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FABRICATION, TESTING AND EVALUATION OF BELLARY TYPE WATER LEVEL RECORDER

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ABSTRACT

Automatic water level recorders are essential in the soil and water conservation and hydrological research. There is an urgent need to design and fabricate indigenous recorders, eliminating some of the constraints of the imported ones, such as the necessity of daily resetting the chart/stylus pen, frequent slips of the beaded wire, clogging and twisting of stylus pen etc., so as to record the runoff events accurately, instead of depending on the costly and imported water level recorders, involving considerable foreign exchange and time. To achieve this object, efforts made at the CS and WCR and TI, Research Centre, Bellary, have resulted in the development of a recorder and is found to work satisfactorily.

INTRODUCTION

The need for automatic water level recorders in the field of soil and water conservation and hydrological studies requires no emphasis. Presently the demand for water level recorders is met mainly by importing them in large numbers and to a limited extent through local sources. However, much delay and inconveniences result in importing them or their spare parts. The performance of indigenous water level recorders is far from satisfactory. Valuable runoff data could not be obtained even through the imported recorders, as on many occasions, a few snag such as frequent slips of the beaded float line, clogging and twisting of the stylus pen etc., make them inoperative. The most commonly used imported Stevens 'F' type recorders, require resetting every day, irrespective of the runoff occurrence. Thus, in a watershed management project, where constant measurements are contemplated, many such recorders demand additional personnel for setting, repairs and replacements of spare parts, inspite of the fact that runoff is a rare event, more especially in semi-arid and arid tracts.

Hence, in order to surmount some of the aforesaid limitations, a need was felt to develop an indigenous, reliable, all weather and easy to repair water level recorder, with minimum number of spare parts. Attempts made in this direction at Central Soil and Water Conservation Research and Training Institute, Research Centre, Bellary have resulted in the development of a satisfactory and dependable water level recorder, named (for the sake of convenience in reference and distinction) as Bellary Type Water Level Recorder. The same has been tested and evaluated at Bellary, Dehradun and Ootacamund Centres and found to be working satisfactorily.

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The Stevens 'F' type recorder has the following limitation and short comings :

(i) Necessity for resetting the chart daily.
(ii) Frequent slips of the beaded wire.
(iii) Clogging and twisting of the stylus pen.
(iv) Difficulty in importing spare parts in time and their exorbitant cost - tax, duty etc.

METHODS AND MATERIALS

For developing the Bellary type water level recorder, the basis has essentially been Stevens 'F' type recorder.

(i) No necessity for resetting the chart daily

In the Stevens 'F' type water level recorder, the clock work mechanism drives the stylus pen from one end of the chart drum to the other. The float (along with the counterweight arrangement connected to the ends of beaded cable) drives the horizontally supported chart drum in consonance with the water level fluctuations and as per the gauge scale adopted. The combined movement of the chart drum and the pen gives a graphic record of the water level variations, against time. As the pen traverses from one end to the other at a specified rate, it requires to be reset daily or weekly depending upon the gears used as per time scale adopted.

As against this system, in the Bellary type recorder, the time axis has been kept continuous on 'OY' axis, and the water level fluctuations are transmitted to the stylus pen carriage assembly through the bush and pulley arrangement, making the stylus pen to traverse across the OX axis, only when there is flow (Fig.1); but it remains stationary at other times, marking a line (24 cm) on 'OY' axis for one full day and continues to perform without interruption for a week, as the clock mechanism drives the horizontally supported chart drum (over which the stylus pen rests at one end) in an anti-clockwise manner, at the rate of 1 cm/hr.

The above change has given the desired effect of dispensing with the practice of deputing a person for resetting, even if there is no runoff flow and to prevent loss of valuable data, because of the closed ends provided in the Bellary Type Water Level Recorder. Due to open ends in the Stevens 'F' type recorder, no hydrograph would be obtained, if the instrument is not reset in time, as the stylus pen would reach the other end and get struck up.

(ii) Avoidance of slipping of beaded wire

The frequent slipping of the beaded float wire is avoided by providing four sets of hemispherical holes on the groove of the pulley at 90° angles, as against only three single holes at

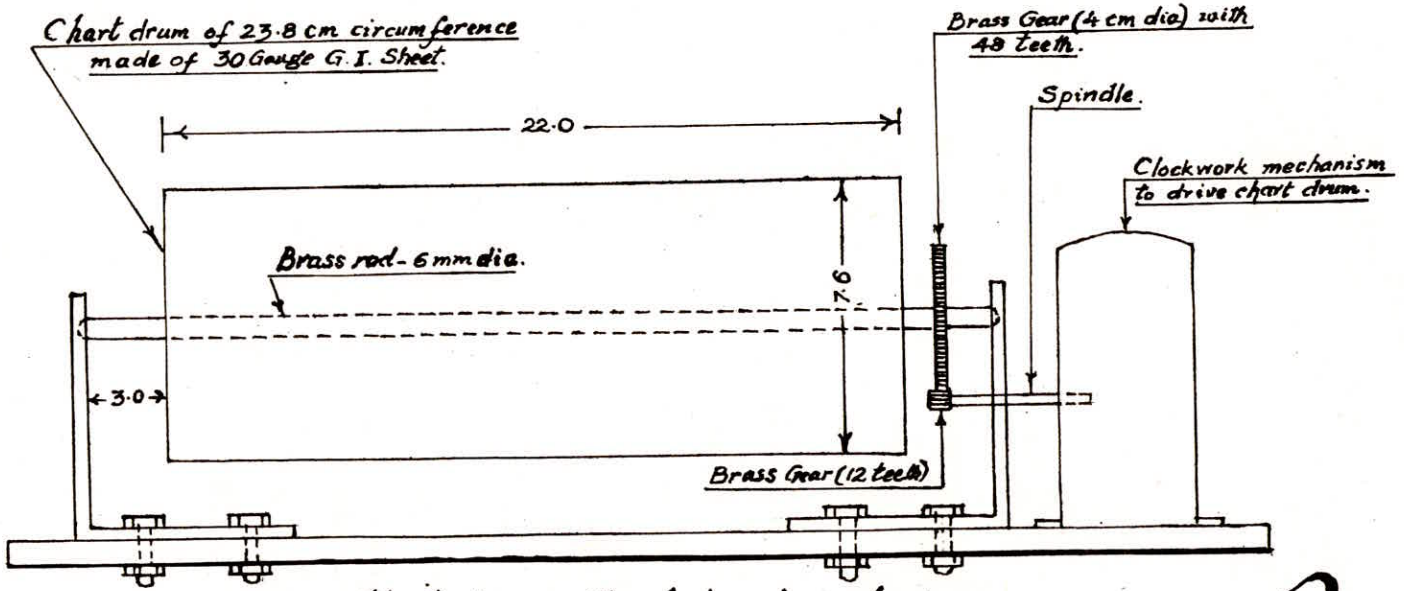

FIG. 1 - Chart drum with clockwork mechanism.

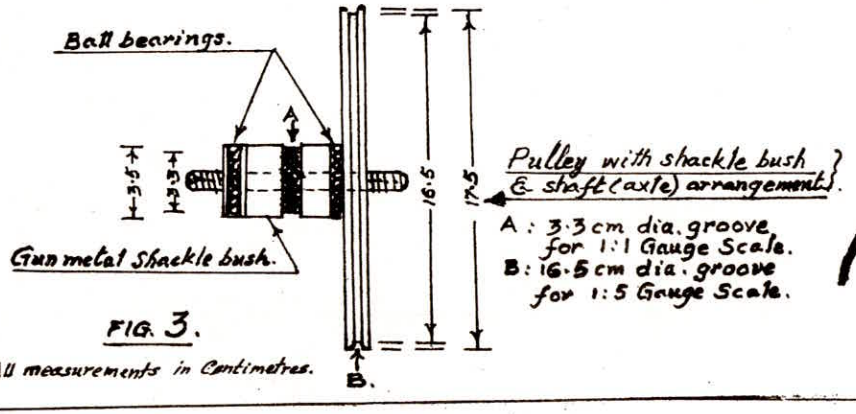

FIG. 3.

Note:- All measurements in Centimetres.

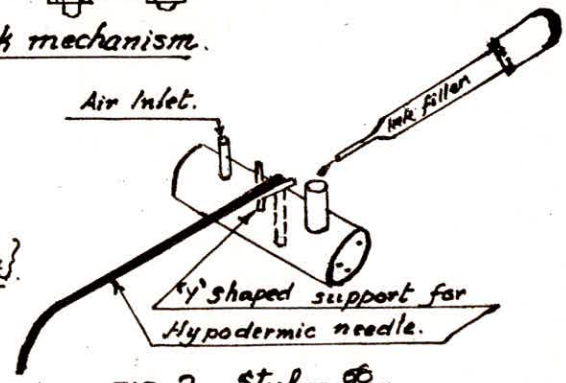

FIG. 2 - Stylus Pen.

120° angles in the Stevens 'F' type recorder. Even if a bead does not fit in the groove, it will find its place in the adjacent groove, thus minimising the length of slippage to a greater extent thereby avoiding errors due to slippage. These additional holes at 90°angles facilitate proper setting of the beaded wire in the grooves, and even if there is slipping it is kept to a bare minimum of 2 to 3 mm as against an abnormal slipping of about 5 to 8 cm, as in the case of Stevens 'F' type water level recorders.

(iii)Improvement in quality and life of stylus pen

Instead of a plastic reservoir, a metallic stylus pen has been designed and used in the bellary type recorder. This prevents mutilation of the ink reservoir, owing to extreme climatic variations. A 'Y' shaped fork arrangement has been provided to the hypodermic needle to prevent it from getting loosened in course of time. Further, the capillary tube of the stylus pen is kept of uniform diameter to avoid clogging using a Physician's injection (hypodermic) needle of 20 to 22 G (Fig.2).

(iv) (a) Quick and timely replacement of spare parts

In the recorder developed at Bellary Centre, the total number of components has been kept at a minimum level, when compared to that of Stevens 'F' type recorder, so that frequent repairs and replacements of spare parts are avoided. As against 37 numbers of components in the Stevens 'F' type recorder, the Bellary type recorder has only 20 number of components (Appendix-I). As most of the parts are of indigenous make, any worn out part can be made locally; this avoids loss of time and delay in procuring imported spare parts.

(b) Low cost, indigenous and Savings in foreign exchange

As the total cost of manufacturing the Bellary type water level recorder will be around Rs.2300/-, there will be considerable savings in terms of foreign exchange in importing the water level recorders, the cost of which is exhorbitant $ 1000/ per piece (Appendix II). Above all, we can take credit for it is being manufactured indigenously in India.

MATERIALS

Clockwork Mechanism

The clockwork of Stevens 'F' type recorder has been made use of in this new recorder. As the present demand for such clocks is meagre, the indigenous clock manufacturers are not com ing forward to manufacture and supply the clocks. Such bottlenecks, perhaps, could be avoided, if the demand is more.

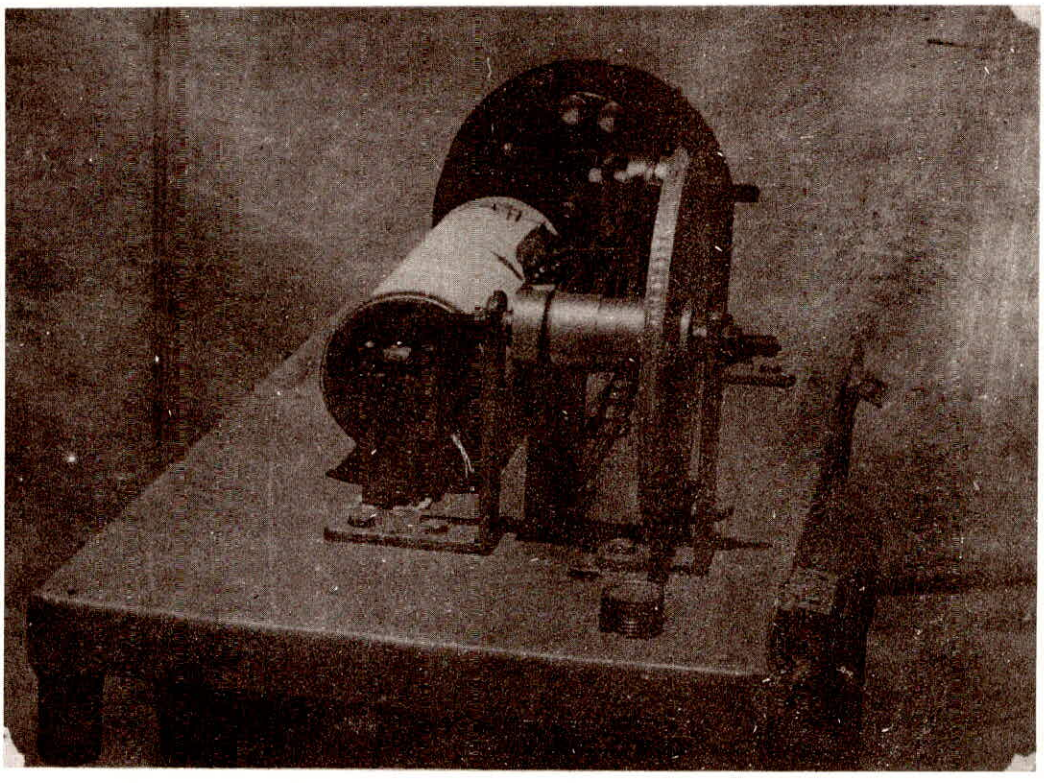

PLATE 1 : BELLARY TYPE WATER LEVEL RECORDER

Chart Drum

This is a hallow cylindrical drum, made of thin G.I. sheet of 30G, having a circumference of 23.90 cm and 22 cm long. A brass rod of 6 mm dia runs through the centre of the drum protruding 3 cm on either ends. This is kept parallel to the carriage rods, carrying the stylus pen and its assembly. A gear with 48 teeth is soldered at the one end of the chart drum, which fits into the gear (with 12 teeth) of the spindle attached to the weekly clock. This chart drum, fixed with two ball bearings housed in a socket, rotates freely on the horizontal axis in an anticlockwise direction.

Float Pulley-bush Arrangement

Two gauge scales of 1:5 and 1:1 are provided in the float pulley and bush respectively, by providing grooves, whose circumference/diameter is in the proportion of 5:1 (Fig.3). Such an arrangement avoids changing of gears. In order to prevent complications and other snags in the smooth functioning of the recorder, provision for additional gears for various other gauge scales (1:2, 1:10 etc.) have been avoided.

Evaluation of the Recorder

The performance of 'Bellary type water level recorder' (Plate 1) was tested on the Soil Conservation Research Farm alongwith imported Stevens 'F' type recorder, under simulated flow conditions in channels in 1980, and under natural rainfall conditions during 1982 and 1983 and the results are summarised below :

Comparative performance of B.T.W.L. Recorder and Stevens 'F' type W.L.R.

Year of evaluation	Flow condition	Rainfall (mm)	Range of deviation in the total volume of runoff %		Remarks
			Max. (+)	Min.(-)	
1980	Simulated-variable flow	302.9	+ 4.2	- 6.9	
1981	-	-	-	-	Prototype W.L.R. were ordered and received in 81.
1982	Natural flow (under rainfall conditions)	504.1	+ 4.7	-4.6	
1983	-do-	684.3	+ 5.3	-4.3	

It can be seen from the above that the performance of Bellary type water level recorder compares well with Stevens 'F' type recorder with deviation between the recorders ranging with-

in only ±5%. A few proto types were supplied to sister Centres (at Chandigarh and Ootacamund) and Institute headquarters at Dehradun for their evaluation. The evaluation report received from Ootacamund Centre is enclosed (vide Appendix-III); the Institute headquarters has since reported that the stylus movement is comparable with 'F' type stage level recorder and that the diameter of the recorder drum is found to be suitable. At the same time, it has been suggested by the Institute, that different sets of gears be provided so that the recorder can be used for short and long durations and similarly for low and high flows. Other suggestions given for quicker replacement of chart, reducing the weight and size of the instrument would be taken care of when the demand for this recorder is more and when bulk orders are placed.

CONCLUSIONS

The performance of Bellary Type Water Level Recorder with minimum no. of parts is quite satisfactory and comparable with that of imported Stevens 'F' type recorder. In any case, the valuable runoff data would not be missed - either owing to human indifference and negligence or due to natural causes, as there is no need to depute any personnel for resetting, no slipping of beaded float wire, and no clogging and twisting of stylus pen. Above all it is indigenous - made in India at less cost.

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APPENDIX-I

PARTS OF STEVENS 'F' TYPE RECORDER

(1) Base (2) Cable (3) Carriage drive (4) Pulley (5) Pulley guide (6) Centre pin (7) Standard (8) Clamp screw (9) Chart guide pin (10) Spring for holding chart (11) Carriage assembly (12) Pen (capillary) (13) Ajusting screw (14) Chart drum (15) Bearings (16) Gauge gear (17) Chart drum pin (18) Flange (19) Flat pulley (36" circ.) (20) Beaded float line (21) Ring attachment (22) Float pulley (18' circ) (23) Tape (24) Washer-float pulley (25) Cup washer (26) Nut (27) Roll pin (28) Shaft (29) Carriage rods (30) Standard for float pulley (31) Float pulley ball bearings (32) Ball bearings for chart drum (33) Clock mounting (34) Mounting screw (35) Clock weekly (36) Casing with padlock arrangements (37) Bolts and nuts for the base (38) Different gauge gears etc.

PARTS OF THE INDIGENOUS WATER LEVEL RECORDER

(1) M.S. Flat 'L' supports (2)Pulley (17.5 cm dia.) (3) Gun-metal bush of 3.5 cm dia (4) Cycle cone rod (5) Ball bearings (3 cm dia) (6) Pen carriage assembly made of brass sheet (7) Stylus pen (8) Chromium plated highly polished brass rods (9) Chart drum made of G.I. sheet -28 G - 26 cm dia. (10)Clock -indigenous/mported (11) Main spring wheel of a daily/weekly clock -48 teeth (12) Small gear -12 teeth (13) T.W.Plank (55 cm x 30 cm x 3 cm) (14)Casing -T.W. Sides with a glass top (15) Guard arrangement for float pulley (16) Counter weight - lead piece (17) Screws (2 cm), bolts (4 cm) and nuts, screws etc. (18) Copper tube of 6 mm dia - 5 cm long (19) Hinges and padlocks etc (20) Beaded steel float wire 2 metres long.

	ABSTRACT OF COST (APPENDIX-II)	Rs. Ps.
1.	Bottom plank and case with glass top	250.00
2.	Pulley 1 No.@ Rs.100 each	100.00
3.	Shackle Bush (gunmetal) 2 nos. @ Rs.25/- each	50.00
4.	Ball bearings - 4 Nos. @ Rs.40/- each	160.00
5.	Axle rods - 2 Nos.@ Rs.15/- each	30.00
6.	Chart drum - 1 No. @ Rs.40/- each	40.00
7.	Stylus pen - 1 No.@ Rs.30/- each	30.00
8.	(a) Clock (wekly) -	800.00
	(b) Gears	50.00
9.	Float and lead counter weight and beaded float wire etc.	200.00
10.	M.S. Flats for supports, brass rods etc.	150.00
11.	Labour charges for fixing in position 5 Men (skilled) @ Rs.30/- man Rs.150.00 5 Men (unskilled) @ Rs.10/ man Rs. 50.00	200.00
12.	Sundries and other unforeseen item of work - painting etc.	100.00
	(a) 2 Nos. ball bearing chromium plating, polishing etc (Additional)	140.00
	Total	2300.00

(Rupees Two thousand three hundred only)

APPENDIX III

REPORT ON EVALUATION OF THE BELLARY TYPE WATER LEVEL RECORDER

The Bellary Type Water Level Recorder was installed at Glenmorgan Research Farm during September, 1984 to compare its performance along with Steven's 'F' type recorder. The same was removed during January,1985, after obtaining enough number of hydrographs. Six of these hydrographs from both the recorders were selected covering low, medium and high flows. The charts were analysed for total volume and peak rates of flow for individual dates to determine whether the differences in their performances with regard to total volumes and peak rates of flow as indicated by Students' 't' test were significant or not. The tests of analysis are furnished in tables A and B hereunder :-

A. Total Volume of flow in cubic metres

Date	F type recorder	Bellary type recorder	Difference X	$(X-\bar{X})^2$
29.9.84	866	670	196	424882.35
6.10.84	2,697	2,599	98	562245.03
7.10.84	1,324	1,275	49	638129.37
8.10.84	8,737	7,171	1,566	515768.15
14.11.84	430	430	0	718815.71
30.11.84	18697	15,519	3,178	5429692.20
		Total	5,087	8289532.81

$X = 5,087$; Mean $\bar{X} = \frac{5,087}{6} = 847.83$

$S = \sqrt{\frac{8289532.81}{5}} = 1287.60$

Standard error $= \frac{1287.60}{\sqrt{6}} = 525.66$

't' $= \frac{847.83}{525.66} = 1.623$ or 1.61

't' from table for 5 degrees of freedom = 4.03 at 1% level
2.57 at 5% level

Result: Since the calculated 't' value of 1.61 is less than tabulated values at 1% and 5% levels, the differences in volumes of flow by both the recorders are not significant.

B. Peak Rates of runoff-m^3/sec

Date	F type recorder	Bellary type recorder	Difference X	$(X-\bar{X})^2$
29.9.84	0.031	0.028	0.003	0.0124695
6.10.84	0.190	0.242	0.052	0.0039272
7.10.84	0.075	0.067	0,008	0.0113778
8.10.84	0.393	0.370	0.023	0.0084028
14.11.84	19.600	19.080	0.520	0.1642948
30.11.84	0.872	0.790	0.082	0.0010671
		Total	0.688	0.2015392

$X = 0.688$; Mean $\bar{X} = \frac{0.688}{6} = 0.114667$

$S = \sqrt{\frac{0.2015392}{5}} = 0.2007681$

Standard error $= \frac{0.2007681}{\sqrt{6}} = 0.0819632$

't' $= \frac{0.114667}{0.0819632} = 1.399$ or 1.40

't' observed from table for 5 degrees of freedom { 4.03 at 1 % level
{ 2.57 at 5 % level

Result: Since the calculated 't' value of 1.40 is less than tabulated values at 1 % and 5 % levels, the difference in peak rates of flow recorded by both types of Recorders are not significant.