A RECORDER FOR MEASURING THE FLOW OVER WEIRS.

BECAUSE of their simplicity and the ease with which they may be standardized, weirs are preferred by many for measuring liquids. Among them is the V-notch weir, the properties of which were first investigated over half a century ago by James Thomson, brother of Lord Kelvin, and further developed by the late James Barr, of the city engineering department, city of Toronto.

With any type of weir or orifice, the rate of flow is dependent upon the head, and once the law of the weir or orifice is known, may be calculated directly therefrom. For most purposes of measurement, however, mere knowledge of the rate of flow at a given instant is not sufficient, but continuous or total results are wanted. This has led to the development of various types of flow recorders. Fig. 1 is designed to illustrate the principle and essential elements of one of the most recent types of such recorders. First there is a float which moves vertically in response to changes in head. With weirs or orifices where there is a free surface of the liquid on the up-stream side, this float rests directly on the surface, whereas with Pitot tubes and Venturi tubes, it ordinarily rests upon the surface of mercury in one of the legs of a U-tube, the two ends of which are subject to the differential pressure due to the Venturi or Pitot tube.

If the motion of the float is employed directly to actuate the recording device, so that the action of the recording pen is directly as the motion of the float, or in proportion to it, a record of rate of flow can be obtained, but the divisions on the chart are not in general equal for equal increments in rate of flow. It is, therefore, necessary to incorporate some kind of translating or modifying mechanism between the motion of the float and the motion of the recording pen. This translating mechanism is ordinarily a cam.

Besides taking account of the law of flow over the weir, the translating mechanism must also provide the proper ratio between float movement and pen movement. The maximum float movement may be, for instance, 4 or 10 ins., whereas the maximum pen movement, that is the maximum height of the chart, may be 2½ ins. The flow of water over a V-notch varies as the 5/2 power of the head, and if the cam for use with a V-notch were of the same length as the maximum movement of the float, it would be very steep at the end corresponding to the high heads, which would give rise to binding between the surface of the cam and the cam follower. In the design of recorders for use with V-notch and rectangular weirs, it is customary, therefore, to make the total length of the cam much greater than the movement of the float, using a multiplying gearing between the float stem and the cam.

In the Cochrane flow recorder herein described, the cam is laid out as a spiral on a flat circular plate, and the multiplying mechanism consists of a small drum mounted upon the spindle of the cam, and having wrapped about it a thin metal cable which is attached to the float spindle, a counterweight on another cable serving to keep the first cable taut. The spiral groove is cut into the surface of the disk, and is so arranged that the part of the cam corresponding to the low heads is near the centre of the disk, and the part corresponding to high heads is near the periphery of the disk, whereby the angle between a tangent to the cam at any point and a tangent at the same point to a circle concentric with the disk is kept small, due to the fact that what would otherwise be the steeper part of the cam is at the greater radius. To accommodate the recorder for use with weirs of different heights it is only necessary to substitute cable drums of the proper respective diameters. One cam serves for all weirs, having the same law connecting head and flow, and hence it has been commercially feasible to devote considerable expense to the mechanical means of reproducing this cam to insure accuracy.

The elimination of friction and back-lash are prime requisites in the design of such apparatus. Back-lash has in the present case been eliminated by the use of a cable drum instead of the gear and pinion drive formerly employed, while friction has been reduced as much as possible by mounting the spindle of the cam upon anti-friction rollers. Accuracy is also promoted by the use of a large, powerful float, and where an enclosed weir chamber is employed, and the float stem must pass through a packing gland, the latter should be of the self-aligning type. By using a slender stem, the harmful effects of errors in alignment are reduced, and the cross-sectional area upon which any pressure which may exist within the

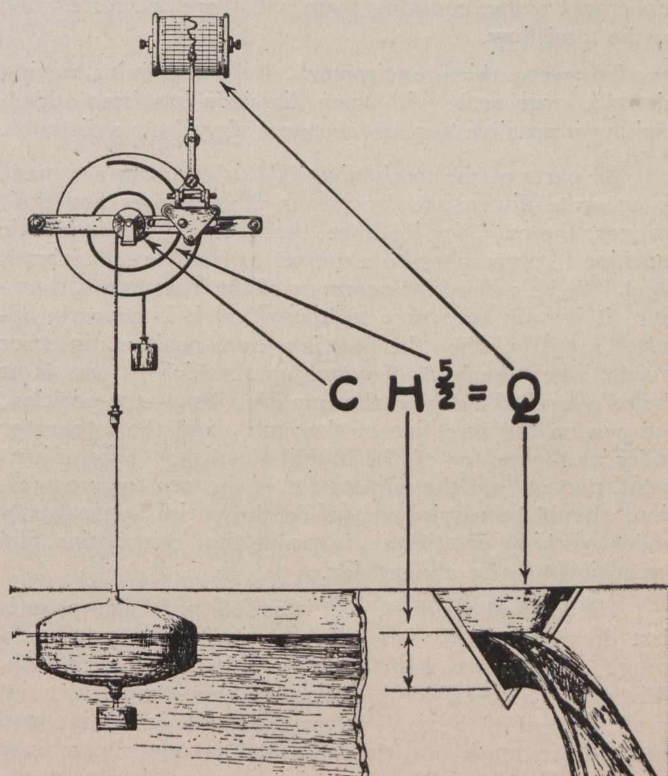

Fig. 1.—Diagram Showing the Principle of the Cochrane Recorder.

float chamber may act in tending to force the stem out of the chamber is minimized.

The pen carriage is provided with large rollers or wheels, which rest upon horizontal ways, so that the cam follower which is attached to the pen carriage moves diametrically to the cam disk. The pen is suspended from the pen carriage in such manner that it rests lightly against the chart drum by gravity, and can readily be removed for cleaning of the pen or while the chart is being renewed. The direction of motion of the chart drum is such that the progress of the pen is from left to right when the chart is held with the bottom toward the observer.

The chart being driven uniformly by a clock, the pen not only records the rate of flow at each instant, but the area under the pen trace is proportional to the total flow