

## HYDROLOGIC INSTRUMENTS

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The purpose of this paper is to present to the Conference the new instruments that have been developed in recent years for use in hydrologic investigations. The writer tried to obtain some information regarding new instruments from W. & L. E. Gurley and from the Instrument Corporation of Baltimore, Maryland (formerly Julien P. Friez & Sons, a subsidiary of the Bendix Corporation), but received nothing new from either inquiry. The standard Friez, Gurley, and Stevens instruments are so well known that it hardly seems necessary to take the time of this Conference describing them. New hydrologic instruments manufactured by Leupold and Stevens Instruments, Portland, Oregon, are briefly described and illustrated herein.

### PRECIPITATION RECORDERS

Instruments in this category are not new but there have been some recent developments that may be of interest. In portions of the Hawaiian Islands precipitation may reach 900 inches per year. The problem was to design a recorder that would register with a reasonable degree of accuracy this total precipitation.

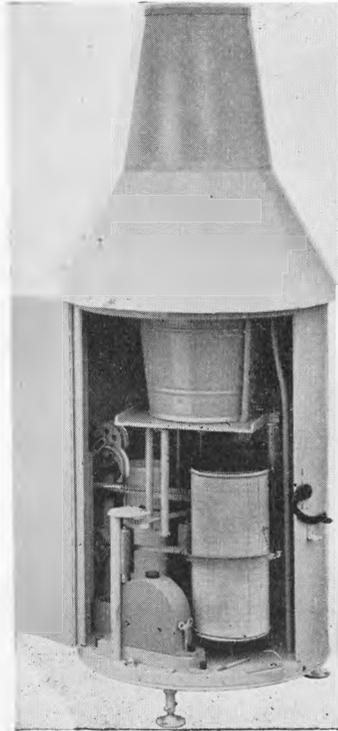


FIG. 1—STEVENS RAIN RECORDER  
WITH EMPTYING SYPHON

The problem was solved by developing a syphon that will empty the collecting tank each time it becomes full. Such a syphon has been under consideration for a number of years, but it is only within recent times that a satisfactory one has been developed. Fig. 1

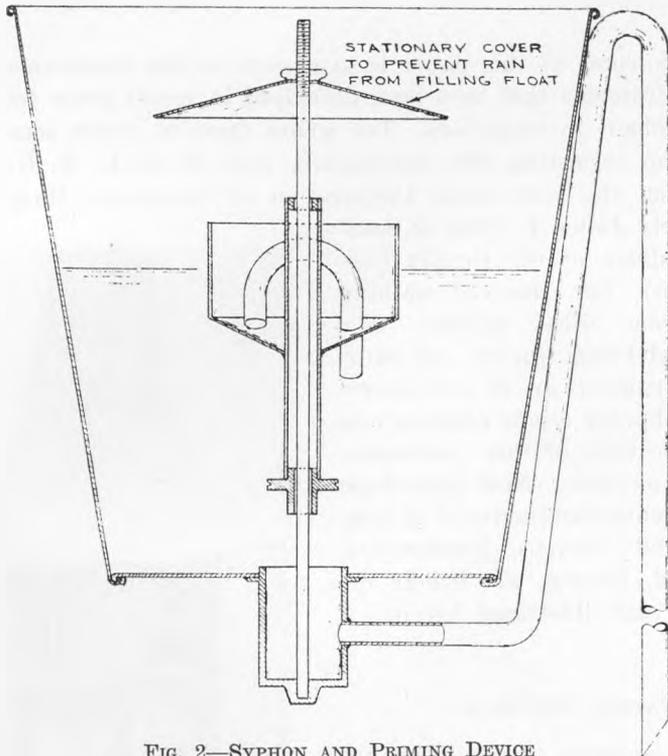


FIG. 2—SYPHON AND PRIMING DEVICE

shows the rain recorder. There is a syphon attached to the tank which discharges the water through the base of the recorder onto the ground.

The difficulty in making such a syphon operative has been that the very low rate of precipitation, which may be merely one drop at a time, is not sufficient to prime the syphon. Therefore, the mechanical primer which is illustrated in Fig. 2 was developed. A float is attached to a sleeve which slides up and down on a rod. The bottom of the sleeve ends in a piston that fits loosely into a

short cylinder attached to the bottom of the tank. From this cylinder the syphon takes off. Inside the float is another syphon. When the tank is filled to a certain level a stop prevents the float from rising farther. Finally the water overflows the rim of the float which, when filled, slides rapidly down the rod. The piston entering the cylinder at the bottom of the tank forces a slug of water through the syphon, clearing it of air and starting its syphonic action. As soon as the water in the tank is emptied the small syphon empties the float and thus all is ready for the next cycle of filling and emptying.

Fig. 3 shows a chart on which there were 14 fillings and emptyings of the bucket. It took 47 hours to fill the tank the first time

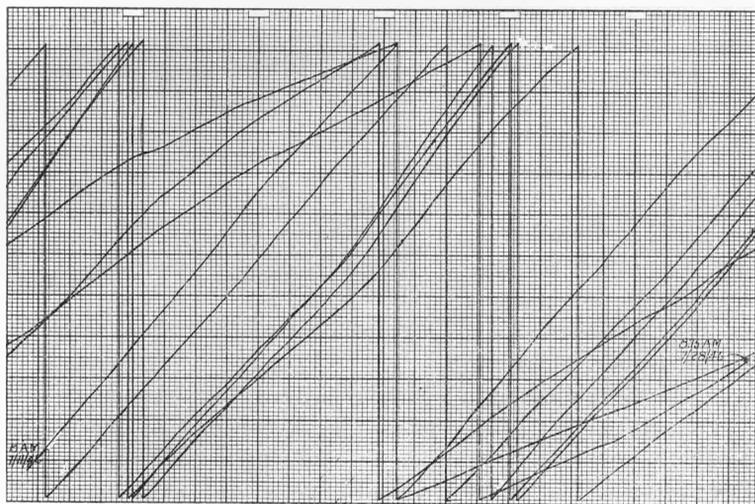


FIG. 3—SAMPLE CHART FROM SYPHON

and 96 hours for the last filling. The chart made 1 revolution in 4 days but was left on for 17 days without confusion in the record. The syphon never fails to operate.

By using a tank with a capacity of only 12 inches a total precipitation capacity of almost any quantity can be registered. The chart shows 157 inches recorded.

## RADIO RECORDING

The first radio water level recorder was made about five years ago, and so far as we know it is still in service. A number of others have been added throughout the country. All of these early ones are operating on about 2650 kilocycles. The maximum range in service is 70 miles with a 25-watt transmitter.

The instruments included in a radio set consist of 4 elements: (1) Telemark-Time Switch which acts as a coding device and also determines the time of broadcasting; (2) the Radio Transmitter which transmits the signals through an antenna near the station; (3) a Radio Receiver which receives the signals through a similar antenna and transmits them

to (4) a Recorder (Figs. 4-7). The Recorder contains a synchronous motor which turns on the current to heat the tubes of the Receiver a few minutes in advance of the anticipated time of broadcasting. Devices have recently been perfected whereby it is possible to have the weight-driven clock at the Transmitter synchronized after each broadcast with the synchronous motor at the Receiving station.

The record is made on a strip chart, a length of about 6 inches being required to record one set of signals. The first part of the signal consists of the identifying number of the station; then follows a set of jogs which indicate the magnitude of the water levels or accumulated precipitation. These are very readily interpreted. A long jog corresponds to 0; all the rest of them are counted. One

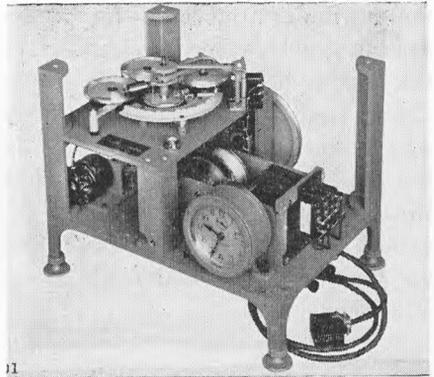


FIG. 4—STEVENS TELEMARX-TIME SWITCH

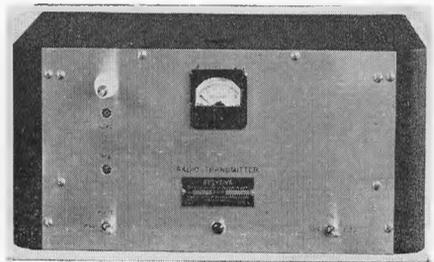


FIG. 5—STEVENS RADIO TRANSMITTER

short jog for one, two for two, three for three, etc., up to nine. Between each figure signal a space is allowed so that there can be no confusion. The only thing which must be predetermined is the location of the decimal point.

Water level recorders have been arranged so that below a certain stage which is not critical the broadcast will be made daily and above that stage it will be made every hour. This of course means that the Radio Receiver must be turned on every hour regardless unless it is manually shut off during the summer season when there is no possible chance of the river reaching that stage.

#### RADIO PRECIPITATION RECORDERS

Radio registration has been developed recently for precipitation recorders. The Type WR (Fig. 8) is a seasonal recorder that can be put in isolated key stations and will run for an entire year with

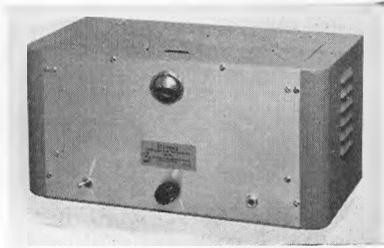


FIG. 6—STEVENS RADIO RECEIVER

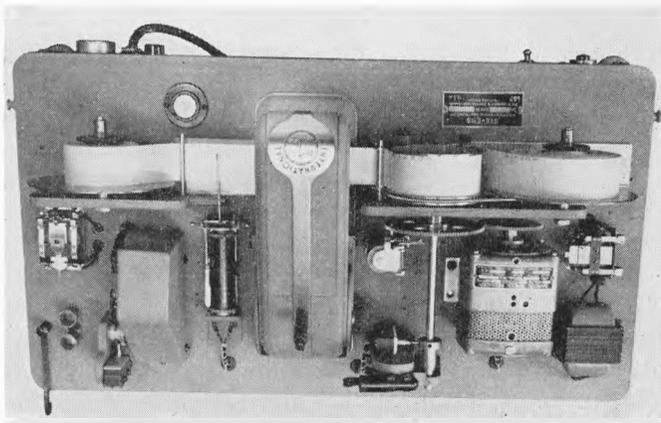


FIG. 7—STEVENS RADIO RECORDER

one setting, if necessary. It has a capacity of 100 inches of liquid precipitation. Of course there may be some doubt as to whether radio equipment can be made to function properly without atten-

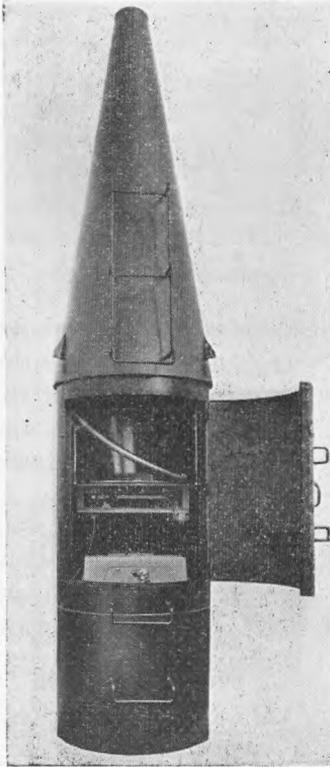


FIG. 8—STEVENS PRECIPITATION  
RECORDER—TYPE W

tion for an entire year. However these stations broadcast at least daily and if any broadcasts fail to materialize, some one can be sent, even on snowshoes if necessary, to put the station in operation.

It is important in snow countries to have the collector always above snow drifts. A combined housing and tower has been devised which consists of circular sections that may be joined together for any needed height.

Another type of radio recorder, not so elaborate, is designated as Type QR. It has a weight-driven clock and will operate for two or three months with one setting. The chart may make one revolution in 8, 16, 32, or 64 days. If the instrument is located in a country where only liquid precipitation will occur the syphon previously described can be provided to obtain practically unlimited capacity. Where snow is likely to occur the capacity may be 24, 48, or 60 inches at varying scales.

Leupold-Stevens Instruments is now experimenting with frequencies in the vicinity of 170 megacycles. It requires much smaller antennas and is free from static. The only restriction is that the transmitting and receiving instruments must be on a line of sight, i.e., there must be no intervening land masses to interrupt the radio waves. A testing station about 35 miles from the plant is being used to test these precipitation recorders. The experiments now under way not only include broadcasting to the plant, which is on a direct line of sight from the broadcasting station, but relays are being developed that can be mounted on high prominences. Hence wherever several stations are to be recorded at a single receiving station, the receiving station and each of the transmit-

ting stations are on a line with this relay, thus permitting the use of high frequencies between transmitting and receiving stations that are not themselves on a direct line of sight.

In the precipitation recorder, as with the water level recorder, facilities are provided whereby broadcasts can be made daily whenever the precipitation is less than a given volume, e.g. 0.2 inches per hour. Whenever it exceeds that rate the broadcasts are made every hour. This saves receiving a lot of records that are not desired and is economical in the use of strip charts and batteries. The Radio Recorder is operated by a synchronous motor and the pen by a relay that causes it to make a jog whenever a contact is made by the coding device through the transmitter. A time stamp prints the date and time of day on the chart at each broadcast.

#### PHOTOCELL RECORDING

For the measurement of water in pipe lines where the pipe is under pressure and where the difference of two heads is an index of flow, as for Venturi tubes, orifices or nozzles—a rather novel device has been developed by which the record is secured through photocells and a water manometer. No mercury is used. Fig. 9 shows a differential manometer and recorder. One water column is connected directly with the head of the Venturi tube and the other to the throat. The tops of the tubes are joined by an air-tight pipe in which there is a tire valve.

The tubes are only long enough to accommodate the maximum difference of heads in the water columns. Around each tube is a photocell cab-

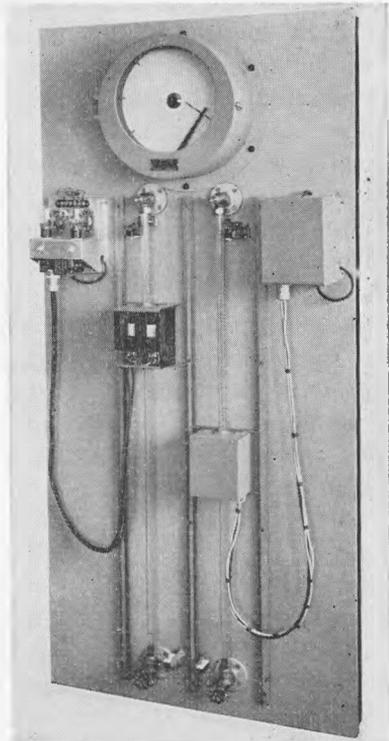


FIG. 9—STEVENS DIFFERENTIAL MANOMETER AND FOTOCCEL RECORDER

inet, suspended on a sprocket chain and counter-weighted over a sprocket pulley that is operated by a reversible motor. The two motors are connected by differential gearing. The cabinets contain two photocells each and a light source placed behind the water column, which is masked by an opaque tube in which two small slots about  $\frac{1}{8}$  inch apart are cut. The one photocell is energized by light passing through a slot in the masking tube above the water in the column. The other photocell is displaced to one side so that it receives the light from the source through another slot in the masking tube and through the water. The water refracts the light rays more than does the air. Whenever the levels in the column change the photocells make contacts and operate relays that energize the motors.

Whenever the water in one column rises to shut off light that passes through the air, it energizes the photocell which causes a relay to start the motor and raise the cabinet until the light again passes through the air to impinge on the photocell. This process is reversed in the case of the photocell receiving light through the water. In this manner both cabinets remain at the top of their respective water columns at all times. Since the motors are connected by differential gearing the shaft of the differential moves in proportion to the difference in heads. This shaft can be used to operate a recorder directly or to operate a remote registering system.

Experiments conducted over a period of years have proven that the compressed air in the space at the top of the columns is not dissolved nor carried away by the fluctuating water. Of course it is absolutely essential that the pipe connection at the top be air-tight. However, with an ordinary tire pump additional air can be pumped into this portion after repairing any leaks.

If the cabinet should rise to the top of the column it closes a limiting switch which turns off the power and also closes a solenoid valve in the supply line to that column. These limiting switches are at both top and bottom of the columns and each supply pipe contains a solenoid valve that shuts off the water to the column if anything happens to it which is not in accordance with normal operation.

## EDITORS' NOTE:

The paper presented before the Conference was accompanied by some 40 lantern slides which included the standard equipment used in hydrologic work as manufactured by the Bendix Corporation (Julien P. Friez & Sons branch) and the W. & L. E. Gurley Company, as well as by Leupold and Stevens Instruments.

