UCRL-7894

UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Livermore, California

Contract No. W-7405-eng-48

PORTABLE BATTERY-OPERATED HIGH-VOLUME AIR SAMPLER

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June 10, 1964

DISCLAIMER

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ABSTRACT: A portable, 32-pound battery-operated air sampler having a flow capacity of 10 cfm has been assembled. The unit consists of a 24-V dc Staplex Hi-Volume sampler powered by light-weight, 12-V, 12-A-hr rechargeable storage batteries. Battery discharge during a sampling period of 30 minutes results in a reduction in flow rate of about 11%. Wet batteries have been repeatedly recharged without damage. Portability and its self-contained features appear to make it useful for short-duration sampling in areas where ac power is not readily available.

INTRODUCTION

There is frequent need for air sampling in areas where ac power does not exist, and where use of motor-generators is impractical. Portable battery-operated air samplers are commercially available, but at present their flow capacities are so low that detection of the maximum allowable concentration of many airborne contaminants cannot be detected within convenient sampling periods. Our operations required a battery-operated sampler that would collect a sample volume of 100 cf within 10 minutes.

*Work done under the auspices of the U. S. Atomic Energy Commission.

Weight was of importance because it may be necessary to hand carry the sampler for considerable distances. It was anticipated that several units might be required so cost was also a consideration. Finally, to expedite production and future maintenance, only commercially available components were considered.

DESCRIPTION

Selection of Components

Our design is based on use of a Staplex Hi-Volume unit, factory equipped with a 24-V dc motor. This motor requires a current of 12 A for rated capacity. For fixed sampling stations, two 12-V, 100-A-hr storage batteries are normally recommended as a power supply. However, these are obviously too heavy to be used with a portable sampler. A search for a light-weight rechargeable 24-V battery system produced two possibilities. One was to assemble a battery pack of silver-zinc alkaline cells in sufficient number to provide the required voltage. The other was to use the compact 12-V, 12-A-hr wet storage batteries now supplied for one of the motor scooters (the Rabbit). Fifteen of the 16-V alkaline cells would be required, weighing a total of eight pounds. The 12-V wet batteries weigh 7 pounds each, and two are required. Therefore, the alkaline cell pack would be about 6 pounds lighter. However, as the alkaline cell system costs about $250.00 compared to $33.00 for the two wet batteries, we chose the latter.

Two of these batteries (MBW3-12D, Yuasa Battery Co., Ltd., Japan) are connected in series. Placed side by side, they measure 5-3/4-in. wide, 5-1/4 in. high, and 5-1/4 in. long. This battery pack was mounted in a metal case (7 × 8 × 10 in.) attached to the bottom of the sampler. The sealed batteries are equipped with breathing tubes. These tubes were manifolded

and led to a vented polyethylene bottle inside the case. This bottle acts as a trap to retain battery fluid if the sampler is overturned and collects water evaporated from the batteries during charging. To eliminate an extra battery charging package, a charging circuit was mounted within the case. This charger — a silicon-controlled rectifier — provides charging rates up to 0.75 A. A spring-wound timing switch (Mark-Time Model 74742, 0 to 30 minutes) was wired into the circuit so that the charging circuit is disconnected in the timing position, when the sampler motor is running. In the off position, the switch disconnects the motor and connects the charging circuit. The charger is fused with a 2-A fuse and a pilot light indicates a charging condition. Figure 1 shows a schematic of the components just described while Fig. 2 shows the batteries and charger removed from the case. Figure 3 is a view of the assembled unit. The sampler weighs 32 pounds. The factory-supplied carrying handle has been replaced with a stronger one to support the additional weight. This modification also provides more clearance between the handle and the sampler body to facilitate carrying the sampler when the hand is heavily gloved.

PERFORMANCE

Figure 4 shows a performance curve for the battery-operated Staplex in which flow capacity is plotted against static pressure. This curve is typical of performance after a 16-hr recharge at an initial charging rate of 0.75 A (the maximum rate recommended).

The effect of battery discharge on flow capacity was determined by a series of six runs in which the flow rate was measured at 5-minute intervals over a 30-minute period. Each run was preceded by a 16-hr battery charge. Flow rates at each time interval were converted to percentage of the initial

flow, and the average values were plotted in Fig. 5. These data show an approximately linear decrease in flow rate over a 20-minute period. At 30 minutes, although the flow rate decreases more sharply, it is still about 89% of that obtained at full battery charge. Initial flow rates typical of those observed with the filter media used are shown in Table I.

It was our original intent to protect the batteries by limiting sampling periods to 10 minutes and to recharge each time the sampler was used. However, since the flow capacity of the recharged sampler is reproducible after a 30-minute run, it appears that the batteries are not damaged during the longer discharge period.

Provisions have been made for equipping the sampler with charcoal filters if the airborne contamination to be sampled contains radioiodine. The Staplex filter holder was replaced with the holder in Fig. 6 (as seen attached to the sampler). A 3-1/4-in. diameter charcoal cartridge can be inserted in this holder and sealed against the internal O ring. As an alternative, an adaptor can be inserted (Fig. 6 lower center) to permit use of the 2-1/2-in.-diameter screw-type cartridge. The particulate filter is placed on the screen support and held in place by the threaded retaining ring as usual.

APPLICATION

The battery operated Hi-Volume Air Sampler just described has performed satisfactorily at the Nevada Test Site under extremes of temperature, humidity, dust exposures and handling conditions. The wet batteries have been recharged repeatedly (about 25 recharges) over a 6-month period with no signs of deterioration.

To date, the only maintenance required is periodic addition of battery water evaporated during recharging. Although current leakage appears to be

low, the batteries of samplers stored for emergency use should be recharged at approximately 2-week intervals to assure full charge performance. In contrast to the ac unit, heat dissipation during sampling is not a problem since power consumption is only about 250 W. Portability and the self-contained features of the unit appear to make it useful for short-duration air sampling in areas where power for conventional equipment is not readily available.

/gmc

Table I. Flow capacity of battery-operated Hi-Volume air sampler.

Particulate filter (3-1/2 in. diameter)	Charcoal cartridge	Average initial flow, cfm (after 16-hr recharge)
Whatman 41	None	15
Gelman E (glass fiber)	None	16
"	BM 2306, 3-1/4 in. diam.	11
"	MSA, GMA, 2-1/2 in. diam.	10

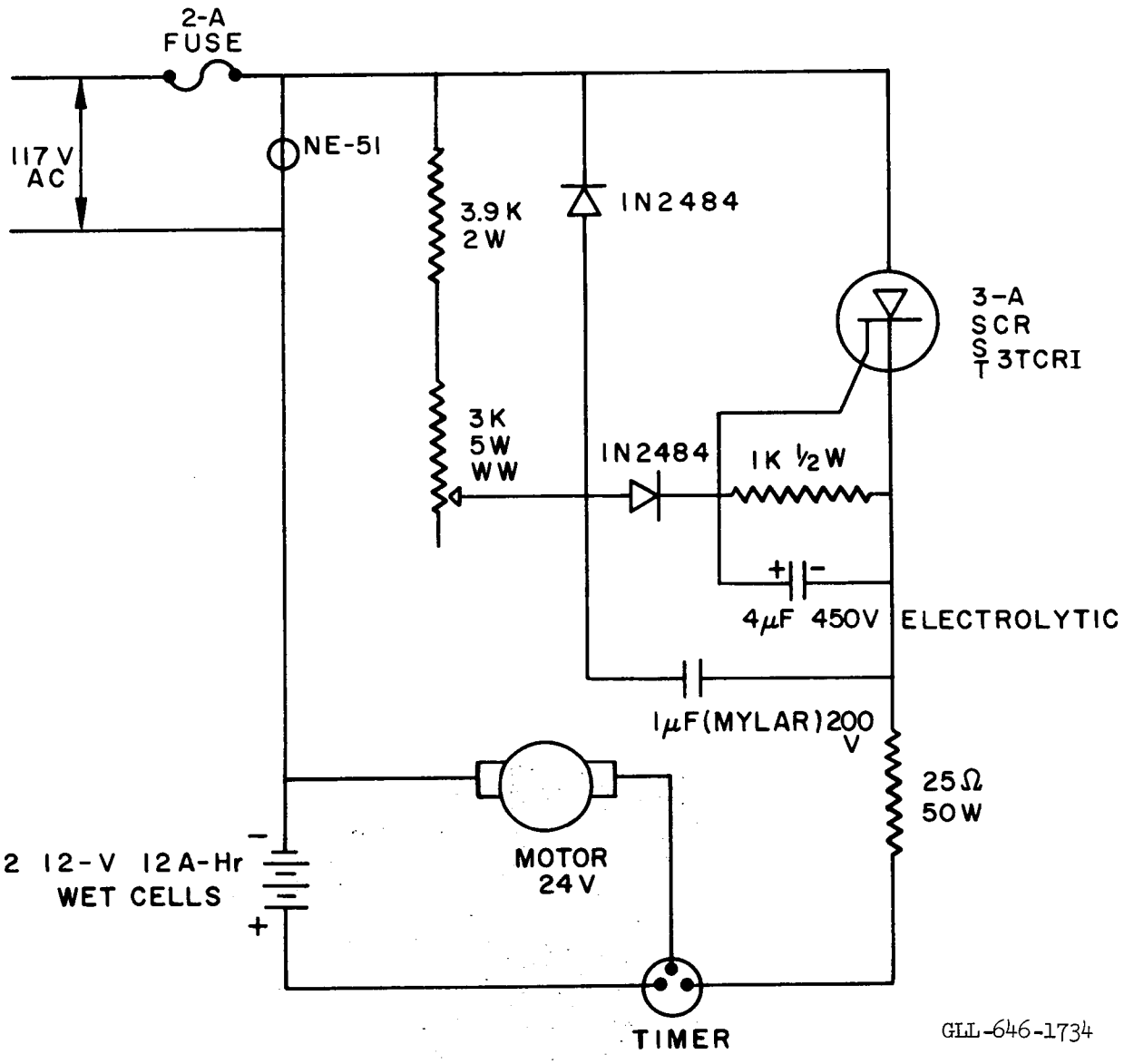

Fig. 1. Schematic of battery-operated high-volume air sampler.

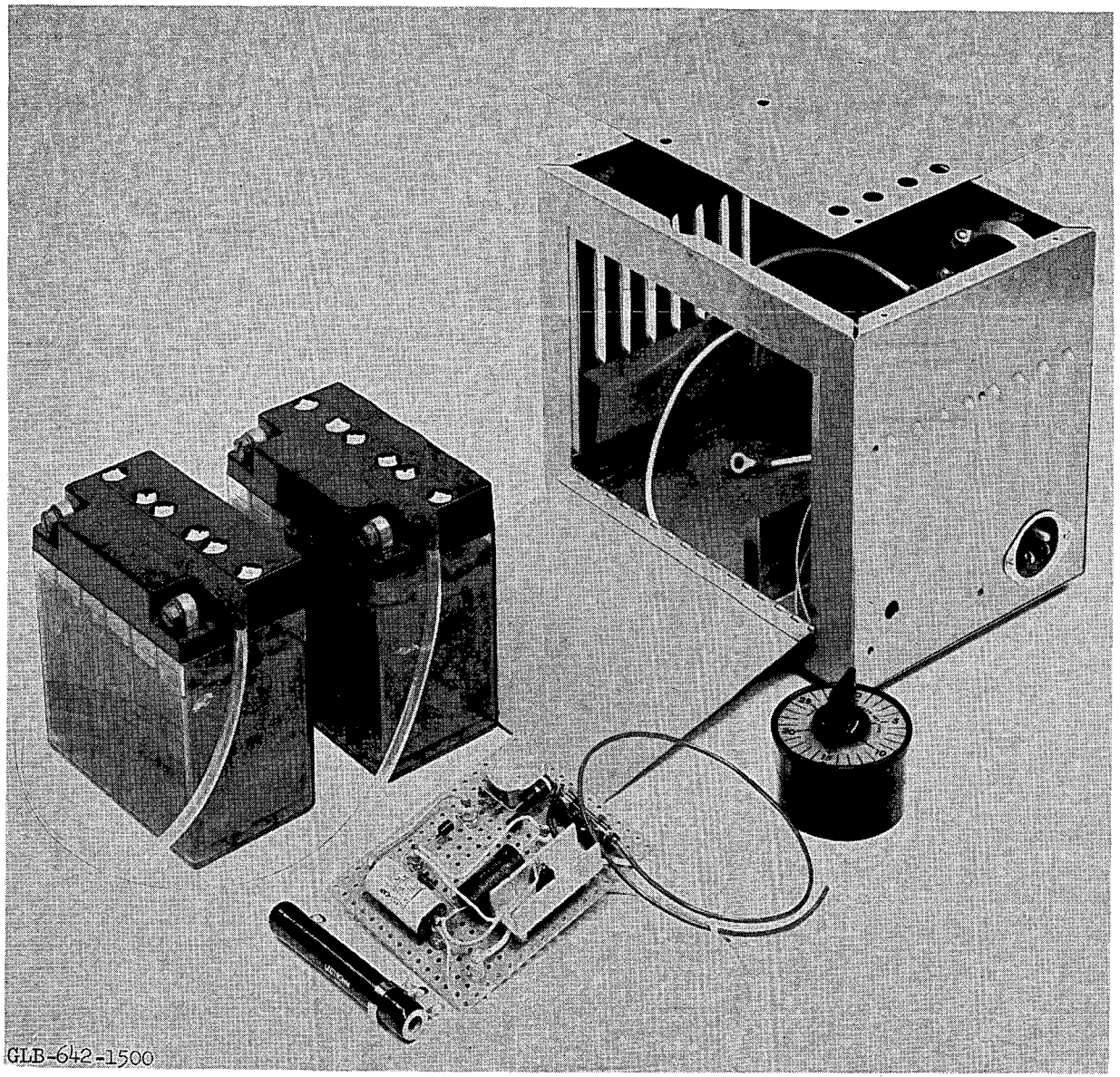

Fig. 2. Batteries and charger removed from the case.

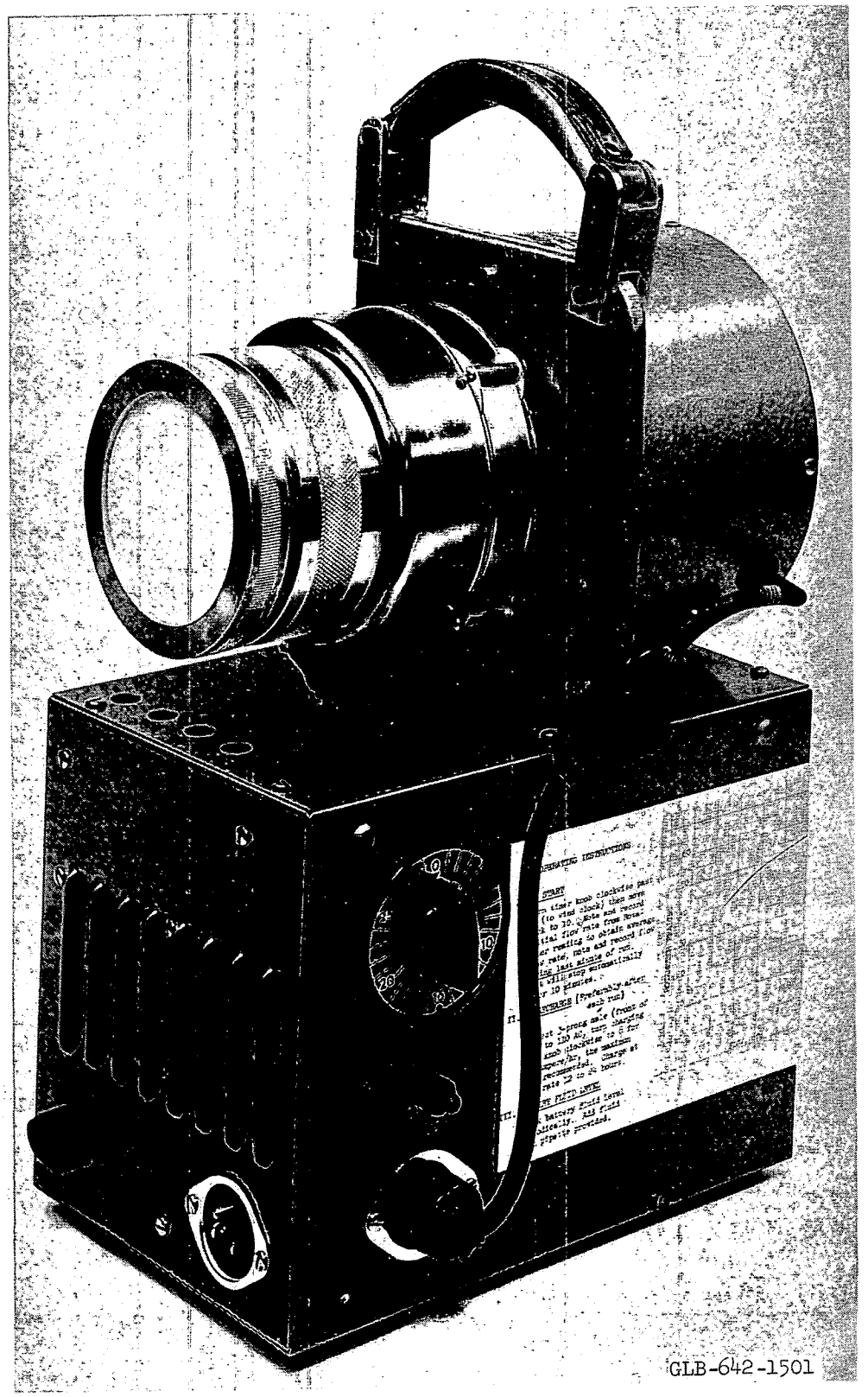

Fig. 3. Battery-operated high-volume air sampler assembled.

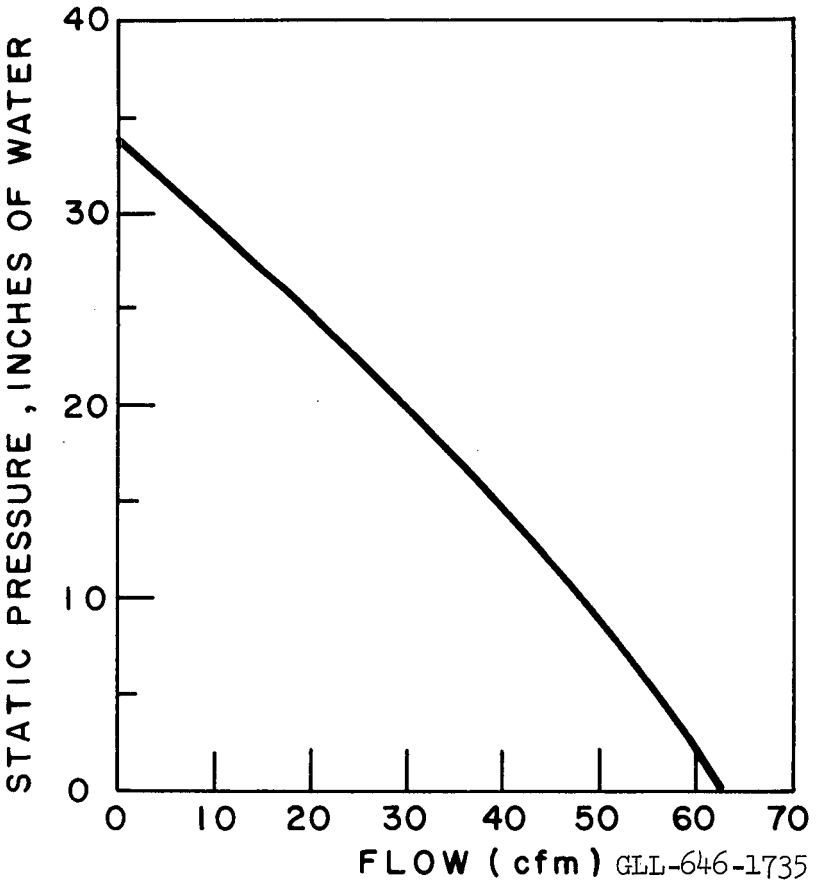

Fig. 4. Performance curve for battery-operated high-volume sampler.

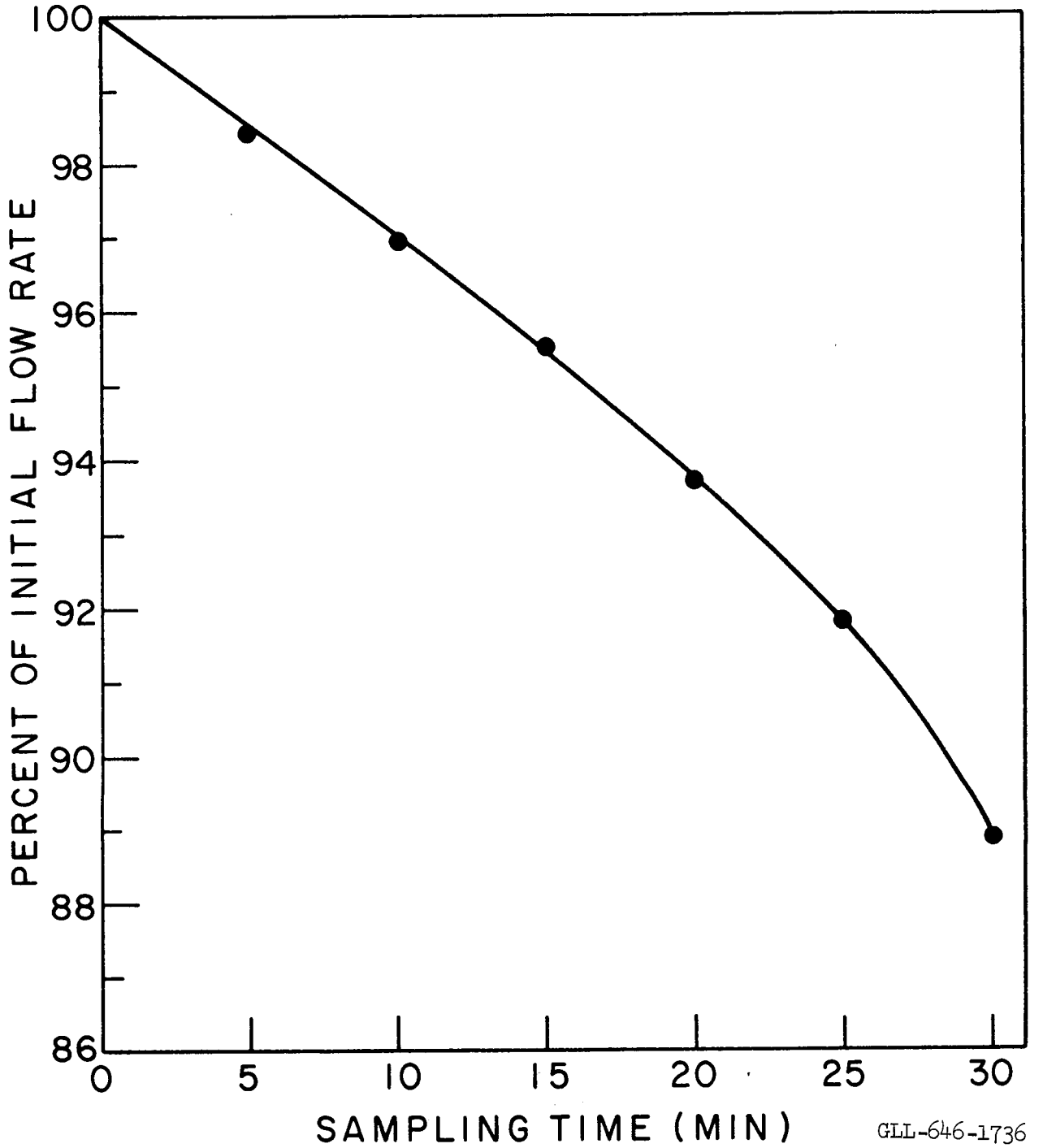

Fig. 5. Effect of battery discharge on flow capacity.

Fig. 6. Particulate filter charcoal cartridges and adaptor for smaller cartridge.