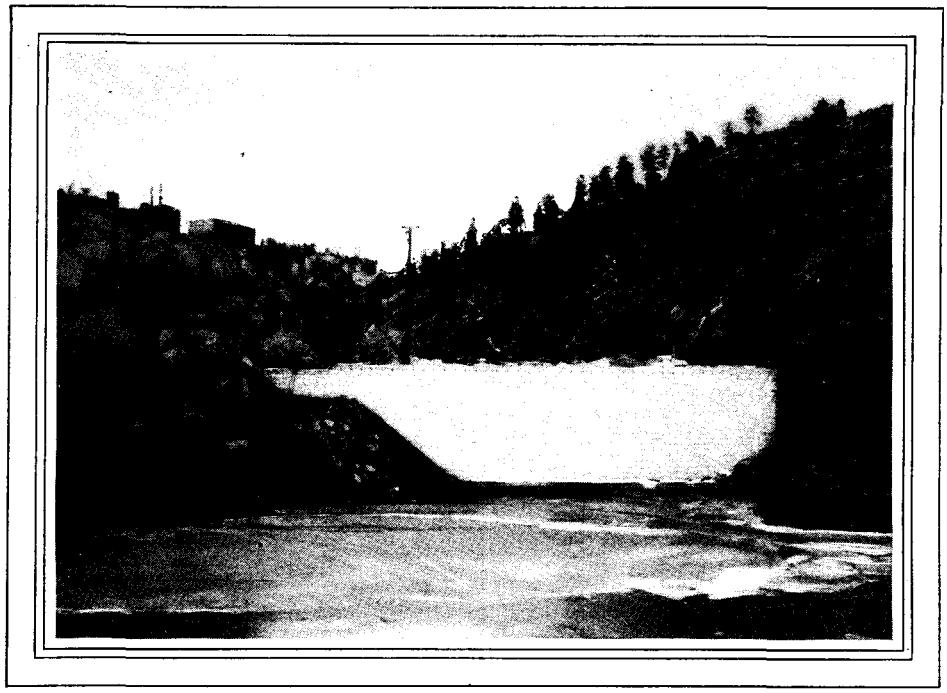

THE CONSTRUCTION OF AN IRRIGATION RESERVOIR—BUILDING THE DAM AT CHEESEMAN LAKE, COLORADO.

The Barren Lands of America.

BY CRITTENDEN MARRIOTT.

FULLY ONE THIRD OF THE SUPERFICIAL AREA OF THE UNITED STATES IS NATURALLY ARID—OF THAT BARREN SPACE PROBABLY A HUNDRED MILLION ACRES CAN BE MADE FRUITFUL BY MEANS OF STORAGE RESERVOIRS—THE GOVERNMENT IS NOW SEEKING OUT SUITABLE SITES FOR DAMS IN ORDER TO RECLAIM LANDS NOT PERMANENTLY BARREN.

OF the three million square miles of land in the United States, excluding Alaska and the islands, one million three hundred thousand are arid. Much of this vast area must ever remain unproductive, because it is either too rocky and barren ever to be worth cultivating, or because it lies at elevations too high for successful tillage. The greater part of it, however, lies at convenient altitudes and consists of rich soil, needing only water to make it equal or superior to the greater part of the cultivated lands of the United States.

But much even of this available land must always continue arid, for the reason that there is not enough water to supply it, nor ever will be. If all the rain that falls upon the Western hills could be utilized in the most economical way and at the most suitable times, still more than half the arid land would remain unwatered. When it is considered that certainly half, and probably three fourths, of this rainfall must always be lost for one reason or another, it becomes evident that only a small portion of the available land can ever be utilized.

But even with all these deductions, the area naturally arid which can be

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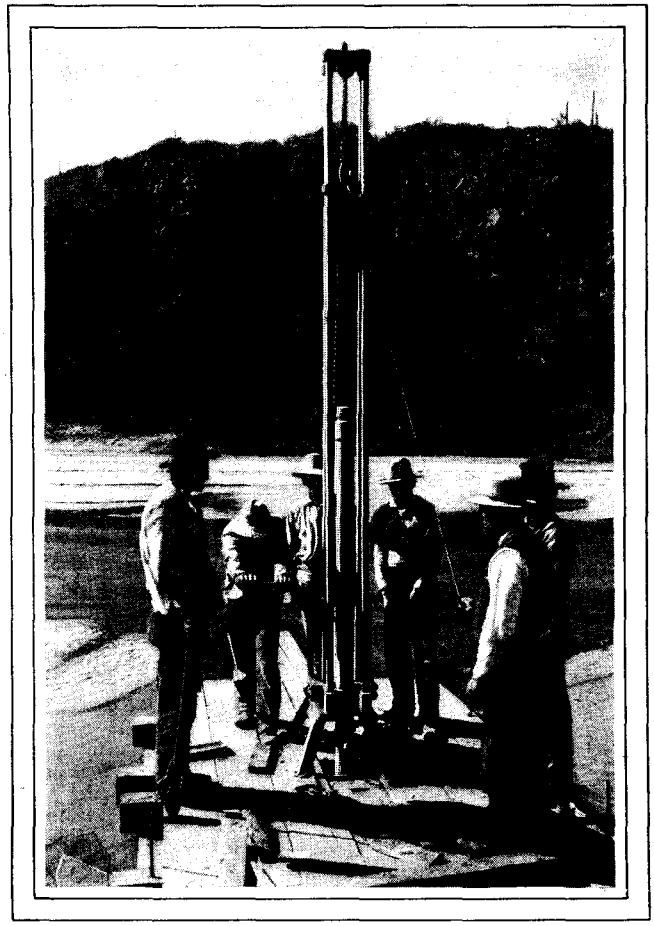
reclaimed is vast in extent, amounting, according to various estimates, to from seventy million to one hundred million acres—an empire larger than the New England States, New York, and Pennsylvania combined. About seven million five hundred thousand acres of this is already under irrigation, utilizing practically all the water available under present methods. To reclaim the rest, it will be necessary to build storage reservoirs, in which the spring floods that now run to waste can be impounded and preserved against the time of need.

THE PROGRESS OF THE EXPERIMENT.

The impression seems to prevail, throughout the Eastern States at least, that the West is demanding that Congress shall inaugurate a policy which has been imperfectly tested and may or may not succeed, but which will, in any case, cost millions of dollars. Than this nothing could be further from the truth. Irrigation is neither new nor untried. The United States today has a larger area receiving artificial water supply than any country in the world except India; and the total annual expense to the government is restricted to the sum received annually from the sales of public lands — a sum now less than two million dollars a year, and steadily decreasing as the available lands are taken up. This sum can be augmented only by rendering salable lands now valueless through lack of water, so that the net cost to the government of a storage system will be the comparatively small sum it would henceforth derive from the sales of its lands if not irrigated. The bill now pending provides specifically that the construction of reservoirs shall proceed only so fast as funds from sales of public lands are available for it.

There are many reasons why the government rather than private capital should undertake this work. First, the government owns most of the land to be irrigated, and will be the chief beneficiary; it owns forty three per cent of all the area of California, sixty per cent of all Colorado, eighty two per cent of Wyoming, eighty four per cent of Montana, Nevada, and Utah.

Only the government can control streams that flow through two or more States, as nearly all streams of any account do, while some traverse half a dozen. If the people of one State impound or divert the waters of an in-



DIAMOND DRILL OUTFIT, BY MEANS OF WHICH EXPLORATIONS ARE MADE TO DETERMINE THE LEVEL OF SOLID BED ROCK FOR THE FOUNDATIONS OF A DAM.

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terstate river, those of the next State are certain to protest. Colorado and Kansas are now hotly litigating over the right of the former to use up the waters of the Arkansas River, thus rendering Kansas farms worthless. Similar conditions would prevail elsewhere were it not that capitalists have been frightened off by threats of litigation and have refrained from building works ardently desired by the local community.

By adding the cost of the reservoir to the price of the land, the government can guard against bad debts as no one else can; it can afford to wait much longer for returns from its investment than can private companies; and, finally, it will be free from most of the ruinous and often preposterous suits against which all reservoir companies have had to contend.

Even where no interstate questions are involved, the objections to private reservoirs are great. Every little stream throughout the West is already utilized by people who live along its banks or on canals fed from it. To preserve their vested rights, it is necessary that the flow at low water stage—when water is most needed—shall not be obstructed. That is to say, during the dry season no additional water must be held back by the reservoir; an amount equal to that coming in at its upper end must be allowed to escape at its lower end. It is difficult to ascertain this amount accurately, and still more difficult to persuade people below, who are depending on it for their very subsistence, that they are getting all they are entitled to. Only the government, which has nothing to gain by favoring one farmer over another, can adjust this delicate matter with any hope of satisfaction to those whom it serves.

The fact that all the arid land can never be irrigated must always be kept in mind. Every reservoir, like every stream of today, will be surrounded by a fringe of semi arid land which will get some water, but never enough at its time of greatest need; the reservoirs will merely convert millions of acres in the present fringe—and beyond it—into valuable land, and create new fringes further away.

Without storage reservoirs the conquest of the arid lands must stop, because without them the available water supply is now practically all appropriated. In most States ditch building has outrun settlement. If water be supplied, ditches now existing in Colorado will irrigate half as much land again as they do at present; those in Nebraska twice as much; those in Idaho and Arizona three times as much; and those in Wyoming four times as much. Altogether, over four million acres in the States named can be irrigated without building another mile of ditch—if only water can be obtained. And there is sufficient water for years to come! The average flow in June in the West is ten times as great as that in July and August; there is too much in the former month and too little in the latter. The difficulty is in saving it. Theoretically, this is easy enough. All that is necessary is to find a stream running through a canyon which, higher up, opens out into a valley wide enough for a reservoir; to throw a dam across it at its narrowest point, thus stopping the water and creating a lake; and to provide means to let the water escape as it is needed. Nothing could be simpler. Unfortunately, things seldom work out quite so easily in practice.

THE CONSTRUCTION OF A DAM.

In the first place, while sites that appear satisfactory are plentiful enough, those that are really so are much rarer than might be supposed. They must not be too far up stream or they will fail to catch the full product of the water shed, nor too far down stream or the channel will be so wide that the cost of the dam will be prohibitory. Then they must be large enough to impound all the available water without requiring too high—and costly—a dam. Many sites that look level to eyes accustomed to the sharp slopes of the hills really have a considerable rise; thus a valley that looks as though it would produce a lake several miles long if barred with a sixty foot dam will often turn out on closer investigation to produce only one fourth of that.

The next matter is to determine how much water there is to impound. It is

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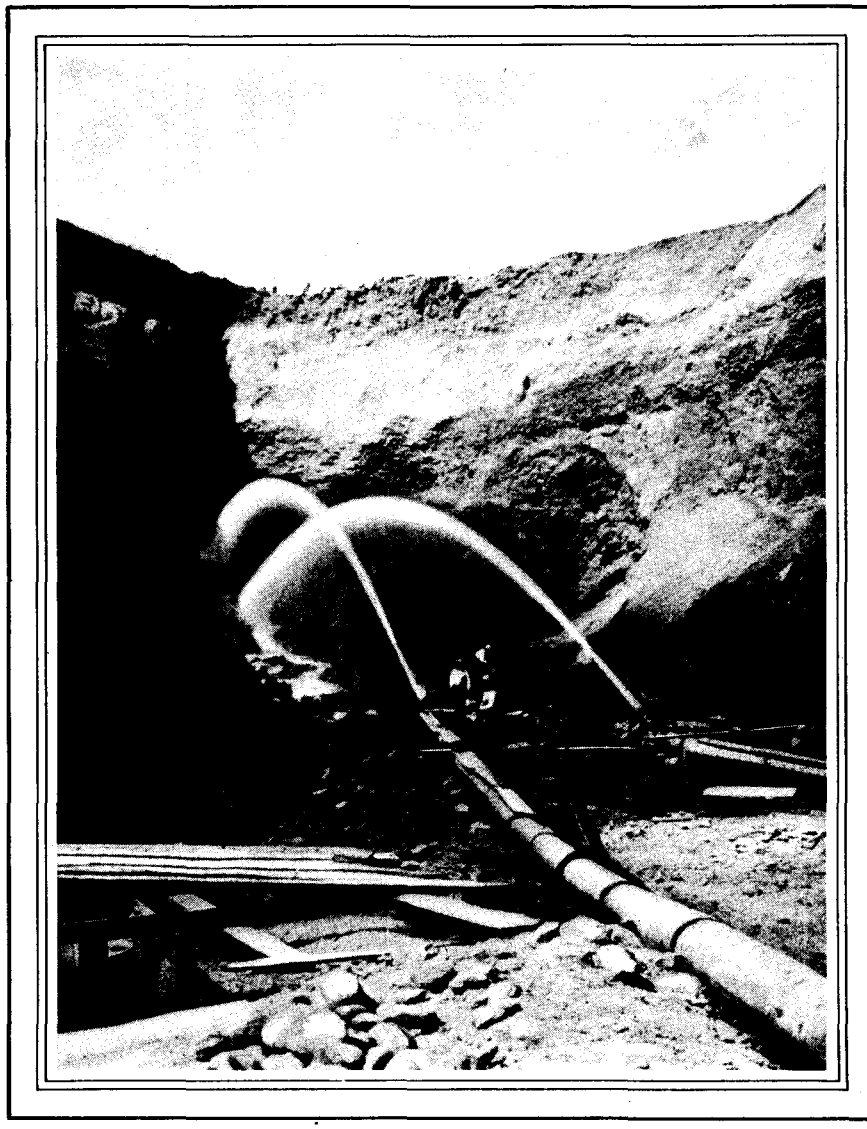

EXCAVATING FOR A PROJECTED RESERVOIR BY THE HYDRAULIC METHOD.

ridiculous to build a one hundred foot dam when a forty foot one will hold all the water that is available. To ascertain this, careful measurements extending over at least one full year are absolutely necessary. Testimony from people living along the banks is worse than useless unless systematic records have been kept. In several instances, where works based on such evidence were hurried to completion without testing, the high dry walls of the dams stand as monuments to the folly of their builders.

When these preliminaries have been established, the question of foundation must be considered. Since water presses equally in all directions, the weight on the lower courses of the dam is equal to the weight on the bottom of the reservoir. It follows that all joints between the dam and its foundations and abutments must be absolutely water tight; permit the merest trickle to get through, and all too soon there will be a hole and then a catastrophe. Consequently, the excavating for the foundations must be carried down until solid bed rock, free from cracks and fissures,

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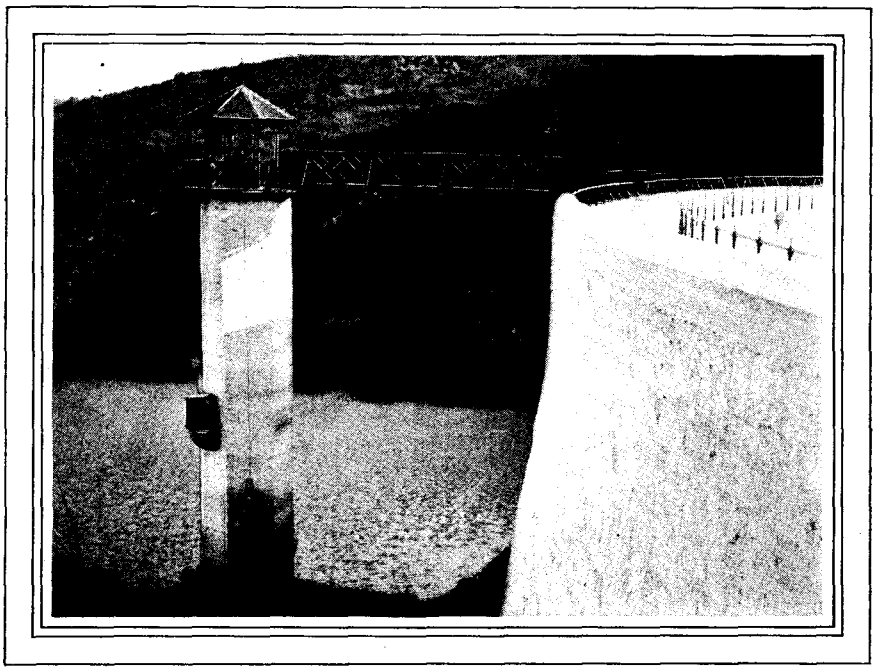
is reached. Similarly, cuts for the abutments must be sunk well into the walls of the canyon. These requirements necessitate searches, sometimes prolonged ones, for the proper spot.

held in position by bracing instead of by piled rocks. Timber dams are for small reservoirs, and are considered as temporary structures.

There are in the United States at



THE OUTLET TOWER AT THE SWEETWATER DAM, CALIFORNIA, ONE OF THE FIVE STORAGE DAMS OWNED BY PRIVATE CAPITAL IN THE UNITED STATES.

After this site is found, it is often necessary to divert the river in order to clear away the accumulation of sand and boulders which is sure to be there, in depth varying from twenty to one hundred feet. Sometimes this débris can be cleared away by means of hydraulic power, when the loose sand and boulders are expelled by water directed with enormous force from hydraulic pipes.

After all this preliminary work, comes the actual construction. Dams may be built of masonry laid in courses; of loose stone with a watertight partition running down through it; of steel, timber, or even of earth. Masonry dams are, of course, the best and the costliest. Next in order of merit are rock filled dams, which have a masonry face with a loose rock backing; after these come dams constructed of a steel plate coated with asphalt and protected by concrete with loose rock piled against it. Then there are steel dams, like the last, but

present five important storage dams owned by private capital—the Sweetwater, Hemet, Otay, and Bear Valley dams in California, and the Lake Cheeseman in Colorado. None of these has proved profitable to the builders, though all have enormously increased the value of the lands fed by them, rescuing most of them indeed from absolute worthlessness.

So far the United States has built no storage dams, though three have been recommended by the Secretary of the Interior and will be built whenever Congress gives assent. One of these is intended to raise the level of St. Mary's River, in Montana, sufficiently to enable it to flow south to the head of the Milk River, thus utilizing its waters, which now flow north to Hudson's Bay and are altogether wasted. Another system is in Nevada, and the third in Arizona, on the San Carlos Indian reservation.

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No. 802—A Portrait.

THE STORY OF TWO MEN, A WOMAN, AND A PICTURE.

BY ELEANOR E. HITCH.

IT was such a queer place to Kent Worthington—this little restaurant in the Rue Leopold Robert. For a while he was content just to sit there and enjoy the novelty of it all.

Presently, though, he realized that his appetite was every moment getting a keener edge to it. He had walked a great deal that afternoon. He looked about him for some one to take his order, and saw a young man placing a plate of soup upon a table near by. Worthington started to call, but hesitated. The youth caught his expression and laughed.

"Can't you get anything to eat?"

"No. I was just wondering how you managed it."

He was glad the boy did not know he had taken him for a waiter.

"You've never been here before!" exclaimed the other. "You see, Mlle. Henriette stays at her desk most of the time, so there's only one waitress for the whole place. Tonight there's a bigger crowd than usual—it's been varnishing day, you know."

"Oh, I see," said Worthington, wondering at the influences of varnishing day.

"The students are expected to forage for themselves whenever there's a crush, so if you'll come into the other room I'll show you where the sideboard is."

As they stepped into the next room there was a burst of applause from the students there. "Hello, Robinson! How are you, monsieur the new associate member?" they cried, gathering about Worthington's companion. Worthington helped himself from the sideboard, and withdrew to his original corner. At intervals he heard bursts of infectious laughter from the other room. Suddenly, in a lull, he heard Robinson greeting a newcomer. Two girls had come in and taken seats near the sideboard at the only vacant table, and the boy had deserted his other friends for them. He could see the softened light in the eyes of the young artist as he looked at the taller girl. He tried to inspect her, but she sat with her back to him, and there was some one between them, allowing only a tantalizing glimpse of a charming outline.

Robinson was extremely happy. "So sorry I missed you two at the *vernissage*," he said. "I want to congratulate you, Miss Cameron. Ever so many nice things were said about No. 802 while I was standing near it. One man refused to believe it was painted by a woman until he was confronted with your name in the catalogue."

"Thank you, Mr. Robinson—no higher compliment could be paid the work of a 'lady artist.'"

"Oh, it wasn't I who said it," he disclaimed earnestly. "I think it's perfectly stunning. It's so well hung, too. You're luckier than most newcomers."

Just then Worthington laid down the *carte du jour* and crossed the room towards the artist. The girl saw his face through the smoky atmosphere, started, and turned again to Robbie. "Oh, you can't complain, Robbie. But I'm hungry. Won't you see what else you can get for us, please?"

She spoke lightly, but her heart throbbed painfully, and all the time she wondered, "How on earth does Kent Worthington come to be in Paris!"

It was like a funny dream that they should come together again in this Bohemian resort. What should she say to him? She was staring hard at one of the posters which lined the wall, but she found that for some reason the gay little Cheret girl was dancing madly—in a wilder gyration than even French poster girls usually indulge in. She realized that the dancing was keeping

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