A LARGE, ADJUSTABLE TIPPING BUCKET GAUGE FOR MEASURING SNOWMELT

By

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INTRODUCTION

The role of forests in influencing snow accumulation and melt has become a significant hydrology research question for forest managers. In particular, the influence of forests on snowmelt from rain-on-snow events has become a critical question in British Columbia and the Pacific Northwest States (Toews and Wilford. 1978; Harr, 1981). One aspect of the research has been to establish snowmelt plots in forested and clearcut areas. Essential equipment in the plot studies are snowmelt lysimeters. Rather than use many small (.274 m^2) lysimeters, the move has been to large (10 - 20 m^2) lysimeters (Haupt, 1969; Helvey and Fowler, 1980; D. Golding, pers. com. 1982; A. Plamandon, pers. com. 1982). In order to measure runoff, a large tipping bucket is required. Experience with the tipping bucket described by Helvey and Fowler (1980) indicated that the unit was not robust (D. Golding, pers. com. 1982). As no large commercial tipping buckets or plans could be found, a unit was designed and constructed in the fall of 1982. This paper describes the 'Smithers Magnum Adjustable Tipping Bucket'.

CONSTRUCTION DETAILS

The bucket and separating wedge are constructed of 22 gauge galvanized sheeting (#1)[2/]. The wedge is not soldered until the axle mount has been fastened.

The axle mount (#2) is a 228.6 mm long, 39 mm by 3.2 mm flat bar. A 12.7 mm hole is drilled 12.7 mm from each end of the bar and then the ends of the bar are bent at right angles to give a 25.4 mm surface for mounting the axle locks. The axle locks are 9.5 mm nuts with set screws, and are welded onto the flat bar over the 12.7 mm holes. The set screw allows the axle to be removed. The axle mount is fastened to the bucket by six #10 machine screws with lock washers and nuts.

The axle is a 228.6 mm long, 9.5 mm diameter cold roll steel rod. The axle bearing mount bracket (#3) is a 50.8 mm long, 88.9 mm by 3.2 mm flat bar. The bearings are sealed roller bearings (Nice - 1614DC). The bearings are held in a bearing retainer that is machined from 11.1 mm mild steel. The retainer has an outside diameter of 42.5 mm and an inside diameter of 28.575 mm (allows for a press fit of the roller bearing). The bearing retainer is welded to the end of the flat bar.

The adjustable bumper support (#4) is a 304.8 mm long, 19.05 mm by 3.175 mm flat bar. The adjustable bumpers are General Motors hood bumpers (part number 400765). The bumpers are attached to the support bar 165 mm apart and positioned so the bumpers are centered on the edge of the bucket. Nuts and lock washers are bolted on each side of the bar to hold the bumper in place at a selected height (i.e., volume). The support bar is bent at right angles 50.8 mm from each end and is bolted with 6.35 mm coarse thread bolts to two 25.4 mm long, 19.05 mm by 3.175 mm flat bar brackets that are welded to the base bars.

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2/ The numbers refer to the labels in Figure 1.

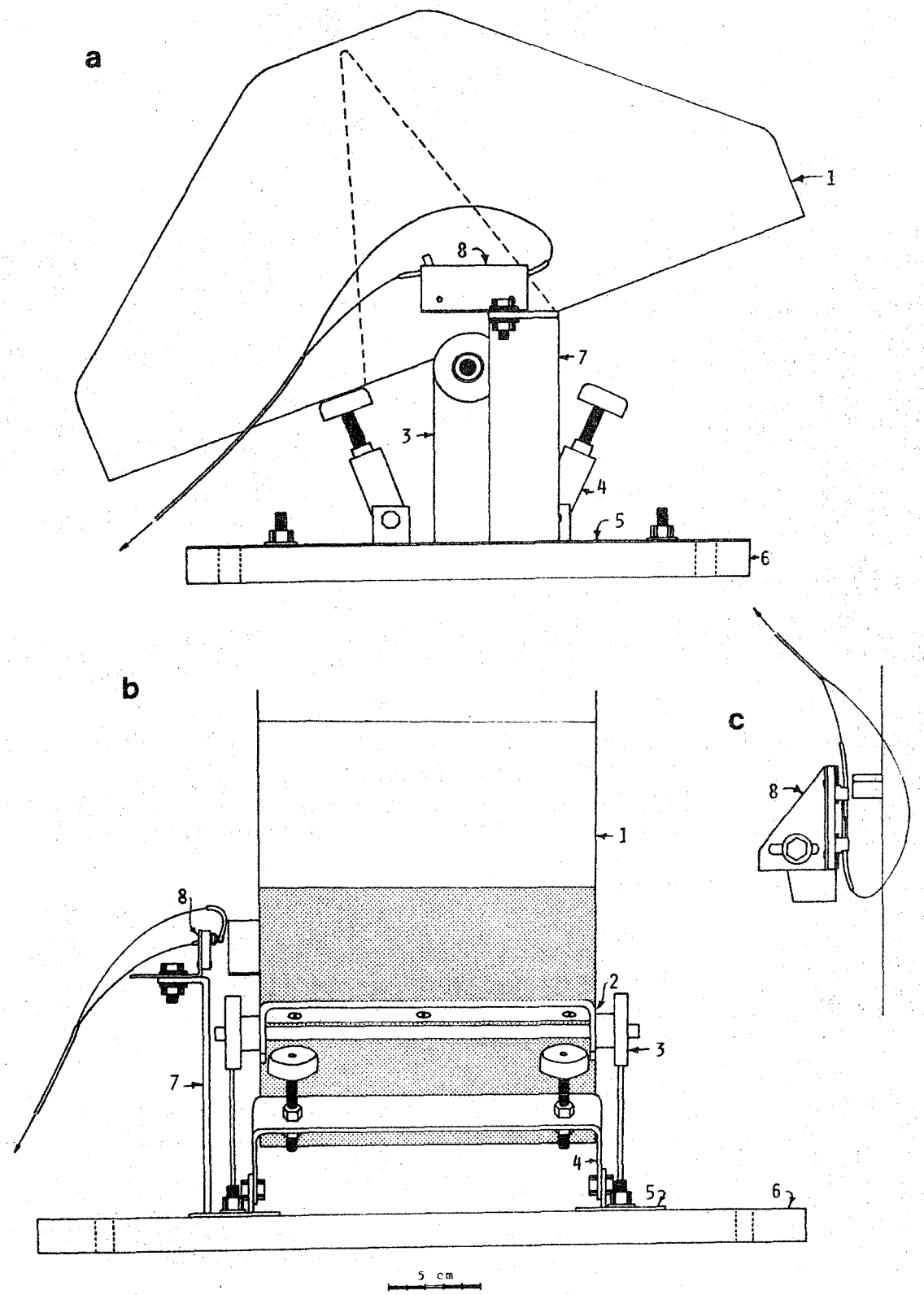

Figure 1. Diagrams of the tipping bucket showing a) side profile, b) end profile, and c) vertical view of the contact plate with reed switch and magnet. Component numbers are referred to in the text.

The base bars (#5) are 304.8 mm long, 50.8 mm by 3.175 mm flat bars. The axle bearing mount is welded in the center. The bumper support brackets are welded 107.95 mm from the end.

The contact support bracket is a 152.4 mm long, 38.1 mm by 3.175 mm flat bar. The bar is bent at right angles at 127 mm and welded to the base bar (127 mm from the end). A bolt hole is drilled and tapped in the top of the support bracket for the contact plate (#8). The contact plate is 2 mm thick right angle aluminium, 60 mm x 25.4 mm x 40 mm. An automotive fuse bracket is bolted to the 25.4 mm by 60 mm side to hold the reed switch (Radio Shack number 275-1610). Contact cement holds the reed switch in position. The contact plate has a slotted hole on the 60 mm x 40 mm side to allow for adjustment. The reed switch is activated by a 25.4 mm rectangular ceramic magnet (Radio Shack number 64-1875) that is glued to the tipping bucket.

The plywood base (#6) is 19.05 mm plywood, 304.8 mm by 419.1 mm. The base bars are bolted to the plywood base. Holes are drilled in the corners of the plywood base for four leveling/fastening bolts.

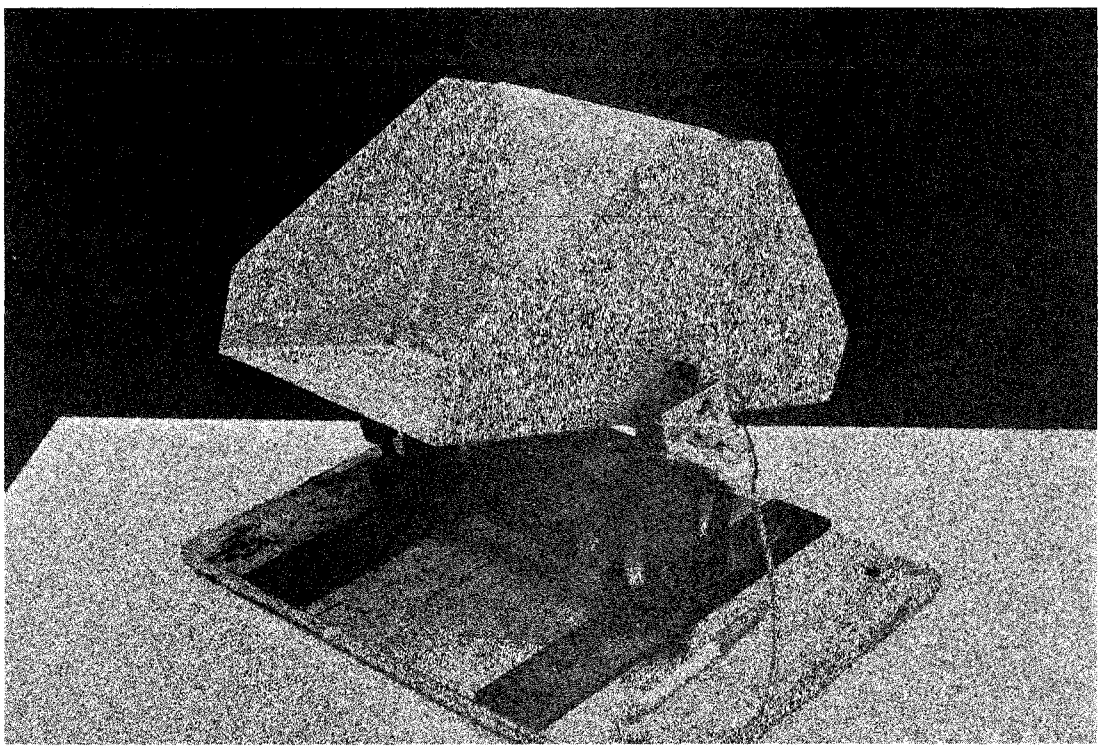

Figure 2. The Smithers Magnum Adjustable Tipping Bucket.

DISCUSSION

Four tipping buckets have been used for the last two years for monitoring snowmelt from plot studies in the Queen Charlotte Islands. The units performed well with the exception of several problems that were easily fixed. Three reed switches malfunctioned and were replaced. A plastic sealed reed switch was recommended over an open, glass reed switch (e.g., Radio Shack number 49-495) (G. Aubertin, pers. com. 1984). The separating wedge on one tipping bucket leaked. This was fixed by re-soldering the joint, but the joint could be strengthened by using a wedge with flanges or tabs that can be bent and soldered into the bucket (i.e., rather than butt soldered joints). Water delivery from the lysimeter is by a 10.16 cm pvc pipe to a 20 litre plastic debris trap bucket, and then through a 5.08 cm pvc pipe to the tipping bucket. On one occassion the water in a plastic bucket froze, breaking the bucket and forcing the 5.08 cm pipe down onto the tipping bucket. Lining the inside of the plastic bucket with a layer of ensolite

eliminated the problem. Even though the bearings are sealed, it is prudent to apply a high quality lubricant such as LPS-3.

Two forest hydrologist in British Columbia have constructed tipping buckets using these plans. The cost was less than $ 300.00 Canadian. One bucket was enlarged by 50%. This unit developed a leaky separating wedge. The use of soldered tab joints is required on larger units.

The Smithers Magnum Adjustable Tipping Bucket has proven to be a robust yet sensitive, economical instrument. The option to adjust the volume from 200 ml to 1.5 litres makes this unit a versatile instrument for plot runoff and precipitation studies.

ACKNOWLEDGEMENTS

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