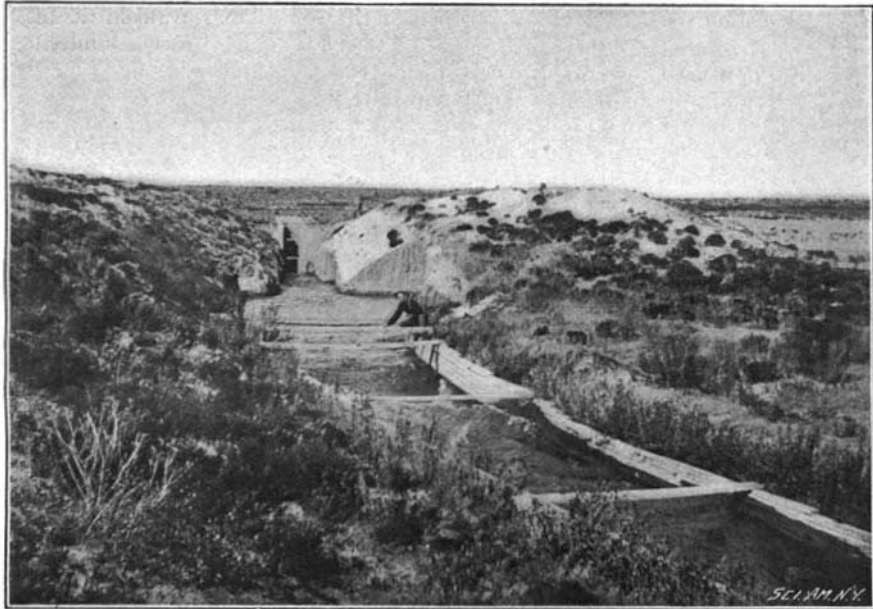


WATER MEASUREMENT AND MANIPULATION IN COLORADO.

BY H. A. CRAFTS.

Colorado cultivates more than two million acres of land, a fact made possible by irrigation alone. When it is known that this land has to be irrigated two or three times over, each season, the magnitude of the



DISCHARGE-WAY AND MEASURING WEIR OF ONE OF THE RESERVOIRS.

labor involved may be imagined. The State is divided into eight water districts, and each of these districts is subdivided into what are known as commissioner districts. There is a State superintendent of irrigation; but really above him in authority is the State engineer. Over each commissioner's district presides a water commissioner, who is appointed by the Governor of the State upon recommendation of a majority of the county commissioners of the counties through which the district extends.

It is the duty of a water commissioner to see that the water appropriated for irrigation in his district is distributed according to the legal rights of the owners of the ditches within his district. These rights have been established by decrees of the district courts of the State, and the decrees are printed in pamphlet form for the guidance of water commissioners and others in interest. The rights of an irrigating ditch to water from a natural stream, with relation to the rights of competing ditches, is based upon the priority of appropriation. Appropriation dates from the completion of a ditch and the taking of water through it for irrigation.

The commissioner's district, covering the Cache la Poudre Valley, extends from Chamber's Lake on the west to the South Platte River on the east, a distance of about eighty miles. It includes a cultivated area of about 250,000 acres and 114 ditch priorities. The aggregate appropriation of all of the ditches is 2,400 cubic feet of water per second. The maximum flow of the river is about 7,000 cubic feet per second. In 1884, a year of high water, it discharged for a period of twenty consecutive days 5,000 cubic feet of water per second; and for a period of fifty-five consecutive days 3,000 cubic feet of water. The river is rated at a weir constructed for the purpose, just inside of the mouth of the cañon.

From these ratings the water commissioner devised a scheme which has proven quite satisfactory. As it happens, two of the largest ditches in the district are of the latest construction—the Larimer and Weld, with an appropriation of 720 cubic feet per second, and the Larimer County, with an appropriation of about 600 cubic feet per second. The head gates of both are

within five miles of the rating weir, and within four miles of each other. In the bed of the river, near each of these head gates, was set a pole marked off in inches, and by using the ratings made at the measuring weir as a basis, a formula was established whereby the amount of water being discharged by the river at any given time could be determined by a glance at one of these stakes. The Larimer and Weld being senior to the Larimer County, and its head gate lower down the river, the stake located at that point is used for observation in the first instance. If sufficient water is flowing to supply full appropriations to all the ditches below, and which are also senior, then any surplus is turned into the Larimer and Weld until its appropriation of 720 cubic feet per second is filled, and then if there still exists a surplus that surplus is given to the Larimer County ditch up to its full appropriation. Above the Larimer County is still the North Poudre Canal, which is the junior of all of the large ditches on the stream, and which comes in for a supply when

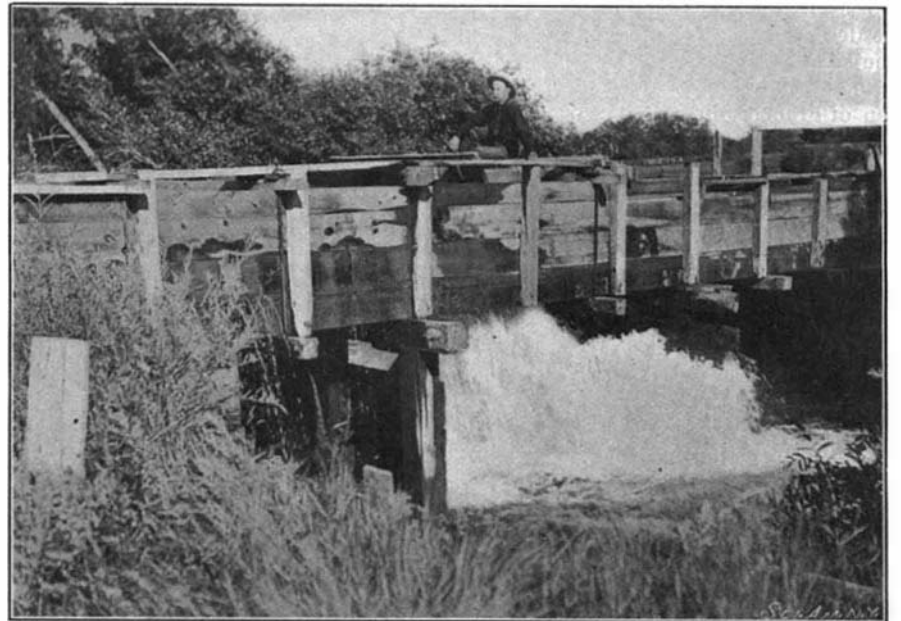
all the others have been given their appropriation. As the appropriations of the three ditches named aggregate an amount about equal to half of the appropriations of all, the problem of distribution can, for the greater part of the time, be solved by cutting the total discharge about in half. So long as there is sufficient water passing the head gate of the Larimer and Weld

ditch to satisfy the appropriations of the senior ditches, the commissioner does not worry himself about them; each ditch gets its full appropriation, and that is the end of it. Occasionally there is complaint that some ditch is taking more than belongs to it, in which case the commissioner has to make an investigation and correct the abuse, if there is one. But should the water fall below the point mentioned, then he must call down the junior ditches in their order, until the senior ditches have their full rights.

The larger ditch companies run their ditches in sections, having a ditch rider for each section. The water of the river is distributed twice a day during the irrigation season—morning and evening. This keeps the superintendents informed of the amount of water their respective ditches are entitled to. Upon this information the superintendent predicates his orders to his subordinates, who are thereby governed in their distribution of water to consumers. The water is kept running in the ditches, night and day, all through the irrigating season. During the daytime the farmers and their hands distribute the water over their land. At night, the hours of which are made very short by the irrigator, and on moonlight nights some farmers remain out irrigating all night. The water is turned upon some level portion of the farm, where it will cover the ground of its own volition. In times of low water it is not uncommon for two large ditches to work on the exchange plan—that is, one ditch for a certain number of days will take all the water that the two are entitled to, and then give the other its turn under a like arrangement. It has been found that water will go much further under this plan. The stor-

ing and distributing of water for irrigation involve many interesting features. Take the Chamber's Lake reservoir of the Water Supply and Storage Company, as one, for instance. It is situated high in the Rocky Mountain range, at least fifty miles from the head gate of the company's main ditch, but tributary to the Cache la Poudre River. When the water stored up in it is needed for use at any time, it is measured into the main current of the river and permitted to run its course. As an equivalent the company is allowed to take from the river at its head gate an equal amount, less a small deduction made for leakage and evaporation on the way down from Chamber's Lake. The using of the natural bed of a stream for the conducting of water for irrigation, as just described, is permitted by a State law.

The manipulation of the water stored in the plains reservoir of this company affords another instance of ingenuity. These reservoirs consist of a chain of six artificial lakes some seven or eight miles eastward from the company's main head gate. The lakes were formed from natural depressions in the land, diked up, and are filled annually through the company's main ditch. But they are so situated that they cannot be drained into the main ditch and the water carried forward to the land desired to be irrigated, nor can they be drained by independent outlets that can be made to reach such land. So the water can only be utilized by means of an exchange with older ditches that lie at a lower level than the reservoirs. The total capacity of these reservoirs is in the neighborhood of 600,000,000 cubic feet of water, so it can be seen that the utilization of the water thus stored is a matter of no small importance. The reservoirs are all connected by canals, and can all be drained, one into another, until the last one is reached. The exchange of water is made both with other ditches direct and with the river below. An exchange is frequently made with the Larimer and Weld ditch, the discharge-way of the reservoirs crossing the ditch in a flume at right-angles, and through the bottom of this flume the water is dropped into the



LARIMER COUNTY DITCH DROPPING RESERVOIR WATER INTO THE LARIMER AND WELD DITCH IN EXCHANGE FOR RIVER WATER.

ditch below, as shown in one of our illustrations. When it is not convenient for the Larimer and Weld to take this water, it is carried on into the river, being measured near the discharge-way of the lakes by a weir, as is also shown in another of our illustrations, and the owners of the reservoir permitted to take an equal amount of water from the river above, at their head gate. There is nothing compulsory about this exchange, but it is made by mutual agreement among the ditch companies.

The Larimer and Weld has a large storage reservoir near its upper extremity, which is so situated that it can be drained directly into the main ditch, and the third of our illustrations shows this being done.

Automatic Development of Photographic Plates.

A method of automatic development has been devised by which each plate is coated on the back with the necessary products, and the development is carried out in water which has been made slightly alkaline; this may be of advantage to tourists, as it avoids the carrying of chemicals. The formula for the solution is as follows:

Pyrogallie acid.....	10 grammes.
Salicylic acid.....	1 "
Dextrine.....	10 "
Alcohol.....	4 c. c.
Water.....	20 "

The solution is spread upon the back of the plate and allowed to dry. The exposure is made as usual, and, to develop, it is sufficient to put the plate in water to which a few drops of ammonia have been added. The coating dissolves and the developer is thus prepared.



LARIMER AND WELD DITCH, DRAWING WATER FROM ITS TERRY LAKE RESERVOIR AND DELIVERING IT INTO ITS MAIN DITCH.