LOS ALAMOS SCIENTIFIC LABORATORY

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LOS ALAMOS SCIENTIFIC LABORATORY
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SAMPLE COLLECTOR AND COUNTER

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ENGINEERING

ABSTRACT

An apparatus is described which automatically separates a flow of drops into a series of equal samples. The samples are collected on foils or in small beakers placed around the outside edge of a rotating turntable. The drops are counted by means of a phototube amplifier which advances a stepping relay whenever a drop interrupts a small beam of light. The stepping relay, in turn, controls the rotation of the turntable.

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INTRODUCTION

This sample collector and counter was built to collect the drops evolved from a resin column and to separate them into 95 equal, consecutive samples of from 1 to 24 drops each.

It was the characteristic of this resin column that the drop rate was very slow, about one drop every minute or two. Thus, the counting was very tedious and, since the runs lasted for hours, the probability of human error was high where the counting was done manually. In addition, several simultaneous runs were required yet there were long layoff periods between runs. This situation posed a difficult problem in the availability of personnel for counting drops.

Another problem was that the drops had to be counted as they fell from any type of orifice in any type of glassware system. In other words, the counter must fit any type of glassware system, whereas in commercially available counters the glassware system must fit the counter.

It was for these reasons that equipment was built to do the job automatically.

DESCRIPTION

This equipment operates as follows:

As the drops fall from the tiny orifice of the resin column (or any other source of drops, for that matter) they interrupt a light beam and then are caught in a small sample holder.

The interruption of the light beam actuates a phototube amplifier (described more fully below) which then "counts" the drop. The operator selects the number of drops per sample, from 1 to 24, by setting the switch on the control panel to the desired number. After the pre-set number of drops have fallen upon a given sample holder, the next sample holder is moved into position under the orifice of the resin column and the cycle is repeated. In this manner up to 95 like samples may be taken automatically.

The sample holders used may be small foils, beakers, or any container small enough to fit around the outside edge of the rotating turntable at $3/4$ inch intervals (See Figs. 1 and 8). This turntable, about two feet in diameter, has 96 "stations" or index points equally spaced around the outside of its upper surface. Thus, up to 95 samples may be taken automatically, the 96th position being required as the "stopped" position, all remaining drops falling upon this station.

It should be emphasized at this point that the resin column (not shown in any of the figures) is not part of the equipment being described and that no control over the drop flow rate is exercised by this equipment. This apparatus merely sorts out the drops into 95 like samples of from 1 to 24 drops, all remaining drops falling upon the 96th sample holder.

The rotating turntable is machined out of $1/2$ inch aluminum plate. Each of the 96 positions is provided with a $1/2$ inch diameter pocket, suitable for positioning small beakers, and a $1/8$ inch wide slot,

suitable for getting tweezers under small foils or plates. Also at each position there is a small detent, located on the outside rim, consisting of a #6-32 round head machine screw.

In practice, square sample foils are usually cut from a sheet of foil with scissors. These are bent sufficiently or hang over the edge of the turntable enough to be picked up without the aid of the pocket or slots, which were machined at considerable expense. In the light of this and other experiences, future turntables will be made thinner and with less machining. As long as the turntable does not warp or curl it is satisfactory.

The turntable is rotated by a 1 rpm, 60 cycle motor through a friction drive. It is stopped every 1/96 of a revolution by the action of the detents located on the outside rim of the turntable, which open a roller-leaf microswitch (Station Stepping Switch, Switch 5, Fig. 6) connected in series with the motor. The motor is simply allowed to coast to a stop, the coasting distance being adequately uniform from station to station. In order to rotate the turntable one station it is necessary only to rotate the turntable far enough to close Switch 5. Switch 5 then keeps the motor running until the next station is reached.

The operation of advancing the turntable far enough to close Switch 5 (i.e., move the detent away from the roller-leaf of the microswitch) is accomplished by energizing the motor momentarily by means of another switch. This can be done manually by the "Reset and Advance" switch on the front panel of the Control Unit, or automatically by the

Drop Counter Control Unit as described below. As geared, it takes approximately 9 seconds for the turntable to advance one station and about 3 seconds for the detent to leave the roller-leaf, closing Switch 5. This speed is adequate since the fastest drop rate contemplated is 4 drops per minute.

The turntable also operates a second roller-leaf microswitch (Power-off Switch, Switch 6, Fig. 6). This switch is opened once each revolution of the turntable by a single detent located on the bottom side of the turntable rim. It is the function of this switch to turn off the entire equipment (except the pilot light) at the end of the run whenever the lower left panel switch is in the "Stop After Last Sample" position. When the latter switch is in the "Run Continuously" position, Switch 6 does not function since it is shorted. In this case the turntable just revolves endlessly so that runs can be started and ended at any station provided the instrument is constantly tended by an operator.

The operation of Switch 6 is phased with the operation of Switch 5 so that it stops the turntable on a station position and not between stations. Otherwise all the drops falling after the last sample would not be caught in a sample holder.

A handle is provided (Fig. 2) on the motor drive mechanism which disengages the motor from the turntable and permits the turntable to be easily rotated by hand. Thus a run for any desired number of samples can be quickly started without waiting for the motor to position the turntable.

As mentioned above, the drops are counted when they interrupt a beam of light as they fall upon the turntable. The light is "piped" from a small lamp to a photocell through two "L" shaped quartz rods. The light beam passes from one quartz rod to the other through a small air gap (Top of Fig. 2). A drop of liquid falling through this air gap interrupts the light beam and actuates the phototube amplifier. The phototube and light source are mounted together in a single small assembly and are connected to the control unit by means of long flexible leads. This unit may then be conveniently positioned by means of ring stand clamps. The air gap is therefore easily located in the path of the falling drops of liquid since the long thin quartz rods permit easy access into otherwise inaccessible positions. Also the quartz rods permit a quick visual check of the light beam location that is not afforded by a system using mirrors or long light paths. In addition it has been found that this system is remarkably insensitive to changes in ambient light. It has been found unnecessary to shield or tape the quartz rods. Even a flashlight does not throw in spurious counts unless directed into the end of the quartz rod. Originally, lucite rods were used and were quite satisfactory, but quartz rods are easier and quicker to make and are more efficient as light pipes. Fire polished ends provide adequate light transmission for this purpose but care must be used not to permit the ends to flare out when the fire polishing is being done. The 3/16 inch diameter quartz rods are easily mounted by inserting them into BNC electrical connectors that have been

drilled out to just clear them (See Fig. 6). These rods are then easily removed for cleaning or replacement by simply disconnecting the BNC plug from its socket.

The light source is a #41 lamp operated at 1.6 volts d.c. The #41 lamp was chosen because of its long life characteristics and because the filament is located near the tip of the glass envelope, thus permitting the filament to be placed very close to the quartz rod. The resulting increase in efficiency of collecting the light thus permits low voltage operation of the lamp with corresponding increase in life. No lenses or reflectors are required in the optical system, a big help in simplifying construction.

An a.c. operated light source cannot be used because the ripple in the light flux is sufficient to cause the phototube amplifier to count. In fact it was found necessary to filter the d.c. full-wave rectifier output as much as possible to prevent slow speed line transients from throwing in counts by changing the light intensity. Conventional constant voltage transformers were found very unsatisfactory for this purpose because of their slow response. In addition, the light source is provided with an alarm circuit that sounds a buzzer in the event of lamp failure. Such a warning permits the operator to finish the run manually or replace the lamp and perhaps save the time and expense of a wasted run.

After passing through the two quartz rods the light beam falls upon a 1P41 miniature gas phototube of the end window type. Because

the phototube is mounted in a small utility box which has small light cracks, the entire glass envelope of the phototube except the end window is wrapped with opaque tape. This expediency greatly simplifies construction of the head unit. A reduction in light intensity caused by a drop falling through the light beam results in a negative voltage pulse of approximately 30 millivolts at the cathode of the phototube. The amplitude and shape of this pulse vary, of course, with the size, velocity and opacity of the drop.

This small negative pulse is then amplified by a single tube and applied to the grid of a trigger tube. The amplifier tube is a 5691 dual triode (ruggedized 6SL7) and the trigger tube is a 5692 (ruggedized 6SN7). The amplifier voltage gain reaches a peak at about 30 cps and at this frequency has a maximum value of about 100 from the phototube cathode to the trigger tube grid. The gain may be reduced from this value by means of a gain control potentiometer. This frequency response characteristic was deliberately chosen in order to reduce the probability of spurious response and at the same time provide optimum amplification of the desired pulse. Under these conditions the best free fall height of the drop before entering the light beam is the shortest, a condition which is also the best for aligning the air gap under the orifice which emits the drops. A longer free fall distance was rejected because it required an amplifier frequency response that made the amplifier too easily disturbed by fast line transients such as those due to switching. The amplifier response below 30 cps was

made to fall off in order to minimize the response to changes in lamp brightness caused by slow variations in line voltage. As a test of stability four of these units were connected to the line here at Los Alamos for three days and not a single spurious count was observed.

The plate load in the normally cutoff side of the trigger circuit is the coil of a Western Electric 276B sealed mercury relay, Relay #1 (Fig. 6). Thus Relay #1 is closed every time a drop of liquid interrupts the light beam. The closing of Relay #1 does two things: (1) It energizes a Veeder-Root register, thus keeping a record of the total number of drops, and (2) it energizes the stepping relay, advancing it one position. It should be noted that the trigger is adjusted to stay thrown for approximately one second and is therefore dead for this period of time so that the operation of the register and stepping relay cannot cause spurious counts.

When the stepping relay has advanced the number of times set on the "Set Drops Per Sample" switch (Switch 4) it completes the circuit which energizes Relay #2, also a Western Electric 276B sealed mercury relay. The coil of this relay is connected as part of an RC time delay circuit and therefore Relay #2 remains in the closed position for approximately 6 or 7 seconds. When Relay #2 closes it resets the stepping relay to its "zero" position and energizes the turntable motor for 6 or 7 seconds, which is long enough to move the detent on the turntable away from the roller-leaf of Switch 5, as explained above, but not long enough to prevent the next detent on the turntable from

stopping the motor at the proper time.

With the turntable advanced one station and the stepping relay reset, the cycle is ready to be repeated. This cycling continues until after the last sample has been collected, at which time the single detent located on the bottom edge of the turntable opens Switch 6 and turns off the entire unit. All subsequent drops falling from the orifice fall upon this final station.

It can be seen that, aside from the phototube and rectifier, only two tubes are used, that all of the relays are hermetically sealed and that the lamp is alarmed to sound a warning buzzer in case of failure. These features provide a high degree of reliability to this equipment, reducing the chance of wasting either valuable samples or the time required to prepare them. Experience has thus far justified the design of this apparatus.

Fig. 1 Drop Counter and Sample Holder Changer

Fig. 2 Phototube Assembly and Turntable Base

Fig. 3 Top View, Drop Counter Control Unit

Fig. 4 Rear View, Drop Counter Control Unit

Fig. 5 Bottom View, Drop Counter Control Unit

NO.	QTY.	DESCRIPTION
1	1	SAMPLE PLATE
2	1	26Y-7016B-2 SHEET C-3
3	1	26Y-7016B-2 SHEET A-11
4	1	CENTRE POST
5	1	26Y-7016B-1 SHEET B-5
6	1	26Y-7016B-5 SHEET A-6
7	1	26Y-7016B-6 SHEET A-7
8	1	26Y-7016B-20 SHEET C-21
9	1	PLATE BASE
10	1	26Y-7016B-11 SHEET B-11
11	1	26Y-7016B-22 SHEET B-22
12	1	26Y-7016B-9 SHEET A-10
13	1	26Y-7016B-10 SHEET B-11
14	1	26Y-7016B-11 SHEET A-11
15	1	26Y-7016B-12 SHEET C-13
16	2	W-101116-FL-10-SS
17	1	B-11 BEARING-NUT-1/2-20-SS
18	1	RETAINING RING-BEARING-1/2-20-SS
19	4	W-32/16-16-FL-10-SS
20	17	W-32/16-16-FL-10-SS
21	17	W-32/16-16-FL-10-SS
22	5	W-32/16-16-FL-10-SS
23	1	MICRO SWITCH-1/2-20-SS
24	8	W-32/16-16-FL-10-SS
25	4	W-32/16-16-FL-10-SS
26	1	B-11 BEARING-NUT-1/2-20-SS
27	1	W-32/16-16-FL-10-SS
28	2	W-32/16-16-FL-10-SS
29	2	W-32/16-16-FL-10-SS
30	2	W-32/16-16-FL-10-SS
31	2	W-32/16-16-FL-10-SS
32	2	W-32/16-16-FL-10-SS
33	2	W-32/16-16-FL-10-SS
34	2	W-32/16-16-FL-10-SS
35	2	W-32/16-16-FL-10-SS
36	2	W-32/16-16-FL-10-SS
37	2	W-32/16-16-FL-10-SS
38	2	W-32/16-16-FL-10-SS
39	2	W-32/16-16-FL-10-SS
40	2	W-32/16-16-FL-10-SS
41	2	W-32/16-16-FL-10-SS
42	2	W-32/16-16-FL-10-SS
43	2	W-32/16-16-FL-10-SS
44	2	W-32/16-16-FL-10-SS
45	2	W-32/16-16-FL-10-SS
46	2	W-32/16-16-FL-10-SS
47	2	W-32/16-16-FL-10-SS
48	2	W-32/16-16-FL-10-SS
49	2	W-32/16-16-FL-10-SS

NO.	QTY.	DESCRIPTION
1	1	W-32/16-16-FL-10-SS
2	1	W-32/16-16-FL-10-SS
3	1	W-32/16-16-FL-10-SS
4	1	W-32/16-16-FL-10-SS
5	1	W-32/16-16-FL-10-SS
6	1	W-32/16-16-FL-10-SS
7	1	W-32/16-16-FL-10-SS
8	1	W-32/16-16-FL-10-SS
9	1	W-32/16-16-FL-10-SS
10	1	W-32/16-16-FL-10-SS
11	1	W-32/16-16-FL-10-SS
12	1	W-32/16-16-FL-10-SS
13	1	W-32/16-16-FL-10-SS
14	1	W-32/16-16-FL-10-SS
15	1	W-32/16-16-FL-10-SS
16	1	W-32/16-16-FL-10-SS
17	1	W-32/16-16-FL-10-SS
18	1	W-32/16-16-FL-10-SS
19	1	W-32/16-16-FL-10-SS
20	1	W-32/16-16-FL-10-SS
21	1	W-32/16-16-FL-10-SS
22	1	W-32/16-16-FL-10-SS
23	1	W-32/16-16-FL-10-SS
24	1	W-32/16-16-FL-10-SS
25	1	W-32/16-16-FL-10-SS
26	1	W-32/16-16-FL-10-SS
27	1	W-32/16-16-FL-10-SS
28	1	W-32/16-16-FL-10-SS
29	1	W-32/16-16-FL-10-SS
30	1	W-32/16-16-FL-10-SS
31	1	W-32/16-16-FL-10-SS
32	1	W-32/16-16-FL-10-SS
33	1	W-32/16-16-FL-10-SS
34	1	W-32/16-16-FL-10-SS
35	1	W-32/16-16-FL-10-SS
36	1	W-32/16-16-FL-10-SS
37	1	W-32/16-16-FL-10-SS
38	1	W-32/16-16-FL-10-SS
39	1	W-32/16-16-FL-10-SS
40	1	W-32/16-16-FL-10-SS
41	1	W-32/16-16-FL-10-SS
42	1	W-32/16-16-FL-10-SS
43	1	W-32/16-16-FL-10-SS
44	1	W-32/16-16-FL-10-SS
45	1	W-32/16-16-FL-10-SS
46	1	W-32/16-16-FL-10-SS
47	1	W-32/16-16-FL-10-SS
48	1	W-32/16-16-FL-10-SS
49	1	W-32/16-16-FL-10-SS

NO.	QTY.	DESCRIPTION
1	1	W-32/16-16-FL-10-SS
2	1	W-32/16-16-FL-10-SS
3	1	W-32/16-16-FL-10-SS
4	1	W-32/16-16-FL-10-SS
5	1	W-32/16-16-FL-10-SS
6	1	W-32/16-16-FL-10-SS
7	1	W-32/16-16-FL-10-SS
8	1	W-32/16-16-FL-10-SS
9	1	W-32/16-16-FL-10-SS
10	1	W-32/16-16-FL-10-SS
11	1	W-32/16-16-FL-10-SS
12	1	W-32/16-16-FL-10-SS
13	1	W-32/16-16-FL-10-SS
14	1	W-32/16-16-FL-10-SS
15	1	W-32/16-16-FL-10-SS
16	1	W-32/16-16-FL-10-SS
17	1	W-32/16-16-FL-10-SS
18	1	W-32/16-16-FL-10-SS
19	1	W-32/16-16-FL-10-SS
20	1	W-32/16-16-FL-10-SS
21	1	W-32/16-16-FL-10-SS
22	1	W-32/16-16-FL-10-SS
23	1	W-32/16-16-FL-10-SS
24	1	W-32/16-16-FL-10-SS
25	1	W-32/16-16-FL-10-SS
26	1	W-32/16-16-FL-10-SS
27	1	W-32/16-16-FL-10-SS
28	1	W-32/16-16-FL-10-SS
29	1	W-32/16-16-FL-10-SS
30	1	W-32/16-16-FL-10-SS
31	1	W-32/16-16-FL-10-SS
32	1	W-32/16-16-FL-10-SS
33	1	W-32/16-16-FL-10-SS
34	1	W-32/16-16-FL-10-SS
35	1	W-32/16-16-FL-10-SS
36	1	W-32/16-16-FL-10-SS
37	1	W-32/16-16-FL-10-SS
38	1	W-32/16-16-FL-10-SS
39	1	W-32/16-16-FL-10-SS
40	1	W-32/16-16-FL-10-SS
41	1	W-32/16-16-FL-10-SS
42	1	W-32/16-16-FL-10-SS
43	1	W-32/16-16-FL-10-SS
44	1	W-32/16-16-FL-10-SS
45	1	W-32/16-16-FL-10-SS
46	1	W-32/16-16-FL-10-SS
47	1	W-32/16-16-FL-10-SS
48	1	W-32/16-16-FL-10-SS
49	1	W-32/16-16-FL-10-SS

BILL OF MATERIAL			
PART NUMBER	QUANTITY	UNIT	DESCRIPTION
-1	1	ASSY	24 DIA. 1/2 175T OR 245T

*36(1065) DRILL - 1/16 DEEP
 6-32 NC TAP - 1/16 DEEP
 96 HOLES EQUALLY
 SPACED AS SHOWN

1/8 WIDE x .020 DEEP SLOT
 96 PLACES EQUALLY
 SPACED AS SHOWN

1/2 DIA POCKET - .010 DEEP
 96 PLACES EQUALLY
 SPACED AS SHOWN

SECTION A-A
 SCALE: 3:1

3/6 DR (1065) THRU
 6-32 NC 2 TAP THRU
 (A1)

15° TYP.

22 1/2 DIA.
 23.250 DIA.
 23 3/4 DIA.

REAM .3750-.3756 THRU

TYPICAL SPACING - TOLERANCE
 IS ± 0.15 BETWEEN ANY
 TWO POCKETS. ERROR NOT ACCUMULATIVE

GENERAL NOTES
 1. UNLESS OTHERWISE SPECIFIED:
 All dimensions are in inches unless otherwise noted.
 2. Surface finish is to be as shown on drawing.
 3. Material is to be as specified in the drawing.

REV.	DATE	DESCRIPTION	BY	CHKD.	APP'D.
A1	1/14/55	*6-32 TAPPED HOLE ADDED	W. J. L.	W. J. L.	W. J. L.

TOLERANCES - UNLESS OTHERWISE NOTED			
FRACTIONAL	DECIMAL	ANGULAR	RADIUS
± .005	± .001	± .005	± .005
ORIGINATION	DATE	REVISION	DATE
W. J. L.	1/14/55	W. J. L.	1/14/55
DRAWN	W. J. L.	CHKD.	W. J. L.
CHECKED	W. J. L.	APP'D.	W. J. L.
PUBL. ENL.	W. J. L.	TOT. BTL.	SCALE
APPROVER	W. J. L.	DATE	SCALE
W. J. L.	1/14/55	1/14/55	1/14/55

TITLE: SAMPLE PLATE
 SAMPLE CHANGER
 SINGLE ROW

DRAWING NO. 26Y-70228
 PART NO. D-2-1