THE VANE METER AND DIVISION PROBLEM

by

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Since early times, possibly 5000 B.C., men have been concerned with the subject of measuring flowing water in units of various kinds. Well, here we are, 1960, and still working on the old problem. Over this period of time, I imagine, there have been thousands of observations made on weirs alone; of various kinds. My individual contribution would be about one thousand tests.

Now about the Vane Meter. It has a history going back about ten years covering roughly 2,500 tests more or less as experimental or research data. I suppose after 20 more years of work and a few hundred tests, the final stages of developing the meter should be close at hand. The evolution of ideas entailing experimental work is intriguing but long hours are spent in the doing.

The Vane Meter is just another contribution to the field of irrigation engineering as another means of measuring flowing water. This subject has, for the past few years, been discussed at the annual meetings of the Four States Irrigation Council and is not a new subject. The present design of the meter appears to possess some practical advantages, such as convenience in operation, and reasonable accuracy in indicating the true discharge and no loss in head. Practically all devices used to measure water requires one or more observations of depth or head to determine the discharge by reference to curves diagrams, or tables. The Vane Meter eliminates such references. Often times, it is not easy to accurately measure the effective heads or depths essential to determine the discharge. Dependable laboratory experiments indicate that it is not necessary to observe the depth of the flowing water. As now developed, the Vane Meter is portable, weighs about three pounds, and is inexpensive. The design is simple, consisting of a triangular metal vane, suitably suspended in the stream, where velocity of flow deflects the vane downstream. The angle of deflection is proportional to the rate of discharge. The angle is determined by means of an arc-shaped glass tube mounted at the top of the vane. The tube is filled with a light weight pure mineral oil, and contains two steel balls. Beneath the tube is a scale graduated in second-feet. In operation the balls will roll out along the scale and indicate the flow. The present design, all metal, is of substantial construction and not intended to be a chrome plated job lending the impression that it is a high grade instrument. The prime purpose of this meter is to measure the flow in a farm lateral, limited to 5 to 10 second-feet where the flow would be at low to moderate velocities. Since the loss in head in measuring the discharge is negligible, the Vane Meter is well suited.

At present, requests are at hand to measure 15 second-feet or more in large channels. Last summer a special Vane Meter was built and installed to accommodate 40 second-feet. Operating satisfactorily at last reports, the Taylor and Gill Ditch at La Porte, Colorado, a special meter has been operated two years, equipped with an electrical driven instrument that records the discharge on a chart in second-feet. In passing, you will note that things grow which extend the time of development and scope of application.

A step forward in the development of the meter has been made since our last meeting. Formerly, a 1/8-inch aluminum sheet was cut to form the vane and rib, both pieces to agree with an accurate template. The tube mounting was built up with pieces of hand pressed Masonite board. It required several hours work to cut the vane, center rib, and glue the several pieces to form the tube mounting. This model is now obsolete. Replacing the old model, we now have the vane and tube mounting of cast aluminum (separate pieces). To assemble is an easy task--no machine work is necessary other than bolting six bolt holes, and no expert mechanic is required. As a metter of fact, anyone with some training and mechanical ability could do the job.

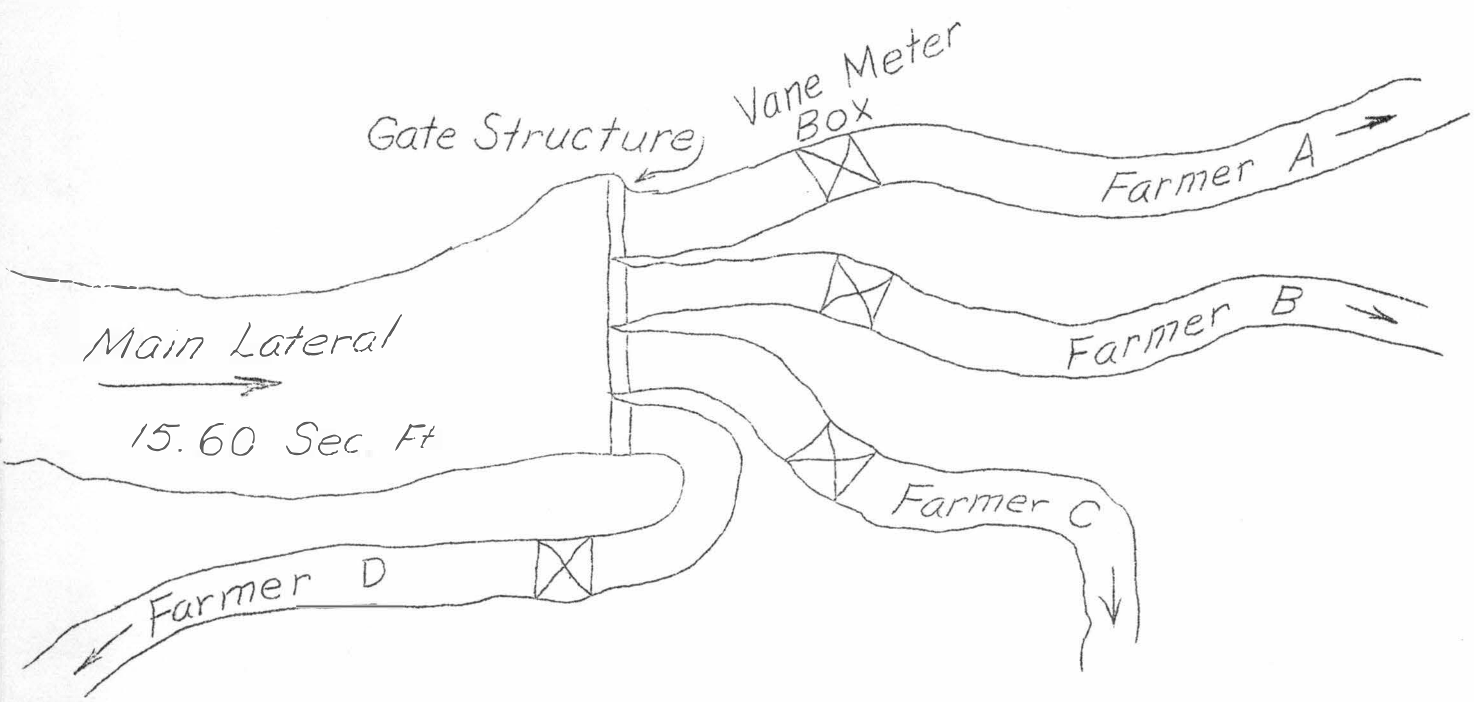
In developing the design of the Vane Meter, a few years back two problems confronted the experimenter. One was to reduce the friction of suspension bearing to a minimum, and the other to damp the pulsations of the trailing vane in the current. The bearing problem was solved by the use of a 50 d steel bridge spike which costs five cents and the damping mechanism came out to be a curved glass tube filled with a pure mineral oil and two 7/32 inch stainless steel balls. Kerosene in the tube was first believed to be the right liquid, but field tests now indicate that this type of oil is unsatisfactory because it is chemically unstable. The new improved cast aluminum meters will be provided with the glass tubes filled with a fairly heavy refined mineral oil as the damping liquid.

It is hoped that the cast meters will be identical for calibration purposes. The present plan is to assemble ten meters, each to be carefully tested in the laboratory and the data plotted as a group. These plotted points, 250 or more, should permit fixing a single curve to be the standard mean calibration for the ten test meters. Inspection of the plotted point will show the uniformity of the meters.

The Vane Meters, so far constructed, have a paper scale graduated in second-feet fixed to the mounting beneath the ball tube. Trouble has been reported in that some of these paper scales have peeled off. To obviate this situation, the standard calibration curve will be the guide in fixing the graduations on the pattern that casts the aluminum tube mounting. These cast graduations will eliminate further calibration and be permanent in a fixed position. The mounting will be carefully adjusted when assembled. The all aluminum metal meter will not require painting. The overall appearance of the complete meter suggests ruggedness and long life of usefulness.

Now about the division problem. At our last meeting, I briefly discussed this practical problem but believe few of the members present gained much from this discussion. It is my intention to leave with you the solution of a common irrigation problem where the use of the Vane Meter is an important factor. The basic idea envolved is to divide the water flowing in a sizeable lateral proportionally according to the rights or shares of the farmers equity in this common supply. Some forty years ago we investigated in the laboratory a device called a proportional divider and were aware at the time that it was impractical. A report of the work was published and possibly a few structures were built in the field.

Let us illustrate our problem by means of a concrete example.



Shares owned by farmers

Farm Lat. A, flat grade, slow velocity	4.5 shares
Farm Lat. B, high velocity	2.0 " "
Farm Lat. C, moderate velocity	3.6 " "
Farm Lat. D, slow velocity	1.5 " "
	11.6 shares

The ditch rider will first adjust the gates in the gate structure to what approximates, in his opinion, to be the proper diversion in each lateral according to the shares in each of the four laterals.

With the Vane Meter, he will measure the flow in each lateral.

Lat. A,	5.25 sec ft
Lat. B,	3.20 sec ft
Lat. C,	4.15 sec ft
Lat. D,	3.00 sec ft
Total	15.60 sec ft

Total shares	11.6
Total flow	15.60 sec ft
Flow per share	$\frac{15.60}{11.6}$ = 1.35 sec ft

The delivery of water to the four farmers at this time will of course be the amount of flow in the Main Lateral or 15.60 sec ft. This observation we will assume to be at 7:00 A.M. At noon, the flow has dropped to 12.0 sec ft, and later afternoon it is 13.80 sec ft. Change of flow in main lateral reduces or increases the diversion to the farmer.

Delivery to the Farmer Sec Ft

	7:00A.M.	Noon	P.M.
A	6.10	4.65	5.35
B	2.70	2.10	2.40
C	4.85	3.75	4.30
D	2.00	1.50	1.80
Check	15.65	12.00	13.85

Flow per share

7:00 A.M.	1.35 sec ft
Noon	1.04 sec ft
P.M.	1.19 sec ft

To operate this scheme of division, the ditch rider measures the flow in each farm lateral with his portable Vane Meter and adds the results to give the flow in the main lateral. At 7:00 A.M. it was 15.60 sec ft. To find the rate of flow per share divide the total flow, 15.60, by number of shares, or 15.60/11.6 = 1.35 sec ft. For the 7:00 A.M. division, he multiplies the farmer's shares by rate per share, as listed. He places the Vane Meter in farm lateral A --the original observation was 5.25, the calculated shows the correct diversion to be 6.10. He raises the regulating gate, in the gate structure, to have the meter read 6.10, next place the meter in lateral B, set gate to have meter read 2.70, gate lowered this time. Place meter in lateral C and adjust gate to have the meter read 4.85. For lateral D the original observation was 3.00 sec ft, now adjust for a flow of 2.00 sec ft. This set up is, of course, fictitious, merely to show the solution of the problem. The flow in lateral D was found to require considerable adjustment, judging the amount of flow is largely guess work and the ditch rider over-estimated in the first setting.

The questions of water lead to the importance of the matter. Our concern is largely supply and delivery. As time moves, and our experience widens, more and more attention will be given to this subject. In setting up this problem, the morning ratio of delivery was based on 1.35 sec ft per share. By noon, it had dropped off to 1.04 or 24 per cent less. This would not be an unusual change. The discharge through the regulating gates is assumed to be under pressure, and the change in stage in the main lateral would not greatly alter the proportional flow in the laterals. Since we feel that water is of importance, the management and use must be given attention. Therefore, attention must be paid to seeing that the water user gets his full legal share of the supply. This set up is to illustrate a practical scheme to divide the water equitably by use of the Vane Meter. In using the old proportional divider, where the gate area or merely width of opening, was intended to govern the lateral flow, it will be noted that Farmer C has a fast lateral, at high velocity, and because of his advantage would receive more than his fair share of the total water supply.