065	.0826	21.40
Green	.073	.0927	26.99
Purple	.081	.1029	33.23
Purple-black	.090	.1143	41.02
Purple-orange	.100	.1270	50.65
Purple-white	.110	.1397	61.28

OPERATION OF THE INSTRUMENT

The instrument shown in FIG. 1 has only one platform **10**, and as a practical matter, one platform is all that the instrument should require. For ease of explanation of the principle upon which the device is based, however, two platforms **10A** and **10B** are shown in the schematic FIGS. 2A, 2B and 2C. Also, rollers **17A** and **19A** are not shown attached to a single wheel, two springs **14A** and **14B** are shown, and two valves **36A** and **36B** are shown acting on two sections of tubing which is over and not under the platform as in FIG. 1.

In FIG. 2A, roller **17A** presses on tubing **23**. This causes a sample held in a test tube **50** to be aspirated. The pressure of the roller **17A** causes the platforms **10A**, **10B** to move down against springs **14A**, **14B**. This releases valves **36A**, **36B**. Thus, pressure on the tube is released to open the tube. Since the lower platform **10A**, as shown in FIGS. 2A to 2C is tied to the upper platform **10B** by a connector, the tubing on the lower platform will also be opened so the movement of the fluid will be back to the diluent container.

When, as shown in FIG. 2B the rollers **17A** and **19A** are not acting on the tubing, the springs **14A**, **14B** push the valves **36A**, **36B** against the tubing. The valve is pressed against the tubing after the rollers, i.e., the valve action takes place closer to the entrance or discharge end of the tubing.

In FIG. 2C, roller **19A** presses and rolls across the tubing. Again the platforms **10A**, **10B** press against the springs, the roller acting on the wider leg of the tubing causes the tubing to open and to aspirate diluent which is ejected along with the original sample into the test tube acting as the sample receiver. Thus, FIG. 2A shows sampling and FIG. 2C shows ejection of the sample.

In FIG. 2A, movement of the wheel as shown will cause a sample to be aspirated. The pressure of the wheel on the support will cause it to move down against the spring and around the pivot. This simultaneously will release the pressure on the tube stop and open the tube. Since the lower platform is tied to the upper platform by a connector, the tubing will also be opened there so that movement of fluid will be back to the diluent container.

In FIG. 2B, the wheel is not pressing on the tubing. The spring causes the tube stop clamps to close, clamping the tubing and preventing siphoning. In FIG. 2C, the wheel is now pressing and turning on the wider leg of the tubing. This causes the tubing to open and aspirates diluent which is ejected along with the original sample into the test tube acting as sample receiver.

I claim:

1. A light, portable, hand operated instrument for sampling a predetermined amount of a liquid sample, and ejecting said sample with a predetermined amount of diluent, comprising in combination:

(a) a rocking platform defining an upper and an underneath portion with a pivot operatively engaging the platform so that the platform can rock, and spring means biasing one side of the platform downwards;

(b) a continuous length of tubing disposed on said platform in a U-shape with first and second parallel arm sections passing across said platform upper portion and a tubing segment passing through the platform and across said underneath portion, the bore diameter of the first arm section being smaller that that of the second arm section, said tubing segment being connected to the first arm segment and having a narrow exit at its other end capable of being dipped into a liquid sample;

(c) projecting valve means disposed under said underneath portion which will apply against said lower tubing segment because of said spring bias rocking said platform on its pivot against said projecting valve means;

(d) a wheel disposed over said upper platform portion with the wheel periphery passing between said first and second tubing sections, hand operable means to turn said wheel, a press roller on each side of said wheel periphery angularly offset from each other disposed to apply pressure on said first and second tubing sections, said wheel pressure removing said spring bias by rocking said platform on said pivot away from said projecting valve means and preventing said valve means from acting on said tubing; and,

(e) a reservoir for holding a diluent connected to the second tubing section, said reservoir comprising an

outer rigid chamber, with an opening to the atmosphere, an inner chamber with a flexible wall protected by said outer chamber so that said wall will collapse progressively under air pressure as liquid is removed from said inner chamber, permitting the instrument to be used in any direction independent of gravity.

2. An instrument as claimed in claim 1, said wheel being a gear wheel, gearing to turn said gear wheel and said hand operable means being a finger rotatable section.

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J. SCOVRONEK, Primary Examiner

U.S. Cl. X.R.

23—253 R; 73—425.6; 417—477