A PORTABLE AIR SAMPLER FOR FIELD USE

by

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INTRODUCTION

The aerial application of insecticides for forest insect control relies on the drift and diffusion of the spray cloud through the forest canopy to provide coverage of the target area. The standard method of assessing the spray deposit is to collect droplets on flat surfaces and by chemical and/or visual means calculate the amount of material present. Flat collecting surfaces are not efficient collectors of very small droplets which can be of significance with respect to spray efficacy and environmental contamination. Yule and Cole (1969) measured the concentration of insecticide in the atmosphere during the New Brunswick spray operation using suction collecting devices. The units were powered either by 110 volt motors which limited their position or by car batteries, which because of their weight, created a problem where they had to be moved considerable distances by hand. Commercial light-weight battery-powered suction devices are available but with their relative high cost a limit on number of units can be imposed.

This report is a description of the construction of an inexpensive, battery powered sampling unit. The sampler is designed for use in the outdoors and with its relatively light weight and design it is readily portable. The sampler can be fitted with a remote control switch system which enables the operator to position units prior to use and then operate them as required from a central site. Figure 1 is a photo of a sampler unit with the remote control feature plus flowmeter and cascade impactor mounted.

The sampler consists of a case with carrying handle, a 12 volt battery and vacuum pump and, if desired, a flowmeter and remote control unit. The complete sampler weighs 12 kg (27 lbs.) with outside dimensions of 282.5 x 42.8 x 209.5 cm (11 1/8 x 5 5/8 x 8 1/4 inches). On a freshly charged battery the unit will run a minimum of 5 hours and will operate at temperatures ranging from 1.3°C to 32.2°C.

Figure 1

Fully equipped air sampler with remote control unit, cascade impactor mounted on frame, flowmeter and remote control receiver.

MATERIALS

The following materials are used in the construction of the carrying case and the pump system:

Main frame: aluminum sheets, 1/8" x 3" x 28"

aluminum angle, 1" x 1" x 1/8", 55 inches long.

Handle: aluminum strap, 1/8" x 1", 11" long.

aluminum rod, 1/2" x 6".

Lid: aluminum sheet, 1/6" x 8 1/2" x 5 3/4".

Component tray: 7 1/2" x 5" x 1/16"

Strap: 1" x 1/16" x 12".

Hinge (piano): 5" length.

Rivets: 1/8" (1/8" x 1/2), 24

Components:

Vacuum pump, Gast U33D, 0.67 cfm free air

Switch, SpSt (1)

Terminal strip, 4 post

Relay, Guardian series 200, 6 vac. DpDt (for remote control)

Telephone jack

Cinch Jones connectors, 2 prong, in line male, 2 prong in line female

Wire, No. 18 AWG, stranded

Nuts and screws, assortment of 6-32 nuts and screws

Remote control, any model.

The unit was built to take a standard 12 volt Ski Doo battery[1,2] (dimensions 7 3/4" x 5 5/32" x 7 9/16" high) and all measurements are

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1 Use of the brand name does not imply endorsement of the product.

2 Ski-Doo battery, available from most outdoor sport supply stores in Canada.

to fit this unit. If another type of battery with different dimensions is used measurements will have to be adjusted accordingly.

Dimensions for stock aluminum are still given commercially in English units, for this reason all measurements used in this publication will be in these units.

The sides of the case and handle supports are made from the 1/8" aluminum plate. The frame to hold the battery is made using the 1 x 1 x 1/8" angle and the lid, base plate for the battery and component tray are from the 3/32" aluminum plate. The handle is made from the 1/2" rod.

Construction of the carrying case is straightforward; all aluminum parts are fastened using 1/8" countersunk aluminum rivets. The frame can be welded but this requires expertise in aluminum welding and will result in an increase in cost.

1. <u>Construction of the carrying case.</u>

The frame to hold the battery is, as has been stated, designed for a standard snowmobile battery. The material used in the frame construction is the 1 x 1 x 1/8" aluminum angle. Two pieces each 27 1/4" long are cut and after being notched as shown in Figure 2 are bent to a U shape. The upper portion of the case is made from the 1/8" plate, two pieces each 3 x 5 3/8" and two pieces each 3 x 8 1/4" are used. Prior to assembly holes are cut in these plates and in the aluminum angle supports. The precise position of the rivet holes is left to the discretion of the builder. Figure 3 shows the position and sizes of other holes required in each plate. A recent modification to the carrying case permits easy removal of the battery. This is done by making four separate legs from the aluminum angle each 11" long which are fastened to the upper portion of the case. Two pieces of angle each 5 1/4" long are cut. Holes are drilled in these cross pieces to match with holes at the bottoms of each leg. The cross pieces are fastened using screws and when the battery is to be removed these pieces are taken off and the battery can be slipped out the bottom of the frame.

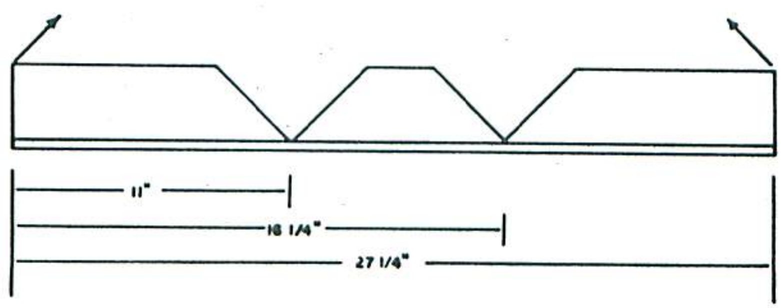

Figure 2

Cuts to the 1 x 1 x 1/8" aluminum angle to make battery frame.

The component tray (Figure 4) is made from 3/32" aluminium plate and is suspended in the case by four strips of aluminum fastened to the case with 6-32" counter-sunk machine screws. Measurements of the tray are 7 1/2 x 5 x 1/16"; it is recommended that the builder cut the tray to fit the inner dimensions of the frame and leave sufficient space for easy insertion or removal of the tray. Notches (notch E in Figure 3 and F in Figure 4) are cut to allow clearance for the handle bolts.

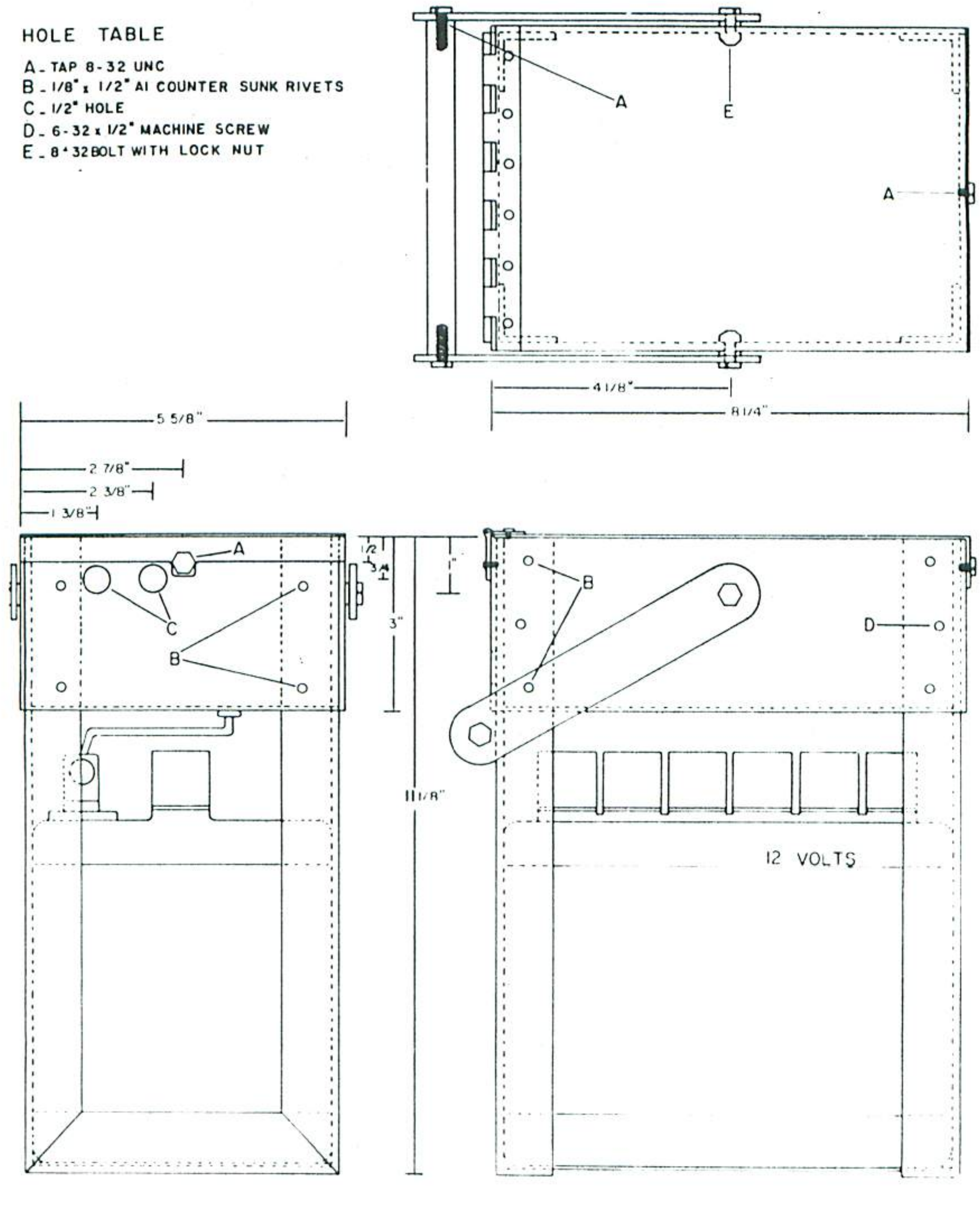

Figure 3
Hole table

INTERNAL COMPONENTS

A - INLET AND OUTLET PORTS, 1/2"
B - SWITCH, SPST
C - VACUUM PUMP
D - JACK INLET, 5/8"
E - JACK
F - NOTCH TO BYPASS HANDLE BOLTS
G - RELAY, SCNO
H - POWER SUPPLY FROM BATTERY
I - TERMINAL STRIP
J - BRACKETS, HELD WITH 6-32 MACHINE SCREWS
K - INLET FOR VACUUM PUMP

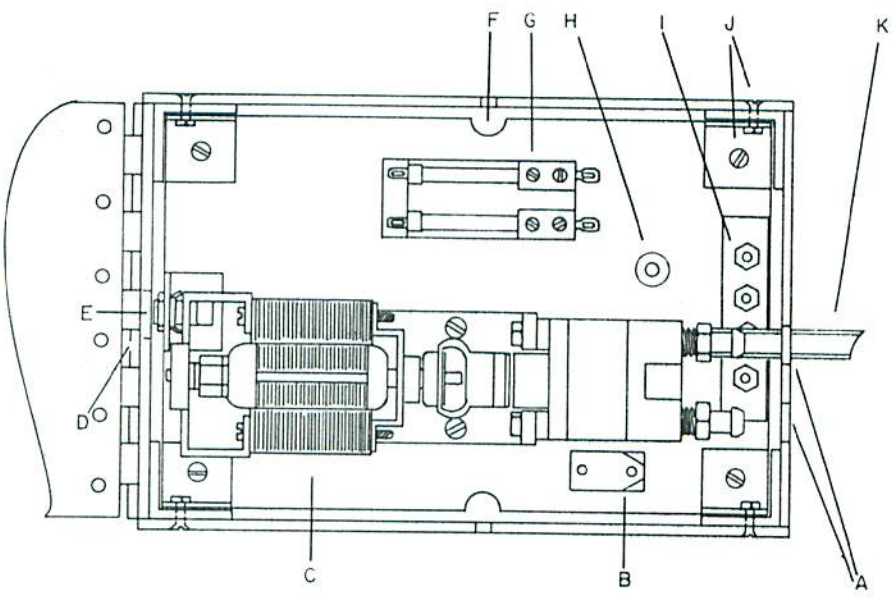

Figure 4

Component tray

The handle is made from the 1/8 x 1 X 11 inch strap and the 1/2 x 6 inch aluminum rod. The strap is cut into two pieces each 5 1/2" long and the ends of the straps are rounded as shown in Figure 3. Centred in each end of the straps is a hole for the 6-32 screws used to fasten the handle into position and to fasten the straps to the frame of the unit. A flat piece of 1/16" aluminum sheet, attached to the case with a piano hinge and suitable screws or rivets makes a lid for the unit.

2. Mounting components

Positioning of the electrical and mechanical components is left to the discretion of the builder. The pump unit is positioned such that the inlet and outlet connections line up with the holes in Figure 3. The electrical parts are mounted as desired, sufficient clearance exists to allow for variations in dimensions of component parts if changes have been introduced by the manufacturers. The electrical components required include a 12 volt DC Gast vacuum pump[1]. Depending on requirements, the pump is available in two capacities. .35 cfm @ 0" Hg. or .67 cfm @ 0" Hg.; in all work done at CCRI the 0.35 cfm pump has been used.

A single pole single throw switch is used to control the pump. A short terminal strip is used to accommodate the wiring.

The model shown in Figure 7 is capable of being operated by remote control and requires two more electrical components. A single contact normally open relay and a standard phone jack are used in the switching line.

A two prong plug (Cinch Jones) is used to connect the component tray to the battery. (See Figure 5).

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[1] Available from Wainbee Ltd., 121 City View Dr., Rexdale, Ont. for approximately $75.00.

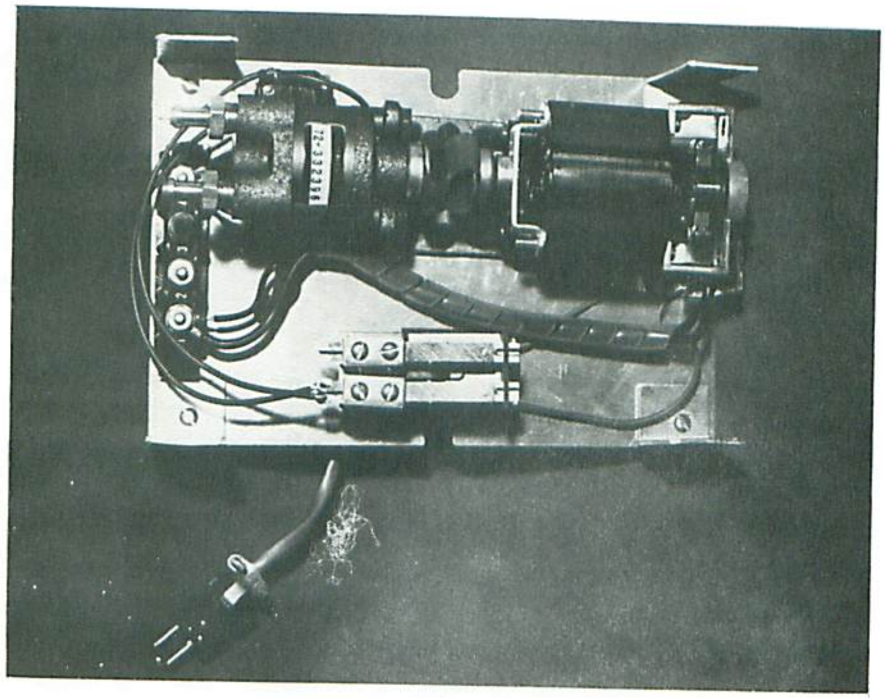

Figure 5
Component tray with pump unit and switch in position

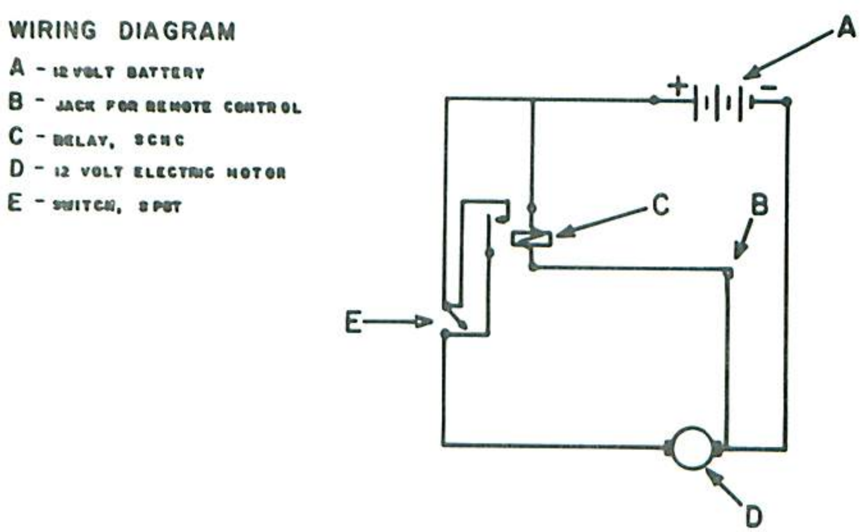

Figure 6
Wiring Diagram

The wiring as shown in Figs. 6 & 7 is completed with 18 AWG stranded plastic jacketed wire. Care should be taken to make a harness of some type to keep the wires from becoming entangled in the pump. (See Figure 5).

3. Remote Control

During an aerial spray, it was found that there was little time before a spray started to be in a number of locations at once to turn on widely scattered samplers. For this reason the original equipment was designed to be operated by remote control.

The system used was a Heathkit 3 channel digital proportinal radio control system, model GD-57.

The servos are mounted in an aluminum box as in Figure 7. Each servo is used to activate a low force push on, push off switch. In this manner, a number of samplers can be turned on and off at any given time.

4. Field Evaluation

The portable sampler described in this report is very versatile in the field. Figure 8 below, shows three samplers set up for three different sampling jobs.

A gas wash bottle for the sampling of vapor for gas chromatograph analysis.

A cascade impactor for drop size determination and colorimeter analysis.

A filter for solid particulate studies.

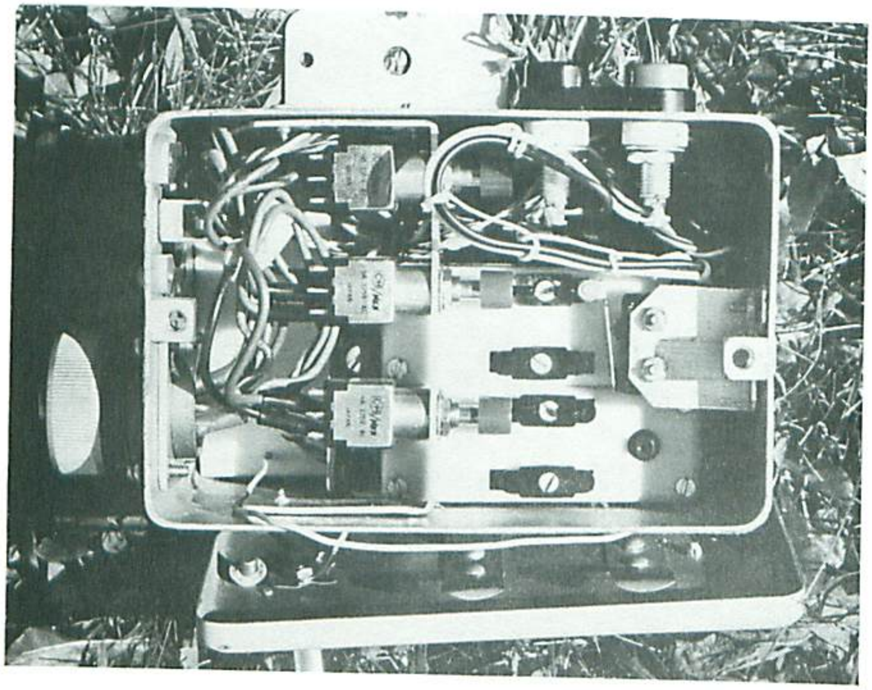

Figure 7
Remote control switching device

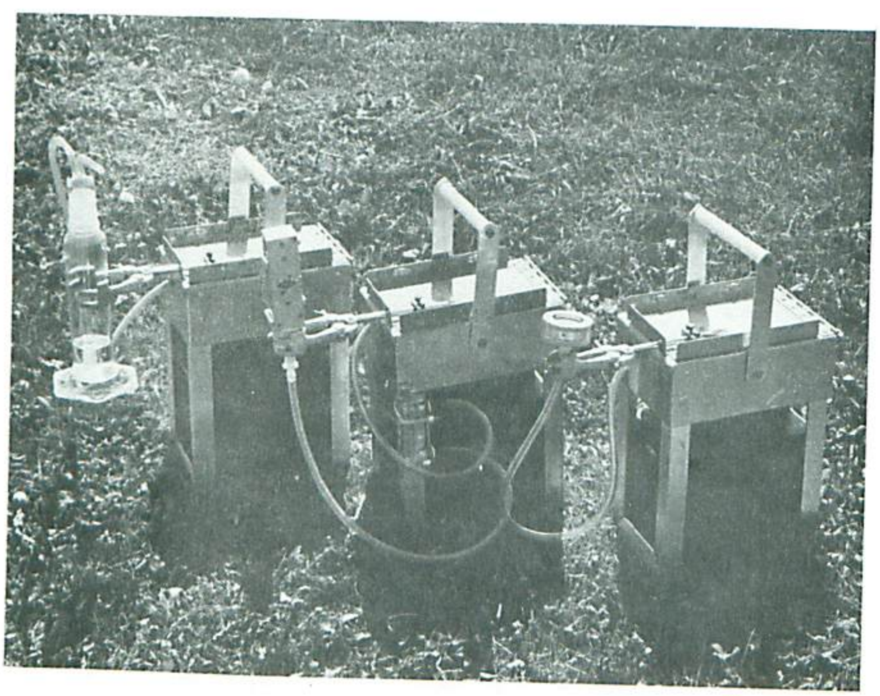

Figure 8
Three typical configurations for samplers

The flow rate from the pump is determined by one of two methods. The rate can be pre determined by a flowmeter and by using a restrictor or a bypass valve the desired flow can be set on each sampler. If flow rates have to be changed often, a flowmeter can be mounted on each sampler. (See middle sampler in Figure 8).

The flowmeter used is number 8221 available from Gelman[1] and is calibrated from .2 to .7 cfm or 5 to 20 lpm. The meter is four inches long, and its small size makes it quite suitable for the system.

The various sampling devices can be attached to the sampler in any number of different ways. The samplers in this report use a standard laboratory clamp fastened to the lid of the sampler. This type of clamp is very versatile and will hold almost any type of laboratory equipment. (See the clamps in Figure 8).

For studies where samples are taken within the canopy of a tree, the sampler can be taken from the case. The sampler can be placed in the tree and the battery pack left on the ground. The sampler in this report has been used with 50 feet of hose between the sampler and the pump.

Operation outside was found to be quite satisfactory between 1.6° and 32.2° Centigrade (35° and 90° Fahrenheit). Due to the fact the pump is completely enclosed a temperature study was carried out to determine the external heat range that the unit was capable of operating within. The sampler operated quite well at an outside temperature of 32°C (90° F) stabalizing at 45° C after 20 minutes.

The remote control feature for the samplers makes them quite useful in the field where a number of samplers are to be turned on or off at one time. The Heathkit unit used, (Approximately $200.00)

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[1] Gelman Instrument Company, Ann Arbor, Michigan.

will operate samplers up to 1/2 a mile, line of sight. Forest density and terrain play an important part in the distance at which the control will operate. By using stronger transmitters more range can be obtained.

A typical set up is shown in Figure 10. Up to 500 feet of 18 AWG wire (Beldon Cable 9740) can be used between each sampler and the receiver.

Maintenance on the unit is minimal. The pump requires no lubrication and cleaning instructions are supplied with each pump. The battery which powers the pump is the only item which requires attention. The battery can be charged while still in the case. By fitting a battery charger with the same type of plug that joins the component tray to the battery, charging becomes a simple matter of disconnecting the battery from the tray and plugging it into the charger. When the battery requires water, it is a simple matter to remove the component tray, this leaves the filler caps accessible.

5. Discussion

The portable sampler was designed and built primarily for use in aerial spraying. However the wide operational temperature range, the remote control feature and the portability of the unit make it adaptable to a wide range of uses. The pump is available in 110 Volts AC and could be used where a power supply was available. It is also possible to place two pumps in one case, thus being able to drive two samplers from one unit.

For operating under extremely high temperatures, the case could have ventilation holes placed in it, or the unit could be fitted with a temperature control circuit which would shut the pump off when it got too hot. Visual or audio signals could be installed so that while being used on remote control the unit would signal a positive on or off.

To eliminate charging problems a charging unit could be built into each case. If the remote control system is not used, there are timers which could be installed in each unit which would turn the pump on or off at any given time.

6. Summary

The size and drift of aerial applied spray is a critical factor in the determination of the performance of a spray. This paper describes a portable sampler which can be used effectively to obtain these results.

Reference

YULE, W. N. and A.F.W. COLE, 1969. Measurement of insecticide drift in forestry operations. Proc. 4th Int. Agric. aviat. Cong. (Kingston, 1969): 346-353.