

WATER MEASUREMENT.

The *Scientific American* of May 27 contains an article contributed by G. D. Hiscok, M. E., on the subject of "Terms of Water Measurement for Mining, Irrigation and Mill Power." It says: "The designation of the terms of water measurement seems to be somewhat misunderstood, or has become misleading in many parts of the United States from the manner in which a primitive custom of water measurement has been adopted in different localities and afterwards in some of its forms been made legal by the courts.

Differences in elevation above the sea and the latitude make a slight difference in the flow of water by gravity for a length of time, too small for practical consideration, but just enough for a legal quibble when water measure is referred to the courts.

Variation in the form of the orifice varies the actual delivery per square inch of orifice and with all the conditions of variation in head, form of orifice, elevation of locality, latitude and dissimilarity in the lengths of orifice, there is found a variation in the accepted unit flow through a square inch of orifice of over half a cubic foot per second.

In this view the miner's inch of water used in the early days of California mining has become a standard of varying proportions in different localities, most perplexing as a definite and legal measure; so that the nominal miner's inch may deliver any quantity from 1.20 to 1.78 cubic feet of water per minute.

The largest volume for a miner's inch is the measure used at Smartville, Yuba county, Cal., called the Smartville inch, is derived from a horizontal rectangular orifice 4 inches in depth, through a 2 inch plank, under a head of 9 inches from the center of the orifice, and of the required width for the total flow, this being equal to 1.78 cubic feet per minute per square inch of orifice.

The miner's inch of the Park Canal and Mining Co., El Dorado county, Cal., is equal to 1.45 cubic feet per minute, with an orifice two inches deep through a 1½ inch plank—head 8 inches above center of orifice—this being the rating of several ditch companies in California.

By a series of experiments at Columbia Hill, Cal., lat. 39 degrees, 2,900 feet above the sea, 1.5744 cubic feet per square inch per minute was assigned as a miner's inch, this being the flow per square inch through a rectangular slit 50 inches long, 2 inches deep, equal to 100 square inches, under a head of 7 inches from the center of the slit; this being also the rate with the North Bloomfield, Milton and La Grange Ditch companies.

In other parts of California 50 miner's inches are rated at 60 cubic feet of water, or 1.20 cubic feet per miner's inch. The statutory or legal miner's inch of California is equal to a flow of 1.394 cubic feet per minute, and is defined as the flow through a square orifice 1 inch in depth by 1 inch in width through a 1 inch plank, under a head of 4½ inches above the center of the orifice.

In Colorado, previous to statutory regulations and still in use by agreement, 40 miner's inches are reckoned at 60 cubic feet, or 1.50 cubic feet per

square inch of orifice under a head of six inches above the orifice in the bottom of the delivery box, the stream falling vertically, the actual flow being 1.556 cubic feet per minute.

The statutes of Colorado now provide that "water sold by the inch by any individual or corporation shall be measured as follows, to wit: Every inch shall be considered equal to an inch square orifice, under a 5 inch pressure, and a 5 inch pressure shall be from the top of the orifice of the box, put into the banks of the ditch to the surface of the water."

The practice much in use in Montana is to deliver the water through a horizontal slit 1 inch in depth, of sufficient length for the required supply, under a head of 4 inches above the head of the slit, and is equal to a flow of 1.25 cubic feet per minute per square inch of orifice.

Six and a half inches head above the center of a 1 inch square orifice, or a long horizontal gate 1 inch in depth, is becoming the more usual practice in California, where the miner's inch originated, and will no doubt come into general use as the most satisfactory working condition of water supply for mining and irrigation purposes.

From experiments of the Pelton Water Wheel Co., the relation of flow under various heads and increasing widths of slot, with a uniform thickness of plank and distance of orifice from the bottom of the flume, becomes interesting, in view of the varying practices in different states and localities. With a square orifice 2 inches in depth, 4 inches wide, a 5 inch head above the center of the orifice gave a flow of 1.348 cubic feet per minute; 6 inch head, 1.473 cubic feet; 7 inch head, 1.589 cubic feet per minute per square inch of orifice. By lengthening the orifice horizontally the flow increased in quantity per square inch of orifice, owing to the increase of area relative to the increase of perimeter; so that at 16 inches in width, 5 inch head, flow 1.365; 6 inch head, 1.489; 7 inch head, 1.60 cubic feet per square inch of orifice.

For the purpose of irrigation, the irrigating duty of water takes its base of computation from the flow per second or minute; but as this is not a constant quantity for different localities, owing to variation in value in the miner's inch, the acre duty will be an uncertainty until some general law, fixing a uniform standard of measure or detail, as to head and area to constitute a unit of measure, is made to extend over the different states and territories requiring a system of irrigation.

As an irrigation term the "duty of water" means the area of land upon which a definite volume of water, applied during a given period, will successfully raise crops.

In Utah, where irrigation laws have largely covered the details of water rights, the "unit" of water measurement is designated as one cubic foot of water per second, called the "second foot," is the standard of expression for water service for irrigation, and is equal to 86,400 cubic feet per day. The "acre foot" is the equivalent of one acre covered one foot deep, or 43,560 cubic feet, to which is added the time requirement.

In Utah the "second foot" is equal to two "acre feet" per day—"60 acre

feet" per month; 100 California inches equal 4 acre feet per day; and 100 Colorado inches equal 5 1-6 acre feet per day.

The "second foot" is becoming popular throughout the Western states and territories, from its definiteness of meaning and understanding, and with which there is little chance for technical quibble.

The measurement of water for power in the eastern portion of the United States is the "inch," under a stated head. The "inch" or "inches," meaning the number of square inches opening in a gate, or orifice, leading to a water wheel under some specified head.

The practice varies largely in different states. In New England, the water power companies have specific measures of gate opening, from one foot head upward, and also rate by the theoretical horse power for any form of flow.

Where no specific head is named, a 4 feet head from the center of the gate orifice to the surface of the water in the flume has become legalized in some of the states by statute or court decision; the height or head above or below the statutory 4 feet being reckoned by its relation to the unit, in power-producing effect.

This is made the basis in water power leases in Wisconsin from the time of the earliest leases in that state.

In some cases the actual heads are named. The valuation of variation in the head below and above four feet, when named as a unit, has been a cause of legal contention in several states, and in Wisconsin it has been fairly defined that the power derived from a unit orifice varies proportionately with the variation of the head, and that the area for a given power varies inversely as the square roots of the heads less the proportion of increased head and the reverse for decreased head.

IRRIGATION SCHEME.

Another extensive irrigation scheme is now under way in southwestern Arizona. The plan is to dam the Gila river at the gorge, twelve miles east of Yuma, and create a reservoir thirty miles in length and eight miles in width. The dam, which will be of solid masonry, is to be 4500 feet in length and 110 feet high. It will extend from the mountains on one side of the Gila to the opposite bank on a reef of bed rock, where three small islands rise out of the bed of the stream. These islands will form abutments to the dam, which will be built with such a slope as will carry the water away from the dam without cutting or wearing away the rock at its base. The flume, or canal, which will conduct the water away from this reservoir to the lands to be irrigated, will not be over a mile in length. From the end of the flume to the south and west canals will be constructed over the mesa and valley lands in different directions when the lands which all belong to the United States government are settled. The reservoir, it is estimated, will hold water enough to irrigate the 3,500,000 acres of land lying to the east and south of Yuma, which extend into the Mexican state of Sonora, and will