MEASURING A RIVER'S FLOW.

BY S. MAYS BALL.

The increasing attention which is being given to the conservation of natural resources, particularly to water power and the irrigation projects of the United States Reclamation Service, renders timely some description of the manner in which the water supply is

Gaging the flow of a mountain stream with hand instrument.

measured and recorded. Through the kindness of Mr. H. C. Rizer, Chief Clerk of the United States Geological Survey at Washington, the writer has been given facilities for a study of the system generally adopted, which is as follows:

The quantity of water flowing in a stream is expressed in various terms according as it represents the drainage from a watershed of given area, the rate of continuous flow as for power purposes, or simply volume, and it may be as well to commence with a definition of these terms.

"Second-foot," an abbreviation for one cubic foot per second, is the quantity of water flowing in a stream one foot wide, one foot deep, at a rate of one foot per second. It is generally used as a fundamental unit, from which others are computed.

In connection with pumping and a city's water supply, the water is generally measured in "gallons per minute."

The "miner's inch" is the quantity of water that passes through an orifice one inch square under a head which varies locally. It has been commonly used by miners and irrigators throughout the West and is defined by statute in each State in which it is used.

The average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area, is given as "second-feet per square mile."

"Run-off in inches" is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

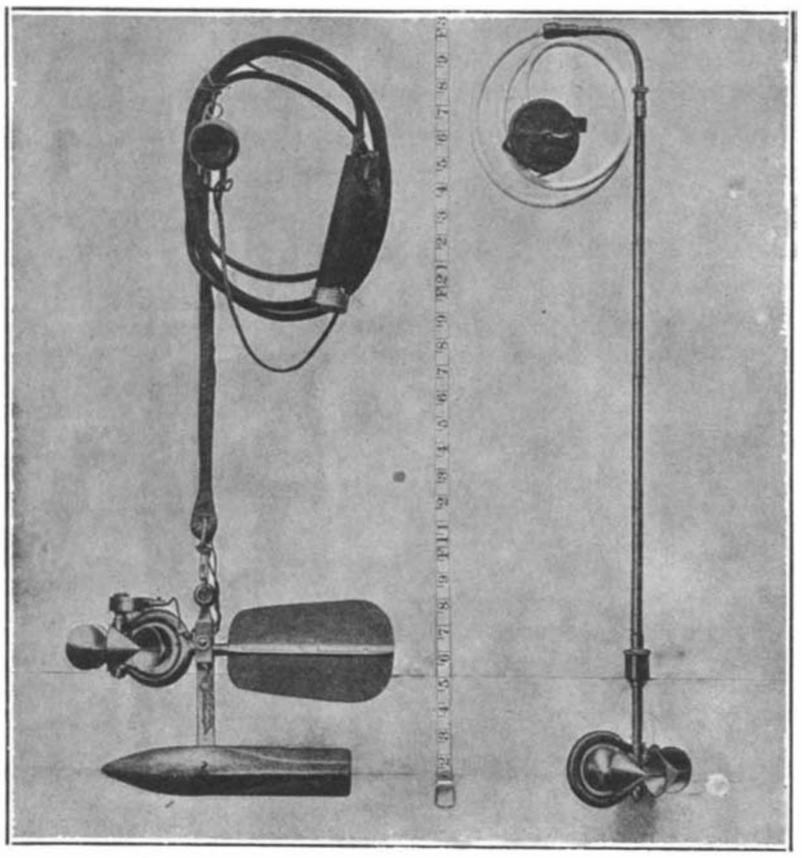
An "acre-foot" is equivalent to 43,560 cubic feet and is the quantity required to cover an acre to the depth of one foot. It is commonly used in connection with storage for irrigation work. There is a convenient relation between the second-foot and the acre-foot. One second-foot flowing for twenty-four hours will deliver 86,400 cubic feet or approximately two acre-feet.

Gaging stations are located upon streams as far as possible at points above and below which the channel is straight, where there are no cross currents or backwaters and where the bed of the stream is smooth and its banks high. Their equipment consists of fixed gages graduated to show the vertical fluctuations of the water surface and permanent bench marks indicating the points of measurement up and down stream: when the channel conditions are satisfactory bridges are used, as from them observations may more readily be made and the cost of equipment is small.

Current velocity is measured sometimes by floats and sometimes by means of the meters illustrated herewith. In measuring by floats, of which there are several kinds, the simplest being a corked bottle weighted at the bottom and carrying a flag at the top, little affected by wind, observation is made of the time taken by the float to pass over a selected "run" of the stream 50 to 200 feet long. A number of velocity determinations are so made at different points across the stream and the mean velocity of the whole section estimated.

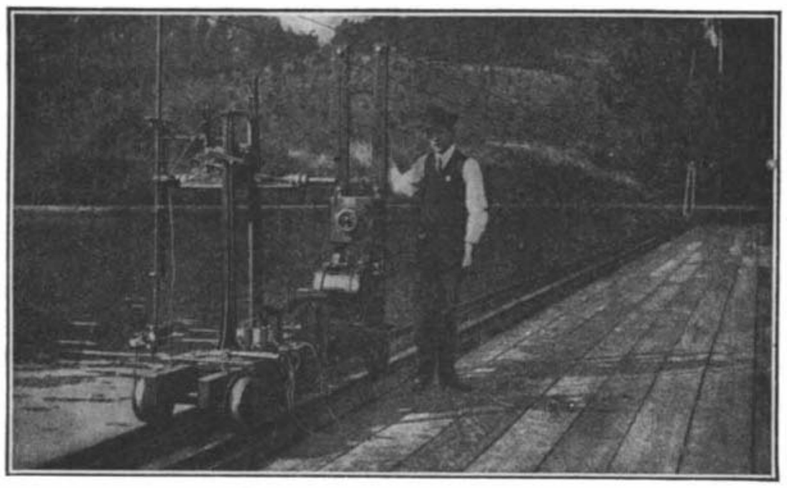
The discharge is the product of that mean and the mean sectional area of the run, which is determined by measurements and soundings of the two ends of the run and at intermediate points.

When meters are used they are held stationary in the current at a number of points across the width of the stream and at different depths, and the velocities recorded are averaged as before. A typical meter much used in the government service is shown in the illustrations, designed by Mr. W. G. Price. Its submerged portion consists of a small wheel carrying five conical buckets similar to that of the smaller instruments; these are rotated by their offering more resistance to the current at their large than at their small ends, the axis of the wheel carrying an eccentric by means of which electrical contacts are made



On the left a small Price electric meter, sounds received at the ear-piece being transmitted by current from the small battery shown ; on the right a Price acoustic meter.

and broken in a suitably-protected water-tight compartment. The number of revolutions made by the wheel are thus electrically recorded by the current of a battery operating the clockwork of the indicator dials. Two of the small portable meters are also shown: in one the revolutions are recorded by the striking of a small hammer on a diaphragm, the sound being conveyed by a tube to the ear of the observer who counts the revolutions, and in the other an electric current from the small battery shown operates a buzzer when the contact is made and broken as has been described for the larger machine.

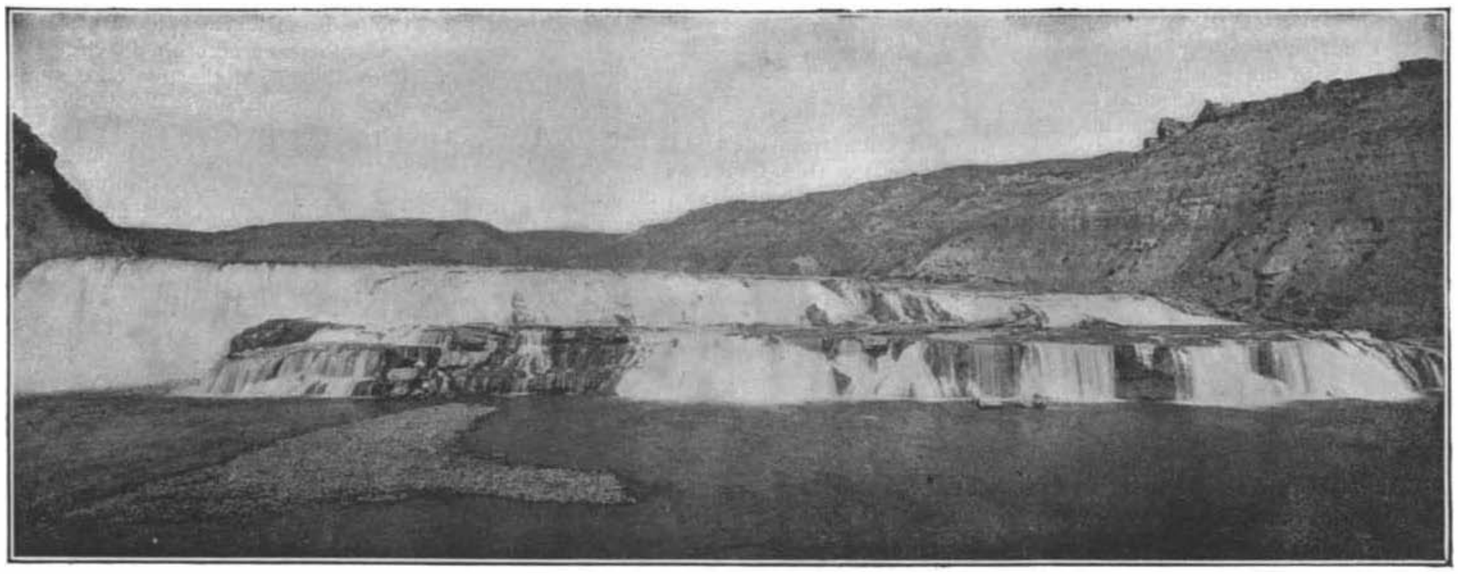


A meter calibrating station : the meters are drawn through still water at a known speed, and the revolutions they make recorded.

In each case the meter is supported above a pointed weight, provided with fins which keep it pointing straight upstream both in the vertical and horizontal plane.

To insure the coincidence of readings by different meters each individual instrument has to be separately "rated," to determine the exact number of revolutions it will make in a current of a certain speed. This is done by drawing the meter through a measured space of still water at a number of different speeds and noting the number of revolutions made, from which a rating table is prepared giving the velocity per second corresponding to any number of revolutions. Current-meter measurements may be made by an observer on a bridge, suspended from a cable, in a boat or wading, and gaging stations are classified in accordance with the method used. A wading station is shown in one of our illustrations.

The velocities indicated by the meters at different points in the stream are averaged by a variety of methods known as "multiple point," "vertical integration," etc. In the various multiple point methods the stream is divided theoretically into strips in the direction of its flow and (*Concluded on page 171.*)



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ing a run of twenty-four hours, when handling material at the speeds as specified in the contract, no part of the motor will rise in temperature more than 70 deg. C. above the surrounding air. All electrical equipment is designed for a direct current of 220 volts. The grab bucket has a cubical capacity of 100 cubic feet of limestone, and the scoop bucket of 132 cubic feet. Both buckets are especially designed for working in limestone. The grab bucket has an overall width of about 7 feet 6 inches and an over-all length when open of 17 feet 6 inches. The capacity of the machine is 200 tons per hour. The hoisting speed is 250 to 275 feet per minute; the racking speed 900 feet per minute; and the whole bridge travels at the rate of 100 to 150 feet per minute.

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the velocity recorded at a number of different depths in each strip. By the vertical integration method the meter is moved at a slow uniform speed from the surface of the stream to the bottom and back again.

For convenience of reference and comparison the results obtained are plotted in the form of a curve on a chart.

Another illustration shows the Great Falls of the Missouri River in Montana. A gaging station at the point from which the photograph is taken was established by the Geological Survey in July, 1902.

The river is favorable at this point for water-power development and shows the kind of stream, apart from navigable rivers, measured and reported upon by the Survey. In this way the Survey constantly brings to the attention of the investing and developing public many previously unnoticed but valuable water-power sites.

We are indebted to the director of the U. S. Geological Survey for the use of the accompanying illustrations.

THE AVIATION MEETING AT RHEIMS.

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with their Bleriot monoplanes. Both Bleriot and Curtiss tried to lower their speed records for one circuit of the course, and the latter succeeded in making 2 seconds better time than before. His time of 8:09 1/5 corresponds to almost 45.7 miles an hour. Bleriot made the circuit in 8:08 2/5, which was 4 seconds slower than formerly.

At the end of 2 hours, 22 minutes, and 51 seconds, Farman had flown 140 kilometers (86.99 miles) and beaten Paulhan's record. It was getting dark rapidly and the spectators could only see the machine as it passed before the grand stand. Ten minutes and 19 seconds later he completed his fifteenth round, and less than five minutes later he had beaten Latham's record. One hundred and sixty kilometers (99.4 miles) were covered in 2:43:35 2/5, and 180 kilometers (111.88 miles) in 3 hours, 4 minutes, 55 2/5 seconds. As it was now 7:30, the nineteenth round afterward made by Farman was not counted in the official figures. He actually covered over 190 kilometers (118.06 miles) and remained in the air all told about 3¼ hours. As he finished in front of the grand stand a searchlight was thrown upon him. He was pulled from his machine and carried upon the shoulders of his friends, receiving a decided ovation. Thus, for the second time, he has won a $10,000 cash prize, the first instance being when he flew 1 kilometer in a closed circuit on January 13th, 1908. It is possible that he will try again to win this sum by making the 140-mile flight from New York to Albany. In the flight for the Grand Prix, he carried enough fuel to fly 3½ hours.

The other prizes awarded in the Grand Prix de la Champagne distance race were as follows:

Second, $5,000, won by Hubert Latham on his Antoinette monoplane. Distance, 154.5 kilometers (96 miles).

Third, $2,000, won by M. Paulhan with his Voisin biplane. Distance, 131 kilometers (81.4 miles).

Fourth, $1,000, won by Count de Lambert with his Wright biplane. Distance, 116 kilometers (72.1 miles).

Fifth, $1,000, won by Paul M. Tissandier. Distance, 111 kilometers (68.97 miles).

Sixth, $1,000, won by M. Roger Sommer with a Farman biplane. Distance, 60 kilometers (37.3 miles).

The distances covered by the other competitors were: 50 kilometers (31.1 miles) by M. Delagrange, with a Bleriot monoplane; 40 kilometers (24.9 miles) covered by M. Bleriot with one of his monoplanes; 30 kilometers (18.64 miles) covered by Mr. Curtiss with his biplane; and 21 kilometers (13.04 miles) covered by M. Lefebvre with his Wright machine.

This first aviation meeting has demonstrated beyond a doubt that the real flying machine is here. That aeroplane races will soon supersede the dangerous automobile races, there can be no question. We expect in our next issue to give full details of the successful machines at Rheims and their motors, as well as further particulars of the flights which were accomplished.

Tire cover and fastening therefor, G. W. Brown 931,674
Tire inner tube, pneumatic, H. K. Raymond 931,648
Tire plug, pneumatic, J. Glanz 931,056
Tire upsetter, J. H. Macdonald 931,325
Tires for wheels, manufacturing elastic, T. L. Carbone 931,563
Tires, making casings for pneumatic vehicle, J. O. King 931,207
Tobacco cutter, rotary, W. A. Hagemeyer .. 931,295
Toe calk machine, D. G. Wyman 931,364
Tongs, A. G. Kjellerstedt 931,317
Toothpick machine cutter, H. A. Dorr 931,044
Top, T. N. Reed 931,187
Toy, S. H. Rogers 931,221
Toy air gun, S. T. Allen 931,553
Toy motor, electric, H. C. Grant 931,417
Toy, moving picture, E. W. Davis 931,184
Toy, musical, O. Einicke 931,286
Toy musical instrument, S. R. Divine 931,578
Track, carrier, W. & J. F. Mitchell 931,455
Track laying machine, J. H. White 931,166
Track rail support, J. W. Kemmerle 931,206
Track sanding device, E. A. Longmire 931,444
Train lighting system, D. C. Jackson 931,613
Tray adjustable support, aseptic, C. F. Booth 931,378
Tripod, tilting top, J. C. Fyfe 931,692
Trolley and support therefor, S. S. Goldman 931,292
Trolley clamp, E. E. Rose 931,345
Trolley clamp, T. Varney 931,355, 931,357
Trolley clamp, H. P. Davis 931,390, 931,391
Trolley conductor clamp, C. Aalborg 931,368
Trolley conductor hanger, H. P. Davis 931,593
Trolley hanger, T. Varney .. 931,353, 931,356, 931,358
Trolley hanger, H. P. Davis 931,392
Trolley hanger, G. B. Dusinberre, 931,397, 931,398, 931,400
Trolley hanger and clamp, C. Aalborg 931,366
Trolley harp, T. A. Gannoe 931,592
Trolley wire hanger, Heimbecker & Orum .. 931,301
Trough and glass support for glazed structures, combined, J. A. Olsson 931,638
Truck, H. C. Grant 931,413, 931,414
T-slot bar, G. H. Vining 931,164
Tube and bar mill conveyer, North & Harrison 931,545
Tube drawing device, W. T. Adams 931,551
Tube making machine, G. A. Lutz 931,134
Tube mill tube trough, J. S. Worth 931,544
Turbine, elastic fluid, B. Ljungstrom 931,323
Typewriter, G. W. Downing 931,689
Typewriting machine, W. F. Helmond 931,303
Typewriting machine, J. J. Cooper 931,680
Typewriting machine, J. C. Doane 931,688
Umbrella, folding, P. L. Page 931,079
Umbrella lock, R. E. Adams 931,550
Undergarment, R. M. Sider 931,151
Upholstering attachment, H. G. Westmore .. 931,106
Upholstering machine, I. Karpen 931,313
Urinal ventilator, A. J. Cheney 931,268
Valve, F. C. Smith 931,155
Valve, L. Schutte 931,228
Valve, C. Wainwright 931,532
Valve, flush, E. Nanfeldt 931,465
Valve for gas main joggle, L. Shaw 931,506
Valve, gas regulating, C. C. Armstrong 931,668
Valve gear, air, E. A. Rix 931,650
Valve, lavatory supply, W. A. Speakman .. 931,512
Valve, triple, W. V. Turner 931,238
Valve, triple, J. W. Cloud 931,271
Vapor electric apparatus system, F. Conrad. 931,114
Vapor generator, R. W. Zierlein 931,664
Vapor rectifiers, system of distribution for, F. Conrad 931,115
Vault, burial, W. E. Haworth 931,299
Vehicle, D. H. James 931,614
Vehicle automatic brake, F. D. Kaser 931,430
Vehicle brake, automatic, G. R. Kelly 931,621
Vehicle foot board, J. Hage 931,601
Vehicle shock absorber, F. N. Rosenstengel. 931,653
Vehicle wheel, B. C. Oblinger 931,214
Vehicle wheel, C. L. Shaw 931,505
Vehicle wheel, T. B. Jeffery 931,615
Veil clasp, B. Honsowetz 931,308
Ventilator. See Draft ventilator.
Ventilator, F. G. Andrews 931,667
Violin chin rest, G. Beisheim 931,251
Wagon brake, W. L. Roper 931,491
Washing compound and making same, clothes, J. H. Schlueter 931,498
Well drilling apparatus, H. B. Walker 931,101
Whalebone stretching and straightening machine, O. Holzbauer 931,204
Wheelbarrow, R. T. Todd 931,096
Wheelwright's tool, F. M. Sturgis 931,160
Whip, H. Flesch 931,047
Whip socket, J. H. Larson 931,437
Windmill regulator, M. S. Newcomer 931,140
Window or shutter operating mechanism, E. Van Noorden 931,239
Window screen, D. M. Henry 931,421
Wire bender, J. S. Pratt 931,480
Wires and cables, hanger and clamp for, C. Aalborg 931,367
Wrapping machine, A. M. Price 931,646
Wrench, F. Smith 931,510
Wrench, J. J. Parsons 931,640
Writing machine, E. B. Hess 931,305
X-ray apparatus, E. W. Caldwell 931,034

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., 361 Broadway, New York.

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