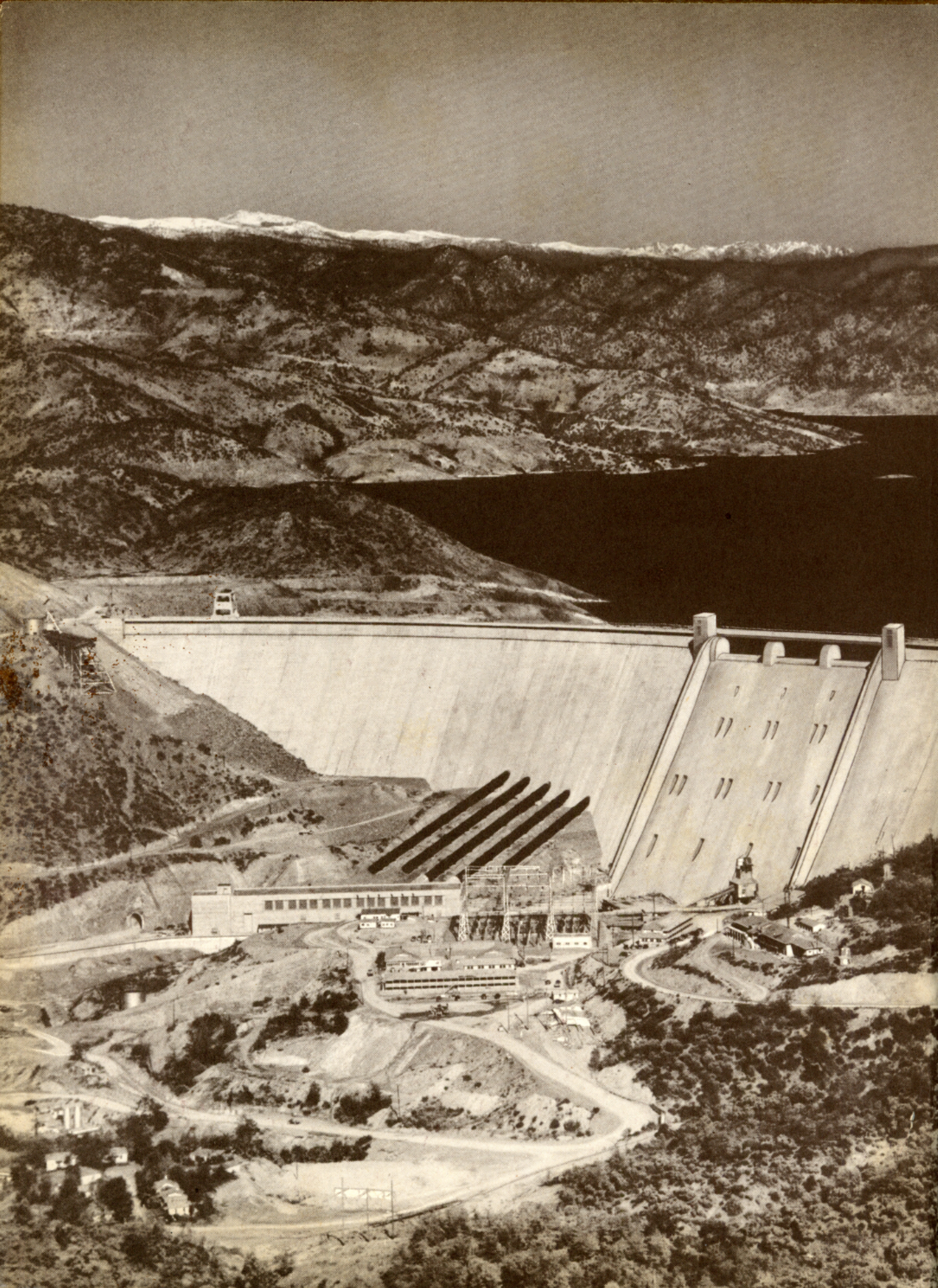
SHASTA DAM

AND ITS BUILDERS



Lithographed in the United States of America
by Schwabacher-Frey Company
San Francisco, California

SHASTA DAM

AND ITS BUILDERS

PUBLISHED BY
PACIFIC CONSTRUCTORS, INC.
APRIL, 1945

The majority of the photographs in this book are by Howard Colby, photographer, for Pacific Constructors, Inc. A few are official U. S. Bureau of Reclamation photographs.

Book design by Shawl Nyeland & Seavey of San Francisco, California

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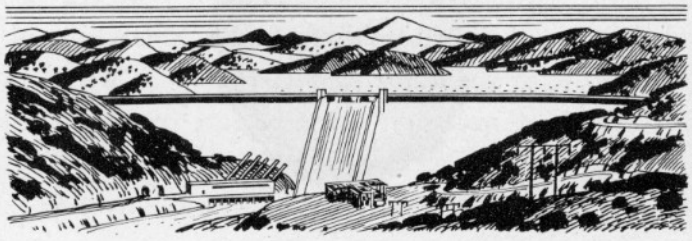


APRIL 1945

FOREWORD

THE STORY of Shasta Dam could well be lost in a myriad of large figures, computations of stresses and strains, and reams of statistics, so overwhelming are they in size and amounts—almost beyond the comprehension of the lay mind. This book, while giving a few of those figures for comparative purposes in order to show the magnitude and feats of design and construction involved in building this dam, is primarily a pictorial review of the progress of construction—"the before and after" picture—and the part played by firms and individuals—plus a little of the human interest story of why and how—Shasta Dam was built. Much, of necessity, must be left out of this book. Specific credit cannot always be given to deserving individuals. Events of major importance at the time they happened may be given only mention in passing. What we present is an overall picture of a construction job and of an organization which has built a lasting monument.

It is not intended nor believed that this book will be of general interest to the public, although the pictorial picture told is the story of rugged construction that stirs the blood and appeals to that constructive instinct existent in the men of America. This book is primarily intended for those men, women, families and companies who have directly or indirectly labored, or been associated, on the construction of Shasta Dam.

Pacific Constructors, Inc.

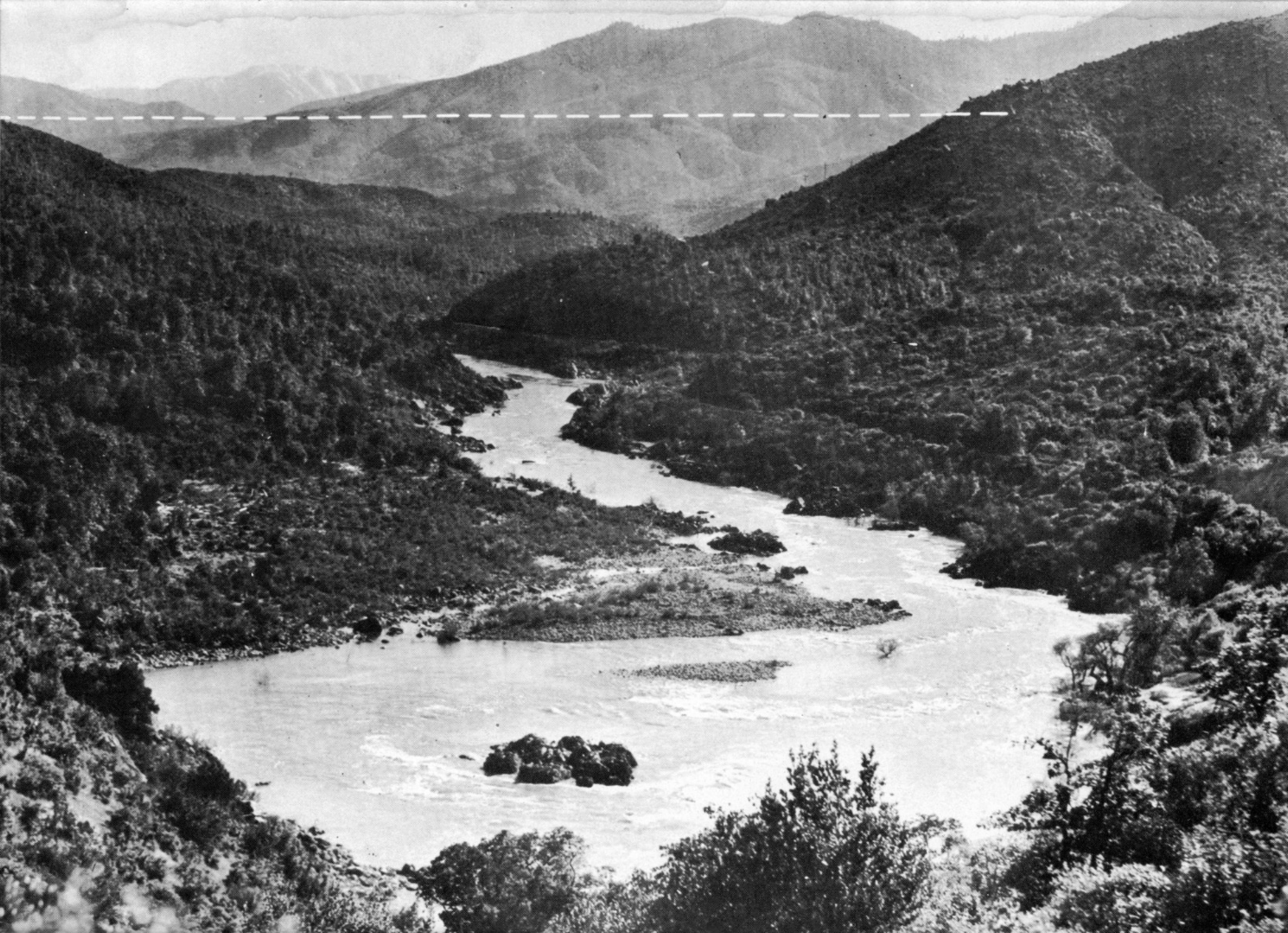
W. A. Johnson

Wm. A. Johnson
President

DEDICATION

To that army of workmen whose skilled hands, through heat and cold, rain and snow, have fashioned this massive bulwark of stone, cement and steel against the floods, this book is faithfully dedicated.

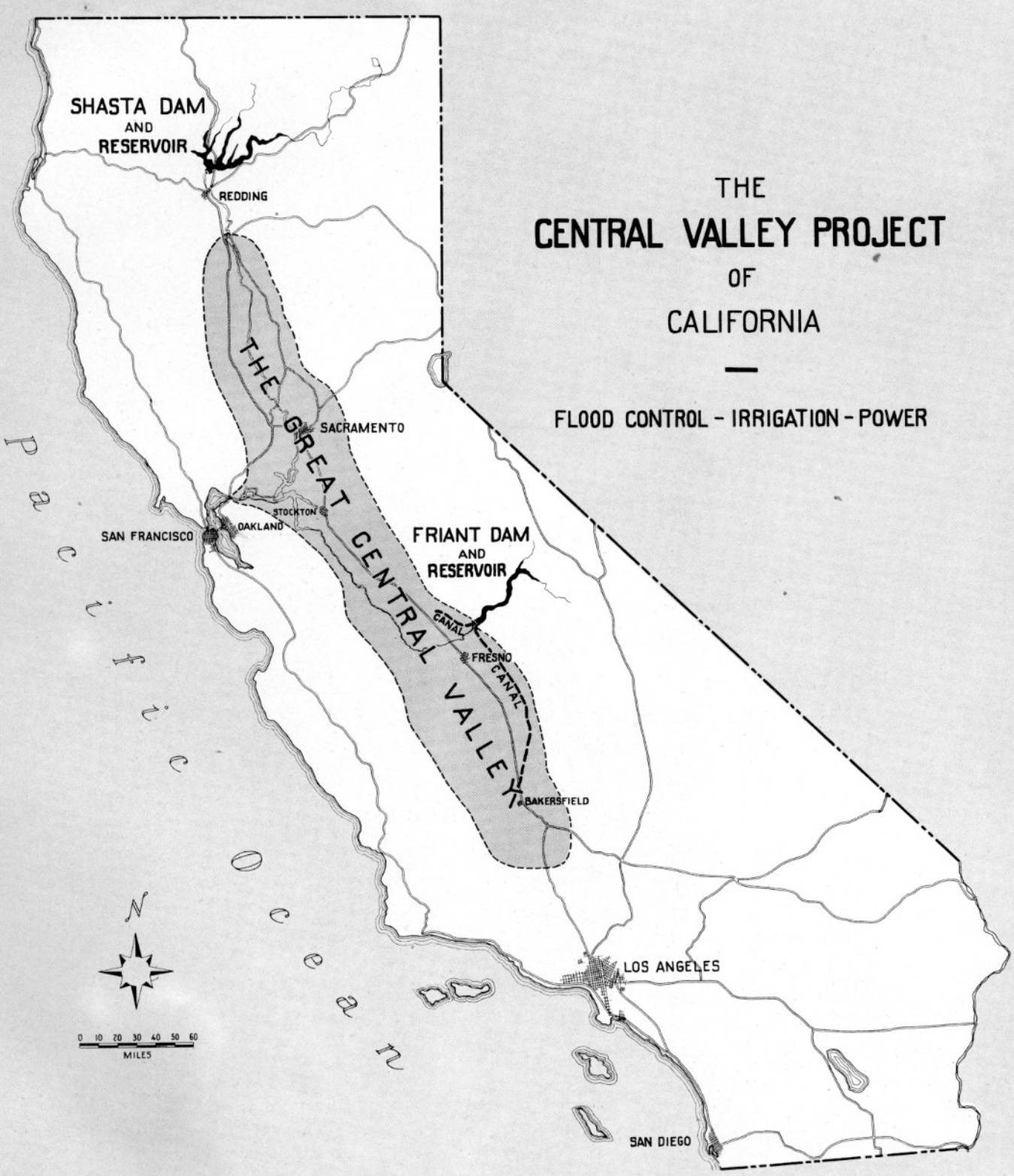
Here is harnessed the power of a mighty river—
Here is provided security—
Here is builded a monument to far-sighted men—
An achievement that all who participated can look to with just pride.



THE PROJECT

Shasta Dam is the fulfillment of a dream of an agricultural and industrial empire in the Sacramento Valley. This dream was visioned many, many years ago. From the close of the Civil War until its building, civil engineers, politicians, men from every field of endeavor, have planned and fought for it. True, these early visionaries conceived no scheme as great in magnitude as the Central Valley Project—no majestic structure the size of Shasta Dam. But these dreamers recognized the need to control the temperamental waters of the Sacramento area—the unlimited possibilities of development and growth—and they fought tenaciously for that dream. Today their dream is in the course of fulfillment and, as our story unfolds, Shasta Dam is to play the leading part.

Damsite before construction started—looking downstream



THE CENTRAL VALLEY PROJECT OF CALIFORNIA

—

FLOOD CONTROL - IRRIGATION - POWER

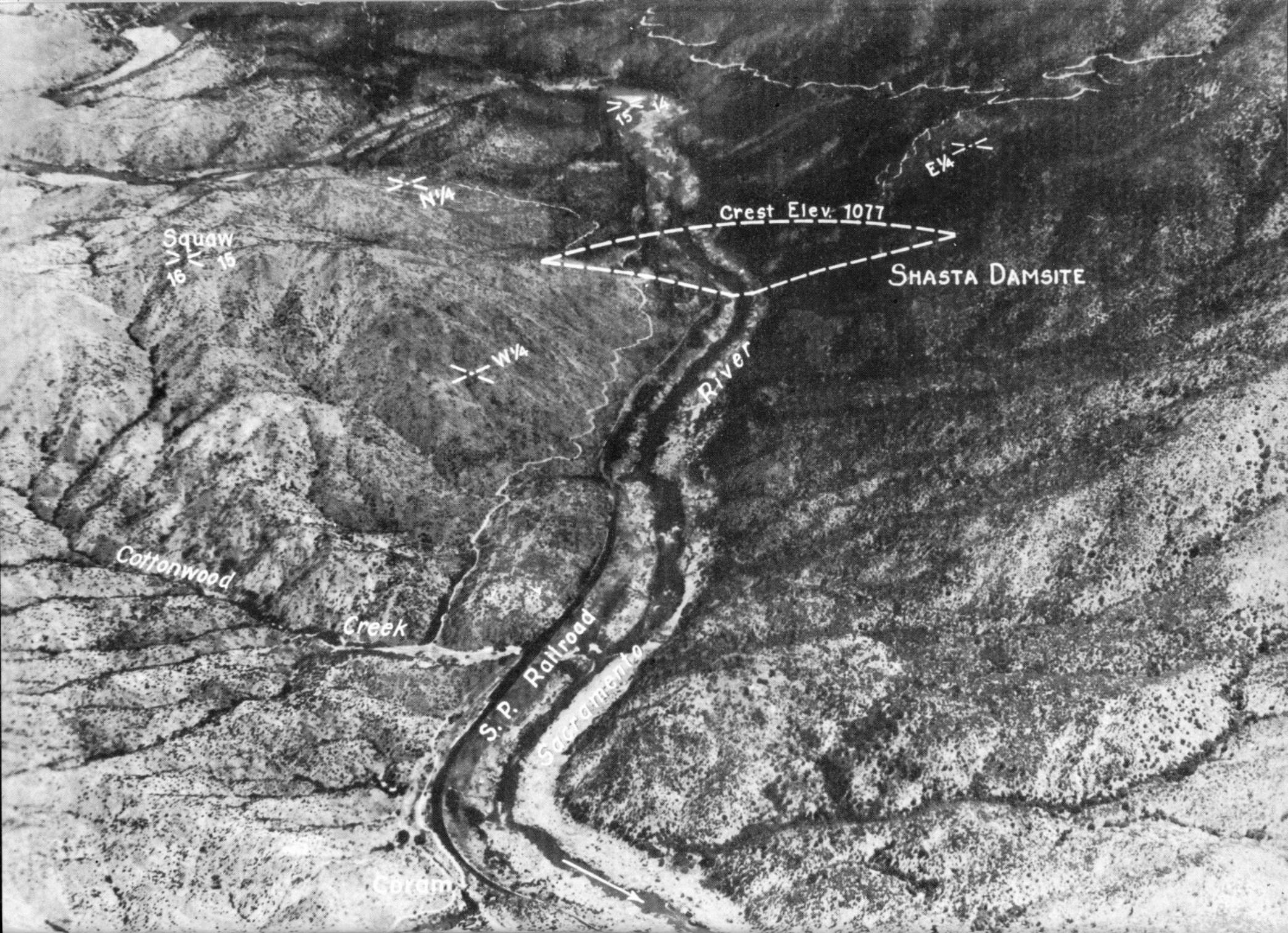
The Central Valley Project "Moves the Rain"

By Viola P. May

THE CENTRAL Valley Project has an historical background of development, investigation and planning, extending back over three-quarters of a century. In that period it is estimated that about $3,000,000.00 has been spent by dozens of Federal, State, local and private boards, commissions and agencies, on studies, surveys and investigations of the Central Valley and its many problems. As early as 1873, President Grant, who sent the Army Engineers to look into the situation, made a report to Congress on the Valley's needs. The period between 1921 and 1934—when the State Legislature adopted the "Central Valley Project Act" which was the means of bringing the project to the stage of actual construction—was one of intense study and investigation, carried on by the three state engineers, W. F. McClure, 1921; Paul Bailey, 1926; and Edward Hyatt. Hyatt, especially must be given the major credit because, by his fine work, he, more than any other single person, carried the project through.

Since financing such an "astounding" project was a major problem, efforts were begun as far back as 1929 to secure assistance from the National Government. Truly, this problem of unprecedented floods in the North; ocean seepage in both the Sacramento and San Joaquin Rivers thereby befouling wells and killing crops; drought in the South; was a national one. With two major dams, 350 miles of canals, scores of siphons, tunnels and bridges—twenty-seven in a nine-mile stretch of the Contra Costa Canal alone—and other auxiliary units, its magnitude called for national support. Certainly every state in the Union enjoyed the food products of this garden empire—unexcelled in the world, but without controlled water, below par and even worthless.

Magner White, in his article in the Saturday Evening Post, April 27, 1940,


15
E¼
N½¼
Crest Elev. 1077
Squaw
16
15
SHASTA DAMSITE
W¼
River
Cottonwood
Creek
S.P. Railroad
Sacramento
Coram

in describing the project's fundamental engineering principle, quotes a Shasta Dam workman, "Mister! We're moving the rain!"

There it is in a nutshell. All the engineering problems originate in misplaced rain—too much in the wrong places, too little where it's needed, and rarely in the right season. So men prepared to store water behind dams—switch the rivers around—move the rain!

Each river has its major dam, Shasta on the Sacramento, Friant on the San Joaquin. On August 30, 1935, in the Rivers and Harbors Bill, $12,000,000.00 of Federal Funds was authorized for the construction of Kennett (now Shasta) Dam. This was followed by $20,000,000.00 from the Emergency Relief Appropriation of 1935 to the Bureau of Reclamation for the purpose of starting construction. In 1936 Congress appropriated $6,900,000.00, and Congress has since appropriated or made available to date a total of over $173,000,000.00.

The Bureau of Reclamation started work on the project in November, 1935. Actual construction was started in 1937 on camp facilities and work on the project works proper began in October, 1937, on the Contra Costa Canal. Construction on Shasta Dam and Power Plant began in September, 1938, and on the relocating of the Southern Pacific Railroad around the Shasta Reservoir, a month later.

Shasta Dam is the "key" structure of the Central Valley Project—its outstanding and most important unit. The waters stored and regulated by this second largest masonry dam in the world will furnish most of the additional water supply to be made available by the entire project. This is in addition to reducing floods along the Sacramento River and the production of electric power.

The selection of the Shasta Dam site for the major storage unit has an interesting background. Because of the size of the structure required and the staggering cost involved not only in the dam, but in the necessary relocation of the Southern Pacific Railroad, state highway and other utilities, few engineers prior to 1920 would have dared to propose a dam at the present site. Selection was made only after careful engineering investigation and economic analyses had been made of many possible alternate sites. The Bureau of Reclamation in their studies and findings confirmed conclusions of the State as to the superior advantages of the Shasta Dam and reservoir, and bids for the project were prepared and let.

Everything about this project is "super". With Friant, Shasta will help store 70% as much water as all other 618 dams in California combined. The longest belt conveyor system in the world—10½ miles in length, carried aggregate from the river bottom at Redding to Coram and the largest and most extensive cableway system ever assembled fed concrete to Shasta Dam's hungry forms. In order to relocate the railroad and highway, the highest double-decked bridge in the

Aerial view of Damsite and vicinity before start of construction

The Pit River Bridge

world was built to get both across a tributary arm of the lake—the Pit River Bridge. Over Shasta's 375 ft. wide spillway, waters will plunge 480 ft.—nearly three times the drop of Niagara Falls, producing the world's largest artificial waterfall.

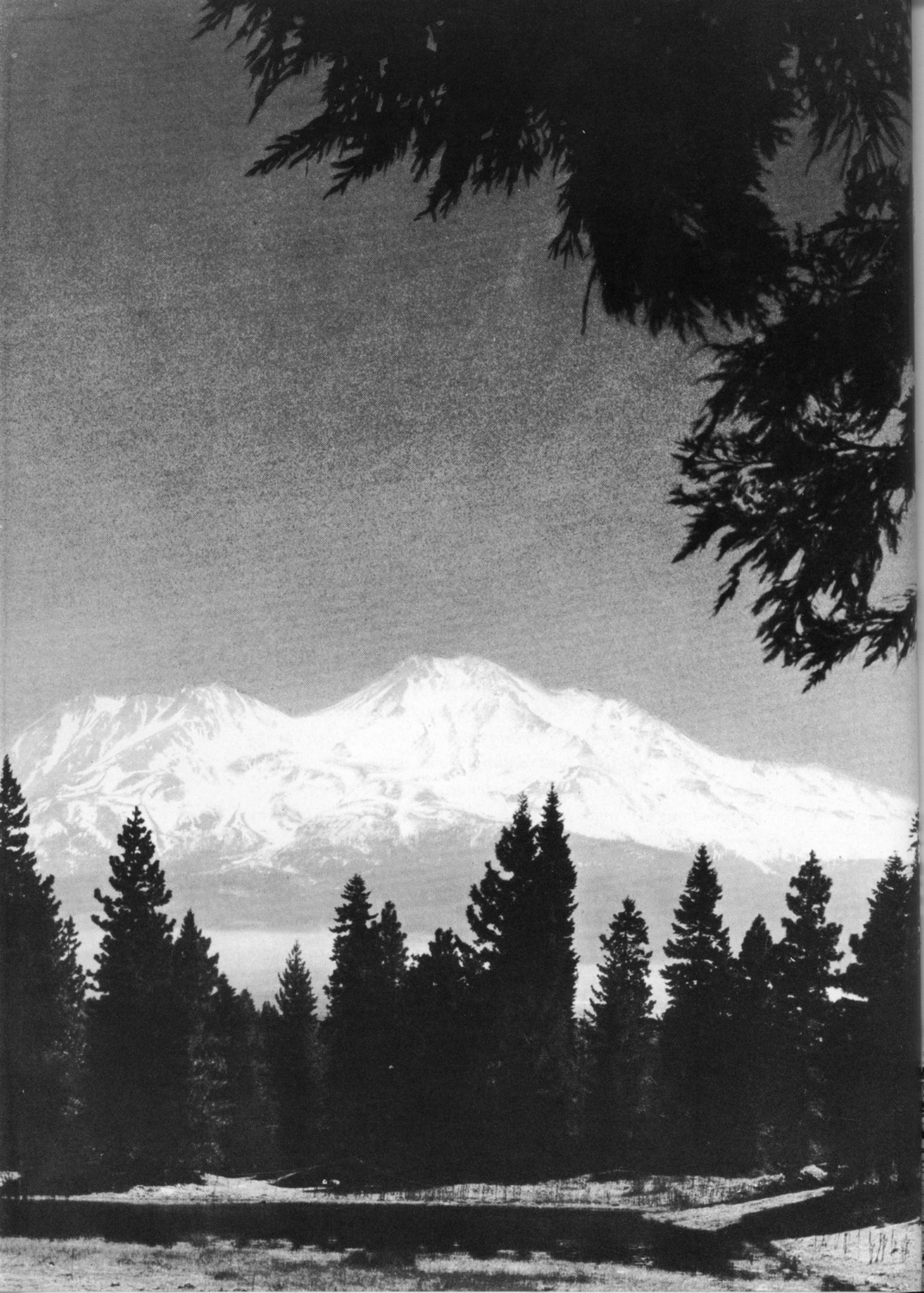
Few projects have merged so many objectives. Some claim the most important feature of the project is irrigation—others flood control—power development—navigation. So the project is "all things to all men".

THE SITE

Shasta Dam has been built in a rugged mountain area whose jutting peaks, winding canyons, dense oak, manzanita and occasional pine tree growth, give one a mistaken feeling of high elevation. Snow-capped Mt. Shasta in the background adds to that illusion. In reality the elevation of the bed of the river is only 550 feet above sea level; the top of the dam, 1077.5. The climate is typical of any location in the interior valleys of Northern California, with one exception—more rain falls in this "dam area" than in any other place in California, ranging from 108 inches a year, down.

The Government had little difficulty acquiring title to this rugged acreage where the dam itself was to be built. Back of the proposed structure, however, were small towns, highway taverns, fishing lodges, roads and railroads whose owners had to be satisfied before work could begin on the dam that would "back-up" water for thirty-five miles, to cover their properties. Most sold their land willingly and moved their possessions. A few clung to their residences until the rising waters lapped hungrily over the roads. Then in frantic haste, they formed a slow moving parade that crept over the narrow canyon roads to safety.

The history of the damsite and some of this surrounding country is told in "Ghosts of Yesterday".



Ghosts of Yesterday

by Viola P. May

STANDING MAJESTICALLY in the background of an ever-changing canvas, snow-capped Mt. Shasta has watched the coming and going of both the White Man and the Indian, and in her heart are hidden secrets at which we today can only guess. For years the Indians hunted in her shadows and fished the waters, fed from her melting snows, in a hunter's and angler's paradise. They roamed our hillsides at will, unmolested by the white man's driving urge to build, tear down, and change. Best known of these tribes who were alternately at peace and at war with the incoming white aggressors, were the Wintun Indians. The few members of that tribe who still live, have watched our dam construction sadly, bewildered and grieved as the rising waters covered their sacred burial grounds. True, the Government carefully moved their dead to a cemetery in Central Valley but they mournfully cry, "With no fire kindled on his grave—how can he be lighted on his way?" Perhaps Mt. Shasta, their great white father, understands as the white man fails to, that "their sleep has been desecrated."

Probably the first white men to look upon this soil were the adventurous trappers who explored this region as early as 1820. Since this particular area was not a part of the old Mexican Grant, these intrepid men came from the North working

Old Town of Coram—1910

Old Balaklala Mine

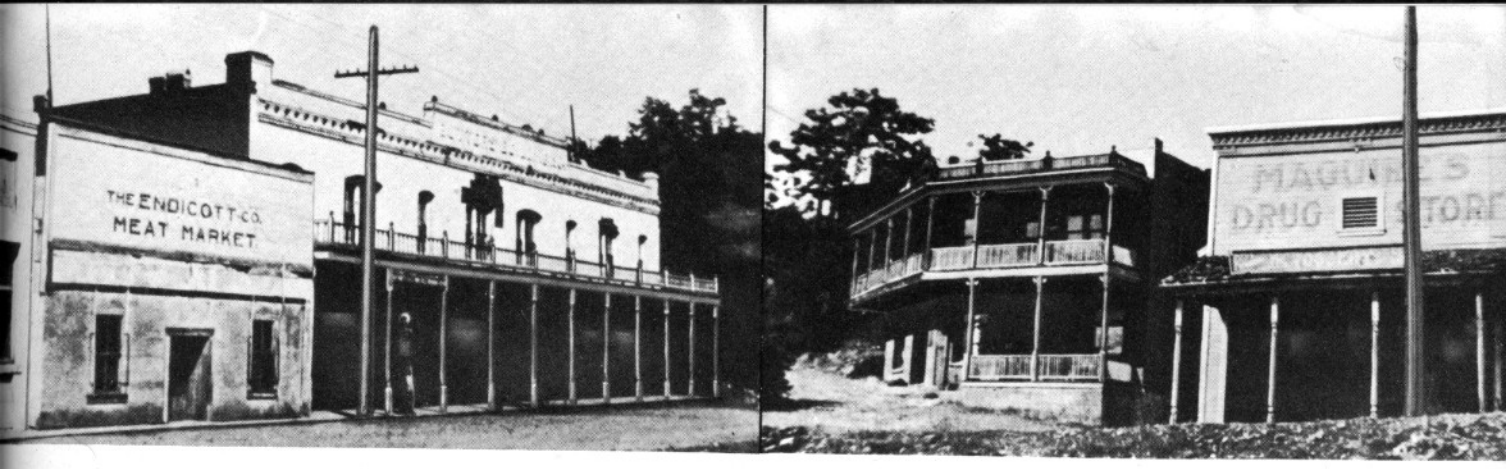
South along the river. By 1831, Michael La Franboise had opened the famous "Sacramento Trail" for the Hudson Bay Company, and it was used extensively by French and Canadian trappers.

By 1850 many of these trappers' trails became express and mail routes until the Indians became so hostile that the trails were closed—to be reopened in 1855 and '56 by Ross McCloud. On the west side of the river at our damsite is a part of one of the old Sacramento Trails —much of it, like many other points of interest—buried under the blue waters of our man-made lake.

Relic of Cramston Stage lines—Mount Shasta in background

The lure of gold, the discovery of the first nuggets of Shasta County at Spring Creek, brought permanent settlers into the present dam area. With the building of the railroad thru' this region about 1875, permanent settlements were established nearby. Most famous of these were Keswick, Coram and Kennett. Keswick was named for Lord Keswick of London, the president of the Mountain Copper Co., Limited. This company started operations in 1896, when the possibilities of copper as "king of minerals" seemed limitless. Joseph Coram, a miner from Montana, established the Balaklala Company at Coram. The mining camp developed into a flourishing town which become an incorporated city boasting a newspaper and a two-teacher school. Fumes from the huge smelters built by companies at all three towns killed all vegetation on the surrounding hillsides—resulting in lawsuits from farmers in nearby regions. (These "cleared hills" saved P.C.I. considerable time in early construction.) Today the only signs of Coram's past glory are empty company buildings—tall, silent sentinels of barren hills.

The growth of Kennett followed the copper boom, with smelter operations beginning in October, 1905. At its peak it had a population of 2,500 and the freight in and out led every station between Sacramento and Portland. Visitors



Old buildings in town of Kennett

in 1915 were impressed with the "permanency" of plant construction. Yet, by 1925, the smelter was shut down for good. When dam construction began, the town was little more than another of those ghost towns, with a few rickety frame houses, clinging to steep hillsides and a famous bar whose paintings, polished bar and grape lighting fixtures, were famous. By 1943 everything that had not been moved by Government order, lay buried under the rising waters of Lake Shasta.

Other buried landmarks of historical interest are old trading posts; stage coach roads where daring bandits made colorful careers. Perhaps these very hills echoed the shots and cries of highwayman and stagecoach driver, for the long, lonely stretch of road from Oregon to Shasta City (the famed "Oregon Trail") held a constant threat of the masked and armed robber. (Notable among the latter was "Black Bart, the PO-8"—self-styled because he usually left behind a poem, as a souvenir).

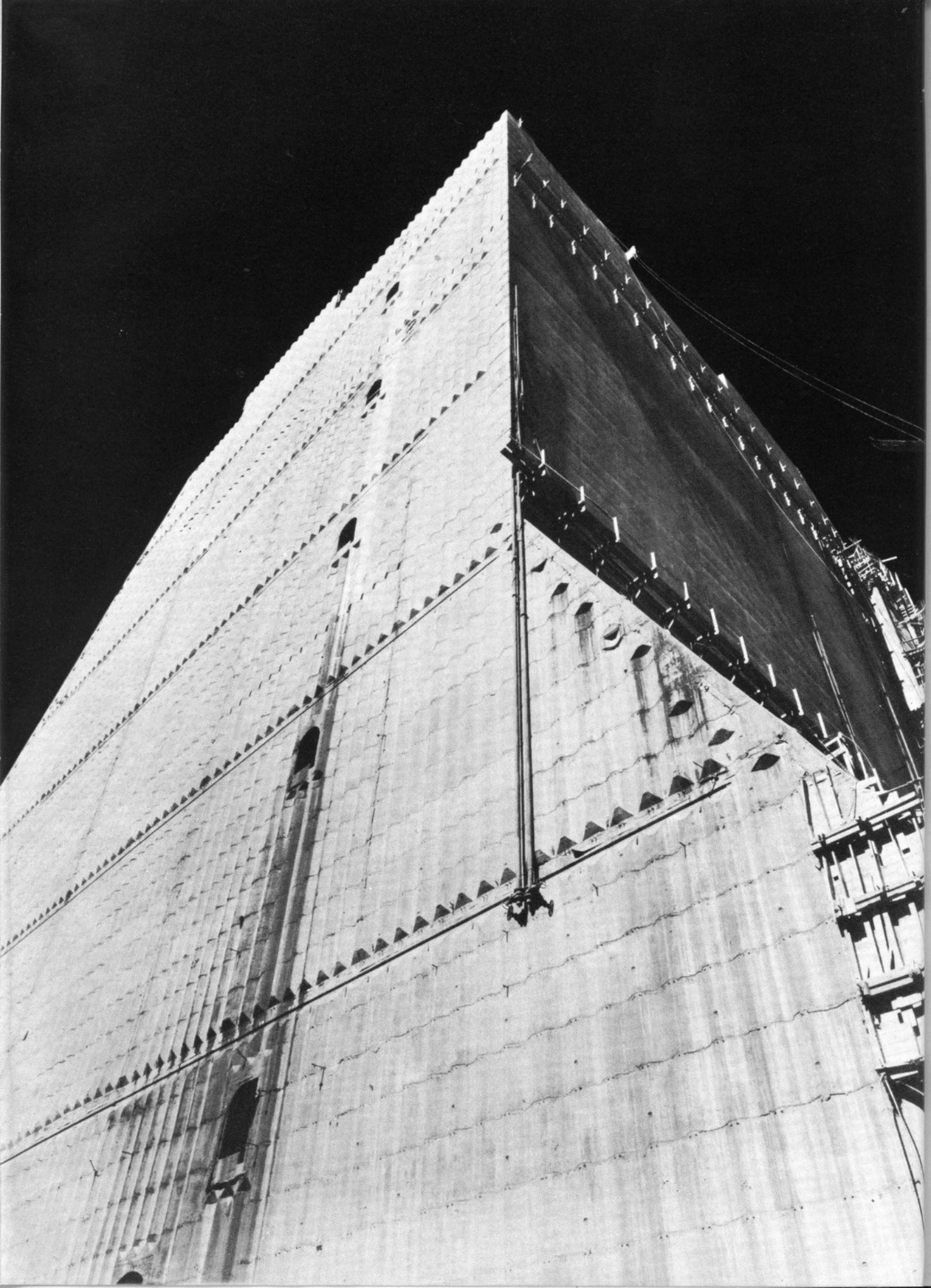
Damsite looking downstream January, 1939

While many old landmarks have been covered, the rising waters have made the caves of this vicinity more accessible. In their beauty and mystery, scientists claim these will rival the Carlsbad Caverns. One of these, the Samwel Cave, the Indians claim is haunted by the spirit of a beautiful Indian girl. While seeking the solace of its magic waters, she fell to her death. Her body was not recovered until 1903 when a party of four white men made the tedious journey to and from the caves (partly to prove or disprove the Indian legend). Buried with appropriate ceremony in the family burial ground, her "sleep" was one of those disturbed by the white man when the Indian cemetery was moved to a new site near Central Valley.

So! "Here, side by side, where mortals trod
Are the works of man and the Works of God."

CONTRACTOR'S ORGANIZATION

The development of plans for large engineering projects begins with investigation and studies to determine which one of several possible developments would prove most desirable. Based on these studies—extensive in scope—the major features of the general plan are established and the project assumes definite form. In the case of Shasta Dam, all these preliminary studies and plans were made by the United States Bureau of Reclamation. Pacific Constructors, Inc. then built the dam according to specifications set and "watched over" by the U.S.B.R. The story of the formation of this company that did the actual building of the dam, its problems and their final solution is dramatically told in the following story by Mr. J. C. Maguire.



The Birth of Pacific Constructors, Inc.

By J. C. Maguire

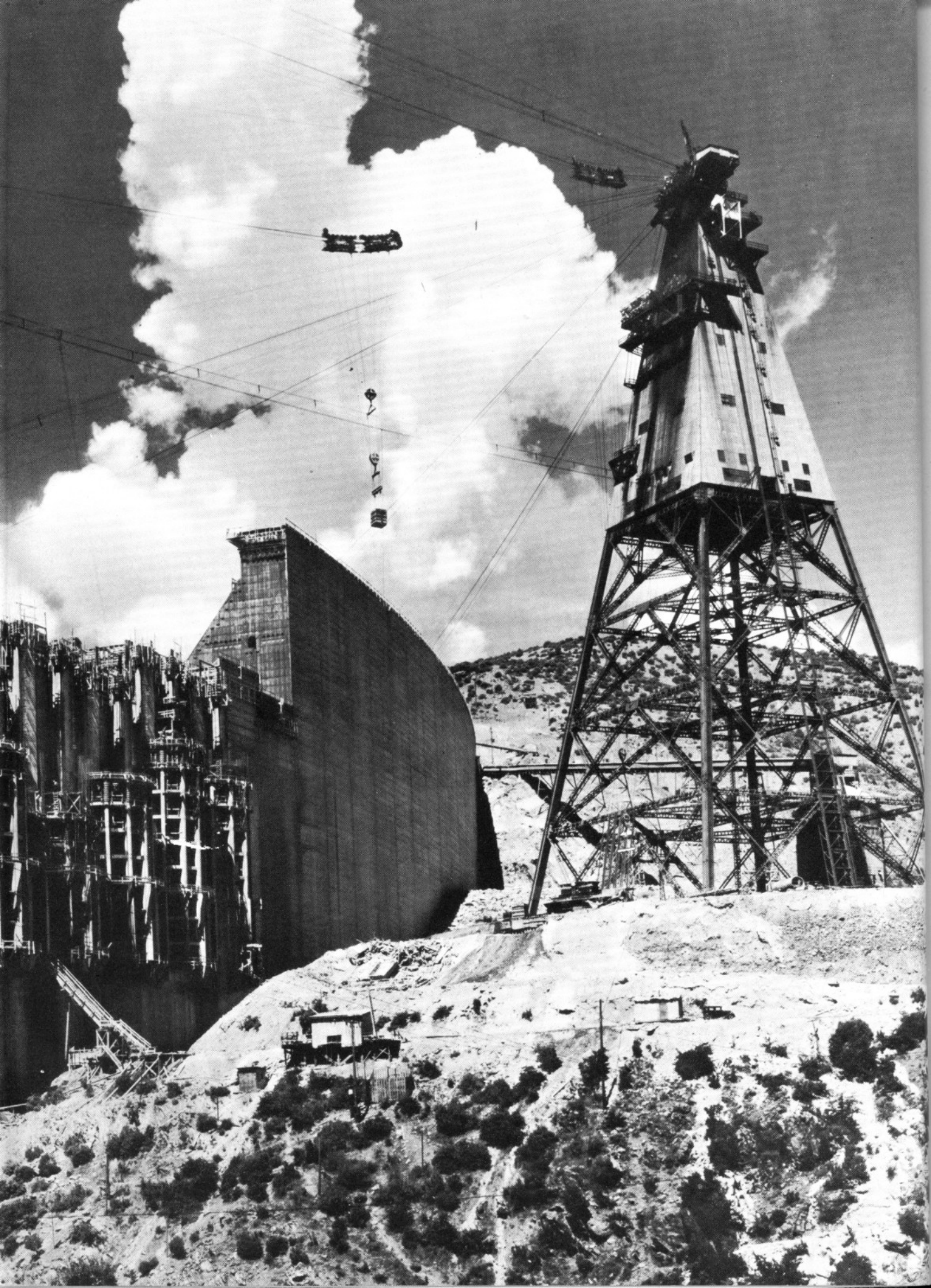
JOINT VENTURE operation by contractors on a large scale is a comparatively recent development in the construction industry. Most contracts are awarded through competitive bidding so that methods of operation, cost records, organization and personnel are regarded pretty much as trade secrets by the individual contractor or construction company and, as such, are generally guarded jealously from competitors. With the advent in the early thirties of a number of huge government projects there came a change. The size of the jobs and requirements of the bonding companies shut out many good responsible contractors from bidding and so the fashion began among such contractors of pooling their resources and grouping together as co-adventurers.

Bonds in huge amounts are required by the Government. The surety companies, after taking heavy losses on contractors through the 1929 depression, as well as being more or less 'punch drunk' from terrific losses generally, established the practice of requiring, as a prerequisite to writing bonds on big jobs, that cash sufficient to finance the contract be raised and impounded under joint control of surety and contractor. This was in addition to showing a satisfactory financial and experience rating as had been previously required. Very few individual construction companies could meet this requirement on jobs running into the tens of millions. Also, recognizing that there is an element of gamble in all construction work, the few contractors who might have qualified, were reluctant to take contracts so huge that a bit of hard luck or miscalculation might wipe them out.

Out of it all developed the practice of grouping together for joint venture operations. This practice met the favor of the Government, as it provided for more bids and a greater measure of competition.

Pacific Constructors, Inc. was born late in 1937 of a desire of a group of

Unusual view of right abutment



Southern California contractors to join together for the purpose of bidding on Grand Coulee Dam upon which the U. S. Bureau of Reclamation was to open bids on December 10th of that year.

Wm. A. Johnson of Los Angeles, one of the leaders in the industry in Southern California with large holdings in a number of construction enterprises, took the lead in getting the group together. After informal discussions with several prominent Los Angeles contractors, a meeting was called by Mr. Johnson which was attended by Steve Griffith, President of Griffith Company, L. E. Dixon, head of the company bearing his name, Clyde Wood, President of the newly formed Metropolitan Construction Company, which was a combination of the Jahn and Bressi Construction Company and the Wood & Bevanda Company, and Floyd Shofner of Shofner, Gordon & Hinman. The proposal of a joint bid on Grand Coulee Dam was enthusiastically received by every one in attendance and immediate action was started to whip a group into shape to make it. As progress was made, there were subsequently invited into the venture D. W. Thurston, a newcomer to Los Angeles but with years of successful operation and experience on heavy construction in the Middle West, Lawler & Maguire of Butte, Montana, operating in the Rocky Mountain area and Hunkin-Conkey Construction, an old and well-known firm of Cleveland, Ohio. All companies accepted and were taken in. This was the original Pacific Constructors group.

By the time the group was finally gotten together, there were only a couple of weeks left for preparing a bid on the Grand Coulee job. About our first official act was to ask for an extension of time, but this met with a refusal and work was immediately started to rush through a bid. Harvey Slocum, who had acted as General Superintendent in building the first section of the Dam, was retained to help us. L. E. Dixon and his organization, Ray Whinnery of the Wm. A. Johnson organization, and Slocum jumped in and worked night and day to prepare a bid on the project.

It was decided to operate as a corporation rather than as a joint venture partnership and a Delaware corporation was organized and perfected. The name "Pacific Constructors, Inc." was chosen as representative of the West Coast group, as well as being short and euphonious. The corporation was registered in Delaware and came into being on November 30, 1937. The original directors were as follows:

Wm. A. Johnson
S. M. Griffith
D. W. Thurston
L. T. Lawler
Floyd Shofner
C. W. Wood
J. C. Maguire

The Headtower and upstream face of Dam

Officers elected at the first meeting of directors, held in Los Angeles on December 1, 1937, were:

Wm. A. Johnson	President
S. M. Griffith	Vice President
J. C. Maguire	Secretary
C. W. Wood	Treasurer

The time for preparing a bid on Grand Coulee Dam proved to be too short to permit careful study and analysis, so that when it came down to setting prices the attitude of all concerned was to play safe on every item and, as a result, our bid was about $8,000,000.00 higher than the only other bid submitted.

Two things however were accomplished by bidding Grand Coulee—

First, the members of the group were afforded a chance to become acquainted with each other. The days and nights spent together working under high pressure, scheming and planning in making up the bid, wore all the veneer off of personalities and the true character and ability of the individuals were revealed. No discords developed at Grand Coulee as they sometimes do in a group so hastily called together. Many of the associates were not personally acquainted until they got together to work up the Grand Coulee bid. An amusing incident that illustrates the development of friendship among the group might well be told—

Hunkin-Conkey Construction Company of Cleveland came into the venture through the good offices of Floyd Shofner who knew and vouched for them. They met many of the Southern California contingent for the first time at Spokane, Washington, where the Grand Coulee bid was made up. The entire group was quartered at the Davenport Hotel and a suite of rooms was engaged and used as headquarters for conferences, etc. Every one was so intensely interested in rushing a bid together that little or no attention was paid to social ceremonies or courtesies. Meals were eaten on the run in groups of two or three as the opportunity presented itself. Guy Conkey, a fine gentleman of the old school, liked to let down a bit when the cocktail hour arrived and take on a highball or two with congenial friends. Being in a new country and naturally reserved, he waited for one of the Westerners to suggest a drink, thinking that surely someone would break the ice. After waiting and waiting with no result, Guy cautiously asked Everett Hunkin if it would be safe to ask one or two of the boys into his room for a drink. As a joke Everett told him that the Western contractors were very much opposed to drinking and would probably not only refuse but would object to having a man who drank liquor as an associate. Guy pondered the situation and could see no harm in taking a drink, as had been his custom for years—so he sneaked off by himself and had a couple of quick ones, but before going back to the meeting he ate a whole package of breath killer so that his perfidy would not be discovered. This went on each evening. Guy guarded his

Night scene—Headtower and Dam

secret carefully. The Westerners seemed like regular fellows in every respect, but their narrow minded attitude on the drinking question surely had him guessing. Finally the day of the letting came. Our bid was in and the pressure was off. When the gang got back to headquarters after the opening, someone produced a bottle of Scotch, and then another one, and one and all proceeded to partake of it. Guy was dumbfounded. First he was indignant at Everett for having deceived him and then he saw the humor of it all and told us what had been going on and joined wholeheartedly in the festivities. He was immensely relieved to find that he could drop all deception and once more "breathe" freely and fully in the presence of his associates without the fear of becoming a social outcast. Everyone left Grand Coulee with that feeling of fellowship that comes from going through a battle together and were willing and anxious to try their luck together on future work.

The other thing accomplished at Grand Coulee was that our extremely high bid gave the successful bidder, who also proved to be our only competitor on Shasta Dam, a false feeling of security in bidding against us on the latter job. After "leaving $8,000,000.00 on the table" at Grand Coulee, they did not rate us as tough competition at Shasta. We beat them only $262,907.00 at Shasta on a $36,000,000.00 job. Had we filed a real tough bid at Grand Coulee they might well have cut their Shasta bid more than this difference.

After licking our wounds from the Grand Coulee venture, it was decided to move East and bid on the Delaware River water tunnel jobs that were being let by the City of New York. Pacific Constructors, Inc. bid on three of the sections during the months of March and April, 1938, but were unsuccessful. However, working together on these ventures brought the associates close together and further cemented the friendships begun at Grand Coulee.

After Grand Coulee Dam, attention of the heavy construction industry was centered on Shasta Dam. Its size (almost twice as big as Boulder and bigger than either unit of Grand Coulee), its location on the tricky Sacramento River; the engineering and construction problems involved, challenged the imagination of both engineer and builder. It was regarded as the most prized contract of the period.

While we were bidding the New York tunnels we were also holding discussions and scheming out a set-up for bidding this job. It was recognized that ample time must be provided to properly study the job, devise methods of construction, and prepare a bid for the job. Our Grand Coulee experience proved this to us. So we began work early.

It was decided that our group should be enlarged and accordingly we set out to pick and choose additional members from among the best heavy constructors of the nation. The officials of the respective companies listed below were contacted,

Cableway Carriage at Headtower

the job and the scheme explained to them, and an invitation extended to participate with us in the venture:

Joe Hogan and Warren Black of The Arundel Corporation, Baltimore

Ed. Foley, Carl and O. W Swenson and Frank Anderson of Foley Brothers, Inc., New York and St. Paul

Harry Mundy and Bob Knox of A. Guthrie & Co., Inc., St. Paul

Bill Callahan and Paul Grafe of W. E. Callahan Construction Co., Dallas

Phelan Shirley of Gunther & Shirley Company, Omaha.

After due consideration and investigation, all accepted. It took a little selling to get Joe Hogan of Arundel interested, as several years before they had bid on a Pacific Coast project and had their low bid rejected. Joe figured they had been "euchred" out of it by the native sons, and the memory of that experience still rankled; also, he did not know any of us very well anyway; but, after thinking about it a few days, he decided to join up with us and take another chance. The other "Easterners" were better acquainted with us and came in without hesitation. Some, however, specified that it was on condition that we bid a "good safe figure." These concerns are all big leaguers and gave our group immediate and unqualified prestige and standing, particularly with the bonding companies whom we had to satisfy before they would write the bond on the job. Each and every one of them have proved to be fine partners. They have been always willing and ready to go to the bat on any of our problems and have supported the officers and given advice and counsel that has been invaluable.

Bids for construction of Shasta Dam were called for by the U. S. Bureau of Reclamation under date of April 1st—bids to be opened at 10 A.M., June 1st, 1938, at the district office at Sacramento, California. A bid bond or certified check for $2,000,000.00 was required with each bid and a performance bond of $5,000,000.00 and a payment bond of $2,500,000.00 were specified. A syndicate of twenty-two bonding companies, made necessary by the size of the contract, organized for the purpose of writing the bond, indicated that they would require, as a prerequisite to writing these bonds, that a cash working fund of $3,000,000.00 be raised and impounded under the joint control of the contractor and the sureties, and that acceptable indemnity be furnished for the full amount of the performance and payment bonds, viz., $7,500,000.00.

In reorganizing Pacific Constructors, Inc. for the Shasta Dam bid, the $3,000,000.00 demanded by the sureties was set up as the paid in capital and

surplus of the corporation and each participant in the venture was required to furnish satisfactory indemnification to the sureties for his proportionate share of participation. As finally organized, the participation was as follows:

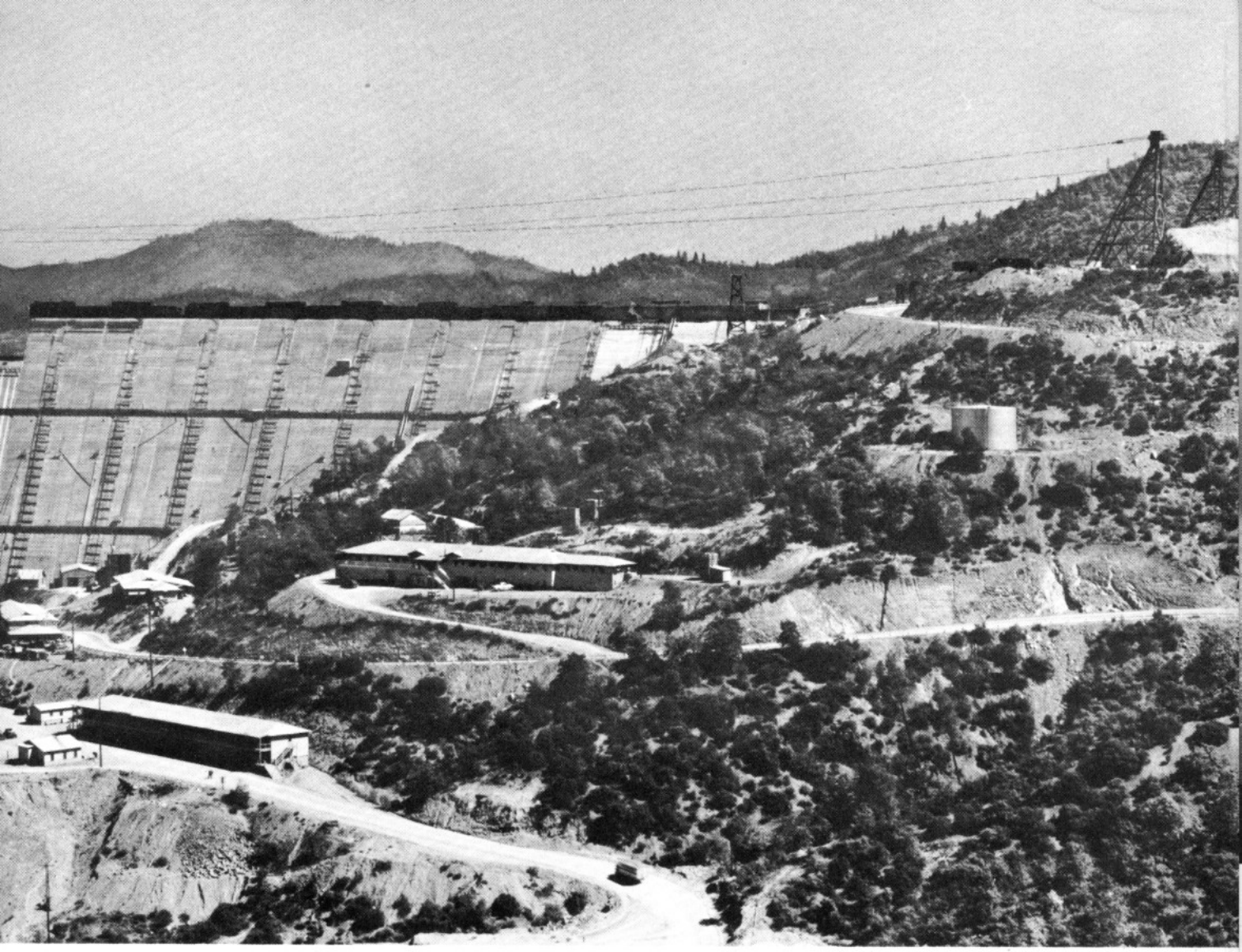
American Pipe and Construction Co. and Wm. A. Johnson	10	%	$ 300,000.00
Griffith Company	10	%	300,000.00
J. C. Maguire & Company	10	%	300,000.00
Metropolitan Construction Co. (Wood, Bevanda, Jahn and Bressi)	10	%	300,000.00
Arundel Corporation	10	%	300,000.00
Foley Brothers, Inc., St. Paul and New York	10	%	300,000.00
L. T. Lawler	6-2/3	%	200,000.00
Shofner, Gordon & Hinman	6-2/3	%	200,000.00
W. E. Callahan Construction Co.—Gunther & Shirley Co.	6-2/3	%	200,000.00
A. Guthrie & Co., Inc.	6-2/3	%	200,000.00
Hunkin-Conkey Construction Co.	5	%	150,000.00
L. E. Dixon Company	4-1/6	%	125,000.00
D. W. Thurston	4-1/6	%	125,000.00
Total	100	%	$3,000,000.00

The bidding of Shasta Dam was in the nature of a joint venture with each participant pledged to pay in the capital for which he subscribed, it being understood that should Pacific Constructors, Inc. be unsuccessful in the bidding, the subscription should be cancelled and all obligations otherwise undertaken, released. If successful, the corporation set-up would be revised to fit the needs of the venture.

The Western members and their engineers had been making a study of Shasta Dam for months. Harvey Slocum had been retained and he went to work immediately after Grand Coulee to study the job; work out a plan of construction; and make an estimate of the cost. Ray Whinnery, engineer for the Wm. A. Johnson enterprises, began to study and estimate the job. L. E. Dixon and his engineers did likewise. These three estimators consulted and exchanged ideas back and forth as the work progressed and each one of them prepared independent estimates using different schemes of operation. The local members of the group kept more or less in touch with these estimates as they were being built up. They were in fact the foundation from which our bid was built. Estimates were also prepared for individual members of the group by James G. Tripp and W. Earle Roche, both recognized as outstanding estimating engineers and these estimates were also made available to the group and were invaluable as a check on the other figures and schemes. In addition, the Eastern members moved in with their engineers and estimators well in advance of the bidding date and made a study of the job

and the estimates so that the job was thoroughly investigated and analyzed by all concerned.

In preparing an estimate each engineer must go through the entire operation of building the dam, step by step. He must, on paper, install a camp and construction buildings, and facilities and equip same. He must devise a scheme for building the project; estimate the machinery and equipment necessary to fit the scheme; and make an estimate of the cost of each and every operation. When his estimate is finished he has built the project on paper from start to finish. On a job the size of Shasta this is an enormous task. The schemes for placing concrete varied greatly, ranging from the two more or less standardized cableway and trestle methods, to variation or combinations of the two, and the costs varied along with the schemes. Also the location of the concrete plant and yards varied from one side of the river to the other. There was a variation of more than 20%



The Dam in April, 1943

between the high and the low estimates of cost and after the five estimates were torn apart and worked over by the individual contractors and their engineers, a figure of about the average was finally accepted by the group as the probable cost.

Then began the work of arriving at a bid price. Many factors had to be taken into consideration. In 1938 the future was beclouded with uncertainties. The New Deal was at the crest of its powers; new and revolutionary laws were being passed that affected all businesses; the threat of inflation was in the air; higher and higher operating costs were a serious threat; there was war and rumors of war. What sort of a price to set for a job running six years into the future was indeed a problem. The Shasta Dam job was mostly a problem of providing organization, construction plant and labor. All of the materials becoming a permanent part of the structure were furnished by the Government, including the sand and

Wm. A. Johnson
President

S. M. Griffith
Vice President

Floyd Shofner
Vice President

J. C. Maguire
Secretary

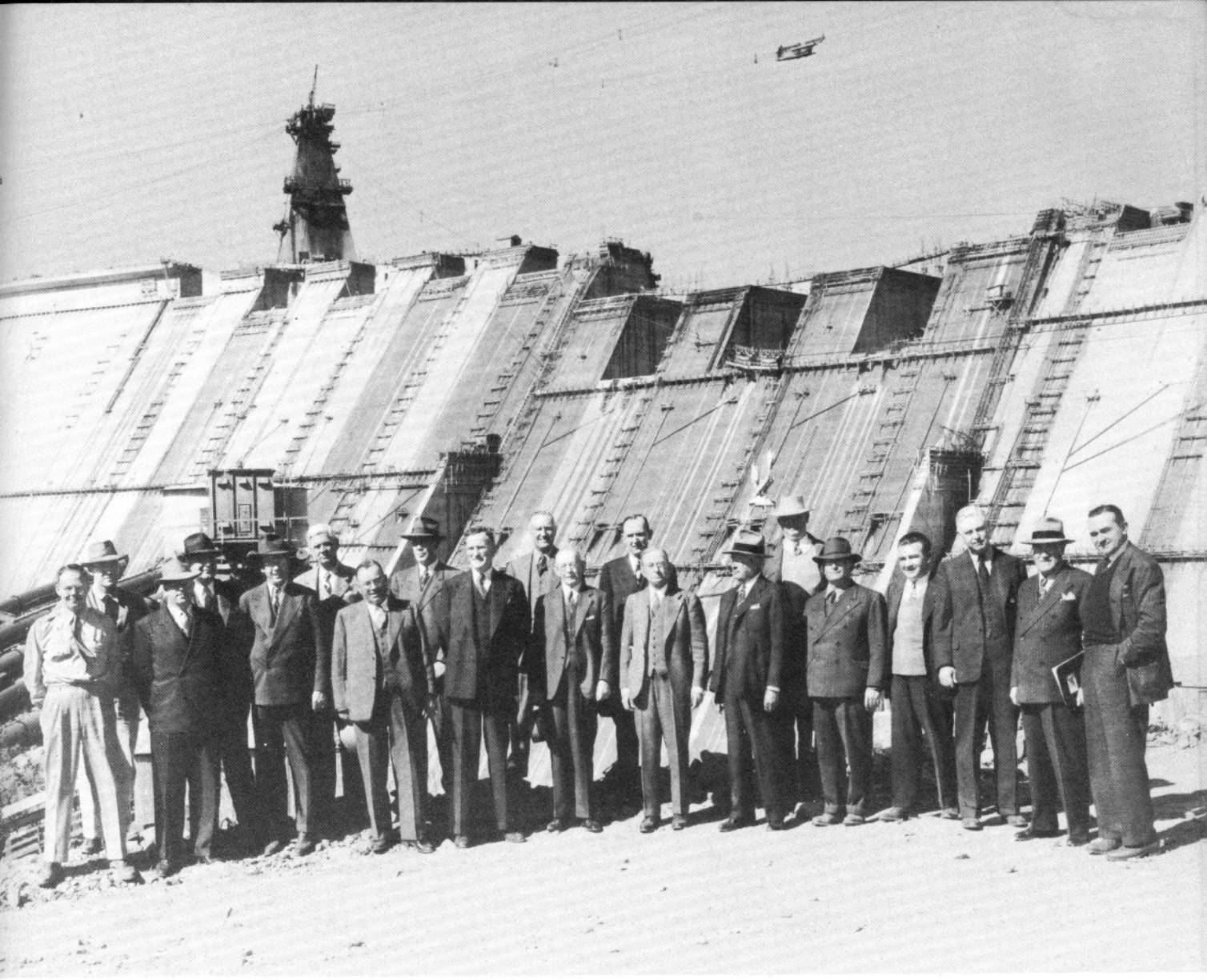
C. W. Wood
Treasurer

L. E. Dixon
Chairman Engineering and Construction Committee

gravel, cement, steel, structures and machinery, etc. The only materials furnished by the contractor were the form lumber, nails, tie rods, etc., and any other materials that were necessary in building the dam but did not become a permanent part of same. The big hazard was labor. The prevailing scale of wages was predetermined by the Government and specified as the *minimum* wage to be paid. But who could guess how much higher wages would go or what efficiency could be secured in the coming six years? There was a measure of security in the fact that the prevailing scale, as determined by the Government, was at the time, the highest scale in the western country and, under the conditions existing at the time, seemed ample for at least a couple of years. Contracts for all plant and equipment and for materials for reasonably early delivery could be made at the prevailing market price, but suppliers and manufacturers backed away from contracts for delivery six years hence or even one or two years ahead. The contractor had to use his best judgment as to what the future conditions would be and make a price accordingly.

Headquarters of our group were established at the Biltmore Hotel, Los Angeles, where all of our Eastern partners were quartered and a suite of rooms in the hotel was engaged for conference purposes. As the zero hour approached, the conferences were long and the situation became tense. Contractors are made or ruined by the bids they make and regardless of how carefully they plan and figure there is always a good percentage of unknowns and uncertainties to be gambled on. It is pretty much like a big poker game. On a job the size of Shasta the contractor's fortune and business future can be at stake. After discussions of all the problems and possibilities, eventually comes the question "What will we bid?" This is the supreme moment. When this time arrived for us, no one came forth with the answer. It was agreed that each member should secretly write the amount of the bid he preferred to make and drop it in a hat and then from these figures perhaps a compromise figure satisfactory to the group, could be arrived at. There was about as much variation in the bid figures of the individuals as there had been in the engineers' estimates. Nick Jahn proved to be the nerviest of the crowd with a figure a couple of million on the down side and one or two conservatives were a million or so on the up side. The members split into three factions—high, low and medium. The lows got together quickly on a bid of approximately 34 million. The highs were up around 37 million and the mediums were about halfway between, but willing to go either way. At no time, however, was there any serious disagreement, nor any indication that we would not eventually get together. One surprising fact developed. Both the Eastern associates, who joined us on condition that we make a safe, conservative bid, proved to be among the leaders for the low bid. After all, it was the Westerners who were conservative. Most of an afternoon was spent arguing for one bid or the other, with the group about evenly divided. Definitely on the high side were Bill Johnson, Paul Grafe, Clyde Wood, L. E. Dixon and the writer, and on the low were Joe Hogan, Carl Swenson, Frank Anderson and Nick Jahn. The others were the mediums, willing to go along with the majority.

The final bid price was arrived at in an amusing way. Carl Swenson was on the low side and was one of the leaders of that faction, arguing their cause long and forcefully. His wise old father, O. W. Swenson, had attended all the meetings and made a study of the estimates in his own quiet way. When price discussions got under way (and before anyone got down to naming a figure), he did a little figuring on the back of an envelope and on a card he wrote his idea of a price for the job. He handed the card to Bill Johnson and left the meeting. Bill proved to be among the highs and as usual took a leading part in the discussions. After the highs and the lows had argued back and forth for a couple of hours the highs agreed among themselves to come down to $36,000,000.00. Bill, knowing that the figure on the card was about $35,990,000.00, said to Carl, "We will compromise



The Board of Directors and several members of Construction Staff—Annual meeting 1944

with your father's figure," and pulled out the card. Carl was reluctant to give in, but stated very graciously that he would defer to his father's judgment and the others then fell in line, and the old gentleman's figure was agreed upon. When Joe Hogan accepted, he remarked that he would accept any price the group agreed on but if we bid over $34,000,000.00 we were just wasting our time. As it turned out, after the months of toil and effort estimating and figuring, it was the more or less psychic bid of a contractor of the old school that finally set the price for Shasta Dam. By such incidents are kingdoms won and lost.

A psychological move was then agreed on. On a job the size of Shasta it is customary to make quite a function out of opening the bids and all bidders are generally in attendance. After our high bid on Grand Coulee Dam, we figured

that we would not be much feared as competitors on Shasta, particularly if we showed indifference toward the job. It was therefore agreed that we should all stay away from Sacramento except "Dick" Dixon who was appointed to file the bid. It was known that the combination of contractors that beat us at Grand Coulee would bid the job. This combination was made up mostly of the old Six Companies crowd, augmented by a couple of new faces, and it was expected that another group, composed mostly of San Francisco contractors, would bid. There were also rumors of a mysterious fourth bidder from the East. When it came to a showdown, the San Francisco group faded out and the Eastern bidder did not materialize, so there were only two bids filed. The Six Companies crowd and their associates bid under the name of the Shasta Construction Company. They attended the letting in full force. When no other bidders appeared on the scene up to the evening before the letting, it is said that there was quite a love feast held to celebrate their good fortune in having no competition on this fine contract. They were in fine fettle as it looked like it was all over but the shouting. The next morning the auditorium at the Reclamation Bureau office, where bids were to be opened, was jammed with officials, engineers, newswriters, the usual crowd of salesmen of contractors' equipment and supplies, and last, but not least, the Shasta Construction Company horde. When "Dick" showed up, unsung and unattended, to file our bid there was much good-natured bantering by the boys. It seemed like a particularly lovely day for Shasta Construction Company. Finally they got down to opening the bids. The first one opened was that of Pacific Constructors. The total was read first and with that the bottom fell out of everything for Shasta Construction Company as they knew they were beaten, barring an error or irregularity in the bid. They quietly folded their tents and stole away. We heard reports of a very stormy session when they arrived at their hotel headquarters in which each blamed the other for not cutting their bid lower, but only they themselves know about this. Perhaps our high bid at Grand Coulee and our little strategy in staying away from the letting had no effect on their bid, but we like to think that we might have out-foxed them just a little.

The results, after the bids were checked and tabulated, were:

Pacific Constructors, Inc. .	$35,939,450.00
Shasta Construction Company . .	36,202,357.00

Shasta Construction Company did not give up the job without a last ditch struggle. The notice to contractors contained the following paragraph:

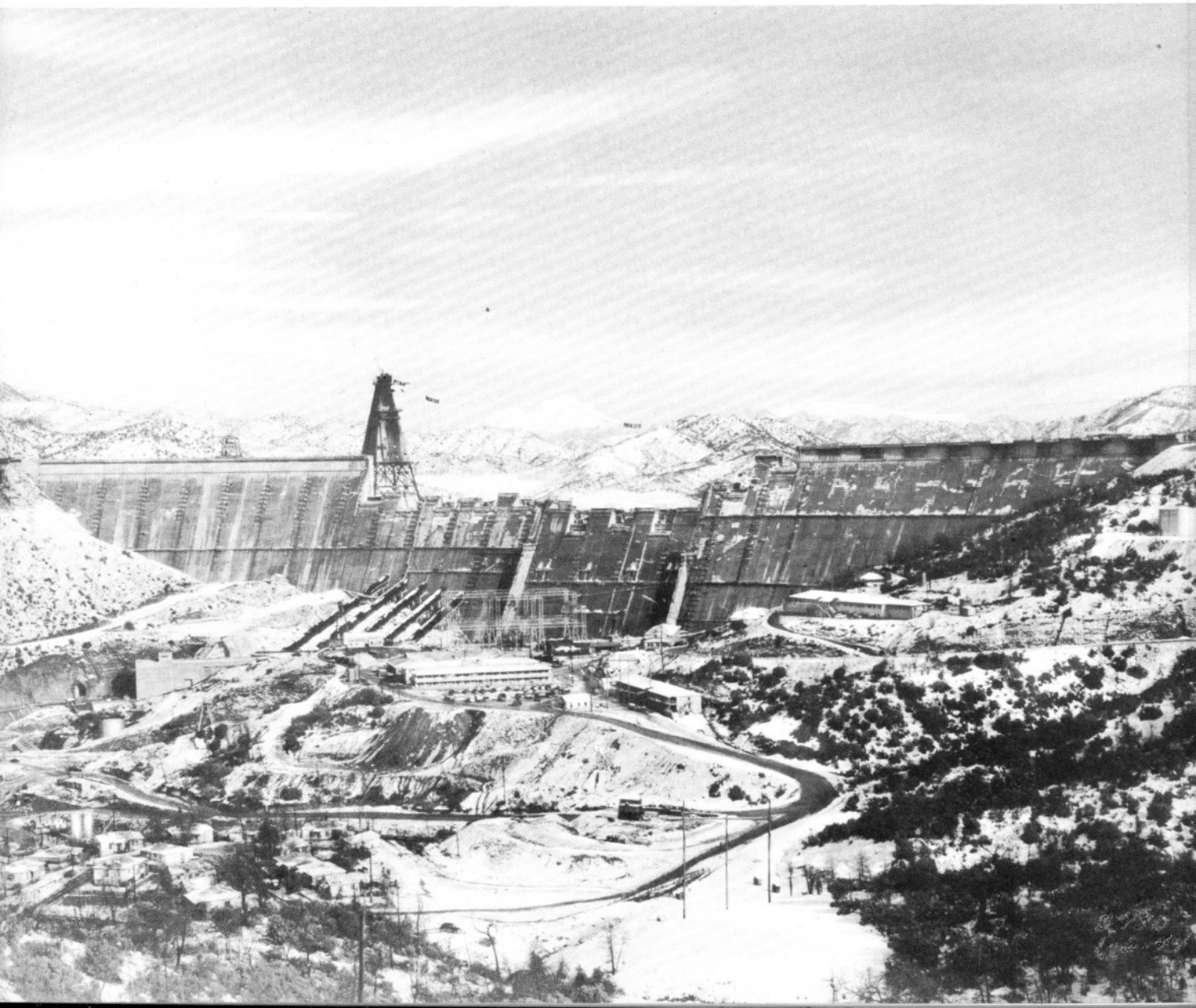
> *"The right is reserved as the interests of the Government may require to reject any and all bids, to waive any informality in bids received and accept or reject any item of any bid unless such bid is qualified by specific limitation."*

Believing that this provision could result in splitting the job up by awarding portions to different contractors and as we wished to bid on an "all or none" basis, we made the following stipulation in our bid:

> *"Bid submitted is based on the award to us of all of the items bid upon."*

Shasta Construction Company attacked this stipulation claiming that it made our bid irregular. They claimed also that the wording "all of the items bid upon" obligated the Government to do 100% of each quantity of each item instead of requiring the award to us of all of the contract as was intended by the stipulation. The use of the word "of" was the bone of contention. The claim was made that if we meant that all of the items should be awarded to us that our stipulation should have read "Bid is based on award of *all the items* bid upon" instead of "all *of* the items." It was also charged that our bid was unbalanced

A rare winter scene



and that, as a result of the unbalancing, the ultimate cost of the job would be higher under our bid than under theirs.

They carried their fight to the Reclamation Bureau at Denver and then on to Washington. A committee was appointed, consisting of Bill Johnson, Paul Grafe and the writer, to follow them up and defend our bid. We met encouragement from the officials at Denver. The Shasta Construction Company crowd had "hogged" the big dam building business for several years, capturing Boulder, Bonneville and Grand Coulee in succession and apparently these officials wanted to see some new faces in the picture and welcomed our competition. We learned that the charge of unbalancing our bid had been overruled by the engineers but that the matter of our stipulation being irregular had been passed on to Washington.

At Denver, we were anxious to make a showing and took a lot of the officials' time to tell our story. When we finished, Chief Engineer Walter, who has since passed to his just reward, told us the following story, which he said fitted the situation:

"A young lawyer appeared before the court on a case that the Judge was already familiar with and upon which he had already made up his mind to rule in favor of the young lawyer's client. The young fellow had worked long and hard on the case and had prepared a long, tiresome and technical brief. When the case was called, the Judge tried to cut the proceeding short, but the youngster knew his rights and insisted on reading his brief and arguing the case from beginning to end. This took several tedious and tiresome hours through which the Judge had to sit and listen. When at last he finished, the Judge heaved a long sigh of relief and after some reflection he said, 'Well in spite of all that, I'm still for you.' "

After this story, we took the hint and did not burden them further but moved on to Washington. We were advised by John Page, Commissioner of Reclamation, that the matter of our stipulation was in the hands of their Legal Department and that no action would be taken until they made a decision. We sat and waited for two weeks before this was forthcoming, in the meantime running around telling our troubles to any Government official whom we could contact that we thought might be of assistance to us. Also, we contacted a well-known legal firm and discussed the whole situation with them and were very much encouraged by the opinion which they gave us in the matter. Also, Joe Hogan came up from Baltimore for a couple of days to do what he could to help us and we were prepared to make an issue of the matter if the solicitor should rule that our stipulation was irregular and sufficient cause for rejecting our bid.

After about the longest two weeks we ever put in, the opinion finally came forth and it was in our favor. On July 2, 1938, Secretary of the Interior Ickes

summoned us to tell us that the contract was to be awarded to us. This was welcome news indeed. We had been fighting a crowd that were veterans in dealing with the Reclamation Bureau and the Department of the Interior. They had numerous influential connections in Washington while we were more or less strangers in a strange land. Henry Kaiser, who has proved to be the outstanding go-getter in the construction industry through the defense program, was actively on the job against us along with several powerful associates.

While we felt our cause was just and that we were entitled to the award and that by no stretch of the imagination would the Government disqualify our bid and award the job to Shasta Construction Company, we *did* fear that enough fuss might have been stirred up to cause the Government to reject all bids and submit the job for letting again. This would give the opposition another chance and was really what they hoped to accomplish. Be it said for the Bureau of Reclamation, it is one department of the Government whose record of honesty is unblemished. They are plenty tough on contractors and have been cussed out time and again for demanding and getting their "pound of flesh" to the full measure of each contract, but they rule without fear or favor and this instance proved that they could not be swayed by outside pressure or promotion.

The day after bids were opened on Shasta Dam, the work of reorganizing Pacific Constructors, Inc. was begun. The plan tentatively agreed upon by the associated companies before the job was bid was carried out. Necessary legal proceedings were completed; stock in the corporation was subscribed for in proportion to the pledges of the associates so that a paid-in capital and surplus of $3,000,000 was provided. The by-laws were revised so that each associate could have satisfactory representation on the Board of Directors and at the first meeting of the reorganized stockholders the following directors were chosen:

Wm. A. Johnson	L. T. Lawler	H. L. Mundy
S. M. Griffith	D. W Thurston	D. A. Daly
Floyd Shofner	J. C. Maguire	S. E. Hunkin
Clyde W. Wood	Jos. V. Hogan	L. E. Dixon
	Paul Grafe	

Later changes included N. F. Jahn as a new member, and W. W. Lawler as successor to L. T. Lawler; C. W. Black successor to Jos. V. Hogan; and R. M. Knox successor to H. L. Mundy. No change was made in the officers except to add Floyd Shofner as Vice President.

To facilitate handling the business of the corporation an Executive Committee with all the powers of the Board of Directors was appointed as follows:

Wm. A. Johnson, *Chairman*

S. M. Griffith	C. W. Wood
D. A. Daly	J. C. Maguire

ORGANIZATION CHART

PACIFIC CONSTRUCTORS INC.

CONTRACTORS FOR CONSTRUCTION OF

SHASTA DAM

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA — A G C

JOB SPONSORS
Wm A. Johnson
J. C. Maguire

DIRECTORS
Wm A. Johnson	President
S. M. Griffith	Vice President
Floyd Shofner	Vice President
J. C. Maguire	Secretary
C. W. Wood	Treasurer
L. E. Dixon	D. W. Thurston
L. T. Lawler	C. W. Black
R. M. Knox	Paul Grafe
D. A. Daly	S. E. Hunkin

N. F. Jahn

EXECUTIVE COMMITTEE
Wm A. Johnson
S. M. Griffith
J. C. Maguire
L. E. Dixon
C. W. Wood

GENERAL SUPERINTENDENT
Frank T. Crowe

HOSPITAL
J. E. Kirkpatrick M. D. Ch. Surgeon
E. B. Myer M. D. Asst. Surgeon
A. F. Bock Superv. after Apr. '42
Dan Brown Superv. before Apr. '42

INSURANCE & SAFETY
T. J. Caulfield	after Jul. '42
E. T. Green	before Jul. '42

MESS & COMMISSARY
C. H. Unger — Chief Steward

GENERAL FOREMAN
Frank Bryant

CARPENTER SUPERVISION
Butler Howell	Dam
Chas. Silva	Powerhouse

CARPENTER FOREMEN
J. F. Dow	Shop
K. E. Hydorn	Field
Jens Pederson	Field
L. Wortley	Field

CHIEF ELECTRICIAN
L. E. Osborn	after Apr. '42
Chas. Bailey	before Apr. '42

ELECTRICAL FOREMEN
Geo. Grosse	Day Shift
Phil. Rendahl	Swing Shift

MASTER MECHANIC
Anthony Bous

FOREMEN
Tom Powell	Day Shift
R. H. Miller	Day Shift
Mike Krumpotic	Swing Shift
Elmo Skuce	Graveyard Shift
A. M. Brown	Excavation
R. H. Myers	Grouting

SUBCONTRACTORS
D. G. & J. G. Longtin - Diamond Drill.
R. E. Selby - Supt
J. P. Murphy Corp - Reinf. Steel
Don Rutherford - Supt.
Teleweld Inc. - Penstocks
T. L. Borman - Supt.
J. H. Mohr - Painting
J. Pinfold - Supt.
E. B. Bishop - Road Paving
A. M. Sturtevant - Supt.
R. G. Clifford - Tunnel Lining
J. H. Trisdale - P. H. Roofing
Carpenter-Vollmer - Tunnel Excav.
Bert Choat - Tunnel Excav.
K. Russell - Glass Blocks

CHIEF ENGINEER
Wm V. Greeley	after Jan '41
B. W. Goodenough	before Jan '41

ENGINEERS
D. C. May	Office Engr.
A. L. Shjeflo	Field Engr.
F. C. Wood	Field Engr.
H. B. Gilroy	Asst Engr.
W. H. Colby	Photos - Progress

RIGGERS
L. P. Sowles	Cableway Supt.
Lamar Pierce	Foreman
Ernest Myers	Foreman
F. G Dunkel	Foreman
Lee King	Foreman
Troy Jones	Foreman
A. C. Mc Cracken	Foreman

CAMP MAINTENANCE
Merritt Butler - Foreman

MACHINE SHOP
Geo. Bogovitch (Asst. Mast. Mech.)
Geo. Malan - Foreman before Apr. '41

EQUIPMENT & INSTALLATIONS
L. H. Freckleton - Mach. Foreman
A. M. Jorgenson - Pipe foreman
J. A. Kortuem - Equip. foreman
Lee Ritchie - Equip. Foreman
K. A. Henry - Shovel Foreman

GARAGE
Geo. Tripp - Foreman - Day
Carl Schrupp - Foreman - Swing

OFFICE MANAGER
F. D. Myers

ACCOUNTING & CLERICAL
E. R. Baker	Auditor
Paul Pulley	Bookkeeper
R. F. Sass	Ch. Timekeeper
F. E. Stuelpnagel	Paymaster
H. L. Murphy	Cost keeper
W. J. Van Veghten	Purch. Agent.
E. H. Mc Adams	Personnel

AUDITORS
J. Arthur Greenfield Co.
M. J. Creamer - Ch. Aud.

There then were appointed a Finance Committee, Insurance Committee, Labor Committee, Engineering and Construction Committee, Purchasing Committee and Organization Committee to which were assigned the problems coming under these classifications. The membership of these committees was not confined to the directors. Merle W. Davidson was called in from the Griffith Company and J. M. MacAdam from American Pipe and Construction Co. to serve on the Insurance Committee on account of their broad knowledge of contractors' insurance and several other associates of member companies were called upon many times and all responded willingly.

Offices were opened in Los Angeles and all the committees went to work on the many problems incidental to getting a new construction company under way on this gigantic project.

Twenty-two surety companies joined in furnishing the bonds in the amount of $7,500,000 required on the contract. Five of these companies were appointed to act as a committee to represent the sureties in handling the trust fund impounded under the joint control of the contractor and sureties.

The matter of getting together a construction organization was of major importance. Plenty of good construction men were available but we all recognized that the task of picking and choosing the right men and welding them into a going concern was a tremendous job. We were struggling along with this problem when along came Frank Crowe, the builder of Boulder Dam, who was just finishing up Parker Dam, and applied for the job of General Superintendent. Here was the outstanding dam builder of the nation, with an organization picked and chosen over the years, ready to move on to the job and go to work. Crowe had spent months studying the job and had a complete plan worked out for the operation. This was a windfall that none of us expected. Crowe became General Superintendent and Pacific Constructors, Inc. was started off on Shasta as a going concern with a ready-made and experienced construction organization.

The various committees did yeoman service in handling their assignments. The Finance Committee had little to do as their problems drifted into the hands of the Executive Committee. The Organization Committee's work was done when Crowe was engaged and an organization chart adopted. The Insurance Committee recommended that we become self-insurers on workmen's compensation, operate our own hospital and place the various forms of insurance with different carriers and all their recommendations were adopted by the directors. The Engineering and Construction Committee, headed by L. E. Dixon, and the Purchasing Committee, headed by D. A. Daly, had a real job to do in the selection and purchase of plant and equipment and spent many long hours on the many problems that confronted them. Crowe's scheme of concrete placement was finally used. An outstanding advocate of cableways, he designed a bold scheme,

using an enormous headtower with cableways radiating out over the dam as the basis of his plan. This was a radical departure from anything heretofore attempted and problems were involved that had the structural engineers and designers guessing. Several experts were retained to pass upon the scheme, notably Mr. A. C. Ackerman, designing engineer of the Dravo Corporation; Professor Lydik S. Jacobsen, Engineering Dean, Stanford University, and Henry D. Dewell, outstanding structural engineer on the San Francisco Bay Bridge, as well as the engineering forces of the American Bridge Company headed by Mr. Christie.

The directors listened to discussions by the experts on stresses and strains, peak loads, recoil action, harmonics, vibrations and fatigue of metals, etc., until they were dizzy. Some of these problems involved the unknown, upon which none of the experts could give us more than an opinion, yet they all agreed that the scheme should work. We eventually followed the recommendation of Frank Crowe that we build the plant "hell for stout" by using a double factor of safety all the way through and ordered the engineers to design the structures accordingly.

The Labor Committee faced the problem of whether to operate non-union, open shop or union and, if union, whether to make a deal with American Federation of Labor or C.I.O. Southern California was a non-union territory and the associates from that section were reluctant to tie up with any union. There was also a sentiment among the residents of Shasta County against the unions. On the other hand, the unions, aided and abetted by the Federal Government, were making rapid strides in controlling the labor of the country.

The C.I.O. were growing so fast that they had American Federation of Labor alarmed and they were both anxious to make a contract with us, so it seemed like the psychological moment to drive a bargain with one or the other. Accordingly, negotiations were started with the American Federation of Labor. Eventually a fair contract was worked out with them. The wage scale was, with one or two exceptions, identical with that established by the Government as the minimum scale for the job. The contract was for the life of the job and was signed by sixteen international unions and the union locals, covering every classification of labor on the job, as well as by officials of the American Federation of Labor. The unions have lived up to the terms of this agreement throughout the job; but, with the advent of war and the increases in rates and overtime provisions established by the Government on defense projects, it has been necessary for us to voluntarily increase wages by more than 50% in order to keep workers on the job.

Other adjustments have been necessary from time to time to conform with Government war regulations. The job has proceeded without any serious labor disturbance. One unauthorized walk-out by cableway operators tied the job up for two or three shifts but there have been no strikes. In view of the fact that practically every project in the area has had numerous strikes and labor dis-

turbances, we feel that we negotiated a good contract and that Frank Crowe and his organization did a good job in administering it.

Financing the job offered no serious problem. The $3,000,000 capital proved to be adequate, especially in view of the fact that the first part of the work proved to be profitable, so that the job to a great extent financed itself. Accounts were opened with four major banks in Los Angeles and three banks in San Francisco as well as carrying operating accounts with two banks in Redding and a depository account in New York City. We felt that ample credit accommodation was available to us at all times but fortunately it was not necessary to use it.

Our greatest financial problem was the matter of taxes. The firm of J. Arthur Greenfield & Company of Los Angeles was retained at the beginning of the job to advise us on these matters. They also audited our accounts once a year and their reports went to the stockholders regularly. The excellent job J. Arthur Greenfield & Company did for us is greatly appreciated.

Through the first few weeks of organizing, the different committees met practically every day. Then as their problems were solved and their work completed, the meetings became less frequent and for the most part were abolished. Every member gave his time and talent unstintingly to the work in hand and each did a fine job on his assignments.

The Executive Committee continued to function throughout the job; a majority of this committee was practically always on call in Los Angeles so that quick action could be taken on any problem when necessary.

The Engineering and Construction Committee, headed by L. E. Dixon, was also kept in existence so that when any engineering or plant or equipment problems developed they could be called in to consider them. Several times throughout the job they were called upon and always did a fine job.

It was a tremendous job to clear a site, build roads, establish a camp and operating shops and yards; build a hospital and office buildings; and then to plan and build the construction plant and to get it in operation. Each move involved consideration and decision by the directors acting through the various committees. The work in the field went along smoothly under the guidance of the experienced hand of Frank Crowe. Finally there came the day that the Shasta Dam job was fully organized and from then on it became more and more a routine operation by the construction organization and less and less a problem of the directors or stockholders. Meetings of the Executive Committee became fewer. President Wm. A. Johnson and Secretary J. C. Maguire were kept actively on the job and became more and more the contact men between the job and the stockholders.

With the war came problems of changing over to war-time operations. Government control of labor and materials created many knotty and irritating conditions

to which we did our best to conform. The need of power to help in the prosecution of the war became of vital importance and Shasta Dam was declared to be a defense project on account of its power development feature. While power development was one of the beneficial features of Shasta Dam, as originally conceived, the project was primarily for irrigation and flood control; but had it not been for the power development, the project would undoubtedly have been shut down through the duration of the war as unessential. Be that as it may, the management was beset by the many problems and changes common to war-time operations and the constantly changing conditions and rules and regulations kept us pretty much on the job. We are proud of having brought this job, taken in 1938 under peace-time conditions, through the troublesome war period without delay or strife and with credit to the management and profit to the stockholders.

The officers extend a vote of thanks to the directors in general and to the Executive Committee in particular. This committee consisted of Steve Griffith, Clyde Wood, Dave Daly and the President and Secretary. When Dave Daly moved East he resigned and was replaced by "Dick" Dixon. The committee has served through the life of the job and has worked closely with the officers. We have had their cooperation and support at all times and it has been a pleasure to work with them. The same can be said about the directors, even though we did not see them so often. There has never been a complaint nor unjust criticism from any of them.

What has been told so far is the story of the brass hats' part of the picture. The real story of Shasta Dam is the story of the men on the job and the part they played in its construction. Pacific Constructors was really a Frank Crowe organization—veteran builders who knew their job. This is emphasized in the chapters that follow. Suffice it to say here that we owe Frank Crowe and the entire construction organization a vote of thanks for their untiring work, devotion and loyalty, and those of us who were in constant touch with the operation give it herewith in full measure.

THE COMPONENT COMPANIES OF PACIFIC CONSTRUCTORS, INC.

The contracting firms and individuals which form the backbone of Pacific Constructors, Inc. have all been engaged in construction work from coast to coast for many years—some from as far back as 1874. Their combined achievements over the years form an impressive parade of "greats" in the world of construction—a cross section of the growth of a great nation. Recent war years have so increased construction horizons that their interests and activities have become world-wide in scope. Home, farm, city and industry have all benefited from the dams, aqueducts, tunnels, highways, power plants, airports, harbors and railroads built by these men and organizations.

Following are brief summaries of the member companies making up Pacific Constructors, Inc.—a "Who's Who and Why" for posterity!

The Component Companies of Pacific Constructors, Inc.

AMERICAN PIPE AND CONSTRUCTION CO.

THE ORIGINAL and predecessor company was the Reinforced Concrete Pipe Company which was founded in California in 1907. During the course of time, as the company and its products developed, the name was changed from time to time to more clearly denote its activities. Successively it became the Western Reinforced Concrete Pipe Company and, after its merger in 1929 with the Bent Concrete Pipe Company, which was originally started by the Bent brothers—Arthur, Stanley and Ernest—it became the American Concrete and Steel Pipe Company and finally to its present name, the American Pipe and Construction Company.

The company pioneered and developed the manufacture of reinforced concrete pipe, bell end non-reinforced sewer pipe, centrifugally spun reinforced concrete pipe, and its broadened activities now also cover concrete cylinder pipe and welded steel pipe for water pressure lines. It also engages in a substantial volume of general construction work. It has pioneered and developed AMER-COAT, a corrosion resistant coating with a synthetic resin base, for application to concrete, steel and wood. It is used extensively in the food, petroleum, shipping and chemical industries.

The company has installed main water supply lines for such cities as Riverside, Tacoma, Ogden and San Diego, and for the United States Navy at Puerto Rico, and the United States Army in Wisconsin and Washington State, as well as for the

Metropolitan Water District of Southern California. It also pioneered in the manufacture and installation of some seventeen miles of 12′-8″ and 11′-8″ diameter reinforced concrete pressure pipe. These sections of pipe, 12′ in length, weighed from 37 to 43 tons and were the largest precast units then known. This development was a direct precursor to the construction by the City of Boston of the same general type of pipe. This company installed two of these sections.

Within recent years the company has participated in a variety of all types of construction work such as roads, dams, sewer and water systems and gravel processing plants in Venezuela and in the Panama Canal Zone. During the war period, it constructed lighters and barges of welded steel for the U. S. Navy.

In December 1944 its officers were:

President
WM. A. JOHNSON
Vice Presidents
HOWARD H. JENKINS
ERNEST F. BENT
ROBERT V. EDWARDS
D. A. DUNKLE
Secretary
J. M. MACADAM
Treasurer
C. GRANT CRAWFORD

THE ARUNDEL CORPORATION

The Arundel Corporation was formed in 1919 by a combination of the Maryland Dredging and Contracting Company, D. L. Taylor and Company, The Arundel Sand and Gravel Company, and several other companies, all of which had been successfully engaged in the field of heavy construction, dredging and aggregate production for some twenty-five years prior to that date. Mr. Frank A. Furst, who had been active in the management of all of the individual companies, became the first president of The Arundel Corporation.

The predecessor companies had completed many important projects along the Atlantic Seaboard and in the Eastern States, including drainage of the Florida Everglades, the construction of the Cape Cod Canal, a concrete dam at Medina, New York, Drydock No. 3 at the Philadelphia Navy Yard, and Aberdeen Proving Ground. Since 1919, The Arundel Corporation has continued in the fields of heavy construction, dredging, subaqueous rock removal, and the production of sand, gravel, crushed stone and premixed concrete. Construction work has included airports, aqueducts, bridges, dams and hydro-electric plants, railroad and highway work, tunnels, large sewers, and river and harbor facilities. The Conowingo, Saluda and Safe Harbor Dams, built by The Arundel Corporation, are among the largest in the east. Contracts for national defense corporation, prior to and since

the entry of the United States into the present war, have included a large amount of work of all types for the Navy in Puerto Rico and other islands of the Caribbean, and dredging and marine work for the Army, Navy and Maritime Commission along the Atlantic Seaboard. Since 1939, The Arundel Corporation has participated with the L. E. Dixon Company in the construction of four large concrete dams on the Pacific Slope.

At the time of the award of the Shasta Dam contract Joseph V. Hogan was president of The Arundel Corporation. He became a director of Pacific Constructors, Inc. and was active in its organization and management until illness forced his retirement from active business in 1940. The officers of The Arundel Corporation as of December, 1944, were:

President: RICHARD A. FROEHLINGER

Vice Presidents:
C. WARREN BLACK
GEORGE H. BACOT
JOHN A. REILLY
L. E. DIXON
WILLIAM G. ARMSTRONG

Secretary and Treasurer:
JOSEPH N. SEIFERT

Assistant Treasurers:
THOMAS K. SHAUGHNESS
ALBERT M. LEIMKUHLER

Assistant Secretaries:
G. DONALD SCHAUB
MARSHALL NORRIS

Chief Engineer:
E. KOHNEN

W. E. CALLAHAN CONSTRUCTION CO.

The W. E. Callahan Construction Company was incorporated in Omaha, Nebraska, March 21, 1912, by W. E. Callahan and his father to continue the construction business started by Bill's father, W. F. Callahan and his uncle, Edward Callahan,

The first work of this company was railroad work and general excavation work in the middle west. Shortly after the incorporation of the new company, it became interested in drainage work in the middle west and south and, in connection with this work, was the prime mover in the development of the dragline excavator. The company did a considerable portion of the work on the Mississippi River levee program, which started in 1927. To date the largest single dragline job performed by the W. E. Callahan Construction Company was the digging of the All American Canal in the Imperial Valley, California.

In 1922 the company started construction on its first dam job. Since that time it has built alone and in joint venture setups, the following dams:

Kemp Dam, Wichita Falls, Texas
Garza Dam, Dallas, Texas
Waco Dam, Waco, Texas
Nashworthy Dam, San Angelo, Texas
Madden Dam in the Canal Zone
Alcova Dam, Alcova, Wyoming
Prado Dam, Corona, California
John Martin Dam, Caddoa, Colorado

The company was a stockholder in the Pleasantville Constructors, which built the section of the Delaware Aqueduct under the Hudson River, and sunk some shafts for this Aqueduct at other locations.

The war work performed by the W. E. Callahan Construction Company, without and with co-adventurers, was the following:

Artillery Proving Ground, Hope, Arkansas
Bluebonnet Bomb-loading Plant, McGregor, Texas
General Construction work in the Hawaiian and South Pacific Islands
Canol Project, Canada and Alaska.

The company is also assisting the British Government in a coal stripping project of great magnitude in the British Isles.

Mr. Callahan, president when the job started, died on January 5, 1944. Officers of the company as of December, 1944, were:

Chairman of the Board: JOE A. WORSHAM
President: PAUL GRAFE
Vice President and Treasurer: W. K. MCILYAR

L. E. DIXON COMPANY

Mr. L. E. Dixon started to work for the Alta Planing Mill Company in 1911 as an estimator. In 1916 he took a similar position with The Edwards and Wildey Company, acting also as chief engineer and managing partner. During the years following World War I, the company was very successful and in 1919 it became the Edwards, Wildey and Dixon Company. Through the 1920's their sign could be found on many corners in the Southwest, California and Arizona—mostly on building projects. They erected the Los Angeles Coliseum, the huge Shrine Auditorium, the College of Law Building for the University of Southern California, the Spreckels Building, San Diego (highest in Southern California when constructed in 1927), the Deauville Beach Club, considered one of the most beautiful and unique structures in Southern California, and the well-known Hollywood Turf Club, as well as residences, apartments, hotels, office and industrial buildings, hospitals and about 600 private homes.

In the engineering construction line may be listed road building, tunnels and pumping plant for the Metropolitan Water District, dams at Sutherland,

A piece of Head Tower steel goes into place

Big Tujunga, Upper Narrows, Chorro Creek, Santa Margarita and San Vicente in California; Horse Mesa and Horseshoe (now building) in Arizona; and Alder and La Grande in Washington.

War work included Camp San Luis Obispo, the Salinas River Dam and Cresta Tunnel, built for the United States Army in 1941. The firm was associated with Arundel Corporation on five of these dams and with Bent Brothers and Mr. Wm. A. Johnson on Horse Mesa Dam and nine miles of Metropolitan Water District tunnel.

Following Mr. Edwards' death in 1928, and Mr. Wildey's withdrawal in 1930, the name of the firm was changed to L. E. Dixon Co., at present located in the Edwards & Wildey Building in Los Angeles. Associated with Mr. Dixon as junior partners, are his two sons, Merrill Dixon—at present in charge of operations at the Horseshoe Dam, and Lt. Richard Dixon, now with the Army Air Corps overseas.

FOLEY BROTHERS, INC.—ST. PAUL—NEW YORK

In 1874 Timothy, Michael, John and Thomas Foley, newly moved to Minnesota from Eastern Canada, formed a partnership known as Foley Brothers to engage in the lumbering and contracting businesses. About the turn of the century the concern was incorporated and has operated in corporate form ever since. In 1930 the company was divided into two separate and distinct entities, each, however, having the same name, Foley Brothers, Inc. One is known as the New York company and the other the Saint Paul company. These two concerns are in every way independent, E. T. Foley being the only individual who owns stock in both.

Few, if any, American contracting concerns have a record of seventy years of continuous operation under the same name. During this long interval Foley Brothers has been regarded as one of the country's leading construction companies. In their earlier days during the great era of railroad expansion, their activities were largely confined to that type of construction. In all they have built over 35,000 miles of railroad, costing over a billion dollars—enough to go around the world with a comfortable lapover. Prior to World War II their operations extended from coast to coast, both in Canada and the United States. Their war activities have extended around the world from Alaska eastward to India. Both the Foley Brothers companies are fully integrated engineering and construction concerns and have performed a great variety of work including railroads, highways, piers, bridges, dams, tunnels, buildings, drydocks, airfields and industrial plants. During war periods they have built many large armament

plants, harbors and docks, highways and air bases and been engaged in natural resource development in the United States and foreign lands. They are now carrying on extensive mining and oil operations.

In December, 1944, the officers and directors of the two Foley Brothers companies were as follows:

FOLEY BROTHERS, INC., ST. PAUL, MINN.

F. J. ANDERSON, *Chairman*
D. A. DALY, *President*
L. D. SINCLAIR, *Vice President and Secretary*
F. L. KOEMPEL, *Treasurer*
E. T. FOLEY
G. T. MALOY, *Vice President*
H. M. BREIMHURST, *Assistant Secretary and Assistant Treasurer*

FOLEY BROTHERS, INC., PLEASANTVILLE, N. Y.

O. W. SWENSON, *President*
CARL L. SWENSON, *Vice President*
A. L. KADELA, *Secretary and Treasurer*
C. L. GONNET, *Assistant Secretary and Assistant Treasurer*
G. H. WILSEY
E. T. FOLEY

GRIFFITH COMPANY

Griffith Company is the owner of and successor to Fairchild-Gilmore-Wilton Company which has operated in California since its incorporation in 1902. The name was changed to Griffith Company in December, 1922. It has engaged in a general contracting business covering highway, heavy engineering and building operations ever since.

This is a sound Southern California construction firm, consistently doing many million dollars worth of business year in and year out, but to quote Steve Griffith the President of the company, "We have never had delusions of grandeur and never wanted to be considered as 'big shots' but try our best to be good 'little shots'."

Among the projects completed during the past few years, each running into several million dollars, are Cajalco Dam, Dikes and Reservoir and Friant Dam in California; Conchas Dam in New Mexico; conduits and siphons for the Metropolitan Water District and numerous large paving and road jobs in Southern California. Since the outbreak of the world war, Griffith Company

has participated in building defense plants, alone and in joint ventures, in amounts running to the hundred millions. Some of these projects are Camp White in Oregon, Tooele Ordnance Plant and Murray Replacement Center in Utah, Santa Ana Air Base, Manzinar Jap Internment Camp, and hospitals and other buildings at various points in Southern California, also contract for furnishing and processing concrete aggregates for Third Locks Structure, Panama Canal Zone.

Officers in December, 1944, were practically the same as those of 1938 when we bid Shasta Dam. They were as follows:

President:
S. M. GRIFFITH
Vice Presidents:
RICHARD M. GRIFFITH
BEN P. GRIFFITH
FRANZ A. FOHL
Vice-President-Treasurer:
M. W. DAVIDSON
Secretary:
W. R. MIRAMS
Assistant Secretary:
MISS CATHERINE ROBERTON
Assistant Treasurer:
H. H. HIESTAND
Auditor:
C. F. REES

GUNTHER AND SHIRLEY COMPANY

The present firm of Gunther and Shirley Company is an outgrowth of a partnership formed in 1890 known as the Phelan-Shirley Company. The partners of the latter firm consisted of Edward Phelan and Michael Shirley and devoted their efforts to railroad construction during its pioneer days both in Canada and the United States. Work was performed over a period of years for the Canadian Pacific and the old Grand Trunk in Canada as well as the Rock Island, Milwaukee, Union Pacific, Great Western and other rail lines in the United States.

Then in 1921 the partnership of Peterson, Shirley and Gunther was formed and engaged in the construction of railroads, highways and dams. Until 1935, when the partnership was dissolved, approximately one hundred and fifty projects were constructed totalling $30,000,000 in value.

Gunther and Shirley Company, formed by Herman Gunther (deceased) and J. P. Shirley, was incorporated in the State of Nebraska in 1935 and has specialized in tunnels, dams, railroads, canals, airports and highways. The firm has been associated on engineering construction projects totalling approximately $300,000,000 in value.

A. GUTHRIE & CO., INC.

A. Guthrie & Co. was founded in the year 1897 by Archibald Guthrie for construction of railroads. The company operated as a partnership until 1914, partners being Archibald Guthrie, Chas. Ffolliott and H. L. Mundy. In that year it was incorporated under the name of A. Guthrie & Co., Inc., with Chas. Ffolliott as President, and has operated up to the present time on heavy construction contracts throughout the United States.

From 1897 to date this company has constructed over 3000 miles of railroad on the Great Northern system alone—in which is included the driving of the New Cascade Tunnel 7.78 miles, completed in three years. Contracts for grading including heavy rock excavation, also bridges and tunnels, have been performed for the New York Central, Northern Pacific, Illinois Central, Pennsylvania, Missouri Pacific, Rock Island and Burlington and other railroads. A large amount of work has been done on construction of levees, dams, canals, highways and industrial plants. Since 1940 A. Guthrie & Co., Inc. and associates completed United States Government contracts covering construction of the Iowa Ordnance Plant, Newfoundland Army Bases, Cornhusker Ordnance Plant, and structures for Kearney Air Base.

Officers:

Chairman of the Board: H. L. MUNDY

President and Treasurer — ROBT. M. KNOX

Vice President and Secretary — B. S. CROOKS

HUNKIN-CONKEY CONSTRUCTION COMPANY

The Hunkin-Conkey Construction Company of Cleveland, Ohio, is one of the oldest firms in The Pacific Constructors, Inc. syndicate, having been founded about seventy-five years ago. Its officers consist of Mr. G. E. Conkey, President, Mr. S. E. Hunkin, Vice President and Treasurer, Mr. C. A. Lohmiller, Vice President, Mr. G. E. Conkey, Jr., Director and Mr. J. L. Erwin, Secretary.

The scope of work of this company has been unusually diversified and has covered a country-wide zone of operations, ranging from the West Coast in 1907, following the San Francisco fire, during which time its entire plant and equipment as well as a major part of its labor personnel were transported by special trains from Ohio. During the industrial revolution created by the automobile in the early part of the 20th century, this company constructed the

major plants of The Goodyear Tire & Rubber Company, The Firestone Tire & Rubber Company, Kelly Springfield Tire & Rubber Company in all sections of the country. During this period heavy construction of steel mills, breakwaters and docks, the Detroit & Cleveland baseball parks, the largest doubledecked concrete bridge in the world, and plants for Ford Motor and other automobile companies were completed. A complete architectural program was inaugurated in the period following World War I consisting of hotels, office buildings, banks and theatres throughout the middle west, eastern seaboard and in the South.

Heavy construction continued in the interim with sewage disposal plants, large power stations, war memorials, tunnels on the Colorado River Aqueduct and the Arlington Memorial Bridge in Washington, D. C., and the largest continuous strip mill in the world for Republic Steel Corporation.

During World War II, this company built airplane plants, ammunition plants, gun plants, housing projects and steel mills totalling over $135,000,000.

Of these, the Ravenna Ordnance Center and Portage Ammunition Depot are among the largest ever built, covering 35 square miles. The buildings on this project, if laid end to end, would make one structure eighteen miles long. Included in the project are 125 miles of railroad and 240 miles of highways.

This plant loaded its first shell ten months after geographic surveys were started and one of its bombs sank the first Japanese submarine off the coast of California shortly after Pearl Harbor.

Several large dams and tunnels were constructed in joint ventures with Shofner, Gordon & Hinman, which are covered in their historical article.

L. T. LAWLER

L. T. Lawler, or "Tim" as he was known to his friends, was born and raised on a farm near Rochester, Minnesota. He began his apprenticeship in the construction business in the early part of the century when the Milwaukee Railroad was building across the continent. Tim was a very young man at the time and worked for Winston Brothers Company and several other well-known firms along the line through Minnesota, Dakota and Montana in capacities ranging from timekeeper to foreman. Upon completion of the line, he joined the operating forces of the railroad and became roadmaster of the tough division through the Bitter Root mountains in Western Montana.

The real estate boom in Canada lured Tim away from the railroad, but when the World War broke out he returned to Montana and entered into a partnership

Riggers secure take-up on a Tail Tower

with Clifton, Applegate & Toole in the building business with headquarters at Butte. As a member of this partnership, he constructed several large buildings in Butte and vicinity.

When the highway program was launched at the close of the World War, Tim struck out on his own and from there on his progress was rapid. In a very few years he was one of Montana's leading highway contractors. Many of the roads and bridges in the State's magnificent highway system were built by his organization.

His first venture into heavy construction was as a member of the syndicate that built San Gabriel Dam, the major project in the Los Angeles County Flood Control System. Then he and associates built Seminoe Dam in Wyoming; and, up to the time of his death, he took an active part in the construction of Shasta Dam.

Tim died suddenly in July, 1940, and his passing was a shock to all his associates with whom he was extremely popular.

J. C. MAGUIRE & CO.

In 1906 V. P. Strange and J. C. Maguire established the firm of Strange & Maguire at Salt Lake City and launched forth in the construction business, building waterworks, sewer and concrete work. Out of this partnership grew the Strange-Maguire Paving Co., doing street paving and general construction in Utah, Idaho and Colorado. In 1913, J. C. Maguire withdrew from this company and established himself at Butte, Montana, as a general contractor, operating in the Intermountain States. Through the next twenty-four years his firm completed numerous contracts for street paving, sewers, waterworks, gas lines, bridges and highways in Montana, Idaho, and neighboring states. In 1937 headquarters were moved to Los Angeles, California, and the present firm style of J. C. Maguire & Co. was adopted.

In 1932 the company associated itself with a group of other contractors, formed the West Slope Construction Company and built San Gabriel Dam for the Los Angeles Flood Control District. In 1935 it participated in a joint venture in building Seminoe Dam for the U. S. Bureau of Reclamation in Wyoming.

Through the World War J. C. Maguire & Co. participated in building the Tooele Ordnance Plant, the Murray Cadet Replacement Center in Utah and was one of the principals in a contract for processing and furnishing concrete aggregates for the Third-Lock Structure, Panama Canal Zone.

As a stockholder in Pleasantville Constructors, Inc., they were also interested in building a section of the Delaware River Water tunnel for the City of New York and in constructing a defense base for the U. S. Government in the Bahama Islands.

METROPOLITAN CONSTRUCTION CO.

This company was formed by the merger, in 1937, of the firms of Wood and Bevanda, and Jahn and Bressi after each had completed the construction of schedules of canal and siphons in the desert section of the Colorado River Aqueduct for the Metropolitan Water District of Southern California.

At the time of the bid for Shasta Dam, the Metropolitan Construction Company had just finished the big job of relocating the California Coast Highway over the tough Cuesta grade near San Luis Obispo. Later, this company constructed a siphon under the Gila River in Arizona for the United States Bureau of Reclamation.

Following are brief summaries of the histories of the members of this company:

M. J. Bevanda

Starting in the early twenties as a contractor for street and sidewalk work in Stockton and other Northern California cities, he branched out into highway work. These jobs included sections of the California State Coast Highway in the vicinity of San Luis Obispo, Santa Maria, Pismo Beach, Atascadero and San Ardo, and two schedules of the highway from Kingman, Arizona, to Boulder Dam. He also built the sewer line from the City of Vallejo to the Carquinez Bridge.

In 1934, a partnership was formed with Clyde W Wood for the construction of about eleven miles of canals and siphons for the Metropolitan Water District of Southern California.

At the present time Bevanda is associated with Vincent Bressi with whom he has undertaken war contracts including the Honey Lake Ordnance Depot near Susanville, California.

Jahn & Bressi Construction Co.

Nicholas F. Jahn and Vincent Bressi, both experienced contractors, formed a partnership in the spring of 1919 and engaged in general contracting work, principally in the Pacific Northwest.

Jobs completed by this firm included the Elliott Avenue hydraulic fill, reconstruction of six miles of Rainier Avenue and First Avenue in Seattle, the two-mile Lake Young's Tunnel Project in Washington, and approximately five hundred miles of streets and highways in California, Washington and Oregon.

In 1934 they undertook about twenty-three miles of canals and siphons on the Colorado River Aqueduct for the Metropolitan Water District of Southern California. This work was completed in 1937.

With a third partner, M. J. Bevanda, and under the name of Jahn, Bressi and Bevanda Constructors, Inc., they built the Tucumcari Tunnels for the United States Bureau of Reclamation in New Mexico, and the Sepulveda Dam, a large earth fill job, for the Los Angeles County Flood Control District.

Clyde W. Wood, Inc.

Clyde W. Wood, President of Clyde W. Wood, Inc., started in the construction field on the engineering side of the fence, back in 1910 in the Turlock Irrigation District, where he stayed until 1913 when he joined the engineering force of the T. K. Beard Construction Company, on several extensive irrigation and highway projects involving hydraulic fill dams; heavy rock work, tunnels—concrete construction, for the next three years. In 1916, he became the construction engineer for the South San Joaquin Irrigation District; afterwards becoming its chief engineer. While here he constructed their drainage system of ditches and deep wells—the large "Hilts Sag" Flume of concrete, and a canal lining and structure program.

Seven years later, in 1923, he entered the construction field as a general contractor, and has had the "fun" of finishing over 150 jobs since. Some of his later jobs have been sections of the Metropolitan Water District; a share of the famous pontoon bridge at Seattle; Dry Dock No. 4 at Mare Island; many airfields for national defense, including the Santa Maria Bomber Base, and the very tricky job of "invading" San Nicholas Island, and building the Army Base and runways thereon.

His firm has also built many boats, barges, ship-sections, and not least, many of the Wood Roadmixers to further the war effort.

He enjoys the association of his four sons in the business with him, and expects to learn how to play golf some day.

SHOFNER, GORDON & HINMAN

In 1935 a partnership was formed under the name of Shofner, Gordon and Hinman which brought together three contractors with many years of experience in back of them as individuals or associates.

Floyd Shofner and J. N. Gordon had already worked together on many jobs under the name of Shofner and Gordon. One of the most important of these was the construction of the Hayfield Tunnel on the Colorado River Aqueduct for the Metropolitan Water District of Southern California.

One of the most interesting and difficult jobs for Shofner, Gordon and Hinman was the construction of the White's Point Tunnel for the Los Angeles County Sanitation District through the Palos Verdes Hills near San Pedro, California. This tunnel is approximately four and one-half miles long and is twelve feet below sea level.

In 1938, in addition to becoming a part of Pacific Constructors, Inc., on the Shasta Dam job, the partnership entered into a joint venture with another group for the construction of the Whitney Point Dam near Binghamton, N. Y. In 1939 and 1940, the joint venture constructed the Laurel Hill Tunnel for the Pennsylvania Turnpike Commission, Harrisburg, Pa. During the years of 1941, 1942 and 1943, the joint venture constructed the Youghiogheny Dam for the War Department at Confluence, Pa.

In addition to the interests already outlined, each member of the partnership has been engaged with other groups, throughout the country for the past six or seven years in various construction and engineering projects.

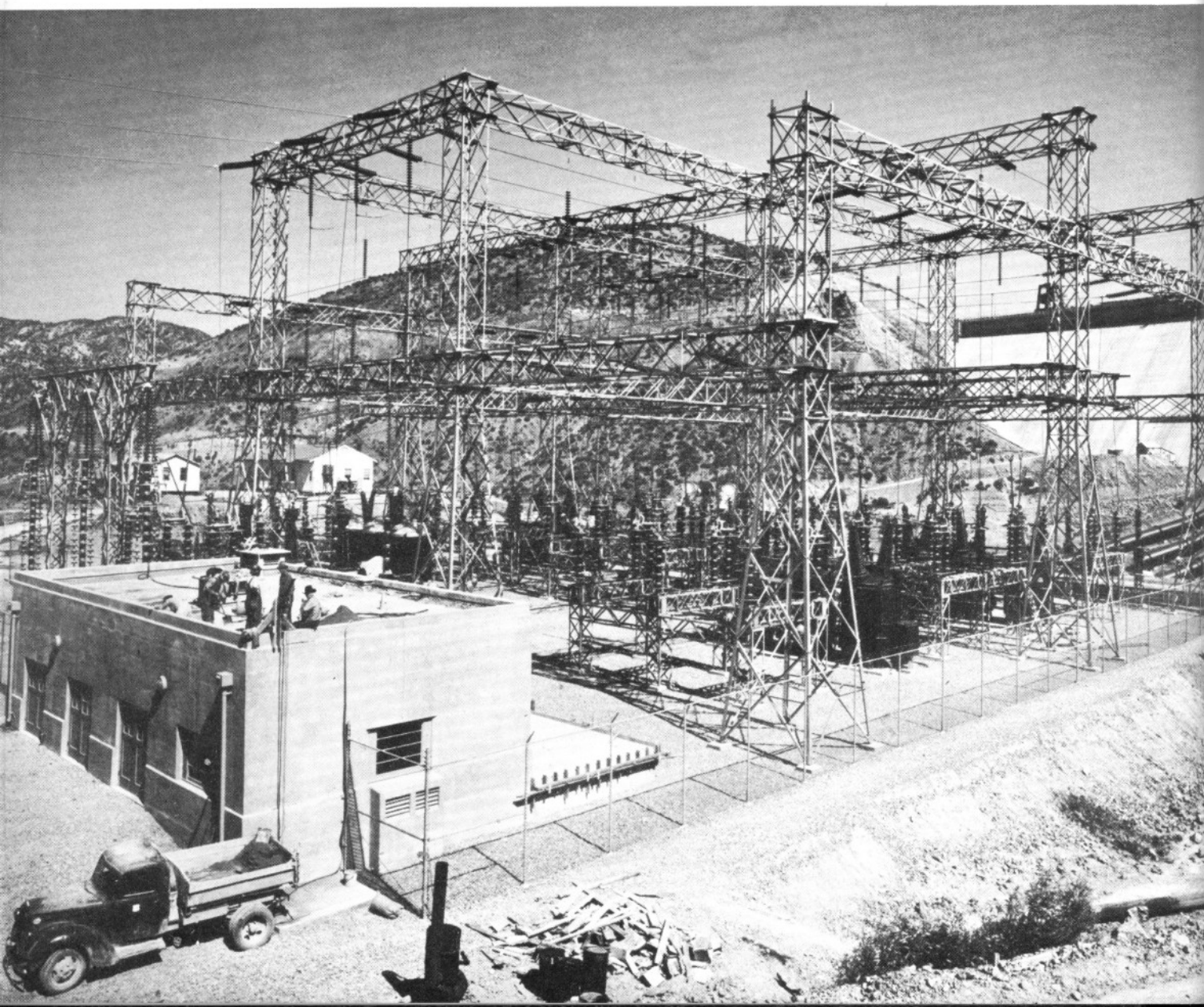
DAVID W. THURSTON

David W. Thurston was a pioneer in the heavy construction business. For many years he was connected with the firms of John F. Casey Company of Pittsburgh, Pennsylvania, and Bates & Rogers Construction Co., Chicago. While he was with these organizations, Mr. Thurston had direct charge of many of the largest and most difficult heavy construction projects in the Middle West.

In June, 1921, Mr. Thurston entered the construction business on his own account under the firm name of D. W. Thurston Company, with headquarters at Detroit, Michigan. His company completed many large contracts in Detroit and vicinity, including all the bridge and grade separation work for the Michigan Central Railroad between Chicago and Buffalo, the foundation for the Niagara Falls Bridge at Niagara Falls, New York, the sub- and superstructure of the Kettle River Bridge at St. Thomas, Ontario, Canada, and a very difficult soft ground tunnel for the City of Detroit.

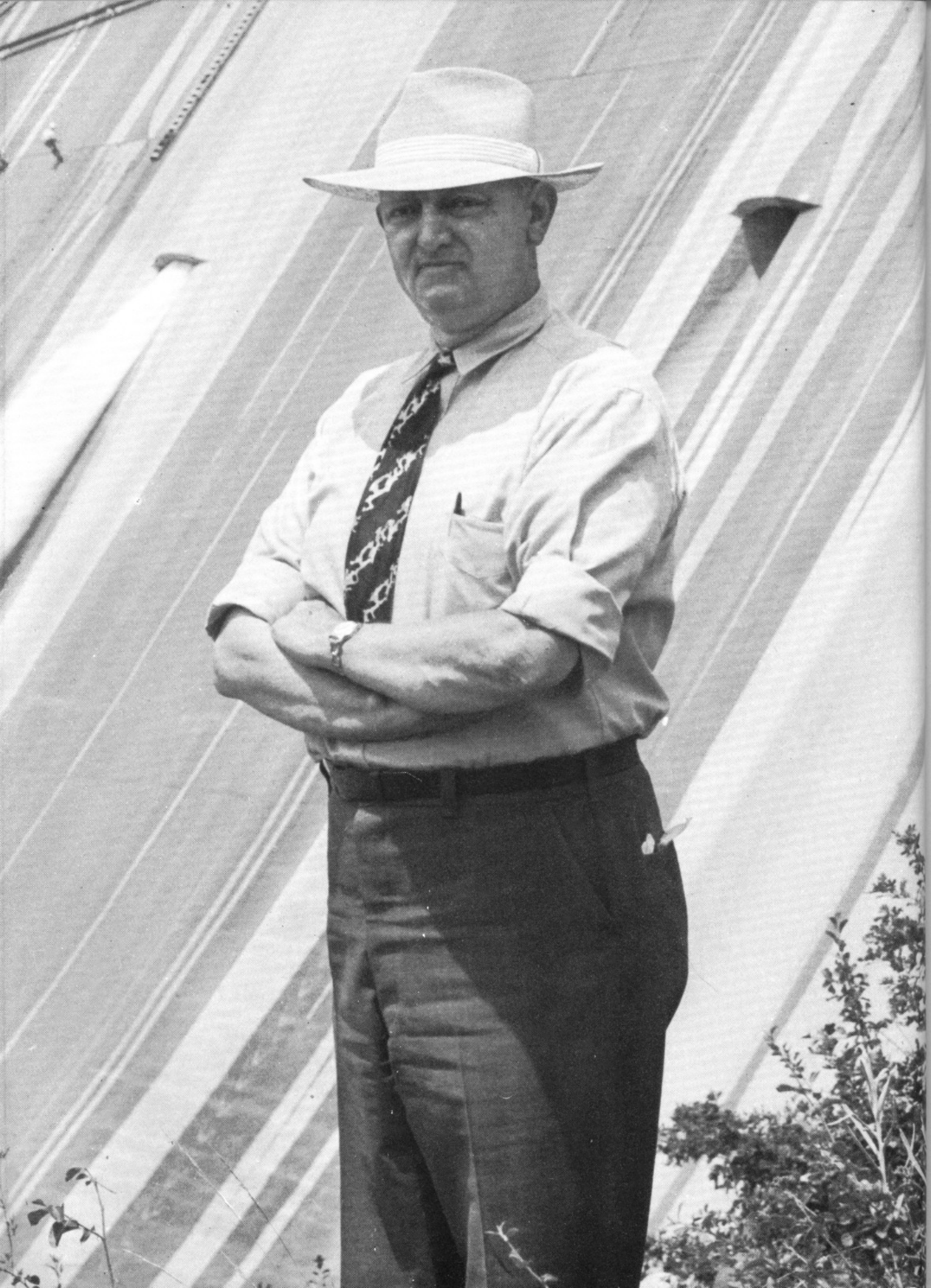
In 1930, Mr. Thurston closed out his business in Detroit and moved to Los Angeles where he again established himself under the same firm name. He was one of the original organizers of Pacific Constructors, Inc., and has taken a deep interest in the firm's operations and problems.

Power Plant Switch Yard



MEN AND EQUIPMENT

Thus far we have watched the history of this project unfold—noted the way the dam was located and the bids let. We're now ready to devote our remaining chapters to the great story of how the dam was built and to the men who worked in every branch of the job, their hands, hearts and minds bent in one direction—doing a job!



The "Old Man"

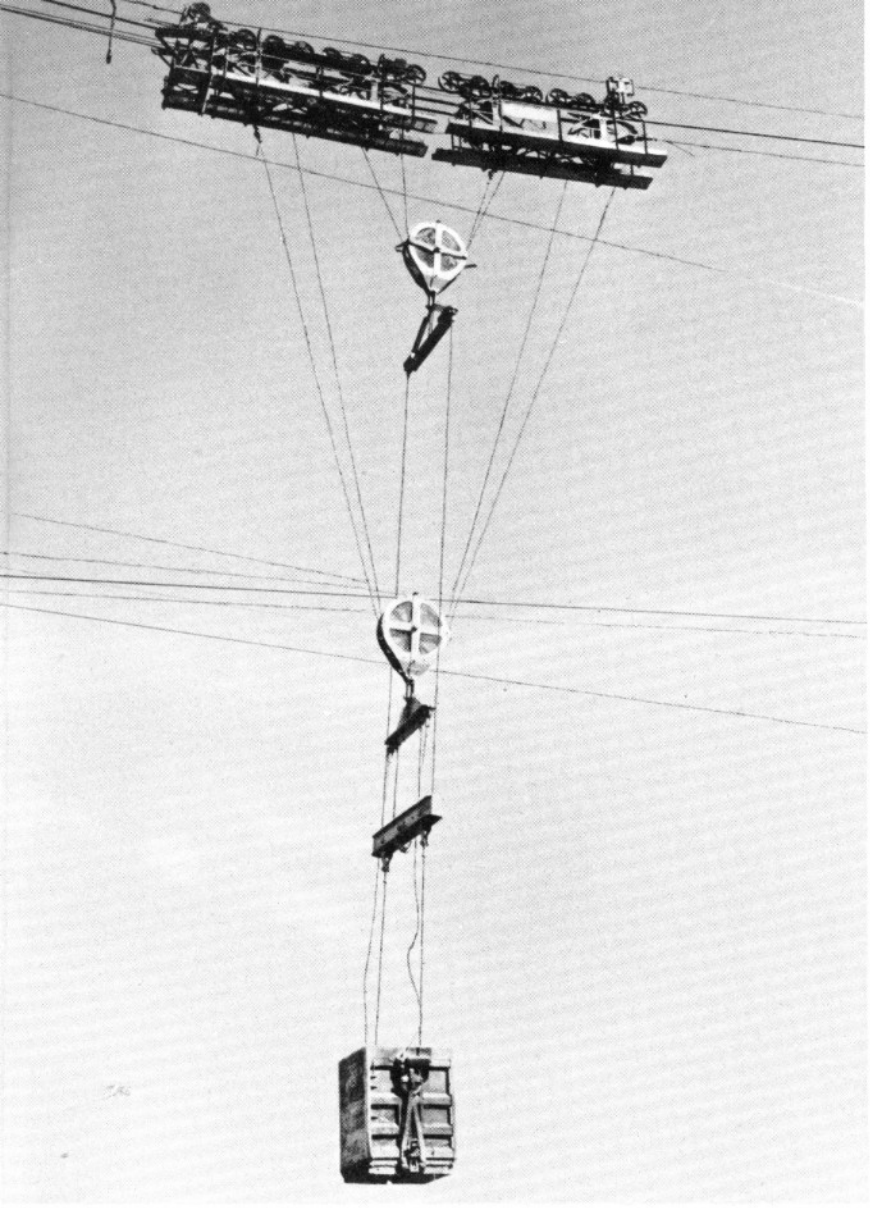
By J. C. Maguire

FRANK CROWE'S career as a constructor had its inception when, after graduating from the University of Maine with the degree of B. S. in Civil Engineering, he rejected the security of a professorship in mathematics in a New England college to take a position as junior engineer with the U. S. Bureau of Reclamation in the wild and woolly West.

For many years, Crowe was a part of the Reclamation Bureau organization, moving from one project to another and advancing rapidly from post to post of ever-increasing responsibility and importance until he soon became one of their top men.

In the early days, most of the Bureau's projects were built by their own forces so that their engineers had the construction work to do along with designing and planning. It was here that Crowe's practical experience as constructor began. His natural ability to organize and get work done soon was recognized and whenever a difficult construction problem developed within the Bureau he was called upon to handle it. Eventually he was made their general superintendent of construction. Most Reclamation projects involve the storage of water and require a dam of one sort or another. With the growth and development of the arid West, bigger and more intricate dams became necessary. The engineers of the Reclamation Bureau were pioneers in both design and construction of dams and Crowe's position in the organization kept him in the front ranks of progress. Arrowrock Dam, Jackson Lake Dam, Tieton and McDonald Lake Dams, as well as many lesser structures were built by the Bureau during his time.

Dr. Hubert Works was made Secretary of the Interior in 1924. He was a strong advocate of the contract system and decreed that all Bureau of Reclamation projects should be contracted. By this time Crowe had a reputation in the West as a constructor and had built up an efficient construction organization. He was faced with a choice of giving it up and confining himself to an engineering post in the Bureau or going over into the construction business. Crowe chose the con-



Cableway Carriage and Bucket Hook-up

struction business. He gives H. W Morrison credit for lifting him over the fence—and, as a member of the Morrison-Knudsen Company, he went right on building bigger and better dams. Guernsey Dam in Wyoming, Bear River in California and Deadwood Dam in Idaho, and several structures were built by this company under his direction.

When Boulder Dam broke upon the industry, most contractors hesitated to tackle it on account of its magnitude and the unusual hazards involved; but Crowe was ready for it. It was his enthusiasm, confidence and prodding that inspired Harry Morrison to get together the Six Companies syndicate to bid on the job, and their subsequent success, with Crowe directing construction, is a matter of history. It was Crowe's estimate, Crowe's bid, Crowe's design of plant and Crowe's organization that built Boulder Dam. If there had been no Frank Crowe, there would have been no Six Companies. It was his success at Boulder that started them on their way to fame.

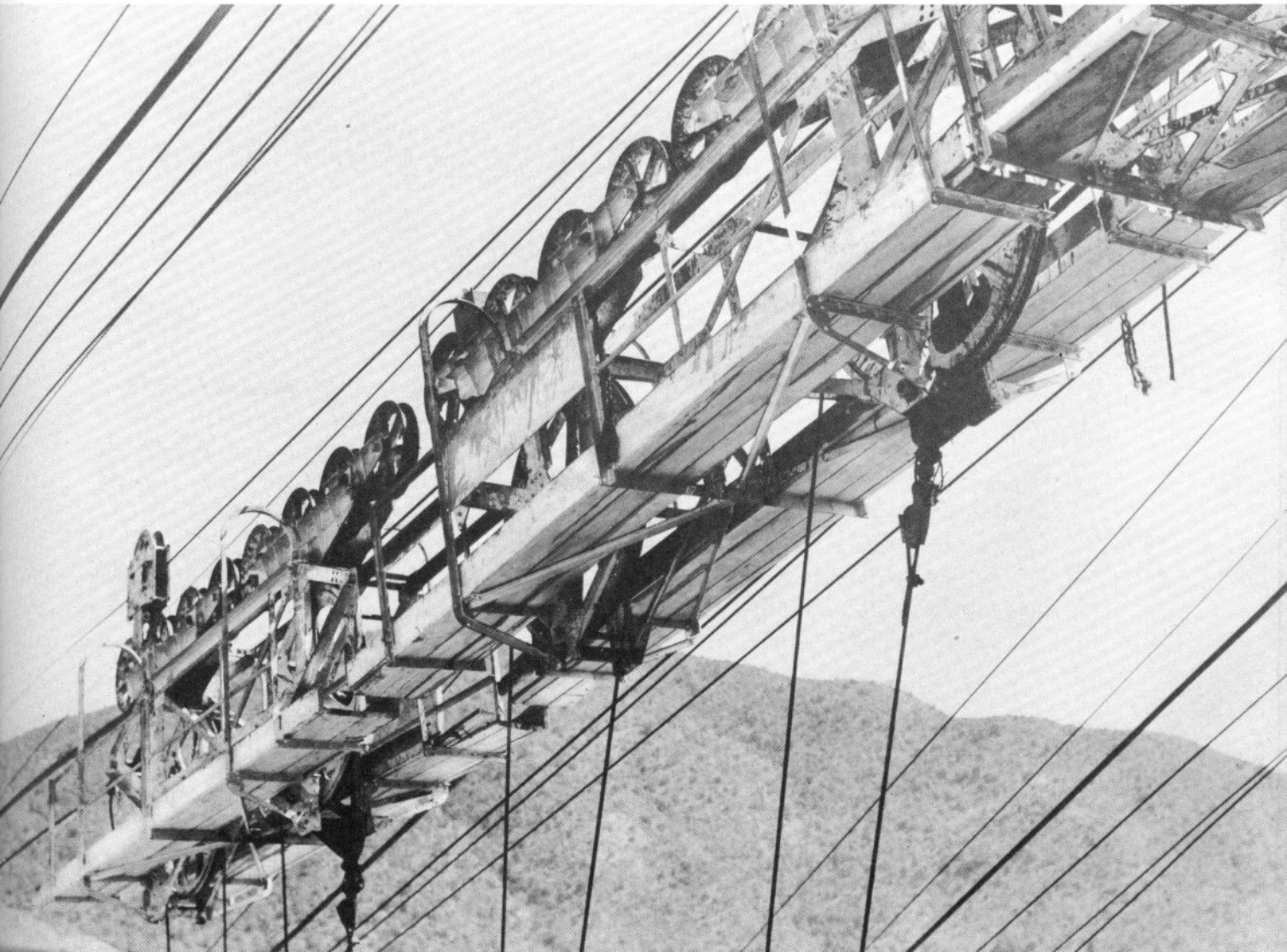
After Boulder, the Six Companies moved down the river and took a contract to build Parker Dam. They "left over a million dollars on the table" in bidding the job, which made some of the members uneasy; and, when unexpected bad foundation conditions developed, they became panicky. The outlook was gloomy but Crowe, who estimated the job, believed his figures were o.k. and convinced Charlie Shea, head of the J. F. Shea Company, and who had gone through Boulder Dam with him as job sponsor, that the job would work out. Shea had unbounded faith in Crowe and, ever ready to take a chance, offered to take the job over from

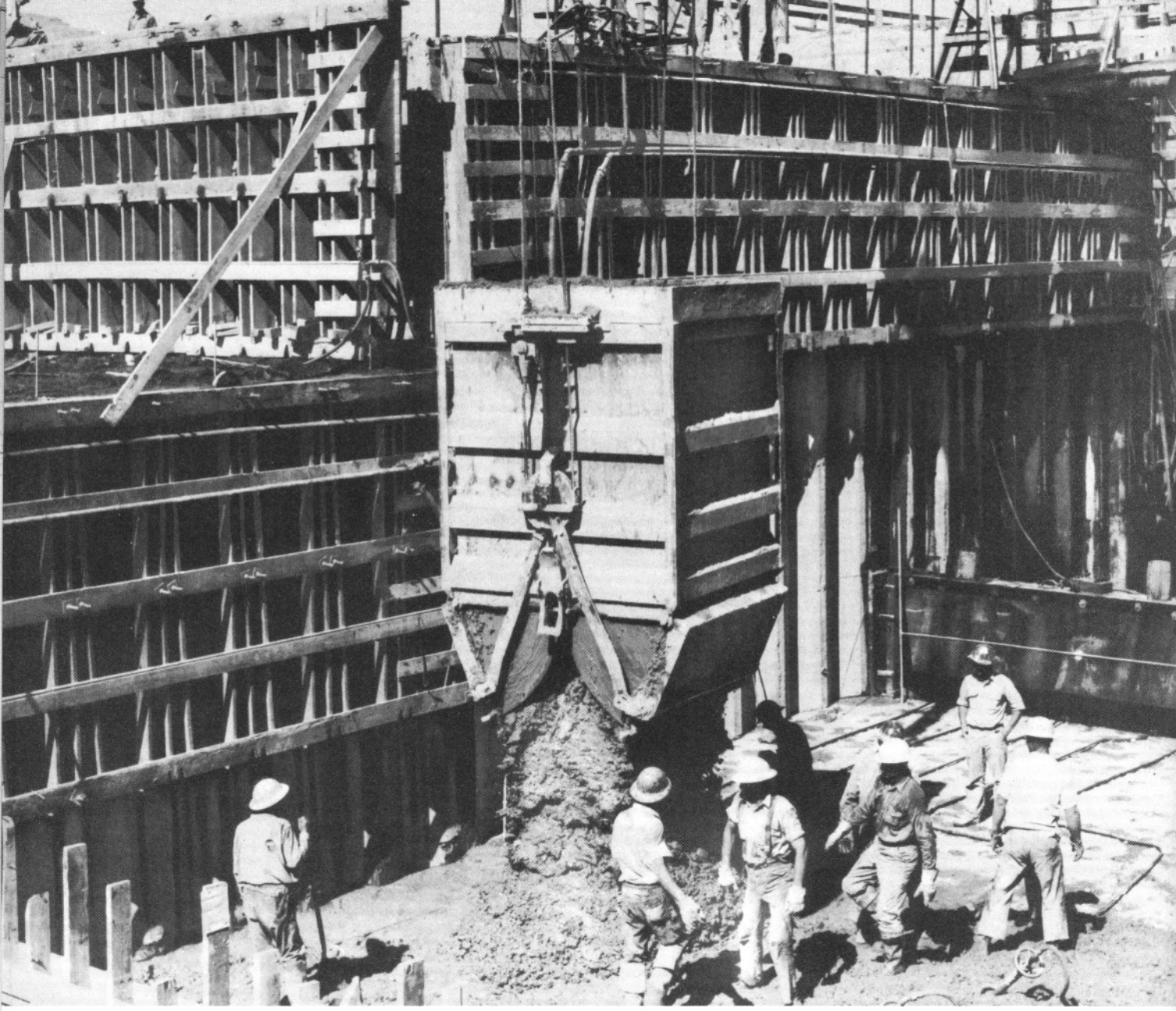
his associates. They jumped at the opportunity to get out, a deal was made, and Shea's company took over. Crowe agreed to handle the job without salary for a share of the profits. He stayed on the job day and night, carried the excavation down more than 250 feet to bedrock, through loose, leaky gravel below the bed of the treacherous Colorado River, built the dam, and came out with a handsome profit for both Shea and himself.

Parker Dam was just well out of the way when along came Shasta Dam. Again it was Crowe, the man with the "know how," who was chosen by Pacific Constructors, Inc., to build the job.

Crowe is unique in the construction business. As a builder of dams he is preeminent. Associated as he has been with many of the largest construction firms in the West, he has never been submerged into any company. He and his men are an institution within themselves. He has a complete dam-building organization, picked and chosen over the years. These men follow him about, from job to job, some from as far back as Arrowrock Dam, approximately thirty years ago, and some now in the second generation on the job, with father and son

Close-up of typical Cableway Carriage





A bucket dumps its 8 yards of concrete

working together in the crews. Crowe directs his work through personal contact with the man on the job. He knows all the old timers by name and a newcomer is not long on the job till he knows him too. To them all, he is the "old man". He can be plenty tough when occasion requires it, as they all well know, but is generally kind and tolerant. They are all brother "working stiffs" and to be called a "working stiff" on a Crowe job, a man must really "rate".

Then there is an inner circle, which is the backbone of the organization, made up of tried and true heads of departments, walking bosses, foremen, operators,

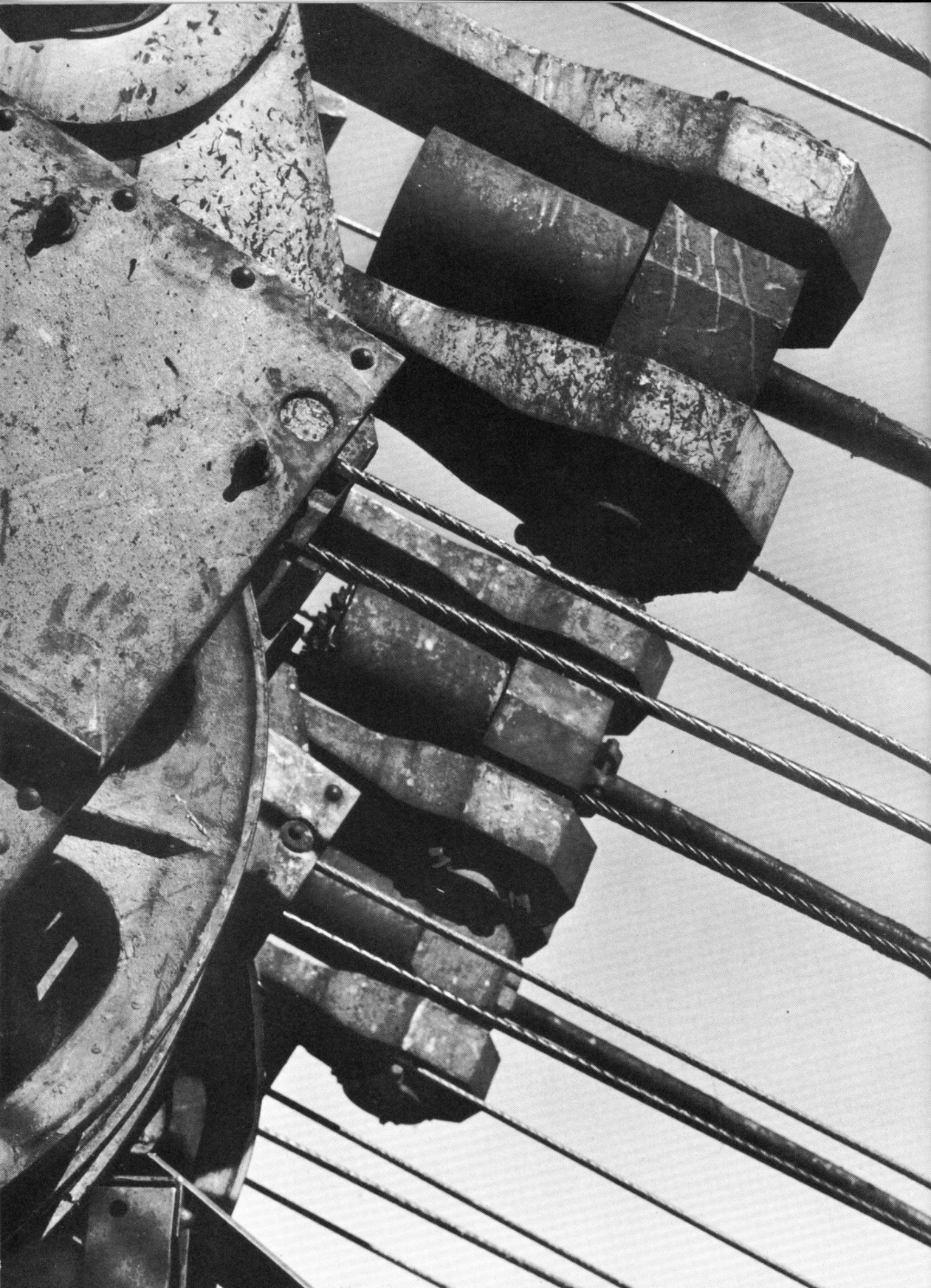
mechanics and workmen. Many high-class men come and go, but a man has to be good and be "right" before he qualifies and is taken into this Crowe royal family. Vacancies in the Crowe organization are filled by promotion whenever possible. In any case, the picking is done by Frank Crowe. Whether it is by design or otherwise, he never permits any of the companies for whom he is working to have much of a hand in picking his men. This is perhaps one reason that it always remains a Frank Crowe organization and never a Six Companies' nor a Pacific Constructors' organization.

It was the loyalty of this Crowe royal family, or perhaps it might be better to say "loyal family," to the "old man" that kept an organization on the job at Shasta Dam when the shipyards and defense jobs were offering the lure of higher wages and softer jobs.

While Crowe will not permit the brass hats to pick his men nor to interfere in the job operation, he gives them every consideration. When he hires himself out, he makes it clear that he is to be given supreme construction command and he accepts full responsibility for results. He has built nineteen dams to date and has yet to fail to deliver the goods. The general administration of the job, financing, legal affairs, taxes and contacts with Government officials, etc., are left to company officers, and through the period of selecting plant and methods of construction, etc., he works with, consults with and defers to them; but, once these matters are settled and the job gets underway, he takes full charge. The associated companies making up Pacific Constructors have been kept informed on progress by the most complete set of reports ever to come off a big job: first, a weekly letter known as "Shasta Dam News," then by a complete detailed monthly cost report and balance sheet, supplemented by progress pictures that tell the whole story.

As a combination engineer and constructor, Crowe perhaps knows more about dams and dam building than any one man in this or any other country. It is his life's work. Much of the equipment used in dam construction are his inventions or have been developed on his jobs. He is the outstanding authority on the cableway method of building dams. The system he designed for Shasta, using a main tower as a hub with cables radiating out to cover the job, was a radical departure from prevailing practice and involved previously unknown stresses and strains. Many authorities shook their heads dubiously and said it would never work, but it proved to be fundamentally sound and was so carefully designed and engineered that it worked perfectly. Crowe is the inventor of the pneumatic method of transporting cement by blowing it through pipes with air pressure. This method is now standard practice on big concrete jobs.

As the science of building with concrete has advanced, and as the size of concrete dams has increased, the engineers have written more and more rigid specifications,



requiring almost absolute accuracy in every operation, such improvements as aggregates weighed and proportioned to the ounce, less and less water in the mix, refrigeration in curing, sandblasting in cleaning between pours, vacuum treatment of exposed surfaces, and many other such refinements have been added—all of which adds to the cost. Crowe has led the way in responding by new and better devices and construction methods, faster operation, robot controls, etc., so that actually, in the face of tougher specifications, higher wages and lower efficiency, the price of mass concrete in dams has gone down steadily over the years.

Crowe has few of those bad habits generally found in good construction men. He is not egotistical—in fact, is rather retiring and modest in dealing with his associates. With it all, however, he has a very good opinion of himself and worlds of self-confidence. In spite of the fact that he, himself, is an honored member of the engineering profession, he has that mark of all good construction men in that he regards engineers and inspectors on his job as unreasonable persecutors. Time Magazine once pictured him as one of the profane, bull-dozing type. The writer of the article must have heard him in a row with one of these men. He really lays it on, especially when he finds progress on some operation held up for a fanciful or finicky reason. "Great delayers" is his pet name for inspectors, but he dignifies his brother engineers with the title of "Engineeros." He really believes that their chief aim in life is to provide ways and means to make it tough for the contractor.

During Crowe's many years on construction work he has lived the job, both figuratively and literally. His home has been the construction camp. At Shasta, however, with a six years' stretch ahead of him, he broke away and built a nice home in Redding (which is only twelve miles from the job) so that his wife and their two fine daughters could have a touch of city life, as well as the benefits of the schools. He likes Redding and Redding likes him. He also has realized one of his life's ambitions by buying himself a cattle ranch not too far away. This had a modest beginning in a 400- or 500-acre ranch on Hat Creek; but, as has always been his habit of doing things in a big way, he has already acquired several more places until now he and his associates have a spread of 12,000 or 15,000 acres of land and a sizeable and growing herd of beef cattle and registered Herefords.

When Crowe's name comes up nowadays among the construction fraternity, the question is asked: "Does he intend to quit with Shasta, or will he go on to build more and more dams?"

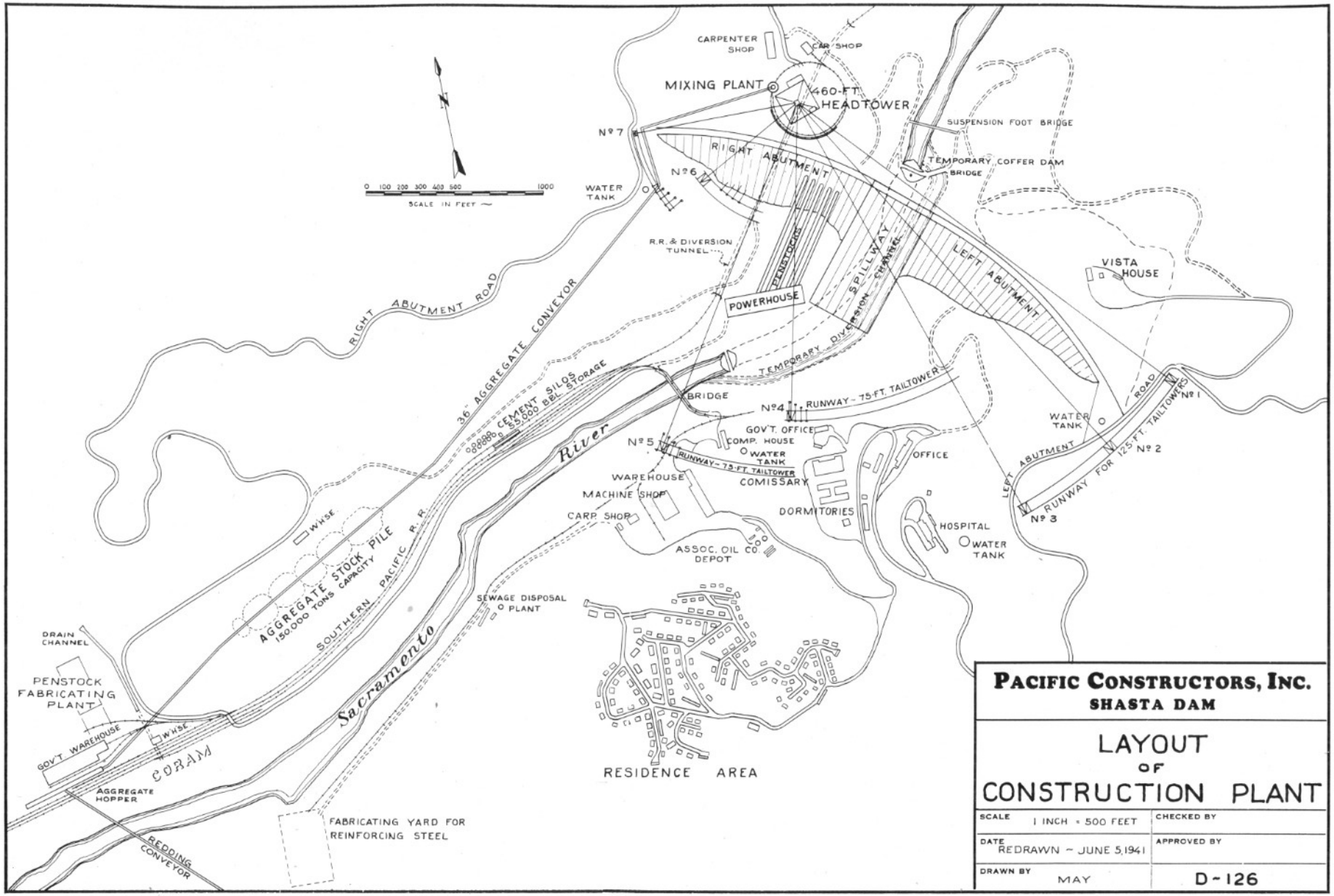
Frank might well retire to the security of his cattle ranches. Will he do it? My guess is that when the first big dam worthy of his mettle shows up, the "old man" will be right in there pitching, and when he blows the whistle, the royal family of Crowe will drop everything and come a-running.

The "Jewels"—Head Tower terminals of main track cables

PLANT

As the story of Shasta unfolds in this book, Frank Crowe's outstanding contribution to the success of this project will become increasingly clear. He was more than General Superintendent. Affectionately called "the Old Man" by young and old, he was interested in everything about his men as well as his job. This "personal touch" in part, is responsible for the loyal, capable group of workers who have followed him from job to job. In the following pages he tells in his own words some of the problems confronting a superintendent building a dam the size of Shasta.

A striking view of the Cableway Head Tower



PACIFIC CONSTRUCTORS, INC.
SHASTA DAM

LAYOUT OF CONSTRUCTION PLANT

SCALE 1 INCH = 500 FEET	CHECKED BY
DATE REDRAWN - JUNE 5, 1941	APPROVED BY
DRAWN BY MAY	D-126

Shasta Construction Plant

By Frank T. Crowe

PLANNING THE plant for Shasta was just an old construction stiff's dream job.

Here was a project big enough to warrant the installation of the best weapons to do the work—not Joe Magee bailing wire equipment and plant, often resorted to to get by on the small job. Fortunately for all concerned, every director of the company supported us in putting in the finest plant that we had brains enough to plan and design.

Here was a job with millions of yards of earth and rock to excavate and the largest single contract ever let for placing concrete—"six and one-half million cubic yards." A systematic river consistently high in the winter and low in the summer, required raising 70 feet to make it run through an ex-railroad tunnel for diversion around the dam during construction of the outlet facilities. All this in a country where work could be carried on twelve months of the year. A main line railroad at our door, high tension power line within a mile of the job, and a paved highway within a mile of the damsite. How could you beat it?

The features definitely fixed were the location of the dam and power house, railroad yards and lines, and delivery point of concrete aggregates which were furnished by the United States f.o.b. Coram, one mile below the dam on the west side of the Sacramento. Although it was necessary to build camp, shops, warehouses and compressor plant at once, the general set-up was such that we did not fear that we might have the mess hall where we really needed the mixer. With the railroad yards on the west side, it was natural to keep all concrete paraphernalia on the west side.

We wanted the shops and warehouses just as close to the job as possible and accessible by railroad and roads, so that they were located on the east side at the grade of the Southern Pacific Railroad and connected to the west side by a combination highway and railroad bridge.

Bucyrus-Erie 120-B Shovel and 25-yd. White Dump Truck

Excavation Plant:

The excavating plant was promptly agreed upon in conference with the directors and consisted of three 120-B and two 48-B Bucyrus-Erie shovels, served by eighteen 25-cu. yd. White trucks and twelve 7-cu. yd. Mack trucks. The drilling was accomplished by forty-two Ingersoll Rand wagon drills, serviced with air from four WN4 Sullivan compressors, making a total of 12,000 cubic feet per minute.

The plant fitted the job perfectly, but the exasperating restrictions inflicted by the U. S. inspectors were terrible. Many times we were ordered to take off 18 inches at a time for three or four times, then ordered to take off up to 18 feet. The base of the dam covers 1,000,000 square feet—each foot a "headache"—one million headaches!

Diversion and Care of River:

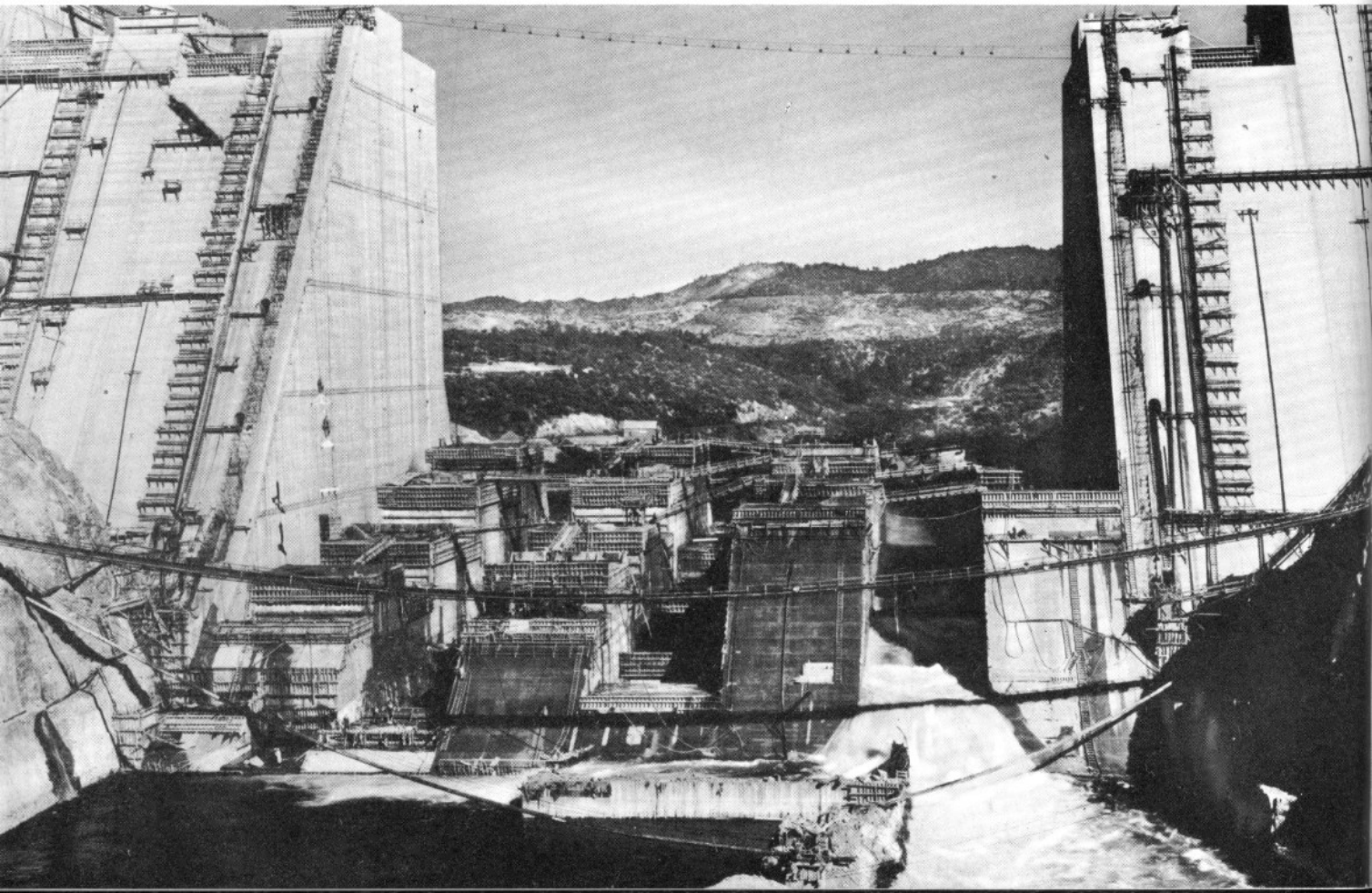
Conditions at the damsite were such that the natural flow of the river must be passed at all times during construction.

The Government furnished a railroad tunnel 70 feet above low water surface in the river for diversion purposes. The Contractor was required to handle the river through the damsite and dam until he could raise it sufficiently to make it go through the tunnel. The River section through the damsite consisted of two channels—the deep channel on the west side and a high channel on the east side with a slight ridge of rock dividing them. By supplementing this natural ridge with a thin reinforced concrete wall anchored into the bed rock, we were able to divert the river from the deep channel to the higher channel during low water without resorting to the conventional diversion flume, which takes millions of feet of lumber to build and is a constant worry because when subjected to heavy floods these flumes generally take off down river. By diverting through this channel, we mucked out the west channel and brought the dam up on the west side leaving block 44 so low we could divert the river through it while we built the dam up on the east side, leaving block 40 low. We then started the routine

River diverted through channel on east side while excavating river bed, August, 1940

River diverted thru Block 44 to excavate east side of River Bed—July, 1942

Down-stream view of Spillway Section—River flow being diverted thru Block 40—November, 1942

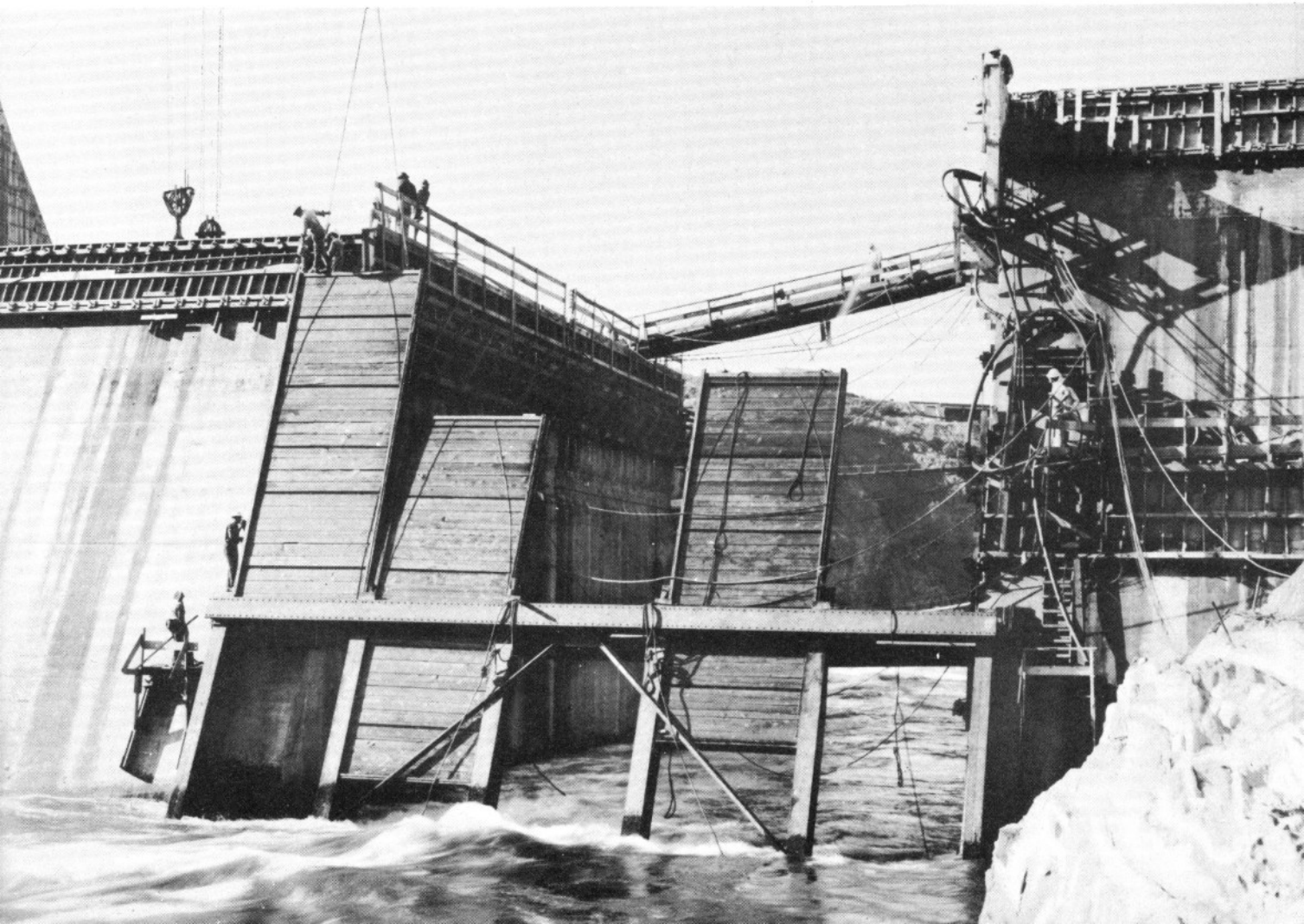


movement of the river from one side to the other, raising the water above the dam ten feet each move. To do this, we designed a new and novel gate, using the Old Bear Trap principle for handling the frame of the gate and slide leaves in the frame to close off the water. By this scheme we were able to handle the gate members with two cableways. The detail of design and operation is covered in an article by David May, "Office Engineero" in Engineering-News Record of September 9, 1943.

Concrete, Aggregate, Mixing and Placing Plant:

The specifications provide that the United States furnish the aggregates f.o.b. Coram, so we built a large conventional track hopper with a capacity of 8,000 cubic yards. Under the hopper we provided a tunnel equipped with a 36-inch conveyor leading to the 150,000-ton stockpile, located on the plateau that the natural topography had provided between the track hopper and the dam. However, before the track hopper was put into service as such it was decided to convey the aggregate from the plant at Redding to Coram by belt conveyor. To adapt

Diversion Gate leaf being set in place for one of the closures of Block 44, September, 1942



The aggregate stock pile

Tail Towers 1, 2, and 3

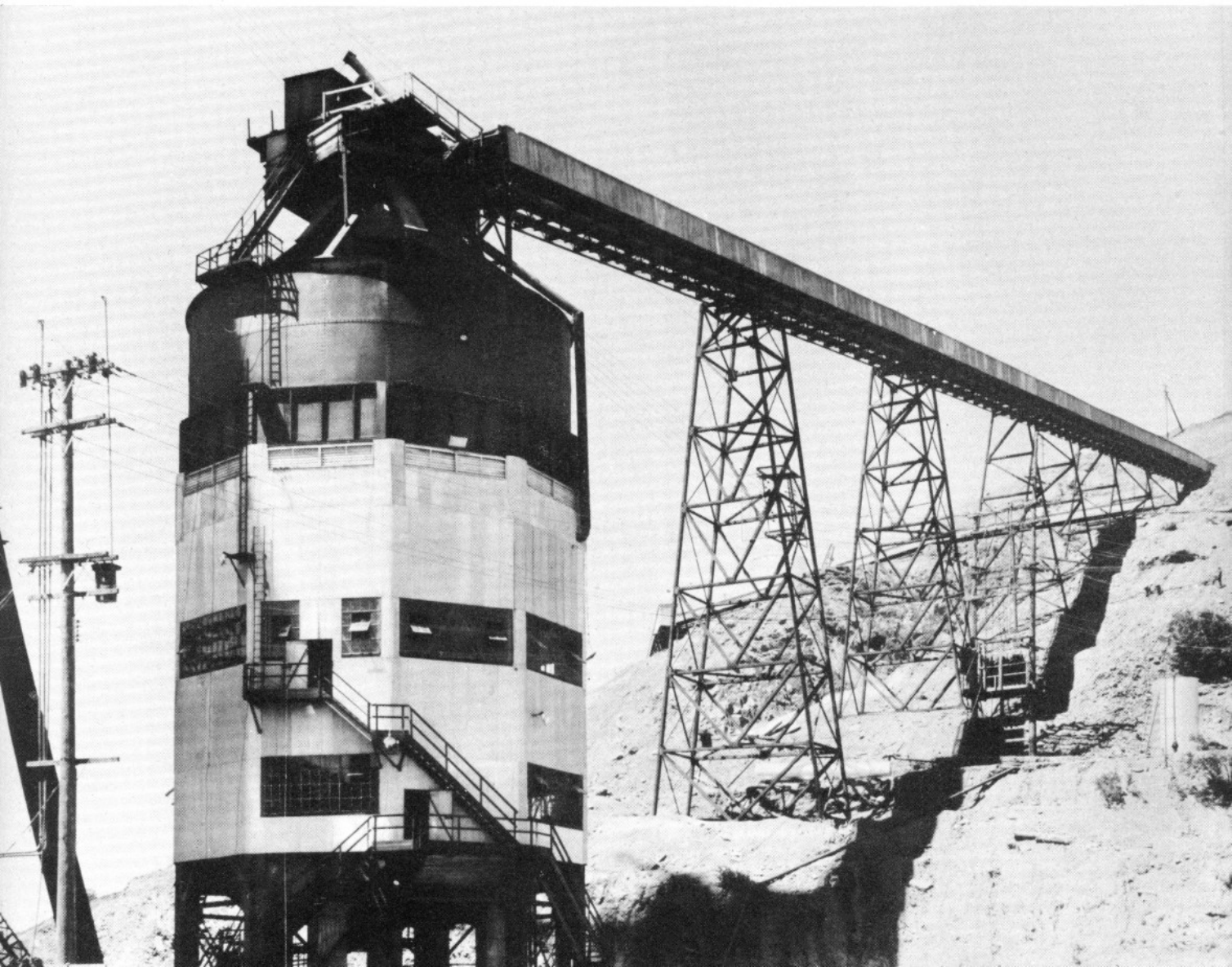
our hopper to this, we placed a 48-inch shuttle belt over the structure. This distributed the various sizes to their respective hoppers.

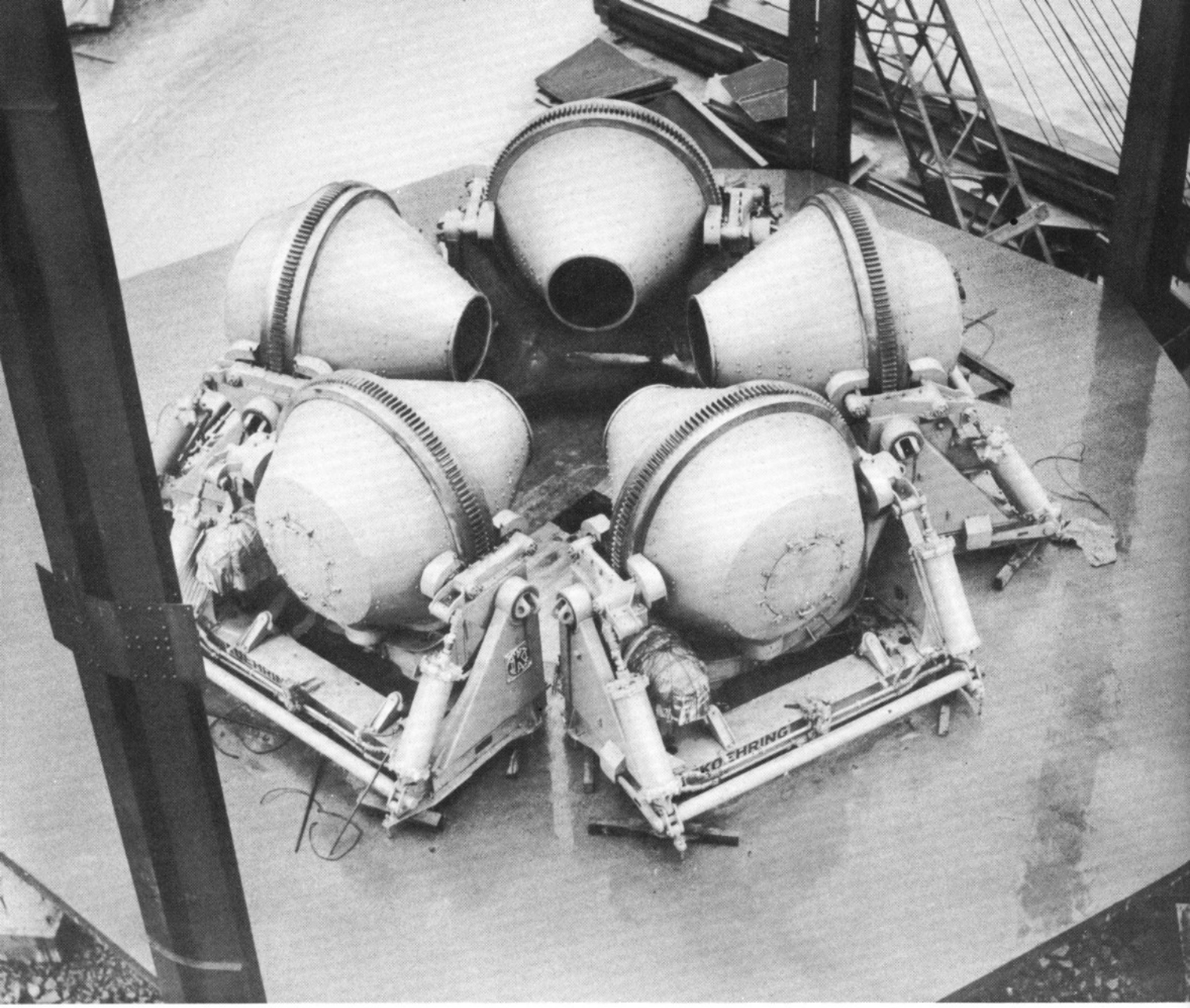
The stockpile layout was a natural: 1,000 feet long, divided into six compartments. Under the stockpile a tunnel was built and provided with a 36-inch belt to carry the materials to the mixer. With this arrangement the screening and crushing plant, or the long conveyor to Redding, might be broken down for a week without interfering with our concrete operations.

For the mixing plant the specifications were such that a conventional Johnson Plant was practically ordered. We purchased a five 4-cubic-yard Mixer arrangement around a common hopper. The mixers were served by overhead bins with a storage capacity of 3,000 tons, through Johnson automatic weighing devices.

The problem "How to place the concrete" was the challenge of the job.

The Mixing Plant





The five 4-yd. mixers in place before building was erected over them

Here a dam was to be built 600 feet high with a top length of 3,500 feet. Naturally we wanted a plant that would place the first and last bucket of concrete without a change over and the necessary delay, disorganization and expense. We wanted equipment that would take the concrete from a mixing plant placed as near as possible to the center of mass of the dam.

Prior to the letting of bids on June 1, 1938, each estimator had his own pet tentative scheme for placing the concrete. These schemes were of necessity sketchy. Several considered a series of three steel trestles at 200 foot intervals in elevation,

using cranes for placing concrete. This involved moving the cranes and mixing plant twice after the original setup. Some figured on parallel cableways to bring the dam to elevation 800, followed by another complete change over to steel trestles and cranes to build the dam from elevation 800 to the top at 1,077.

As for myself, after living with cableways for thirty-five years, I was naturally going to try to adapt some kind of a cableway scheme to the job. Back in 1934 when the first Grand Coulee Dam was let I made the estimate for Six Companies, Inc. At that time I was convinced that if we were going to build high dams in wide river valleys instead of the usual narrow canyons, we must devise new methods as the cableway is only practical on spans up to about 3,000 feet. For Coulee, I devised a scheme which covered the dam completely by using two pivotal head towers 500 feet high with radial tail tower tracks on both sides of of the river. Well! We didn't get Coulee so the scheme was dropped until Shasta came along. One night while John Crowe and I were trying out this scheme on a model of Shasta, we found the topography was such that we could cover the job with one pivotal head tower.

In the fall of 1938 when we actually had the Shasta job to do we really got down to work on the various schemes. We hired a fine engineering crew and made careful studies so that by the March 20, 1939 board meeting, we were ready to make our recommendation. Our recommendation was for a single pivotal tower 460 feet high and weighing 4,000 tons. It was approved by the board and put to work. It has been a very flexible and efficient scheme. We have placed the last yard of concrete with the same cableway that we placed the first yard.

The "Goose Car" loading an 8-yd. bucket

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SACRAMENTO, CALIFORNIA

September 6, 1938

Received September 8, 1938 - w

Pacific Constructors, Inc.
609 South Grand Avenue
Los Angeles, California

Gentlemen:

You are hereby notified to proceed with the execution of the work covered by your contract dated July 6, 1938 (Symbol No. I2r-8762) for construction of Shasta Dam and power plant, Kennett Division, Central Valley Project, California, as described in Specifications No. 780 and supplemental notice to bidders dated May 14, 1938.

Paragraph 23 of Special Conditions as incorporated in these specifications provides that the contractor shall begin work within thirty (30) calendar days after date of receipt of notice to proceed and shall complete all of the work within two thousand (2000) calendar days from the date of receipt of such notice.

Kindly acknowledge receipt of this letter, giving the exact date upon which you received it.

Yours very truly,

Walker R. Young
Supervising Engineer

(via Registered Mail -
Return receipt requested)

cc-Chief Engineer, in dup.
D.C., Los Angeles
Construction Engineer, Redding in dup.
(one copy for contractor's local
representative)

So We Built It

By David C. May

On August 21, 1938, without fanfare or ceremony, the first bulldozer started fighting its way thru thickets of manzanita and varieties of oak (including poison) and grimly started its job of building roads and levelling building sites downstream from the site of the dam proper. There rapidly followed, the trucks, drills, compressors and shovels that were necessary to carve the mountain sides and river bed into a cradle to receive the great mass of concrete that forms the dam.

Even as men and machines went to work on the job of road building and excavation for the dam and powerhouse, other crews tackled the job of providing living quarters in the form of dormitories for 265 men and houses for 130 families. Remember the crews of "Bing" Bingham pouring little puddles of concrete for the supports for the houses close on the heels of Ford Walker and Frank Wood, the "staker-outers"—and Charlie Williams cruising around in his nice new pickup looking after his army of carpenters—and the noisy and temperamental ditch-digger grinding its way around camp making the trenches for water, sewer and gas mains?

Almost before we knew it, people were moving into the houses, the dormitories were filling up, and Pat Unger began presiding over his big love—the mess hall and commissary.

In the residence area the natural urge to plant lawns, shrubs and otherwise beautify the premises started very early, almost before the dishes were washed after the first meal. Ground conditions were discouragingly rocky and the clay was sticky and hard to handle. So, one Sunday, Si Bous, George Tripp, Lee Ritchie and Ike Searway got hold of the 18-B and a couple of trucks, and with Lee at the shovel controls, moved onto a great pile of black sandy loam down near the river and started to haul one or two loads to their lawns. It wasn't long before everybody

First equipment and temporary open-air garage—September, 1938

got the idea and soon the whole camp was echoing to the roar of racing motors, shouts of directions and many invitations to the growing crew of drivers, and to Si Bous and George Tripp, the directing geniuses, to come inside and be rewarded with liquid refreshments. All in all, it was a very profitable afternoon and everybody had a good start toward an attractive home—lawns were soon green and gardens well on their way. In addition to those men mentioned above, the labors of the following men in this worthy community effort were gratefully acknowledged: George Bogovich, Leon (Freck) Freckleton, Spike Jorgenson and Carl Schrupp.

Excavation:

From the very first, the age-old process of drilling, loading holes with explosives, shooting and removing blasted rock went ahead rapidly and smoothly in the capable and experienced hands of General Foreman Frank Bryant and his Excavation Foremen Jack Lloyd, A. M. Brown and "Big George" Backley. Their equipment was the best that money could buy and they knew how to use it. The latest design in easily moved Ingersoll Rand wagon drills, the big 25-yard White dump trucks, the 120-B and 48-B Bucyrus-Erie shovels and the fleet of Caterpillar bulldozers were all seemingly made to order for this job.

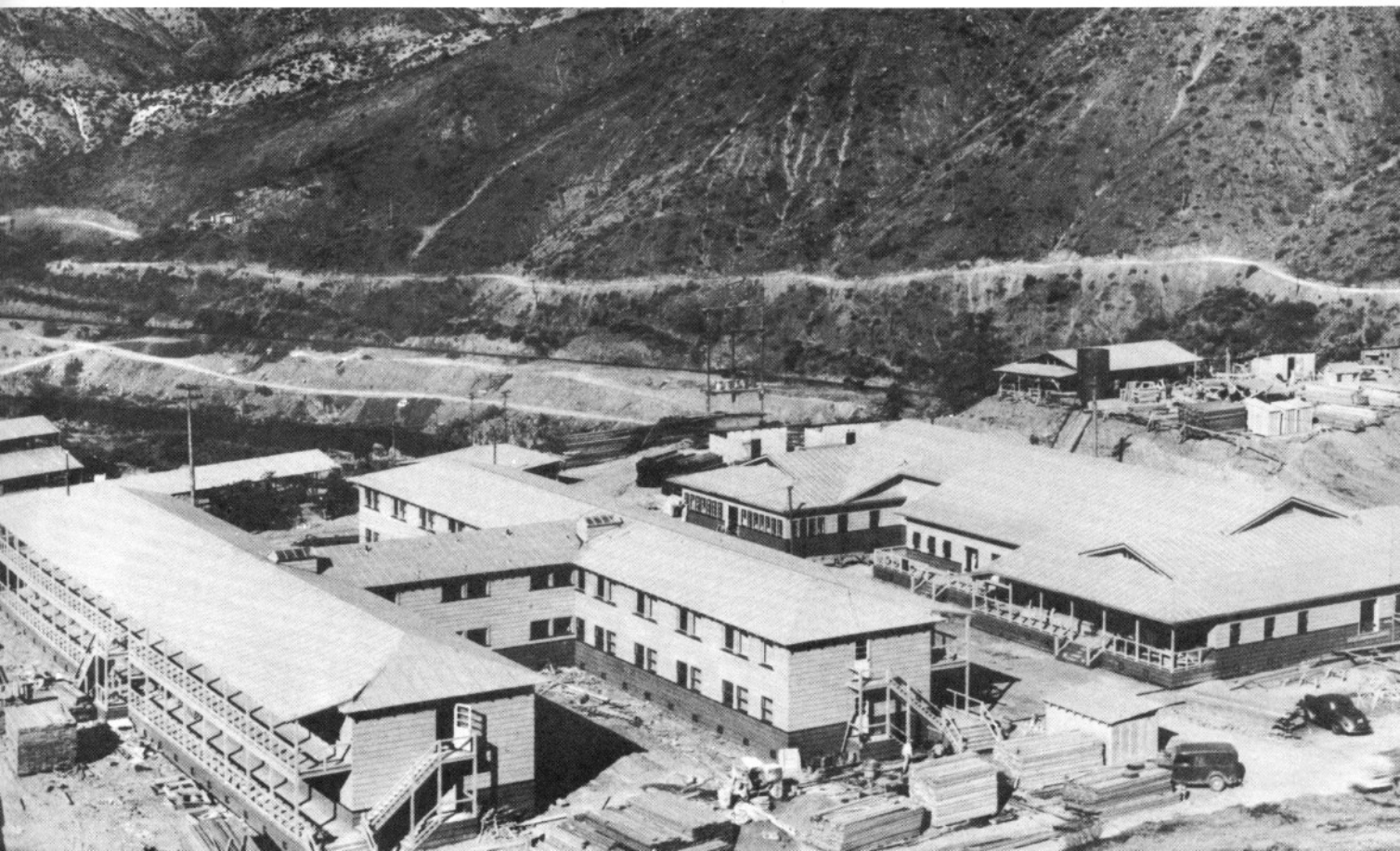
During the first ten months excavated material was removed from the foundation of the dam at the average rate of nearly 200,000 cubic yards per month. the peak month was 476,700 cubic yards, or over 13,000 per day. This is quite remarkable when you consider the rugged terrain and the requirement that all muck had to be hauled a minimum distance of a thousand feet upstream from the axis of the dam and spotted so that select material could later be reclaimed for the embankments and fills.

The next forty months saw excavation work slow down considerably in the painful task of pecking away piecemeal at the bedrock until the engineers and geologists were thoroughly satisfied that the dam would rest on the best possible foundation.

Throughout all this excavation work the equipment stood up extremely well, considering the fact that all the pieces had to take a terrific beating. They always do on rock work. Here's where P.C.I. was very fortunate in having a mechanical department that knew its business. A garage under the supervision of George Tripp could do anything to a truck or tractor from changing tires or treads to completely overhauling the motors. If ever a shop could jack up a radiator cap and build a new truck under it—this one could.

Another part of the mechanical department included the machine shop and its crew under the direction of George Malan and, later, George Bogovich. The shop was completely equipped and could handle the biggest equipment as well as make anything needed on the job that could be made of metal. It even included

Dormitories and Mess Hall under construction



Wagon Drills at work

a home-made automatic machine that could make 1-inch diameter "she-bolts" by the thousands.

Both these shops put in a continuous six-year performance of which Si Bous, the Master Mechanic, could well be proud.

The dump trucks as well as everything larger than pick-ups were equipped for Butane which was found to be a very economical fuel; in addition it was found to be very easy on the motors. Gasoline, Butane and Diesel oil were all furnished under a contract with Tide Water Associated Oil Company which maintained an extensive plant right on the job—a complete storage depot for all types of motor fuels, complete with dispensing pumps. In addition they installed a central plant for converting liquid butane to gas under controlled pressures for use in heating of the Hospital, Office, Dormitories and Messhall. W. A. Reanier and Lloyd Holton represented Associated in official capacities; I. L. ("Ike") Koppel, H. E. Clark, G. J. Corel and J. J. Lynch were successive resident managers. Pacific Constructors is indebted to these men and their company for a fine job of handling the night and day fuel supply problem, particularly in the later months when rationing was in effect.

Lubricating oils were furnished almost exclusively by the Richfield Oil Company. Here too, valuable service was rendered, especially in the field of research and development of special purpose oils and greases for such things as heavy duty bearings, the ropes of the cableway system and exposed parts of heavy earth moving equipment. John R. Keane represented Richfield in our dealings with that Company.

Explosives for the excavation work were furnished by the Atlas Powder Company. Nearly four million pounds of 40% gelatine powder were used during the course of the work. Genial E. F. ("Gene") Daily was Field Representative for Atlas.

Tires for the trucks and other rolling stock, for the most part, were products of General Tire and Rubber Company with whom we signed a contract early in the job.

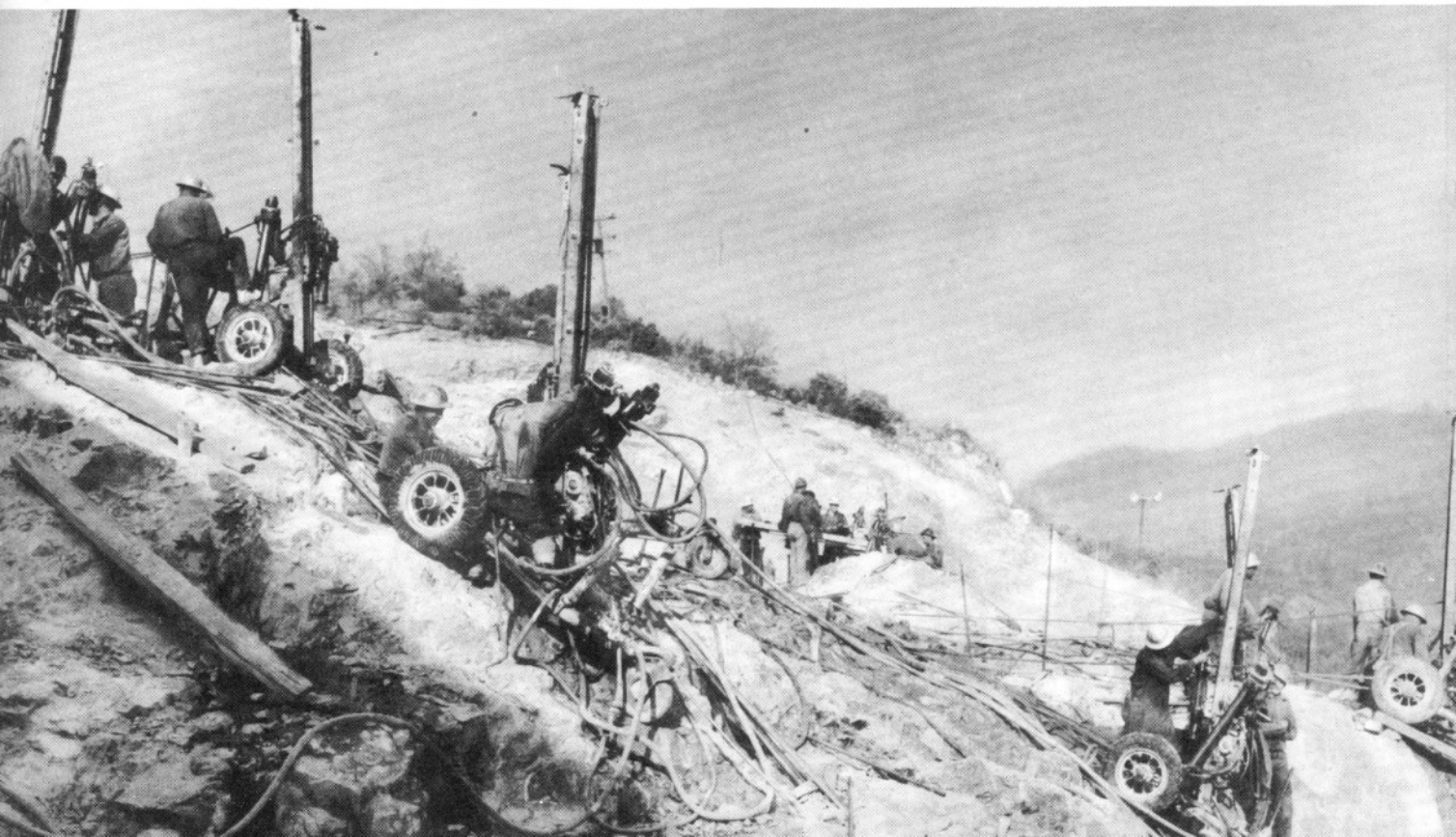
Concreting:

As soon as dam excavation and construction of camp buildings was well under way, the efforts of the engineering staff were turned to the big job of laying out and designing the many parts of the complex system for placing concrete.

Men taking part in laying out, designing, estimating, comparing, analyzing and otherwise developing the various schemes were Bert Goodenough, Chief Engineer; Larry Sowles, Plant Engineer; designers Hi Grady, John Crowe, Nels Sansteby, Archie Vincent, Walter Brown, Howard Peckworth, John Banks and Harry Mundy, and estimators Dave May and Elmo Skuce.

After a comprehensive report on costs of the various schemes had been prepared it was then presented to the Engineering Committee of the Board of Directors by Frank Crowe. This committee had been in almost constant touch with the engineering department during the development of the various plans and was well prepared for the conferences that followed with consulting experts on the finer points of design of the large and unusual structures involved in

Wagon Drills on hillside work



East Abutment key way excavation near completion

the competing plans. Committee and experts declared Frank Crowe's scheme of a high central headtower with its radiating cableways, the cheapest and most feasible, and best fitted to the concrete placing problems peculiar to Shasta Dam.

With this decision there came the big job of getting out the detailed plans for the complicated system of steel towers and trestles, and the many parts for the aggregate handling facilities and mixing plant. The designers sharpened their pencils and really began to apply themselves to their text books and drafting tables.

Frank Crowe kept in constant touch with all the work that followed. Many a tough design job was made easier and shorter through help and advice from his great store of knowledge and experience; for back of the "Old Man" there lies an impressive parade of dams—more of them than have been built by any other one man.

Early in the design stage, negotiations were started with Columbia Steel Company, a United States Steel Corporation subsidiary, for the purchase and erection of most of the fifteen million pounds of structural steel required for the various features of the concreting plant. The contract finally agreed upon contained a paragraph that stated, "The Steel Company does hereby guarantee the head tower to be erected by it hereunder to carry, without failure in any respect, the loads shown on the drawing during the entire time that Pacific Constructors, Inc., is engaged in performing its contract with the United States for the construction of Shasta Dam." This didn't necessarily mean that we were passing the buck. It meant

Looking down into the deepest part of the excavation —elevation 475—602 feet below the top of the Dam

Crews crowd into the transports at shift change time

that steel company engineers and designers would provide a double check on our work—for after all, here was something that called for use of cableways on a scale never tried before. Stresses and strains never before encountered in such work had to be taken into consideration. The head tower would have to stand against a lopsided pull which in certain circumstances could reach an intensity of over two million pounds—that's why Crowe said he wanted it built "hell for stout."

The American Bridge Company, another subsidiary of United States Steel Corporation, was commissioned with the job of fabricating and erecting the head tower. Their engineers checked our blue prints—our engineers checked their blue prints, columns were strengthened, struts were stiffened, until every one was satisfied that the structure would do its job without chance of failure in any member.

Steel for the tower began arriving at the damsite late in September, 1939. The first pieces of steel were dropped into the 100-foot deep footing shafts on October 6, 1939; the last piece of corrugated sheeting was placed on the completed tower July 15, 1940. The intervening months were very busy ones for Otto Shultz, the superintendent for American Bridge, and his gang of erectors. Swarming over the network of steel like monkeys in a jungle tree, driving drift

pins, setting bolts and bucking rivets, not one man was seriously injured.

The fine work of the Columbia Steel Company and American Bridge Company was due in no small part to the high calibre of such men as J. R. Fox, Contracting Manager of Columbia's bridge and structural department, C. D. Christie, manager of erection for American Bridge Company, and Hans Christie (that grand old man), Columbia's representative here on the job during design and erection stages.

Steel furnished by Columbia and fabricated by other United States Steel subsidiaries and subcontractors Consolidated Steel Co. and Western Pipe and Steel Co., ran into quite an impressive weight figure,—7,089 tons, of which 4,092 tons was for the Head Tower.

As the work on the head tower progressed, the tail towers and trestles were also being erected so that cable installation could start as soon as possible. J. H. Pomeroy & Co. erected tail towers 1, 2 and 3, and P. C. I. rigger and structural crews under the direction of S. L. ("Red") Wixson erected the trestle and other tail towers.

Meanwhile, negotiations had been completed with the Lidgerwood Manufacturing Company of Elizabeth, New Jersey, for three new 500 horsepower, 3-drum hoists, and three new cableway carriages. J. S. Foster, Vice President and Chief Engineer for Lidgerwood, worked hard and long on these units to

Pumping out and excavating "The Hole"—Note fill Coffer-dam for diversion—November, 1940

Early stage of concrete work, East Abutment—September, 1940

make them the best ever built. The other four cableway hoists and carriages were hand-me-downs from Boulder Dam via Bonnieville, O'Shaughnessy and Parker. These were also Lidgerwood and Mr. Foster had built his experience into them just as well as into the three new ones.

Installing the cables and carriages was a big job in itself. "Red" Wixson and his experienced riggers were faced with a good many problems but they licked them all in one way or another so that by the middle of June, 1940, four of the seven cableways were completely installed and ready to go.

The main track cables for cableways 1, 2, 3, 4 and 5 were purchased new from the American Steel and Wire Company. Two of each were ordered to provide replacement since it was expected that they would wear out after handling a million tons of material. Cables for rigs 6 and 7 were also manufactured by American but had seen previous service at Bonnieville. All were of locked coil construction, three inches in diameter. These track cables gave excellent service, some giving as high as 2,941,000 tons before replacement was necessary.

L. P. (Larry) Sowles replaced "Red" Wixson as cableway Superintendent after the latter, in partnership with John Crowe, was the successful bidder for the

job of clearing portions of the reservoir site.

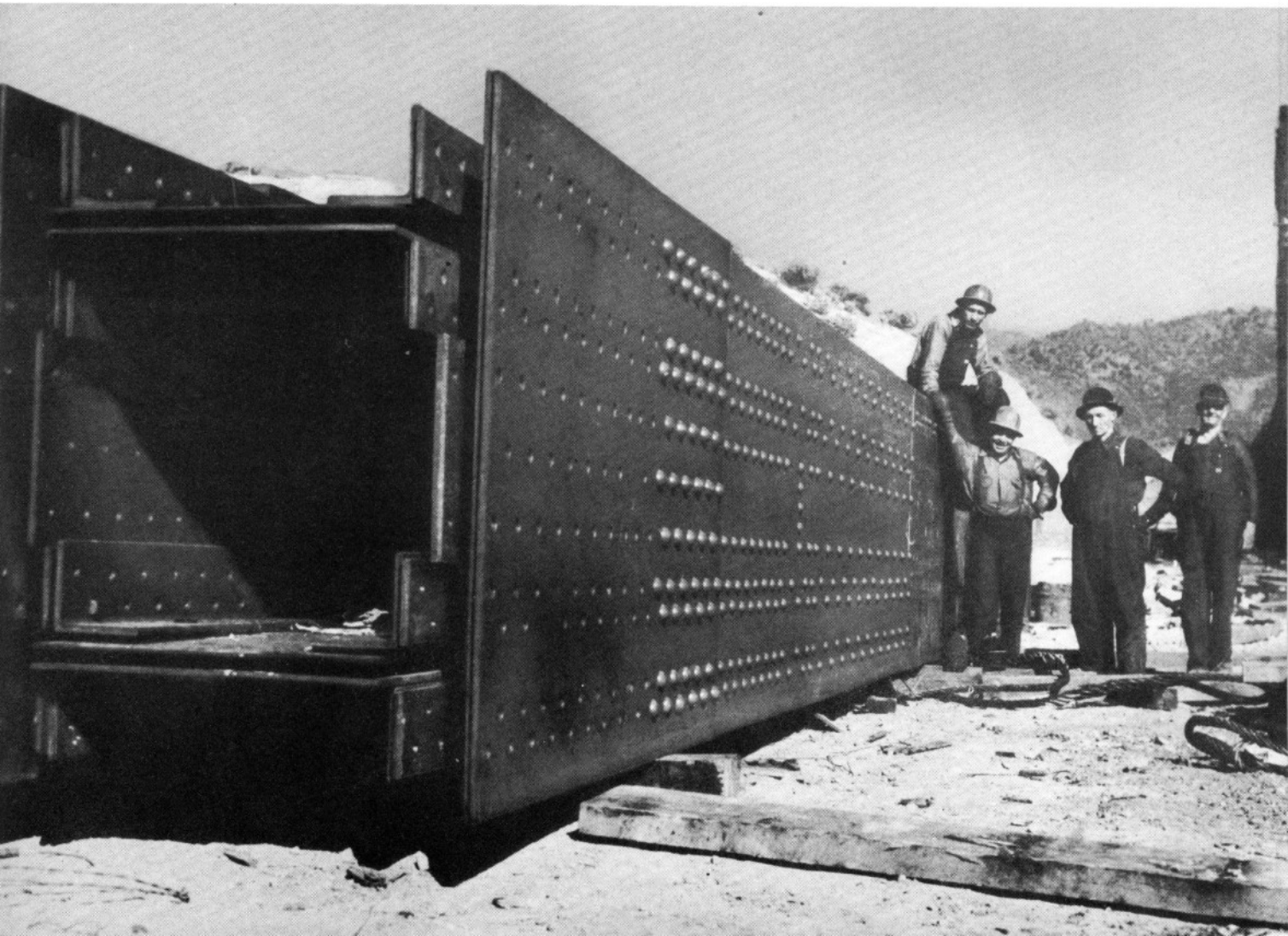
Most of the tonnage handled by the cableways was, of course, concrete with about 3% going into cleanup and about 1% going into forms, reinforcing steel, and miscellaneous items.

The following tabulation gives the final data on the work these cableways performed:

SHASTA DAM CABLEWAYS

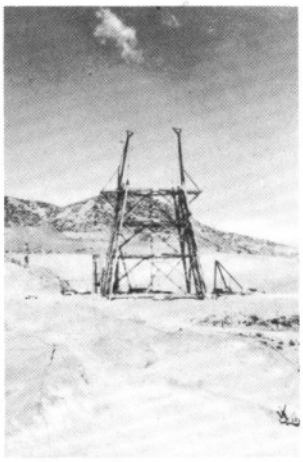
Cableway Number	Length of Span	Number Months in Operation	Number of Times Cable Was Replaced	TONNAGES HANDLED			
				Concrete (Incl. Bucket)	Cleanup	Forms, Reinf. Steel, Etc.	Total
1	2,670 ft.	55	1	3,615,000	88,000	18,000	3,721,000
2	2,670 ft.	55	1	4,250,000	99,000	20,000	4,369,000
3	2,670 ft.	55	1	3,940,000	102,000	18,000	4,060,000
4	1,798 ft.	48	1	2,750,000	113,000	28,000	2,891,000
5	2,115 ft.	54	0	1,096,000	103,000	96,000	1,295,000
6	720 ft.	21	1	1,241,000	38,000	9,000	1,288,000
7	979 ft.	45	0	1,591,000	68,000	12,000	1,671,000
GRAND TOTALS				18,483,000	611,000	201,000	19,295,000

Typical Leg Section for Head Tower

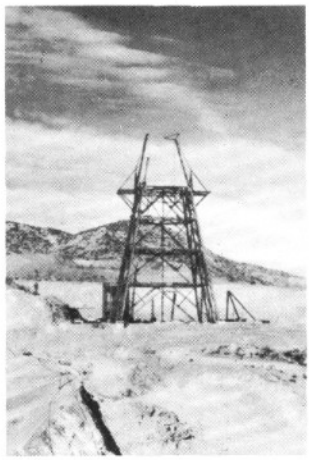


THE HEAD TOWER GROWS

October 14, 1939

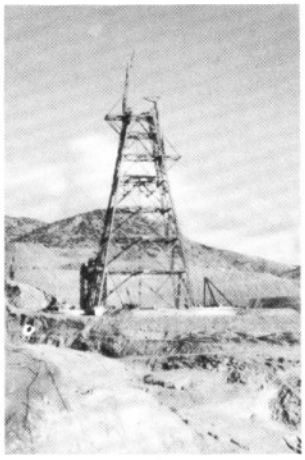


January 12, 1940

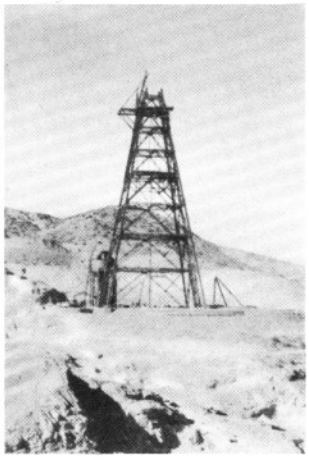


January 29, 1940

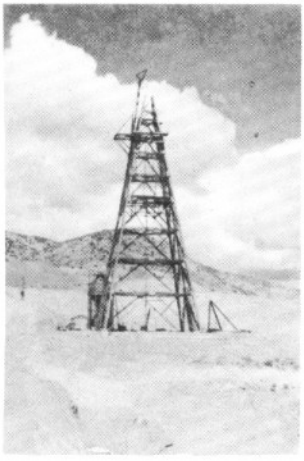
February 3, 1940



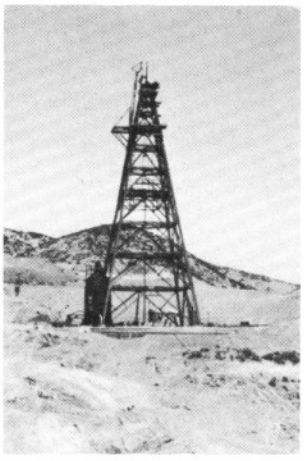
February 29, 1940



March 12, 1940



March 16, 1940



April 7, 1940

June 22, 1940

Cement unloading and storage facilities

After the concreting work on the dam once got under way it followed a more or less routine pattern. Frank Bryant did plenty of plain and fancy figuring to keep the pours lined up, and Butler Howell's carpenters and form raisers, and the pipemen and cleanup men one step ahead of each other and sometimes only a half a step ahead of the concrete placing crews.

The outfits that had to keep a half a step ahead of *everybody* were the diamond drillers and grouters. These crews had to drill 1⅜-inch diameter holes into the foundation rock to a depth of thirty feet, and at each ten-foot stage, force grout into the hole to fill surrounding cracks. Diamond drilling was performed under a subcontract with D. G. Longtin of San Francisco. His superintendent in the field was R. E. Selby, an expert on drills and drilling machines. Selby's organization did a very creditable job of drilling 183,500 feet of holes for foundation grouting ahead of concreting, and 139,300 feet of holes for high pressure grouting from the galleries in the dam. When you consider that the total of all diamond drilling was over 61 miles, and that over 54 carloads of sacked cement were pumped into those holes you get a good idea of the big job these crews did. Foreman on the grouting work, which was performed by P.C.I. crews, was R. H. Myers.

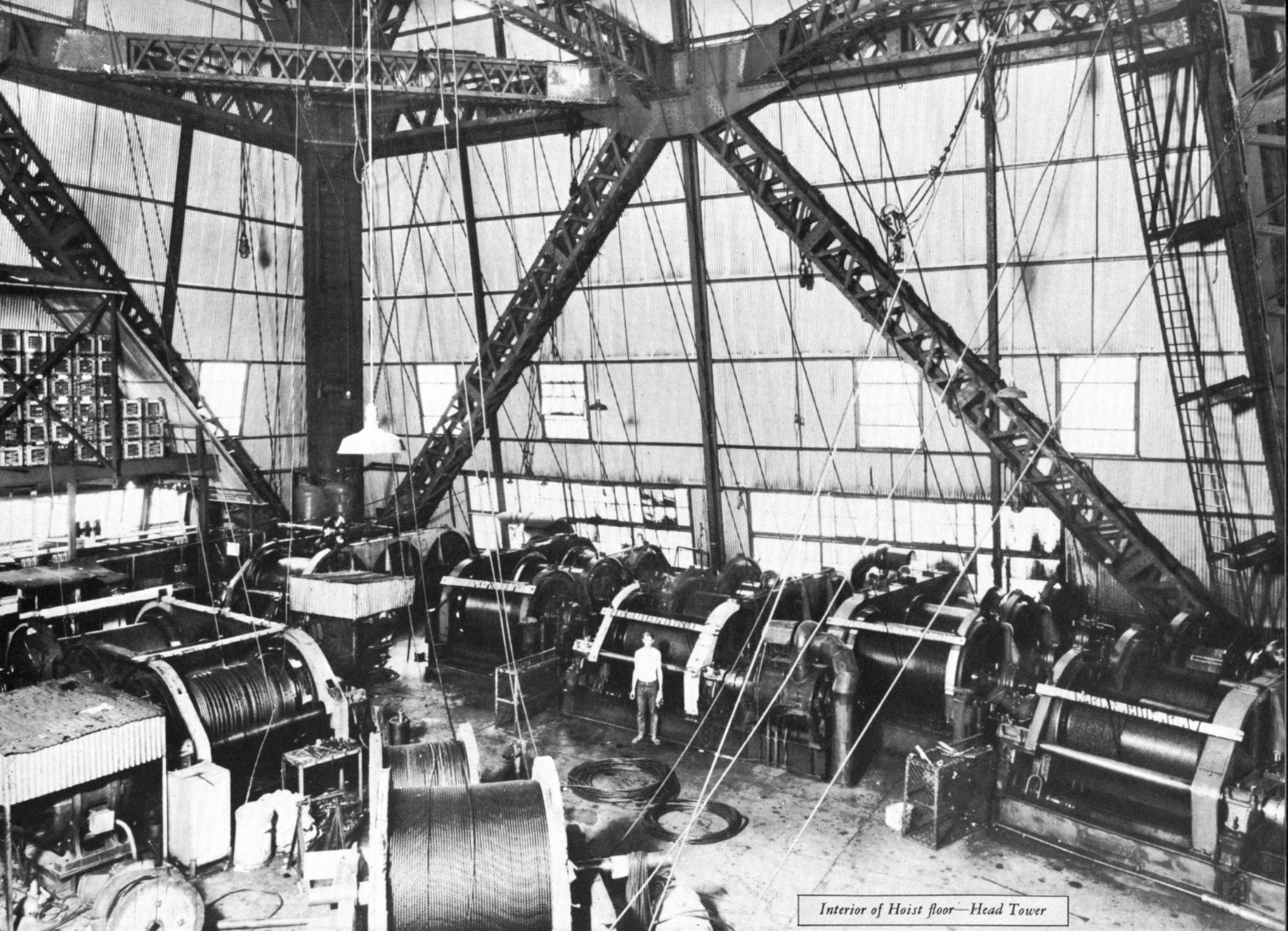
Powerhouse concrete work started within a week of that on the dam in July, 1940, and proceeded slowly and painstakingly until completion in 1943. This kind of a structure requires an enormous amount of form work which has to be precise as well as produce a surface finish that is free from blemish. Perfection was

attained under the watchful, very, very watchful, eyes of the Government Engineers and Inspectors. Chas. Silva, carpenter foreman, can look back on that job with a great deal of pain and pride.

A big part of concrete work is the placing of reinforcing steel. While the dam as a whole didn't call for much steel except around the galleries and large pipes, there was plenty in the Powerhouse and in the training walls and towers on the dam — more than thirty-two million pounds of it! This work was performed under subcontract by the J. Philip Murphy Company of San Francisco. A very capable superintendent, Don Rutherford, and his experienced crew of benders and placers did much to bring the job of building Shasta Dam and Power Plant to a successful conclusion.

Other subcontracts which materially helped P.C.I. to finish this job without having to obtain specialized equipment and experienced operators were: E. B. Bishop for the paving of the east side highway and the camp streets; Teleweld Inc. for the welding on the penstocks; J. H. Mohr for the cleaning and painting of the penstocks; and R. G. Clifford for the placing of the concrete lining in the foundation tunnels. Several workmen on the job undertook smaller sub-contracts on a unit price basis with P.C.I. putting up the equipment and taking care of the payrolls. These were: Ira Carpenter and Christ Vollmer, foundation tunnel excavation; Bert Choat, foundation tunnel excavation; J. H. Trisdale, highway guard

Excavation for the Powerhouse



Interior of Hoist floor—Head Tower

structures and powerhouse roofing; and Kenneth Russell, glass block installation in the powerhouse.

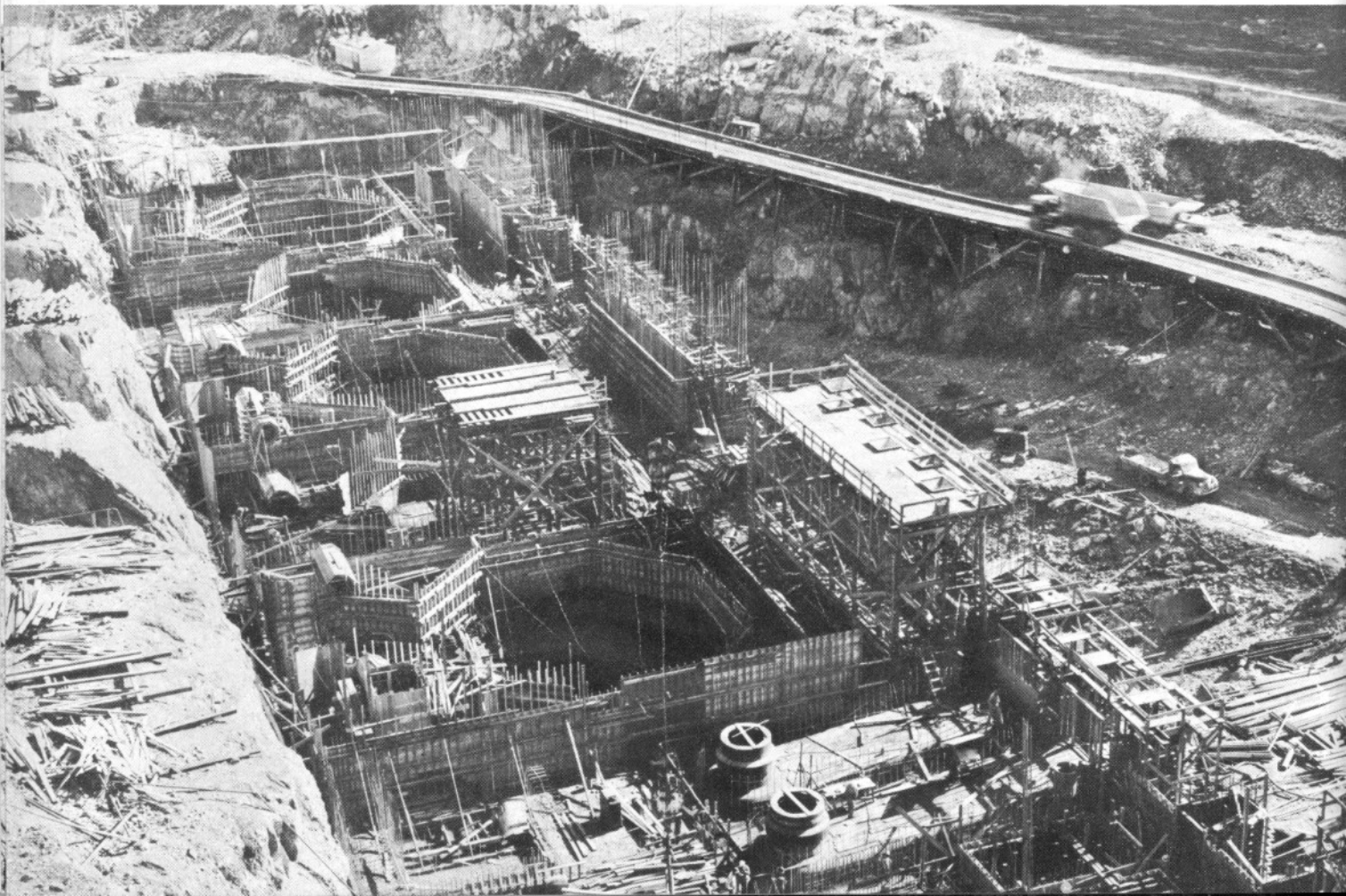
W. V. Greeley, as Chief Engineer for Pacific Constructors, Inc., after January, 1941, administered the subcontracts — a tough job sometimes when it came to questions of policy and interpretations of the specifications.

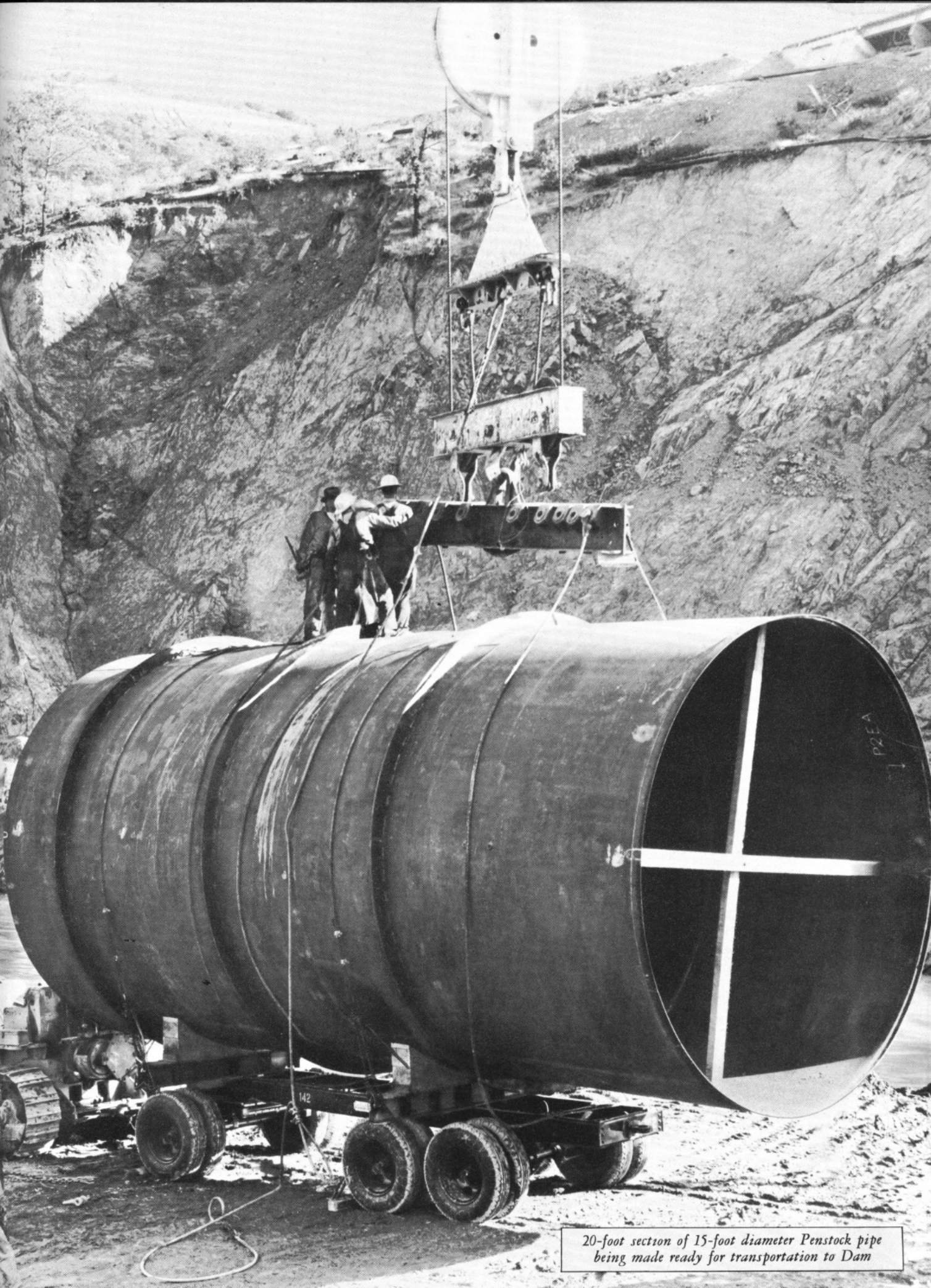
The Forces of Nature:

One of the things counted on at the outset of the job was the fact that heavy rainfall could be expected between the months of November and May, and that resultant flooding in the river bed would give us some trouble. We weren't disappointed!

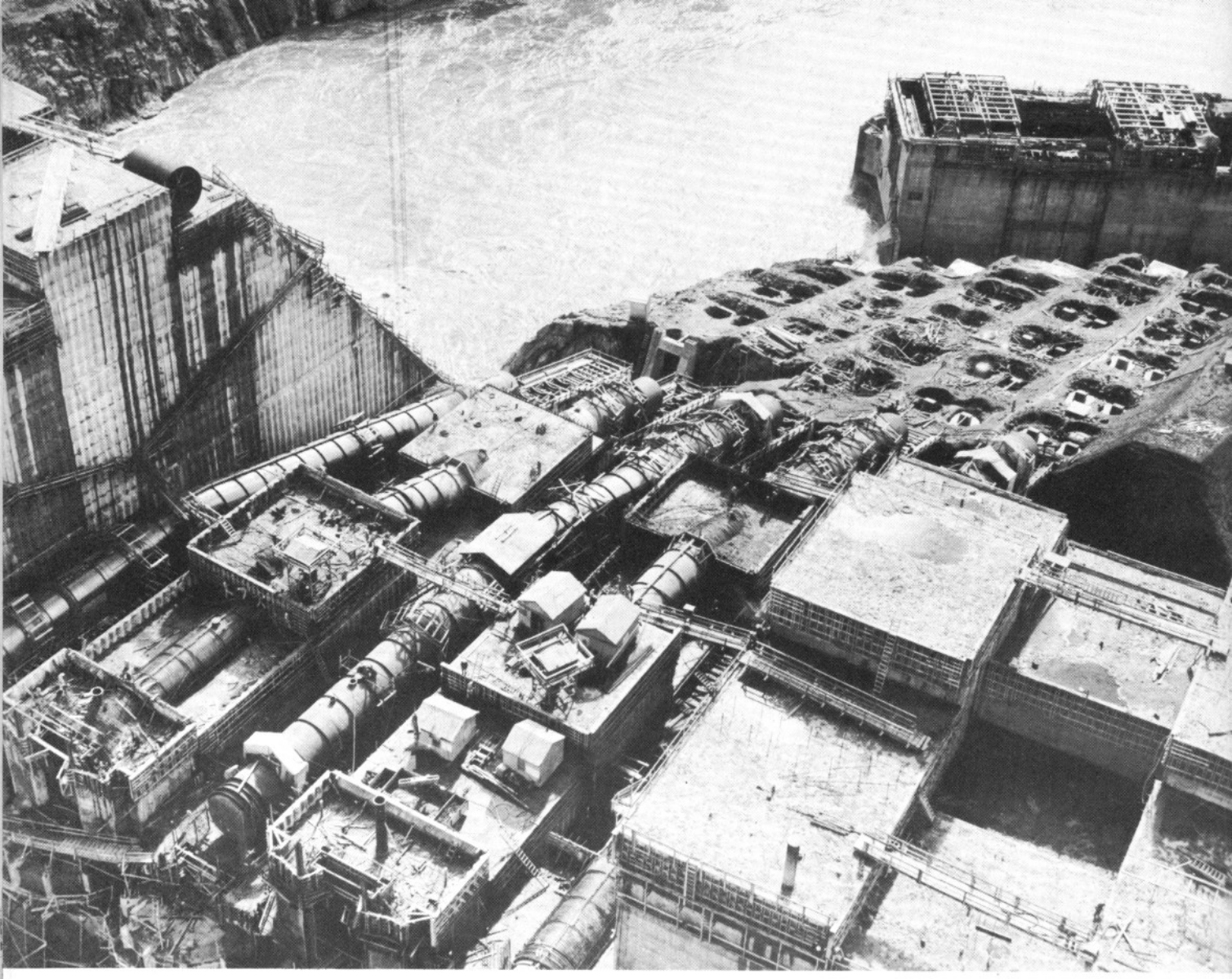
Rainfall records for the five complete seasons construction was under way were as follows: 41.0 inches in 1938-39; 94.8 inches in 1939-40; 108.2 inches in 1940-41; 75.9 inches in 1941-42; 50.7 inches in 1942-43; and 42.5 inches in 1943-44. During the biggest season (1940-41), it was not unusual to record weekly downpours of from 8 to 13 inches—a lot of rain in any man's language. Just to show you what J. Pluvius could really do when egged on by a crisp south wind, here are a few records: The greatest single storm brought 30.7 inches in twelve days between December 15 and December 26, 1940. The greatest amount

Powerhouse forming and steel work





20-foot section of 15-foot diameter Penstock pipe being made ready for transportation to Dam



Penstocks partially embedded in Dam

of rain recorded in any one 24-hour period was 9.2 inches on March 29, 1940. The greatest short period concentration was on February 27, 1940, when about six inches fell in four hours.

Snow we had too on several occasions, the biggest fall being a deposit of 28 inches on January 20, 1943. This and other snowfalls didn't last long, however, in the warm California sun. (Perhaps, after all, the Chamber of Commerce is right in not mentioning such occurrences.)

Floods came with the rains, bringing some real headaches to the job. Here, too, a record was established. The storms in February, 1940, wound up a grand finale on the 28th by swelling the Sacramento River to a peak of more than 185,000 cubic feet per second at the dam site, the highest flow of a 49-year record. This flood took out two spans of our main rail and truck bridge and their supporting

bent, as well as the upper temporary truck suspension bridge. Also lost, was the new bridge over the river at Coram just completed by the Columbia Construction Company for the conveyor crossing. Within a few hours the gap in the main bridge was spanned with a temporary suspended catwalk to accommodate travel by foot to the west side. Trucks on that side were supplied with fuel from a small trailer and work was resumed.

Span 6 and bent 6 were recovered from the river just below the bridge and were reinstalled on March 13th, 1940. A new span 5 was received and erected that same day. This meant that only 2 weeks elapsed between the time the bridge went out and the time new girders arrived here from the American Bridge Company's plant at Gary, Indiana. Since we were able to use the old span 6 girders, the new ones found a resting place near the junk pile. We were able to use this double girder later for other purposes. We also later found uses for the span 5 girders which were also recovered from the River bed, nicked and dented a little here and there but otherwise perfectly sound.

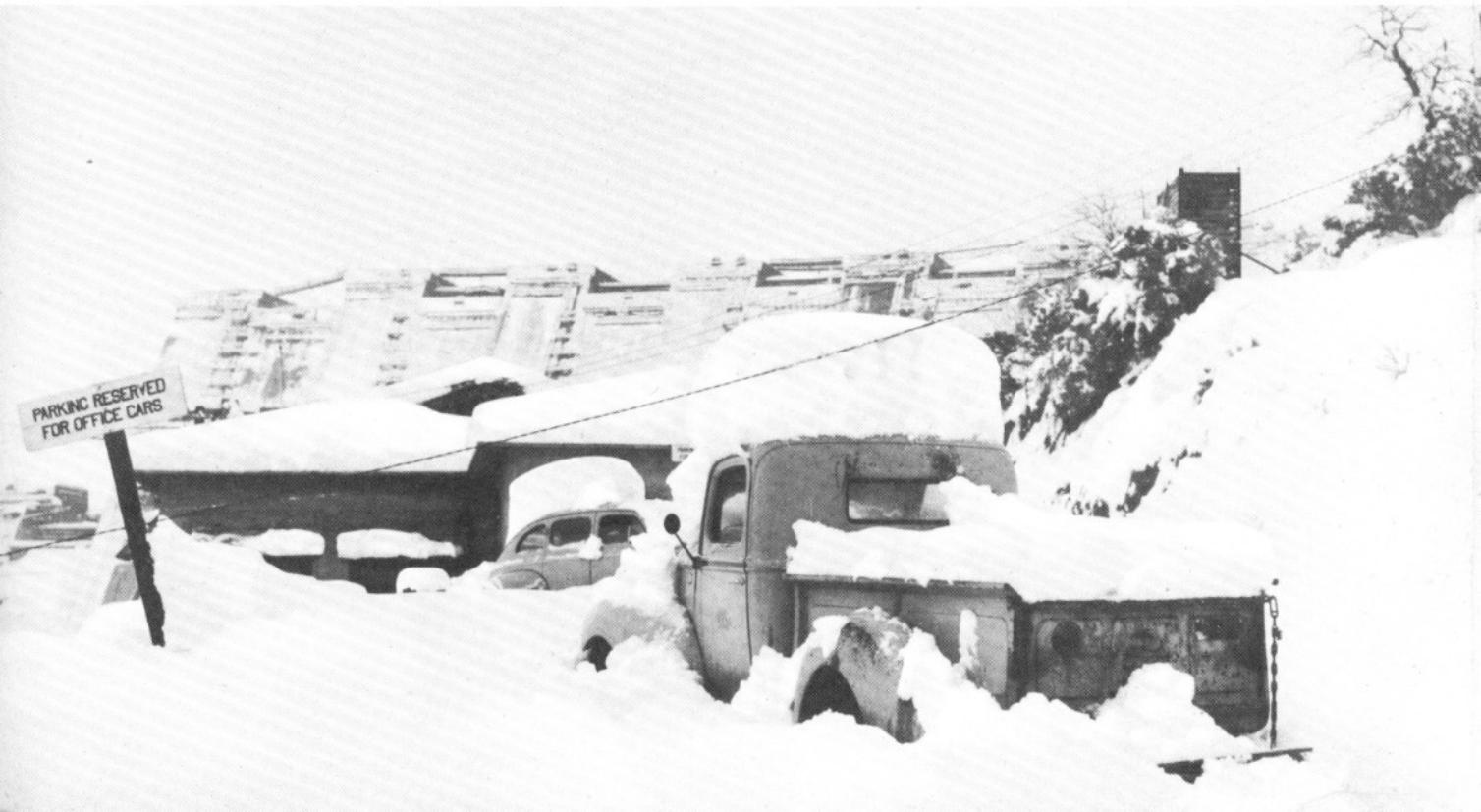
* * *

As one's mind flashes back over the job, certain things stand out—a vivid personal experience perhaps—or an event that left its indelible impression.

In the latter category it was perhaps that first bucket of concrete, placed on July 8, 1940, at ten in the morning in block 38-C. To some that was the moment all had been waiting for. That it was a memorable occasion, no one can deny.

Ed Hyatt, State Engineer, could see in that event the realization of a dream of conquest over a mighty river and all that it meant to agriculture and industry in his state.

Scene at time of big snowstorm—January, 1943



Main truck bridge at peak of 1940 flood

Ralph Lowry, Construction Engineer for the Bureau of Reclamation, could look on the scene and picture that first glob of concrete as the laying of a cornerstone for a mighty structure.

Frank Crowe could well have thought of his many other dams and realized with a great deal of pride that here was his biggest. (You may be sure, however, that there also were other things on his mind at that moment—Would everyone be pleased with his new bucket? Would the cableway operator and his bell boy handle it the way they should in front of a critical audience and a big array of cameras? Would the bucket open slowly enough?)

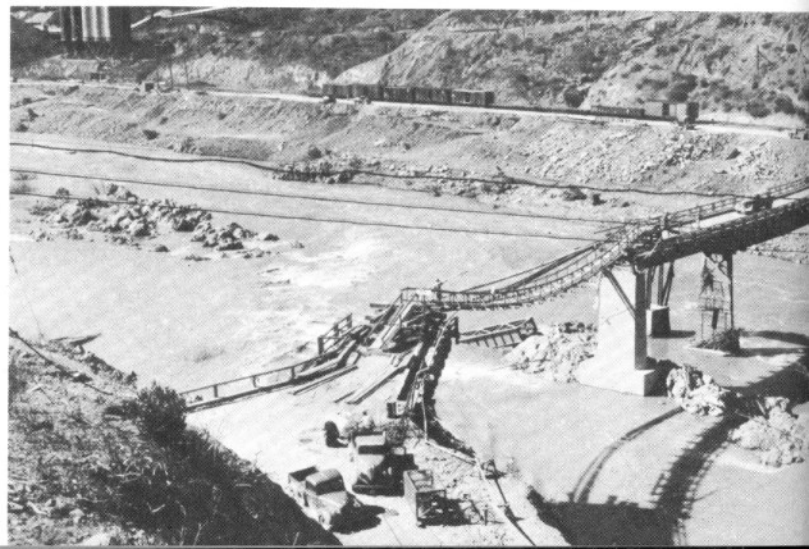
President Wm. A. Johnson of Pacific Constructors, Inc., could look on that first bucket of concrete with a great deal of pride and satisfaction, for here was the justification of his faith in the planning and performance of his organization.

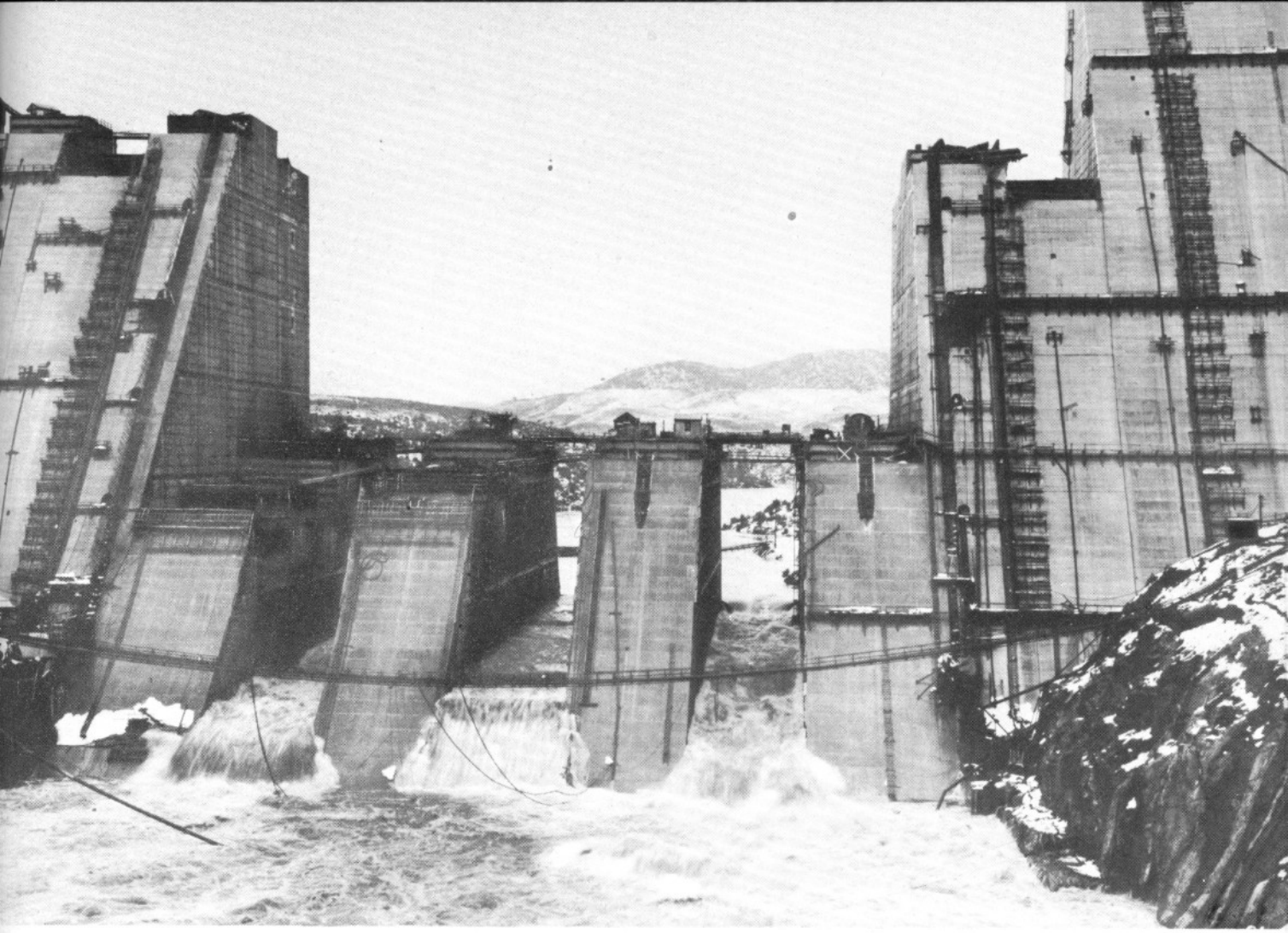
General Foreman Frank Bryant was probably too busy about that time to give much thought to the significance of the event other than that it marked the beginning of a truly big job for him—that of organizing the pours from there on so that concrete could be placed at the maximum rate.

—And so for all of us who witnessed that event.

Perhaps the red-letter day on this job was the day we placed nearly 12,000 cubic yards of concrete. A good many men have vivid memories of that day! They were out for blood! Friant Dam under Harvey Slocum had just boasted a record of something over 8,000 yards for one day's work down their way—while P.C.I.'s Office Engineer was visiting there at that! Add to this fact that the U.S.B.R. issued a press release calling attention to Friant's big achievement. The result can perhaps best be told by quoting the "Old Man's" words in the weekly news letter of August 9, 1941. "Well—Saturday (Aug. 9) the boys set the stage for a record run—rolled up their sleeves and put in 11,790 cubic yards of concrete. It was a thrilling show for any construction stiff to see. The mixing plant was the controlling feature. Graveyard shift

Main truck bridge after 1940 flood





One of the 1943 floods passing thru the three low spillway blocks

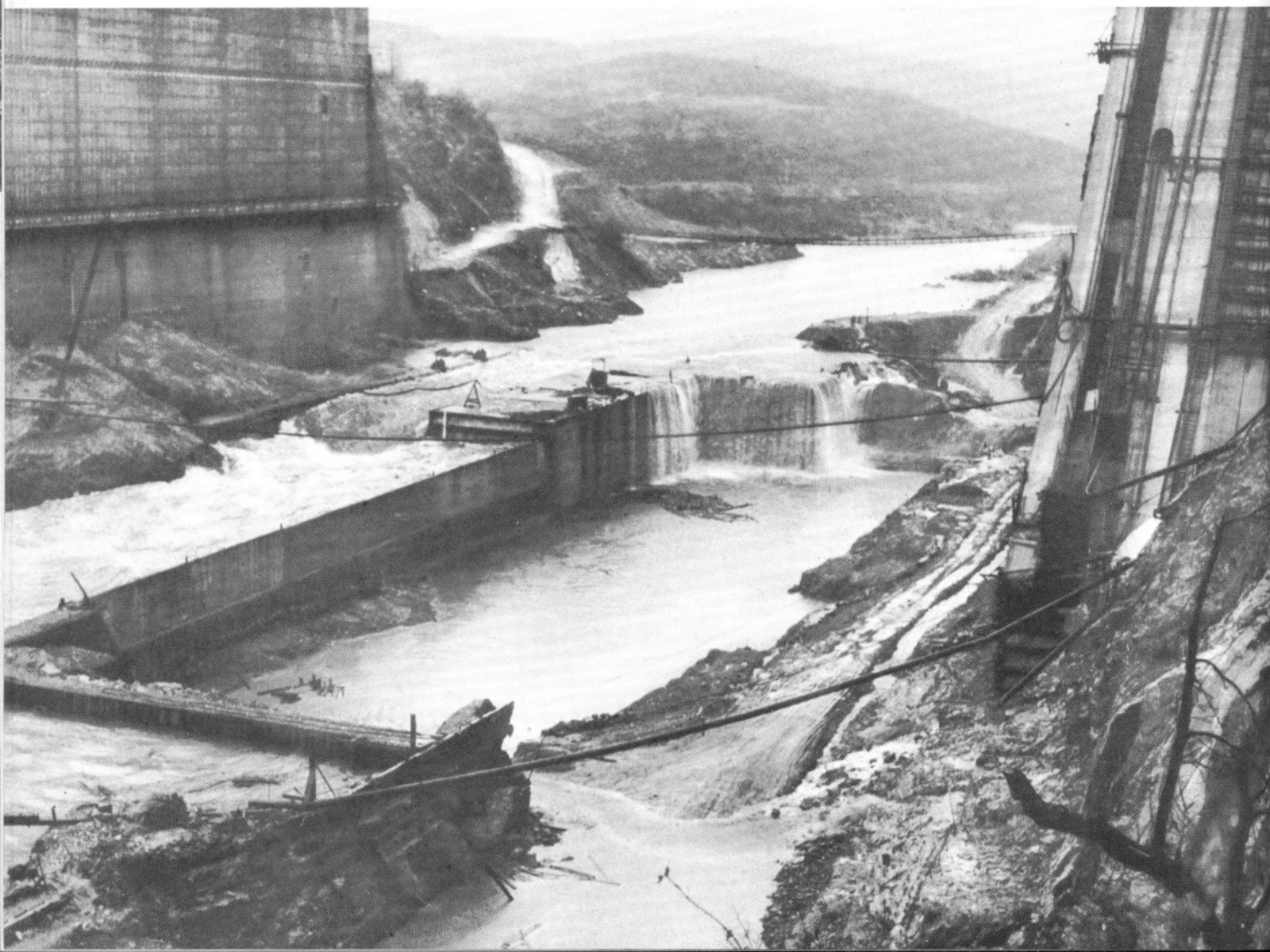
put in 3,951.2 cubic yards; day shift put in 3,852.3 cubic yards; and swing shift put in 3,986.9 cubic yards—a total of 11,790.4 cubic yards. The maximum daily run at Boulder Dam was 10,464 cubic yards."

At Grand Coulee Dam the maximum placing for 24 hours was about 20,000, but this came from *two* plants the size of ours, making their per-plant run less than Shasta's.

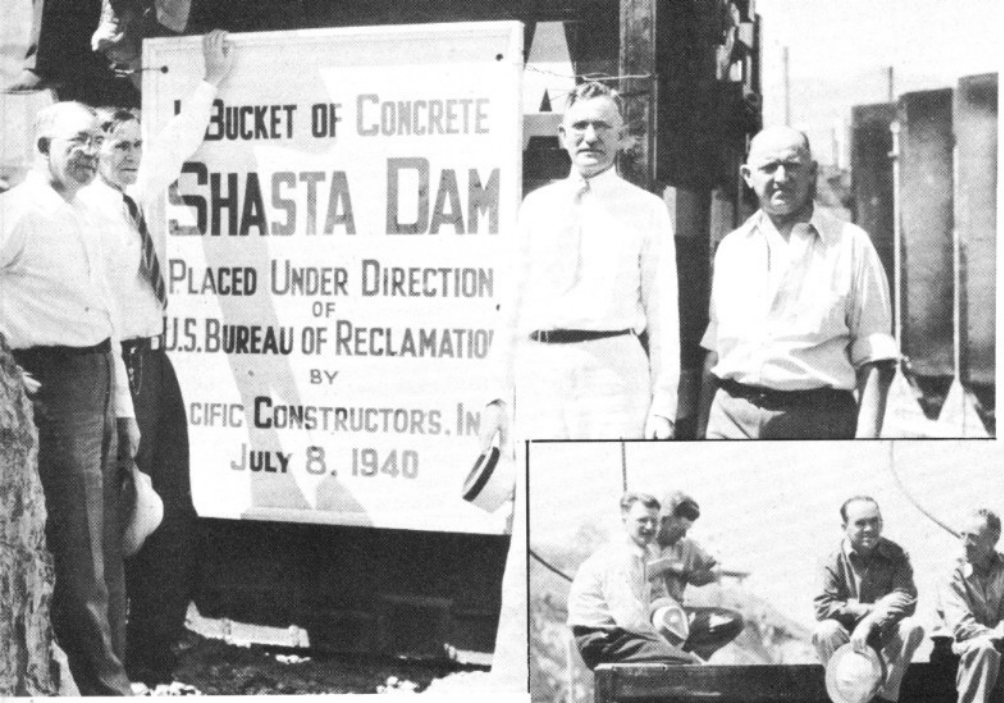
Then there were such milestones as the one millionth yard of concrete and the succeeding two, three, four, five and six millionth yards; the moment the Sacramento River started flowing through the diversion tunnel, for then and only then could we consider the river licked; the first water through the tube valves; the first time the generators in the powerhouse were turned over; the moment when Shasta's power surged out over the transmission lines for the first time; and the last bucket of concrete, placed in the spillway bridge, on December 22, 1944. All of these were very important happenings at Shasta Dam, and in them all there could be found a thrill of accomplishment.

Placing the first bucket of concrete

A 1940 flood just topping the Coffer-dam



Downstream portal of Diversion Tunnel
shortly after final diversion

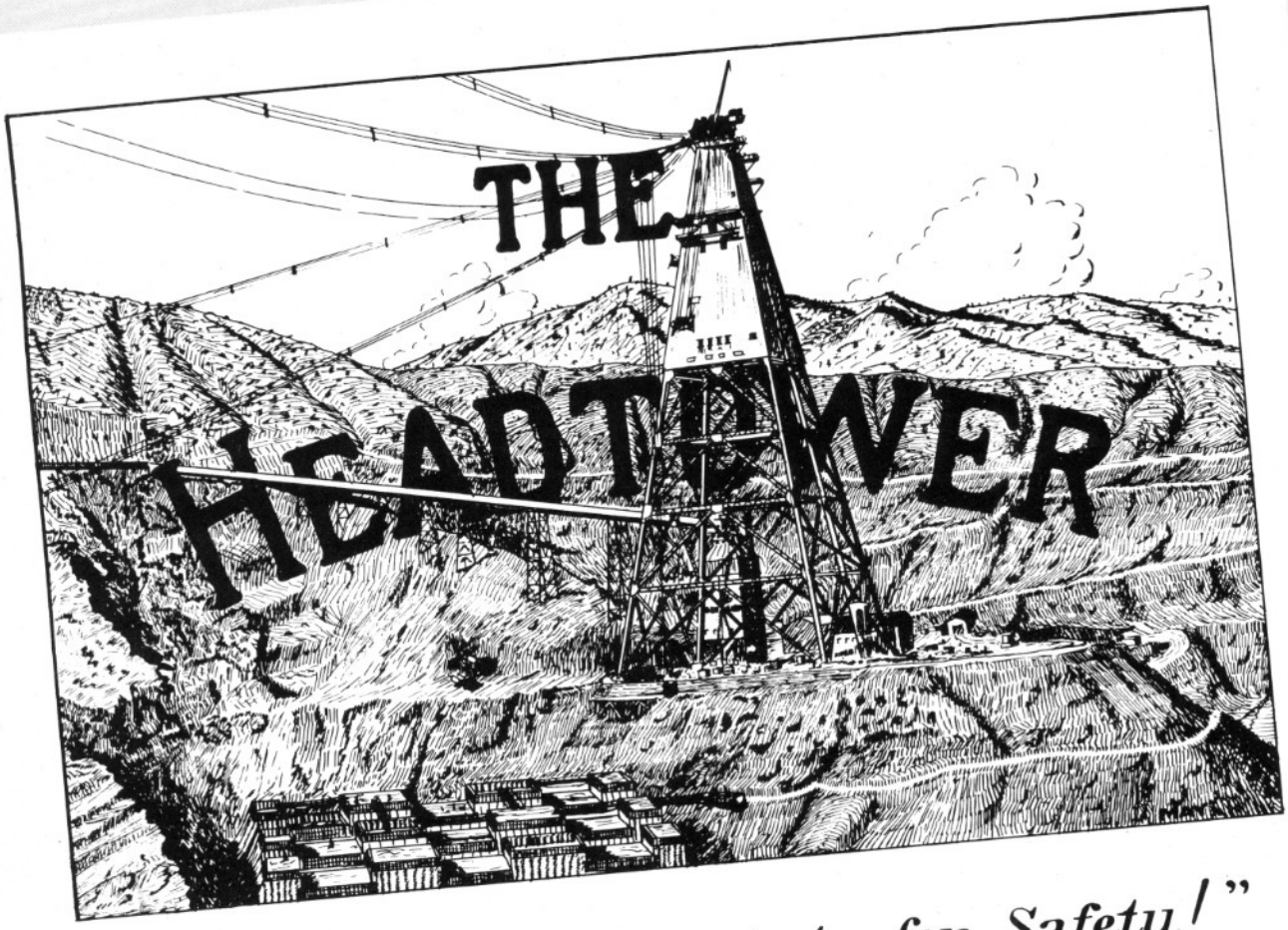


First Bucket Personalities:
Left to right—
Ralph Lowry
Edward Hyatt
Wm. A. Johnson
F. T. Crowe

Standing, Left to right—
Roland Curran
Ralph Lowry
Grant Bloodgood
Edward Hyatt
Wm. A. Johnson
Frank Bryant
Bert Goodenough
Karl Collett
W. A. Dexheimer
F. T. Crowe
On Bucket, Left to right—
George Bogovich
George Malan
Larry Sowles
"Red" Wixson
Butler Howell
Si Bous

Signs fastened to bucket as milestones of succeeding millionth yards


LAST BUCKET
OF CONCRETE
SHASTA DAM
PLACED UNDER DIRECTION
OF
U.S. BUREAU OF RECLAMATION
BY
PACIFIC CONSTRUCTORS. INC.
6,535,000 YARDS
JULY 8,1940 TO DEC. 22,1944



"There is no Substitute for Safety!"

YOU DON'T HAVE TO BE CRAZY TO TAKE CHANCES

- BUT IT HELPS!

VOL. 2 FEBRUARY 1943 Nº 9

Published Monthly at Shasta Dam, California.
By Pacific Constructors Inc. in the Interests of Safety.

INSURANCE AND SAFETY

On a project this size, the facilities to care for the safety and well-being of the men employed are of vital importance, to assure the best efforts and interest of the working men. Shasta Dam builders went "all out" in their endeavor to provide the best medical care available and the most satisfactory insurance plans. Both are described in detail in the two following articles.

Cover—Magazine "Head Tower"

Insurance and Safety

By T. J. Caulfield

ONE OF the major items in a job the size of Shasta not covered by a specific bid item but noted by one short paragraph in the specifications was the provision for safety, which necessitates insurance. Estimates to cover this item at standard insurance rates amounted to a sum in excess of $2,000,000. In 1938 this sum was more than most construction contracts.

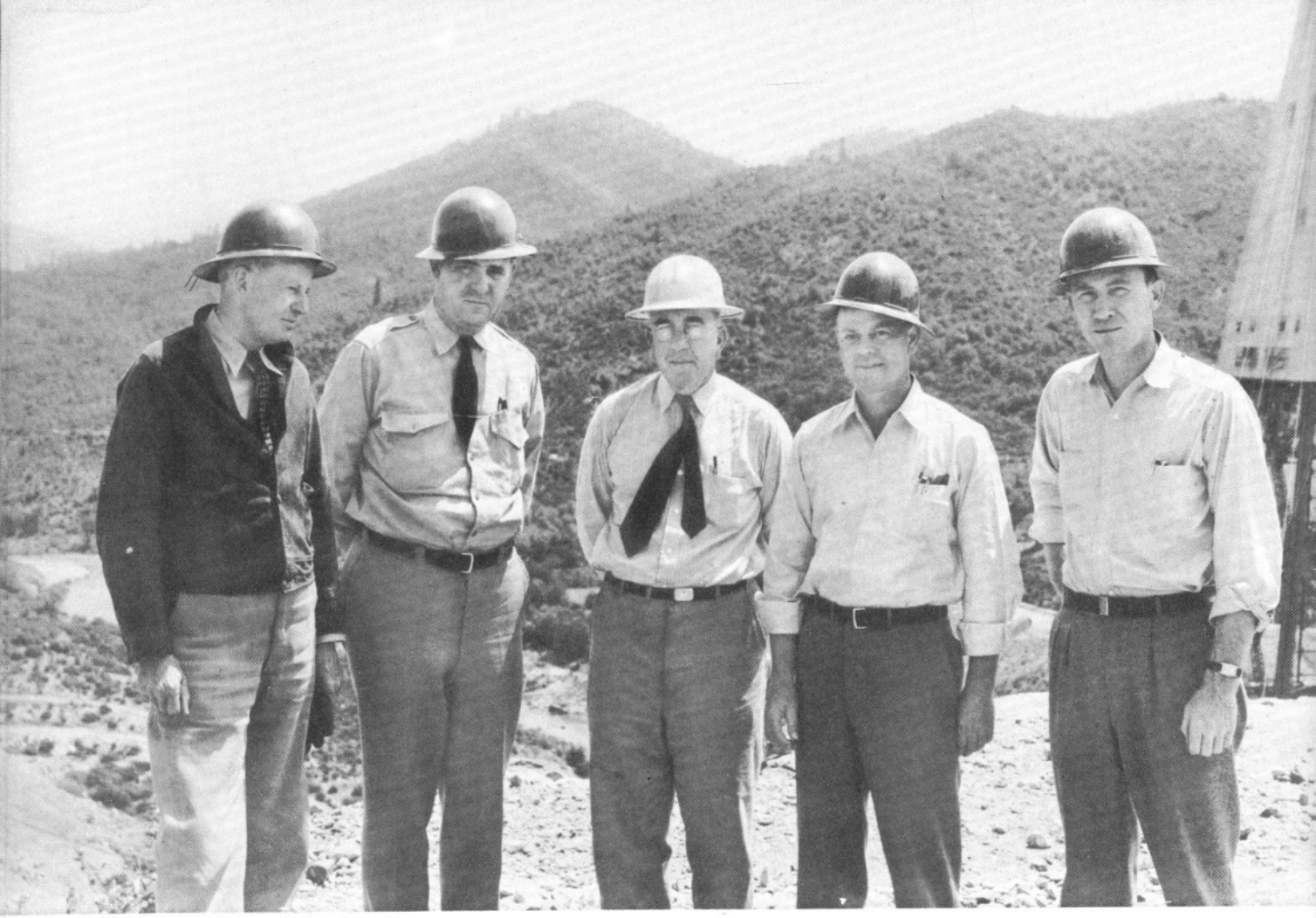
An Insurance Committee, composed of Mr. L. T. Lawler, Mr. J. M. MacAdam, of the American Pipe and Construction Company, and Mr. Merle W. Davidson of the Griffith Company, reviewed innumerable proposals as to the best possible safety and insurance program for the job. These proposals ranged from straight premium insurance to the establishment of an insurance company. It is interesting to note that an average of the numerous proposals by these insurance experts forecast an estimate of fifty fatalities and total permanent disability cases for the estimated 15,000,000 man hours and five years to complete the job.

It was finally decided to self insure and Mr. E. T. Green was given the job of safety engineer and insurance manager. Self insurance, as the term implies, puts all the responsibility and costs for compensable accidents upon the company itself.

A definite safety program was started. Briefly, it consisted of regular foremen's meetings, detailed tabulations of all accidents as to type and cause, poster campaigns for the prevention of accidents, first aid instruction and safety inspections. A list of all accidents was printed and distributed to the foremen each month. This program placed the responsibility for safety instruction and the prevention of accidents to men in his crew directly on the foreman. Thus the enforcement of safety regulations was made a part of each foreman's duties.

For the first 2½ years, the major part of the job consisted of the excavation and removal of over four million cubic yards of dirt and rock. This required the use of explosives varying in amounts from one 50-lb. box to several 25-ton carload

125-ton Gantry Crane on Dam roadway



Original Safety Advisory Committee
Left to right—E. T. Green, Floyd I. Ross, L. K. Rhinehardt, W. A. Dexheimer, W. V. Greeley

shots. The interest of the management in safety and its effectiveness can best be illustrated by the fact that during this 2½ years of heavy excavation, which involved the use of 3,700,000 pounds of explosives, there was only one minor explosion accident which resulted in the partial loss of vision in one eye. Safety records such as this are made only by experienced men. This job was fortunate in this respect that F. T. Crowe and his organization of dam builders that had been doing this type of work exclusively for years, moved in on this job en masse. These men, under the "Old Man's" constant eagle eye, had learned long ago that "*safety pays*".

In July, 1940, after a year's work in building an elaborate and unique concrete placing system, the first bucket of concrete was placed. However, due to unforeseen foundation difficulties, it was not until the spring of 1941 that stepped-up concrete placing operations created a 100% increase in manpower.

In May of 1941, a Safety Advisory Committee was organized to correlate the work of the company, the United States Bureau of Reclamation and the

California State Industrial Accident Commission. The separate work of these agencies was thereby simplified and the idea was actively supported by the officials of all three agencies. This committee, later called the "five wise men," consisted of William V. Greeley, Pacific Constructors' chief engineer-chairman, and members E. T. Green, P.C.I. safety engineer; Floyd I. Ross, U.S.B.R. safety engineer; L. K. Rhinehardt, Chief of the Construction Section, California State Industrial Accident Commission; and W. A. Dexheimer, chief inspector, U.S.B.R. This committee met once a week, made a tour of inspection of the entire job, held a meeting in the afternoon and made recommendations for safety on the job. Union representatives of all the crafts were invited to attend these meetings and voice their opinions. The committee worked long and diligently. The writer was employed to help carry out the recommendations of the committee. The tempo of the safety program in general was stepped up. The "Headtower", a paper dedicated to safety, was started by P.C.I. Safety Department, printed each month and distributed to every employee. Its popularity can best be verified by the fact that there was never any evidence of its being thrown away in the area adjoining the payroll window. Two years later, a check of our mailing list showed that copies were being sent into most of the states and all the fighting fronts. Within two months the steep upward frequency and severity curves reached their peak and were started on their slow but sure course downward. During the course of the next year 5,150,000 man hours were worked, which was 92% in excess of the total man hours worked during the previous 34 months to May, 1941, and during this year, frequency and severity had been reduced an average of 35%. This, in spite of the start of the manpower shortage.

In July, 1942, E. T. Green resigned and the writer was made manager of the Industrial Insurance and Safety Department. The Safety Advisory Committee underwent numerous changes during the course of the next year. Floyd Ross, the U.S.B.R. representative, moved to San Francisco and was replaced by Al Hines. Mr. Rhinehardt's counsel was lost when the demands of war construction in other parts of the state made it impossible for him to actively participate. W. A. Dexheimer became a captain in the Army Engineers and Roscoe Granger took his chair as one of the "5 wise men".

This committee still meets once a month and can be justly proud of its efforts in the interest of safety on Shasta Dam.

All compensation claims were managed by the safety and insurance manager and have been adjudicated and closed as expediently as possible. The best of medical care provided at Shasta Dam Hospital, and elsewhere when required in a small percentage of cases, has been proven to produce the best results for both employees' personal benefit and good will and the company's financial interests.

It is gratifying to note that in building the world's second largest dam, which

required roughly 19,000,000 man hours of heavy construction, all previous dam building insurance statistics have been shattered in that to date we have had only fourteen fatalities and two total permanent disabilities. This in itself is positive proof of the safety-mindedness of the construction men who built Shasta Dam.

Shasta Dam Hospital

By Viola P. May

THE SHASTA DAM HOSPITAL was one of the best built, equipped and staffed hospitals in the northern part of California. In planning this hospital, no one plan was found that would fit all situations. Forethought had to be given to such problems as the number of men employed, topography of the land, employee and employee-family care, accessibility to workmen on duty and the nearness to larger medical centers. The hazards that would be encountered on the job resembled those to be found on any project which used heavy machinery and had the heights to be found at Shasta Dam. Huge electric shovels, 25-yard trucks, dynamite, mining and timbering operations—all of these contributed to the possibility of accidents even tho' strict safety rules were observed. Hence, the dam hospital had to be prepared for every kind of accident or sickness—temporary or complete care of patients.

The basic design of the hospital and its facilities and equipment were planned by John E. Kirkpatrick, M.D., F.A.C.S., and Daniel M. Brown, R.N.

Constructed, it was a modern 25-bed hospital, air conditioned, and equipped with the latest devices medical science had produced. The building was long and rectangular in shape with the out-patient activities grouped at one end and the in-patients at the other. The administrative and physician's offices occupied the center—separating the two patient groups. On the main floor were four private rooms, two four-bed wards, a twelve-bed ward, utility rooms, kitchen and dining room. These comprised the in-patient grouping. On the north, or out-patient section, were the X-ray and darkroom, physiotherapy and emergency rooms; operating, sterilizing and scrub rooms, clinical laboratory; splint and stretcher room—all grouped so that out-patients could be cared for, with no traffic thru' the hospital proper. In the basement were an examining room and quarters for part of the nursing staff. The hospital was available to employees 24 hours a day.

Hospital Convalescing Ward

The hospital was approved at first by the State Industrial Accident Commission for an industrial hospital. In 1942, it was given the full approval of the American College of Surgeons. It was the only hospital in northern California so approved.

"Patient comfort" being the prime consideration, every effort was made to make the hospital the best. All doors were four feet wide and the corridors, eight feet wide to facilitate moving beds from one part of the building to another. The furniture, paint and fixtures were planned to give a pleasing, restful interior i.e. light green walls, tan curtains, brown linoleum and furniture, and Venetian blinds. Separate entrances for visitors, in-patients and out-patients, helped to minimize noise and confusion. Wide sun porches were available for convalescent patients in wheel chairs and beds.

Since many of the injuries on the job—due to the type of work—were fractures, an especially built ambulance was a part of the hospital equipment. The ambulance was equipped with an inhalator, emergency kit with hypodermics, dressings, splints and all necessary equipment. It was kept at the hospital ready for emergency calls. A registered male nurse accompanied the ambulance on all trips. By giving proper care at the scene of the accident many possible serious complications were prevented. A special skip for attachment to any one of the job's seven cableways provided a quick, safe way to move badly injured cases to the ambulance. Plasma and blood transfusions were immediately available at the hospital.

From the beginning a co-operative medical plan, which cared for all illness needs, was in force. Voluntary membership included almost the entire working force and cost the workman a weekly fee of 50c. Families were not included in

Hospital Surgery Room

the prepayment plan, but, except for obstetrics and tuberculosis, all types of cases were cared for and rates were reasonable.

Every employee had to pass a physical examination, which included a blood test and complete urinalysis, for employment. 18,307 examinations were given in the six-year period of construction. 26,999 patients were treated, of whom 2,904 were hospitalized. There were over 600 major operations performed. 3,558 persons were X-rayed. There was no limit to the times a patient could apply for dispensary care, and all drugs and supplies were furnished. All this service was dedicated to the prevention of illness. Certainly good hospital and medical care made for better employer-employee relationship, lessened lost man hours and played a valuable part in dam construction.

During the peak of activity the hospital employed two doctors. Dr. John Kirkpatrick headed the hospital organization during the entire construction period. During the six-year period he was assisted by Drs. Frutchy, H. T. Hinman and Everett Myer. Dan Brown, followed by Alexis Bock, were the supervisors. From ten to twelve nurses, six of them men nurses, an X-ray and laboratory technician, employed full time, helped make hospital procedure efficient and effective.

Qualifications for all hospital employees were stiff. Good basic training, ability to think and act quickly, scrupulous personal neatness were supplemented on this job by a needed good "patient understanding", the ability to understand and talk the workman's language.

All nurses were members of their state and national organizations. Several held offices in their local districts. They were instrumental in forming District 41 of the State of California Nurses' Association and were leaders in the eight-hour movement in this area. Tho' this was a union project, nurses were never required to become members.

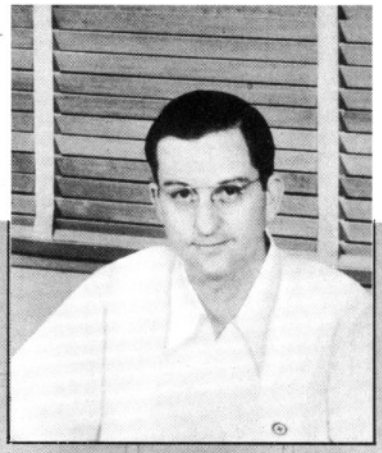
As work neared completion, the employee needs lessened and by August, 1944, the "medical plan" was abandoned. By October, it was no longer necessary to keep even one doctor full-time on the job, so the hospital and its equipment were sold. A first aid station was maintained until the end of the job—staffed by Alexis Bock, R.N., one nurse and one nurse's aide. All patients requiring more than preliminary first aid were treated by Dr. Hinman in Redding, fifteen miles away, or referred to Dr. Kirkpatrick in San Francisco.

Of interest to everyone, is the hospital's mortality rate. There were only eight industrial deaths (of the fourteen on the job) in the hospital during the entire period of the job. Each of these was so badly injured that no life saving procedure could be instituted. There were no surgical deaths among the employees. There were no deaths from pneumonia. Only one surgical death occurred in the hospital and that was in the case of a three day old infant who was born with an intestinal obstruction. In comparison with other hospitals caring for both industrial and

general cases, this is a superlative record.

Close cooperation between the safety and medical departments proved beneficial and aided in making this a record job for "low loss" in human life as well as preventing many avoidable accidents.

Hospital Staff:
Sitting, left to right—Mrs. Florence Sanford, E. G. Kroman, A. C. Most, Everett B. Myer, Alexis F. Bock, B. L. Brodrick, Mrs. Dorothy N. Small
Standing, left to right—Wm. A. Overing, Miss Myrna Schmidt, Miss Marion Dezellem, Miss Anne M. Rial, Mrs. Irene Hebert, Mrs. Flossie Fader, Mrs. Gertrude Harders, Miss Betty Hebert, Miss Edith Hazell, Mrs. Orpha Tullis, Mrs. Edith Eckelbarger
Inserts, left—Daniel M. Brown; right—Dr. John E. Kirkpatrick



A Woman Looks at Camp Life

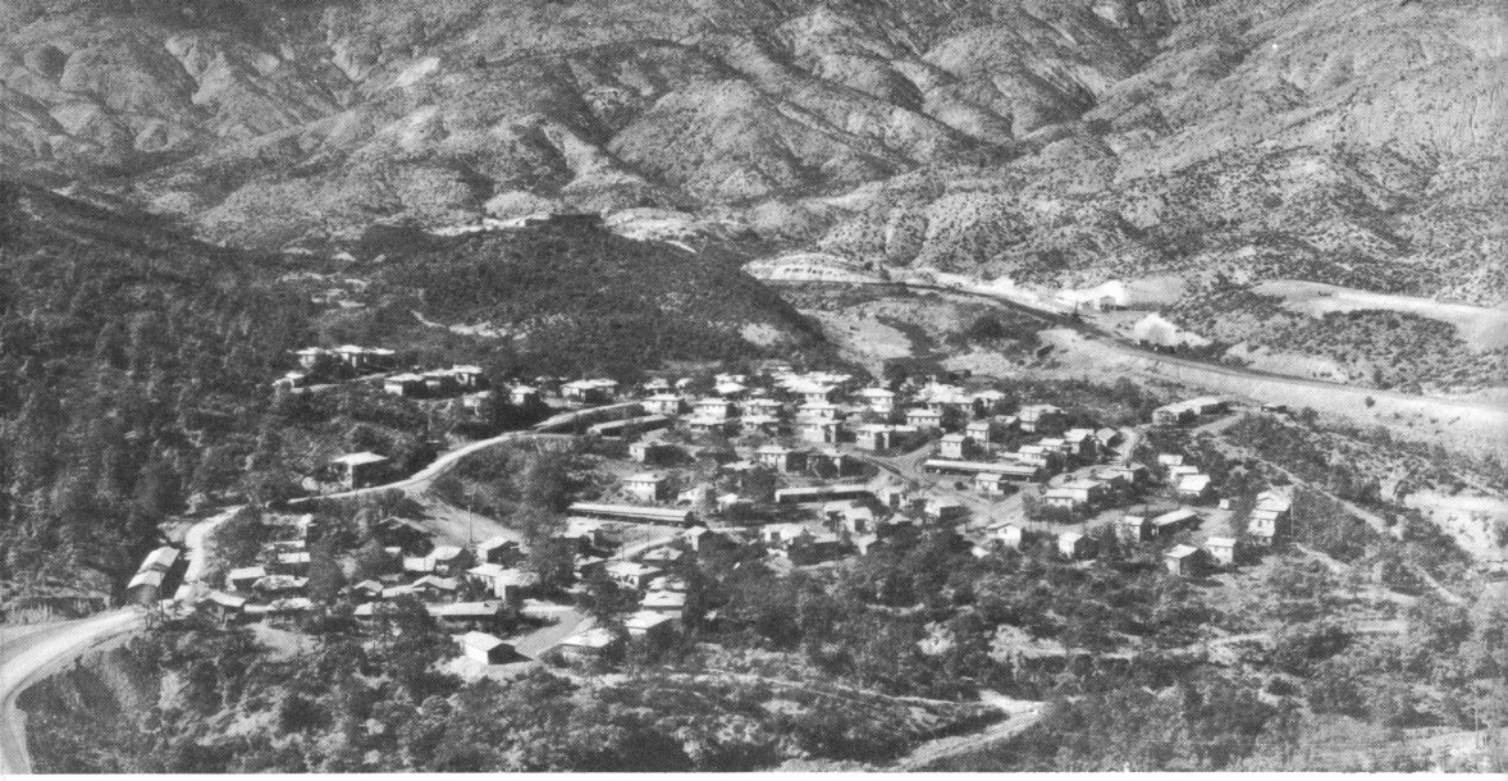
By Viola P. May

To THE construction man, home is where his wife and children are. On location this may mean anything from a tent in the desert a hundred miles from the nearest store, to a cabin on the mountainside. In the case of Shasta Dam, home was in a beautiful village, built in a once isolated mountain canyon, fifteen miles from the City of Redding.

Hardly had the government order to "go ahead" been issued, when people began to pour into Redding—some old-timers who had worked for Frank Crowe, general superintendent of Pacific Constructors, Inc., for "y'ars and y'ars"; others, who had jobs awaiting them; many, the hangers-on that follow every construction job, waiting for a chance to get on. This sudden influx brought such an acute housing problem to Redding (where Government and Pacific Constructors' employees lived until their respective camps were built) that houses were impossible to find. I, who had hopelessly and unsuccessfully househunted, and finally resigned myself to a makeshift life in an auto court, read with grim humor and deep understanding an ad in the local paper: "Wanted: To rent, a house, furnished or unfurnished. We have a child and a dog, and refuse to part with either." Our rented double, consisting of two bedrooms furnished with beds only, tiny kitchenette, and shared shower, was so small it could have been placed in our previous living room and no one would have noticed. When we squeezed around the table to eat, we were packed so close we could scarcely move. The task of keeping in my own plate and avoiding the children's elbows seemed at times more than the food was worth.

Meanwhile, in a once isolated mountain canyon, there arose with amazing rapidity the buildings that were to house a new community. First to be built were offices, shops, two large dormitories for construction workers, one dormitory for the office staff, a big mess hall serving excellent food, a general store to solve the immediate problems of food and simple necessities, a coffee shop for those who

Aerial View of the Dam—January, 1941



Shasta Dam Village

wanted a snack, a pool hall for amusement for the men, a fire station housing a modern fire truck, and a hospital completely equipped. Soon the hillsides were dotted with the 131 houses that made the village complete. Only the difficulty of access to camp over narrow, twisting mountain roads in cold rainy weather kept the women from hounding the carpenters to death with their desires to have their homes as nearly like those of their city cousins as possible. Our two-, three- and five-room houses, for all their temporary aspects, were substantial affairs, with composition walls inside, pine wood outside. When the carpenters moved out of ours, we sanded, varnished, and waxed the floors, laid the linoleum, painted walls and woodwork. Those who wanted any change in plan, such as a bathtub instead of a shower, or sanitary tubs on the back porch, were allowed to have them by paying a little higher monthly rent. All houses were equipped with electric stoves and electric water heaters. For house heat, most of us installed oil stoves.

With our houses in livable order, we attacked the problem of landscaping the yards with the enthusiasm and vigor of those who intend to stay where they are for many years. Days spent in digging roots and stumps of manzanita and poison oak (with a week off, in my case, for doctoring a good itchy case of poison oak as a result) preceded the hauling of truckloads of dirt brought from the river to cover the hard clay soil. Lawns, flowers, even outdoor living rooms with barbecue pits soon gave camp the appearance of a *beautiful* mountain resort.

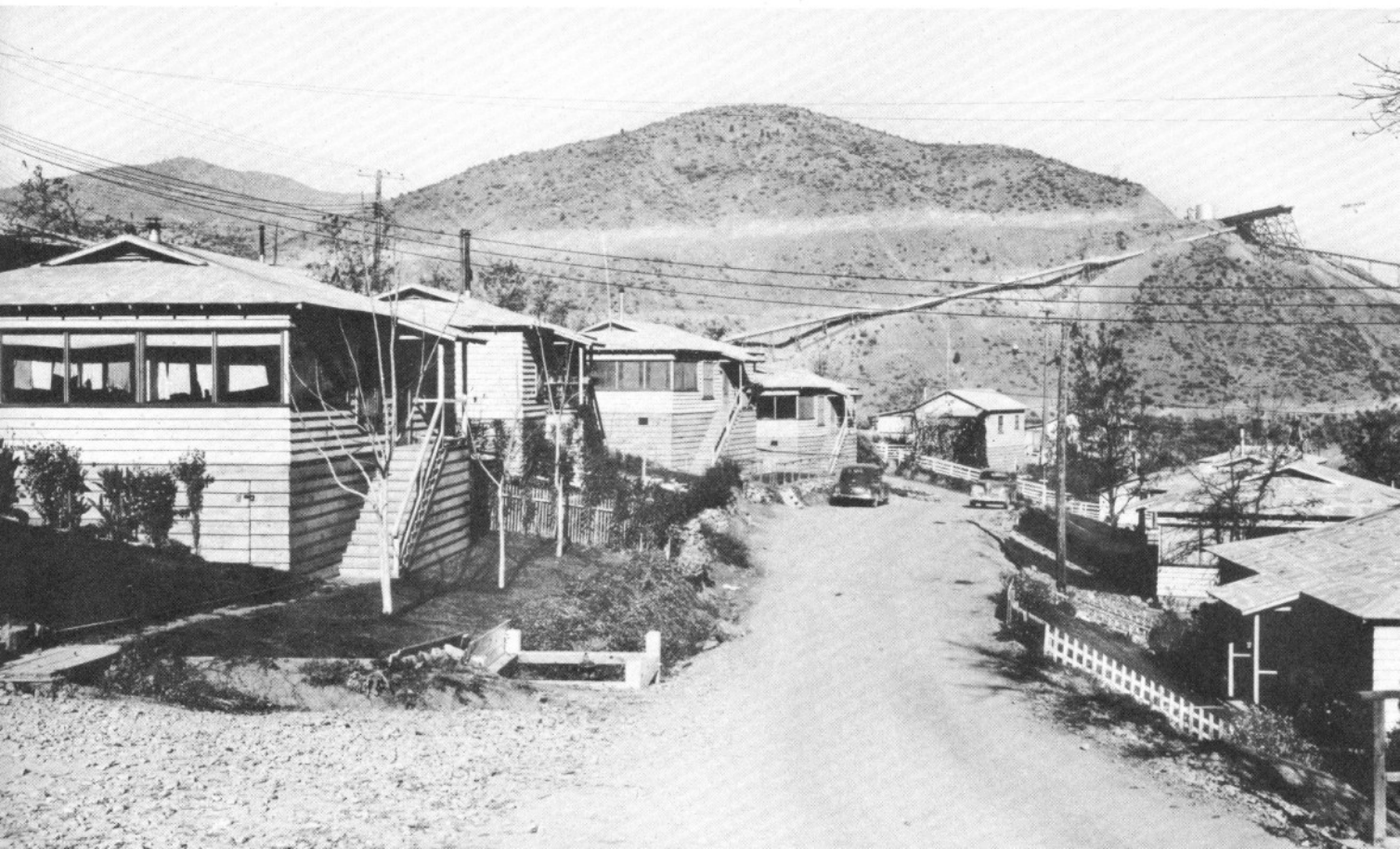
Houses were not available for all who worked on the job, so between Redding and the dam site arose the boom towns of Santa Claus, Project City, Summit City, Boomtown and others. Prior to construction, perhaps a dozen people lived between

Redding and the dam. Soon, it was estimated that about 11,000 lived in these towns, which had sprung up "over night"—where six years ago were only pine trees and dense manzanita growth.

The inhabitants of "the village" were a composite group from various jobs. One street might well be named Parker Dam Avenue, for the same women who discussed the desert heat over their back fences, here compared notes on their growing flowers and plants. Another street might be Boulder Dam Avenue, for a great many of the people who shared their joys and sorrows on that project were next-door neighbors here. For variety and outside interest, there were the families who helped build the great aqueduct for the metropolitan cities of southern California; those who watched Bonneville grow to maturity; those who worked on the Yuma Project; some from big jobs in the East and South—all working together with one big aim, the successful completion of Shasta Dam.

In spite of their "three-shift life" (for work never stopped at Shasta Dam) these "constructions stiffs" showed a tendency to be quite normal people. They made, indeed, an educational melting pot where Phi Beta Kappas rubbed elbows with some "without benefit of school diplomas"—the common bond, their children and the problems of daily living. Their activities resembled those of any small town. There were the usual bridge clubs, and the usual number who didn't care for cards. There were bowling teams for both men and women, who played in weekly competition with teams in Redding. There was a P.C.I. baseball team, loyally supported by outspoken rooters from camp; there was a book club for the

Typical Village Street



One of the 3-room houses—Firplace and arbor installed by "Red" Neville, the original occupant

women, that met bimonthly to discuss current events and new books. Gold panning was a fascinating game that young and old played at in spare time. A few found it a paying hobby. Fishing and hunting were sports that appealed to a big majority, and the country-side was ideal for these sports. There were Scout troops for boys and girls, Parent-Teacher activities that kept parents busy; the war adding to these, a busy group of Red Cross workers.

The problem of educating our children was a continuously perplexing one. Our company built a school some three miles from camp, at Summit City. No sooner were its hurriedly constructed rooms opened than children poured in, in overwhelming numbers. Soon the rough tables and backless benches that had to be used the first year were full. The teacher's desk would accommodate no more. The floors were congested with boys and girls who were delighted with the novelty,

confusion, and fun of a new school. Two more rooms had to be built at once, and since then two additional rooms have been added and the outhouses have been replaced by modern plumbing. Some 350 children attended the 10-teacher school, making this one of the largest rural grammar schools in the United States. As the dam neared completion, enrollment dropped to about 250. Since the school enrolled children from Government Camp, Summit City and Central Valley, as well as Shasta Dam, it will be a permanent school in use long after its builders have left.

Children, as a group, enjoyed camp life. My own wished we could always live here. Yards were small, sidewalks nil, and roads—though surfaced the first year—were steep and hilly, making skating and other city activities poor sport. Big signs at the entrance to the residential section warned visitors, "Drive slowly! Children playing in the streets!" The hills were ideal for hikes and wild flower hunts, and wild grape and blackberry picking in season added variety to such outings.

Summers were so hot that almost every house had its homemade "desert

The 5-room house occupied by Office Manager F. D. Myers

Toyon School

cooler." This practical, though inelegant, device consisted of a box full of excelsior kept continuously wet by dripping water from a pipe above. The box stood just outside a sunny window, and an electric fan blew air through it into the house. Strange as it may seem, a cooler outside the living room window made a difference of 15 to 20 degrees in the temperature inside on a very hot day. (The principle on which it worked was, of course, that heat from the atmosphere was absorbed for the vaporization of the water.)

Climate regulated much of our activity—the heat of summer and the rain of winter. For winters here, in our experience, were just a series of rain and more

rain. Those of us who came from desert country where two inches a year was a lot of rain, felt we'd never "dry out" after living through 108 inches one year. Nor were these gentle apologetic rains! At times the deluge was so great that I could hardly see across the street, and winds drove the rain in a frenzy that turned the hilly streets into torrents. These rains and floods were costly to the job and to the employees. Parents who kept their children cooped indoors day after day felt the strain, but their troubles were as nothing compared to the men who sat at home, watching the rain rob them of paycheck after paycheck—sometimes, as one housewife ruefully complained, owing the company money at the end of the week instead of having a paycheck come in.

Each year brought its changes to camp life as well as dam construction. The last year the camp store and hospital were closed. This presented a real problem (with gas rationing and the nearest stores several miles away!) Appeals to the Redding rationing boards from worried women brought a limited B gas allowance so that trips to town could be made bi-weekly. By sharing the ride, we were able to keep up Parent-Teachers Association, Scout activities and bandage rolling as well as a few social activities.

Few of us had ever lived in more interesting country. The scenery was magnificent. Near us, an easy day's outing, were Lassen National Park, Mt. Shasta, the Trinity Alps, and old ghost mining towns. From my front room windows I looked out on the job, watched the cableways in operation, saw the giant tower silhouetted against the sky, dwarfing snow-capped Mt. Shasta in the background. At night, camp from a distance looked like a fairyland, its shops and hillsides marked by thousands of sparkling lights.

The dangerous life we lived was brought to our attention as we entered camp. A huge sign warned: "Drive slowly! Construction zone. Death is so permanent!" Though every precaution possible was taken to safeguard the men on the job—signs everywhere, classes in first aid and safety training—there were a few who began the job and did not live to see it finished.

Many were unable to stay to see the "finishing touches" put on the job. The departure of "old stand-bys", old-timers, was the occasion for farewell dinners and parties, which, while great fun, were tinged with a touch of sadness that congenial friends and good workers must part—some to meet no more. Others, of us—having built, will move on, to begin another project; to build another village, taking with us little but memories of friends and places. We have shared the joys of conquest; the satisfaction of high achievement; a philosophy of peace that comes from nearness to nature; close kinship with neighbors—and these are precious treasures!

(NOTE:—Parts of this article have been taken from an article by the author, published in *Civil Engineering*, January, 1942, issue—permission to reprint having been secured.)

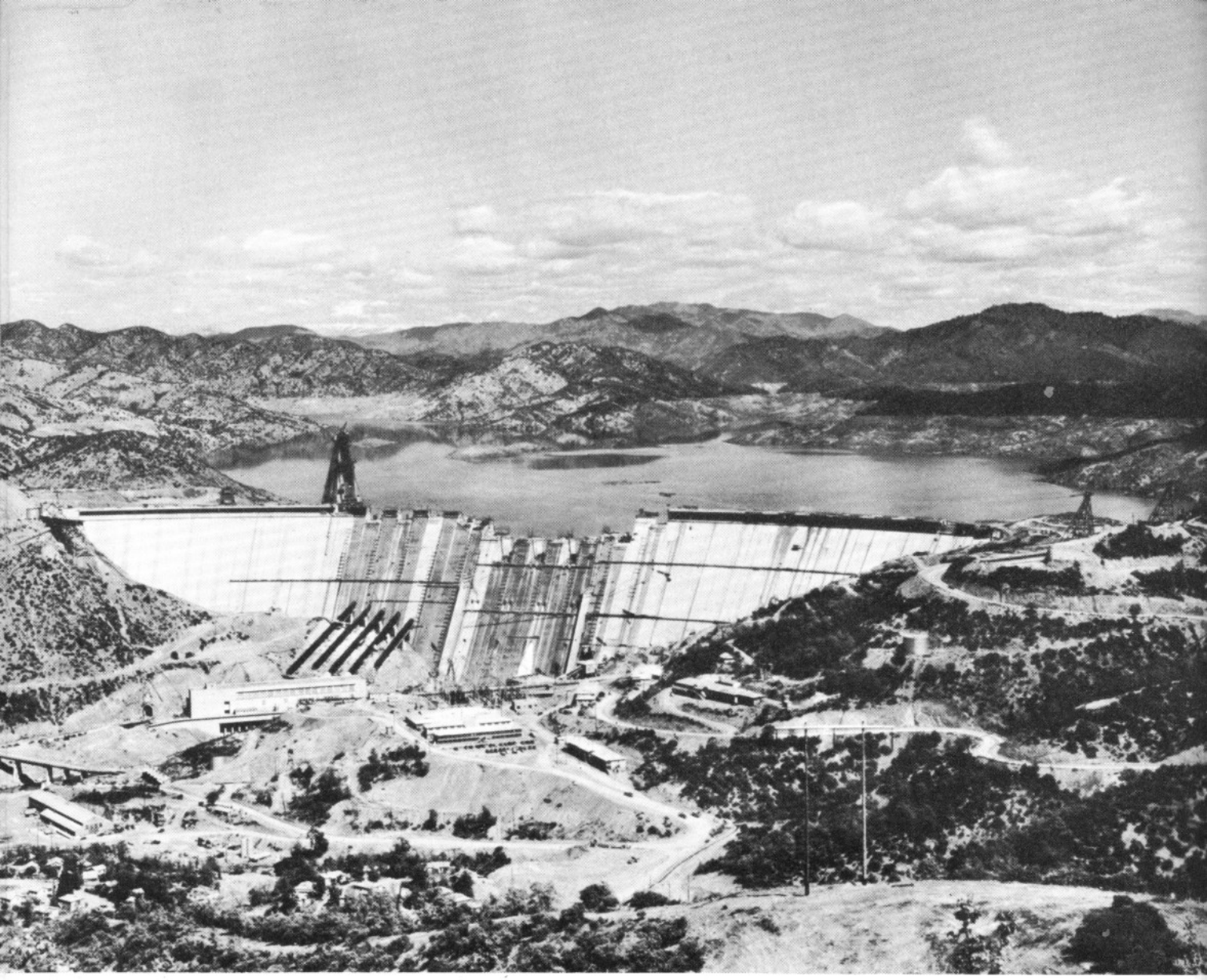
Interesting Facts and Figures

By David C. May

DURING THE time Shasta Dam was under construction many questions concerning the various features were voiced by visitors and even by the workmen themselves. Many of these queries had to do with why this particular spot was chosen for building the dam. Others touched on the shape of the dam; the geological formations underlying the structure; the fact that so many blocks had to be formed and poured when it looked so easy to just put up a big form front and back and pour concrete continuously—subjects all deserving of serious and studied explanations. Other questions were asked from time to time, too, which were a little different in character. For instance, one kindly old lady asked the official lecturer at the Vista House, "Does a man ride on the trolley way up there on that rope and wind up the concrete bucket?" And then again, "What will become of the water after they extract the electricity from it?" (These last types will not necessarily be covered in the following discussions.)

SITE: The site on which Shasta Dam was constructed was chosen only after preliminary investigation and consideration was given to several possible sites, notably the Baird site, on the tributary Pit River about eight miles upstream from Shasta, and the Table Mountain site, on the Sacramento River about twenty miles downstream from Shasta and about ten miles north of the City of Red Bluff. This last site is still (at the time of this writing) a possibility for another dam for flood control purposes, much to the concern of certain property owners and other elements in Redding and in the area which would be subject to intermittent flooding in the retaining basin which would be formed by Table Mountain Dam. The site chosen for more thorough investigation was that stretch of the Sacramento River between Coram and Kennett, twelve miles upstream from the City of Redding and about five miles below the confluence of the Pit, McCloud and Sacramento Rivers.

Head Tower and Mixing Plant



General view of Dam as it neared completion—April, 1944

At this location in 1924, 1925 and 1930, diamond drilling and tunneling explorations were performed by the State of California. Later, in 1936 and 1937, a final investigation was made by the Bureau of Reclamation, not only to determine the adequacy of the foundation but also to obtain data necessary for the final design of the dam. Foundation explorations, completed before construction work was started, consisted of 101 small-diameter diamond-drill holes with an aggregate length of 14,495 feet, three calyx holes of 3-foot diameter with an aggregate length of 188 feet and fourteen tunnels with an aggregate length of 5,732 feet. These investigations confirmed the opinion of the geologists that the foundation was adequate for the proposed structure.

GEOLOGY: William ("Doc") Gardner, geologist for the Bureau of Reclamation, Sacramento, California, has written the following interesting history and description of the rock formation in the vicinity of the dam:

"Shasta Dam is founded principally on a hard rock formation over 300 million years old. On casual observation all the rock appears to be about the same but close study discloses important differences in details which show that originally the rocks were remarkably different from their present condition and from each other. Most of the rocks were of volcanic origin; some were lava flows and dikes, others were originally volcanic ash (tuff and breccia) and still others were sands and gravels deposited by streams wandering through the ancient volcanic region. That period of volcanic activity was far older and had no relationship to the comparatively recent activity at Mt. Lassen.

"The ancient volcanic rocks were buried later under thousands of feet of sediments (sandstones, shales and limestones) and still younger volcanic rocks. Then the whole rock mass was tilted and squeezed into folds. Hot, molten masses rose from deep below the earth's surface and were squeezed into the crust where the masses solidified into granitic rocks. All of this caused the ancient volcanic rocks to be under high pressures and rather high temperatures. These conditions were so severe that to withstand them the rock materials had to rearrange themselves to take up less space; thus, a dense, hard, solid rock was developed by the alteration of the original materials. Since then the region has been raised up into mountains and erosion has removed much of the rocks that overlay the ancient volcanics and exposed the latter in the region of Shasta Dam.

"The original volcanic materials would have been called andesite. After alteration to their present condition they are called meta-andesite. Some of the best exposures are along the Sacramento River a few miles below Shasta Dam at the old railroad station of Copley and because of this the formation was named the Copley meta-andesite.

"In addition to the meta-andesite there are two fairly large dikes on the east side of the dam. They run about parallel to the river. One is a diorite and the other a dacite porphyry.

"The soil and rock outcrops are dominantly red and brown in contrast to the bluish green color of the fresh, unweathered rock. This is due to weathering which has oxidized the iron in the fresh minerals, much the same as iron or steel rusts and turns brown."

DESIGN: The two chief characteristics to be decided upon in the design of any dam are shape and the material from which it is to be constructed. Important considerations in the final selection of the kind of dam you build are topography of site, purpose for which the dam is to be used, foundation conditions, economy, safety of the structure, and architectural effects. As listed here, they are not

Excavation near bed of river—

necessarily in the order of their importance.

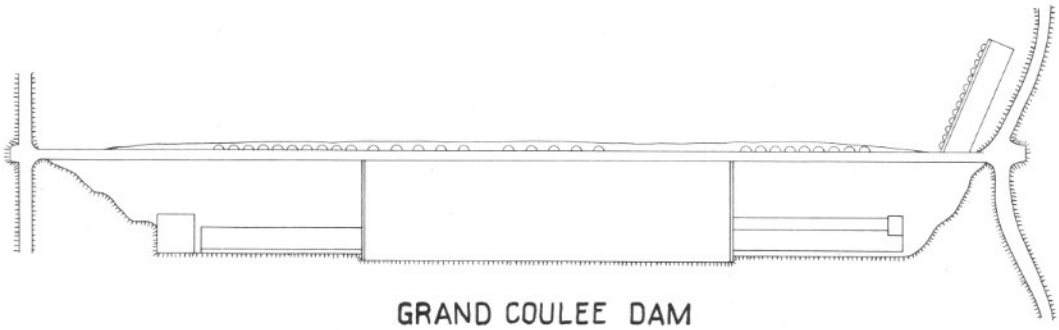
In the case of Shasta Dam the type finally selected was a curved concrete gravity dam as this was best adapted to all the imposed conditions. Safety and economy were, however, the primary considerations. As for safety, there were other dams of comparable height to use for precedent; and as for economy, both the spillway and many outlets could be made integral with the structure, thus eliminating costly separate structures. An illustration of economy is to be seen by comparing Shasta Dam with Boulder Dam. In the case of Boulder Dam, a deep

Note soft seams which had to be dug out

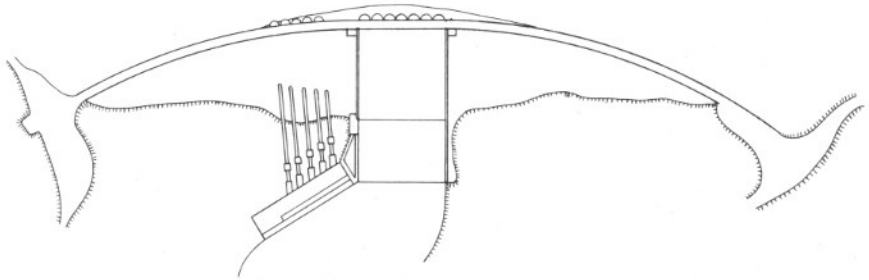
narrow gorge permitted a curved dam higher than Shasta, but due to the topography separate structures had to be built for the spillway and diversion facilities making Boulder a more expensive structure even though it contained only half the volume of concrete that Shasta required.

To fit most economically the topography of the rock foundation, the axis (upstream face) of Shasta Dam was designed with a radius of 2,500 feet, except for the 375-foot long straight overflow spillway section located at approximately the center of the structure and almost directly over the original bed of the river.

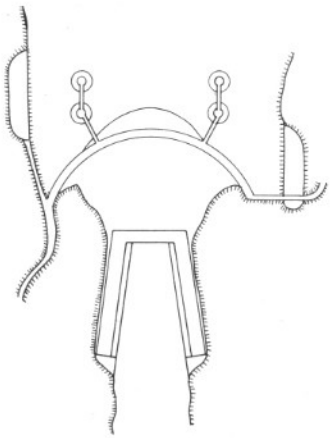
WORLD'S FIVE LARGEST CONCRETE DAMS



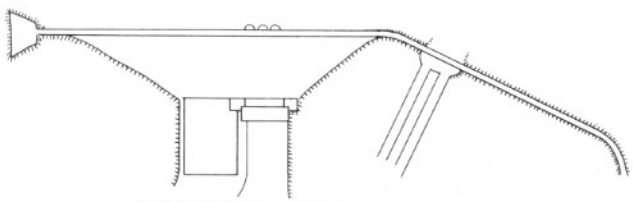
GRAND COULEE DAM
COLUMBIA RIVER ~ WASHINGTON
CREST LENGTH - 4,200 FT.



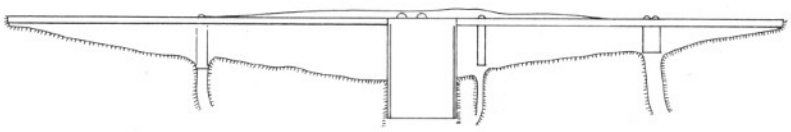
SHASTA DAM
SACRAMENTO RIVER ~ CALIFORNIA
CREST LENGTH - 3,500 FT.



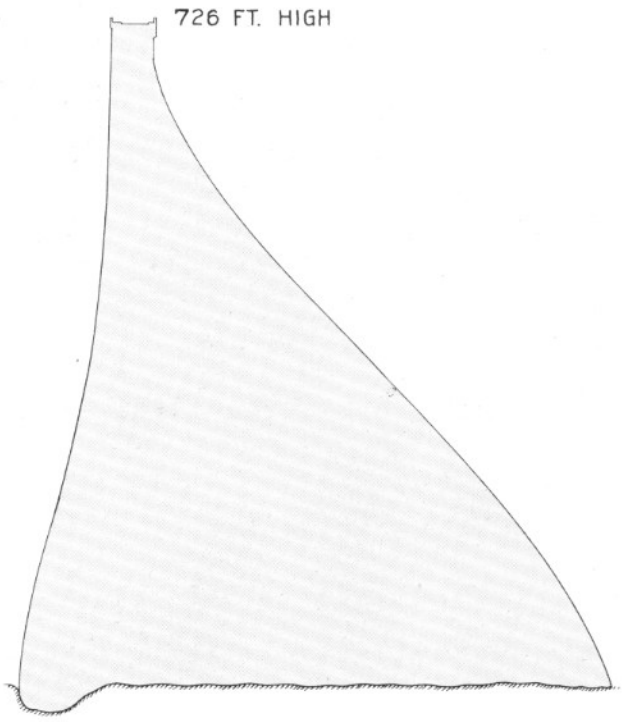
BOULDER DAM
COLORADO RIVER
ARIZONA - NEVADA
CREST LENGTH - 1,282 FT.



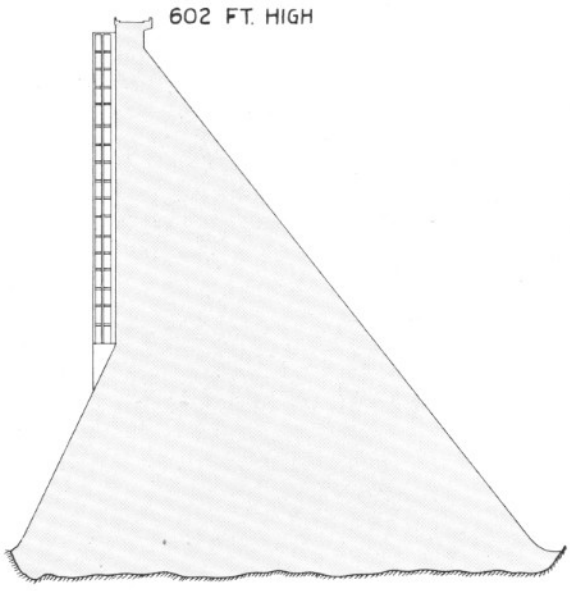
FONTANA DAM
LITTLE TENNESSEE RIVER ~ NORTH CAROLINA
CREST LENGTH - 1,750 FT.



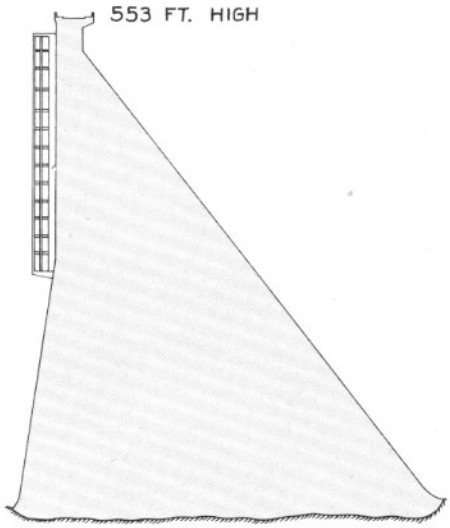
FRIANT DAM
SAN JOAQUIN RIVER ~ CALIFORNIA
CREST LENGTH - 3,430 FT.



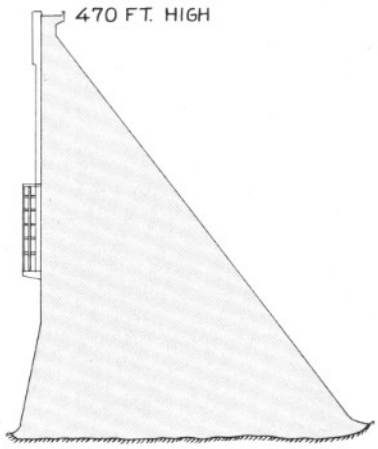
BOULDER



SHASTA



GRAND COULEE



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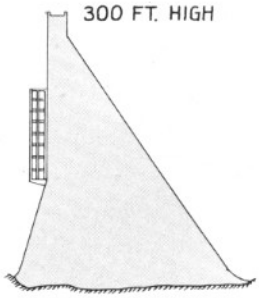
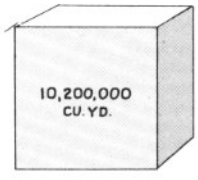
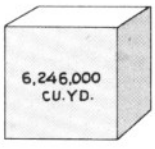


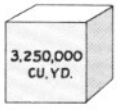
FRIANT



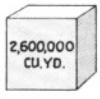
GRAND COULEE



SHASTA



BOULDER



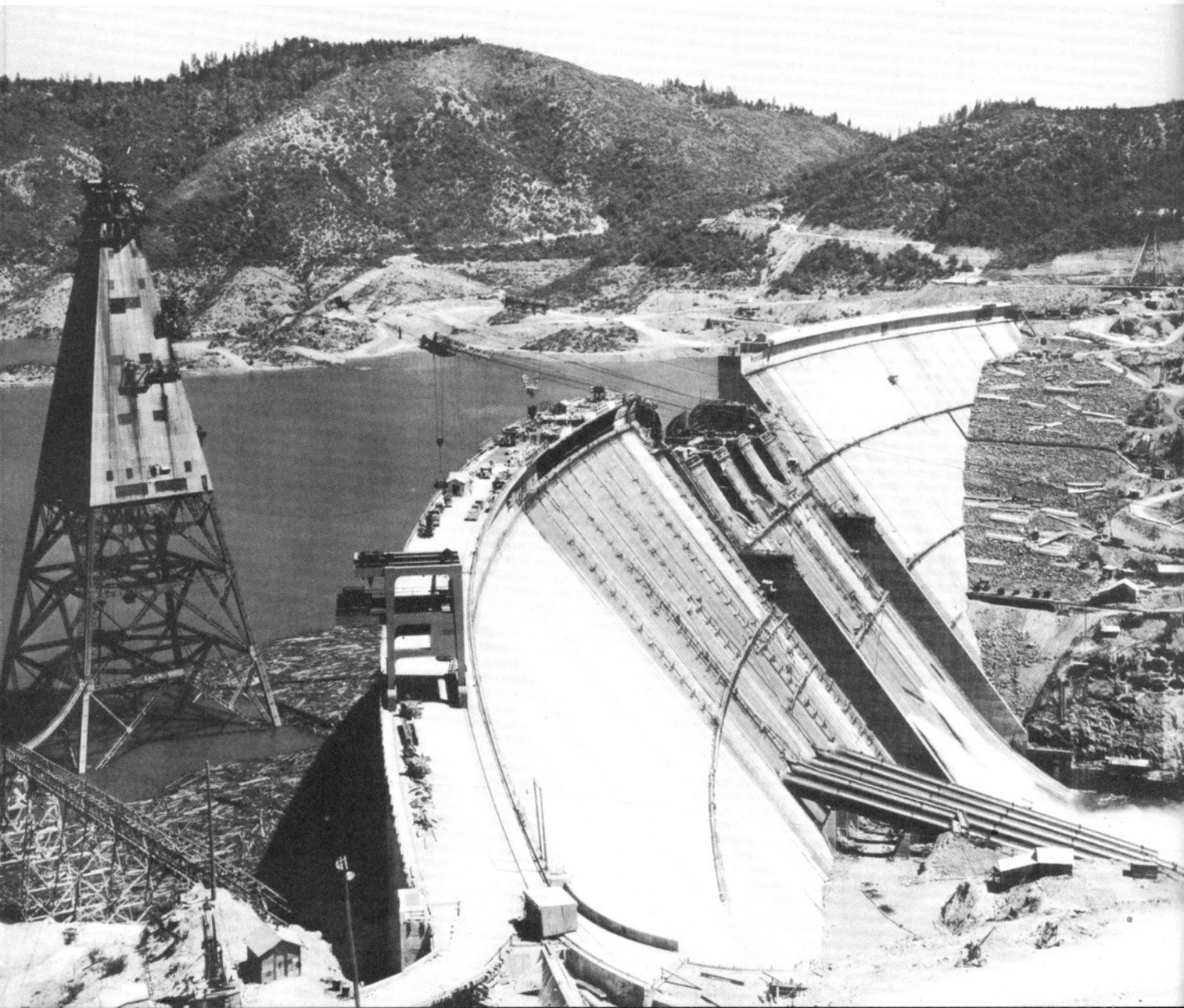
FONTANA

FRIANT

Also, by curving the axis of the dam, an additional element of safety is developed in that a small portion of the total external water load is transferred horizontally to the abutment foundation by arch action. At the left end of the dam, where it joins the abutment, an earth and rock-fill type dam, 525 feet long, with a concrete core wall, was adopted because of its economy and suitability to the geologic foundation conditions. At its junction with the concrete portion of the dam, this embankment has a maximum height of 100 feet.

After it was decided that the concrete gravity type of dam with curved axis was the most appropriate for Shasta Dam, the next step on the part of the designers was to determine the cross sectional dimensions and structural requirements for flood control. Trial sections were sketched for both the overflow and non-overflow portions (based largely on the results of analysis of other dams with similar

View of Dam from high on West abutment—May, 1944



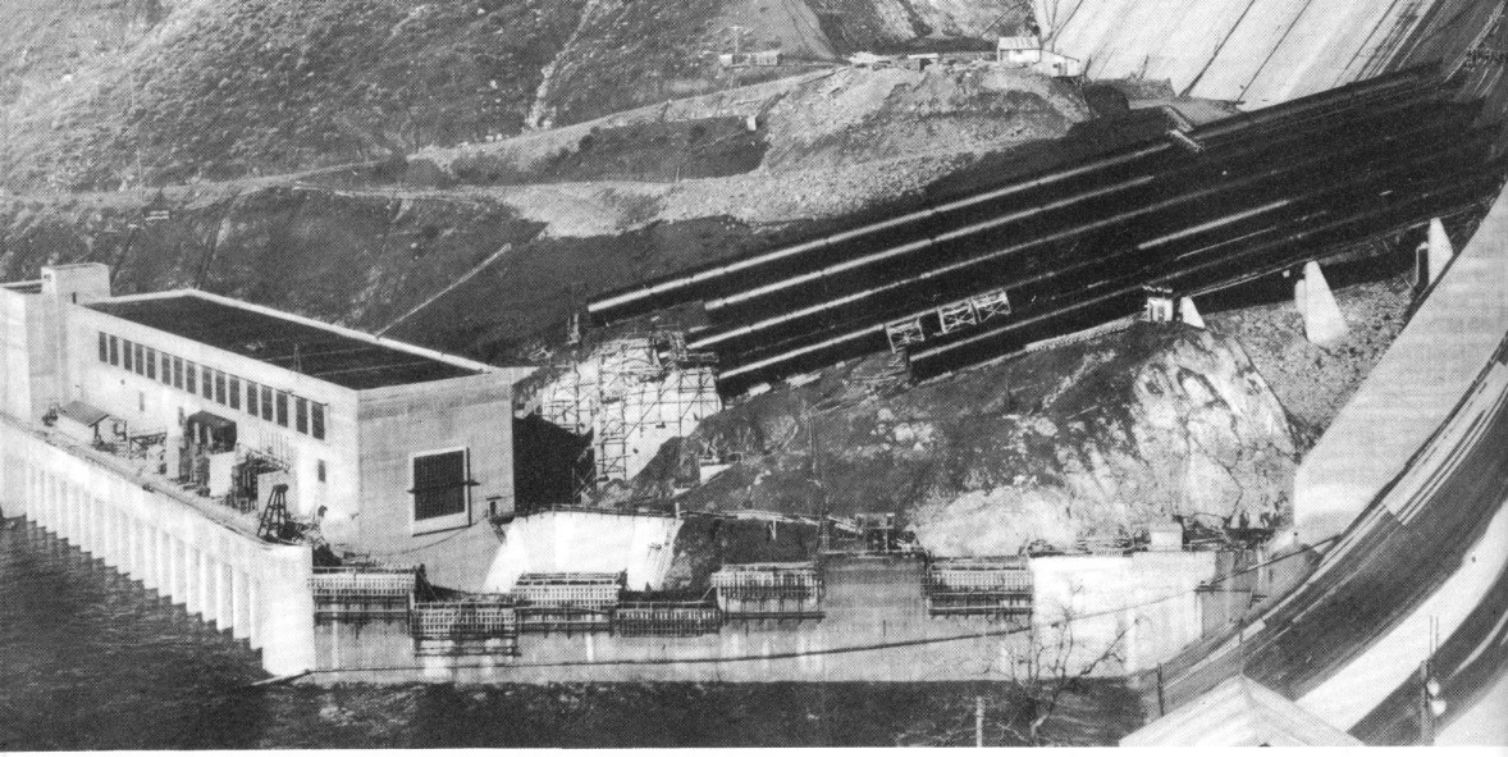
The apron below the Dam

characteristics). These sections were then analyzed to determine whether factors of safety were adequate.

The very word "gravity" in the description of this type of dam tells the story back of the basic assumption in determining the cross sectional dimensions. All resistance to loading is dependent upon gravity action entirely. That is, resistance against the tremendous load of water behind the dam trying to push it over or slide it down the canyon is dependent entirely on the weight of the structure itself. It is only natural, therefore, that the basic profile of a concrete gravity type dam be large at the bottom and taper toward the top, and that the upstream face be provided with a sloping fillet so that the weight of water pressing directly down upon it can help hold the dam in position.

In passing, it might be well to point out that it is the depth of water behind a dam that produces the load the structure must resist. Except for possible wave action during storms, the length of reservoir and quantity of water have no other effect on it. Thus, the reservoir would only need to extend upstream one foot to get the same loads that result with the reservoir twenty or thirty miles long.

Always considered in the design of modern structures is the possible effect of



Power House and Penstocks

earthquakes. This was not overlooked in the case of Shasta Dam even though there are no known active faults in the vicinity. Ancient faults and crushed zones were found as excavation progressed but they have been dead for many, many years. It was assumed that the horizontal and vertical components of an earthquake shock would have an acceleration equal to one tenth that of gravity (3.2 feet per second) and a vibration period of one second. The dam was accordingly designed to absorb that stress without rupture.

Power Plant: A major feature of Shasta Dam is the hydroelectric power plant located just downstream from the dam on the right bank of the river. Ultimately housed in the building will be five units, each consisting of a 103,000 horsepower vertical turbine directly connected to a 75,000 KVA generator, the turbine being served by a 15-foot plate steel welded penstock. At the time of this writing, only two units were installed and operating. World War II took its toll in the form of transfer of two other units to the Grand Coulee Power Plant, which was ready to receive them some time before Shasta was completed.

Power is generated at 13,800 volts and passes through transformers and a switching station at the dam for transmission at 230,000 volts to the substation farther down the valley.

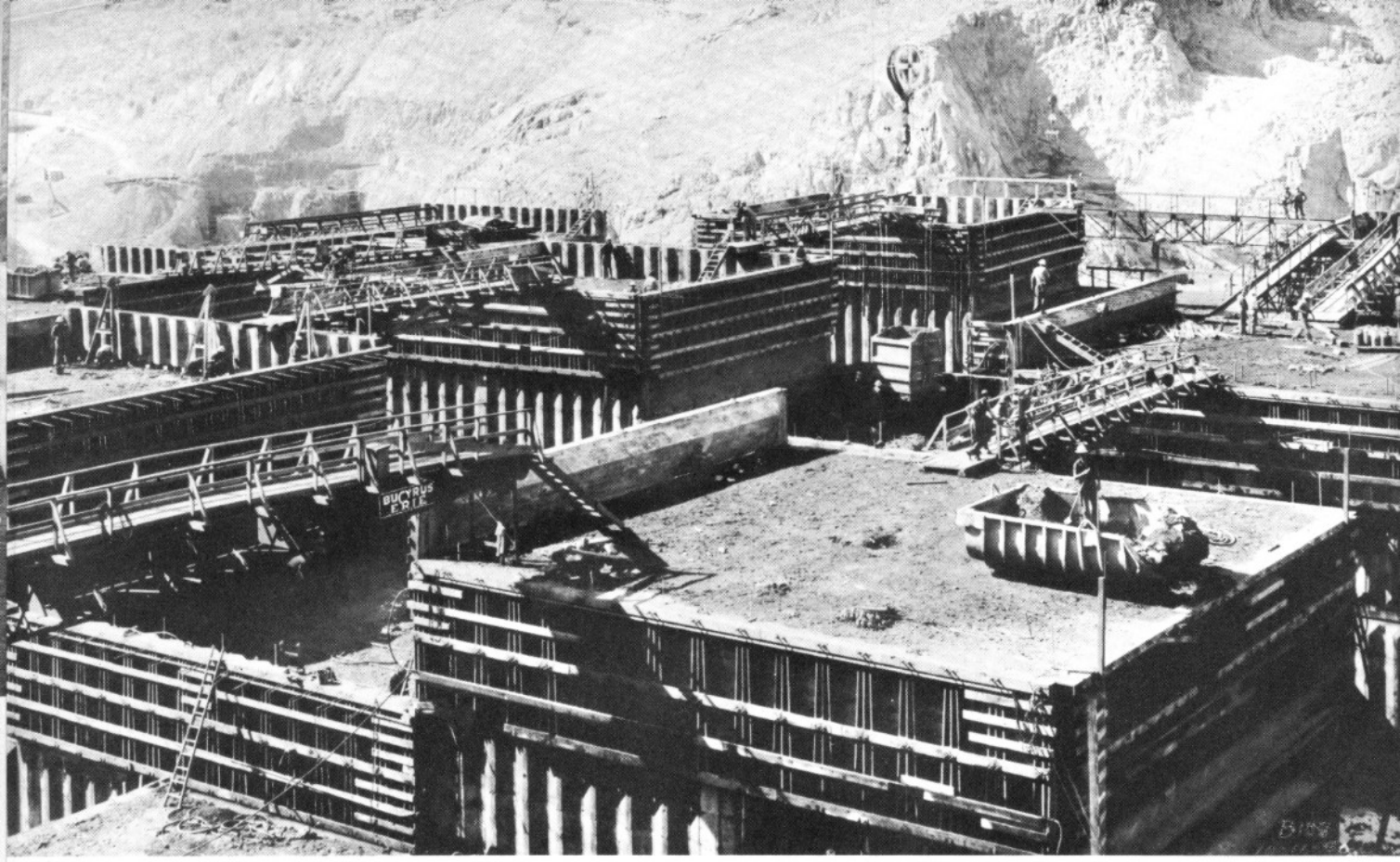
Block System of Construction: If Shasta Dam had been built by placing concrete in a single mass between two forms, built from abutment to abutment, outlining the upstream and downstream faces only, numerous inter-connecting cracks would develop similar to those in the natural foundation, if not worse. Concrete placed at an average temperature of 70° F. would soon attain a temperature of 105° F. because of the heat of hydration of the setting cement.

Eventually, under natural conditions, the temperature of the mass would drop to an average of 55° F. Thus there would be a maximum reduction in temperature of 50° F. with a consequent reduction in volume from the fact that a mass of almost any material shrinks as it cools. Under these conditions it can be computed that theoretically, a transverse crack 9½ inches wide would open up somewhere along the dam. Actually, because of restraint developed by foundation contact, a single crack would not be formed, but instead there would be numerous irregular cracks aggregating a total width of 9½ inches. It naturally follows that if these cracks were spaced 50 feet apart, each would have a width of something over ⅛ of an inch. Haphazard cracking would bring up a very serious problem; that of plugging up those cracks to prevent leakage and consequent leaching action on the soluble compounds of the concrete. So what better thing to do than to put the cracks where you want them and provide for sealing off those cracks after the concrete has attained its final temperature and contraction has stopped?

This was done by marking off the dam in blocks, roughly 50 feet square and installing pipe as the work progressed through which to pump a sealing mixture of cement and water when the cracks (joints) attained their maximum width. Thus was it possible to control the location, width, and even the time of opening of these predetermined joints. Longitudinal joints (parallel to the axis) were staggered where they crossed the transverse joints and were provided with horizontal keyways, whereas the transverse joints were designed with continuous vertical keyways to prevent slipping on lines normal to the axis.

COOLING THE CONCRETE: Many people have asked, "Why cool the concrete?" The answer is very simple. In a structure as large as Shasta Dam, many decades would elapse before the concrete would reach its final temperature and the joints

High and low blocks in high and low rows—Note use of cantilever type forms



Block system of forming

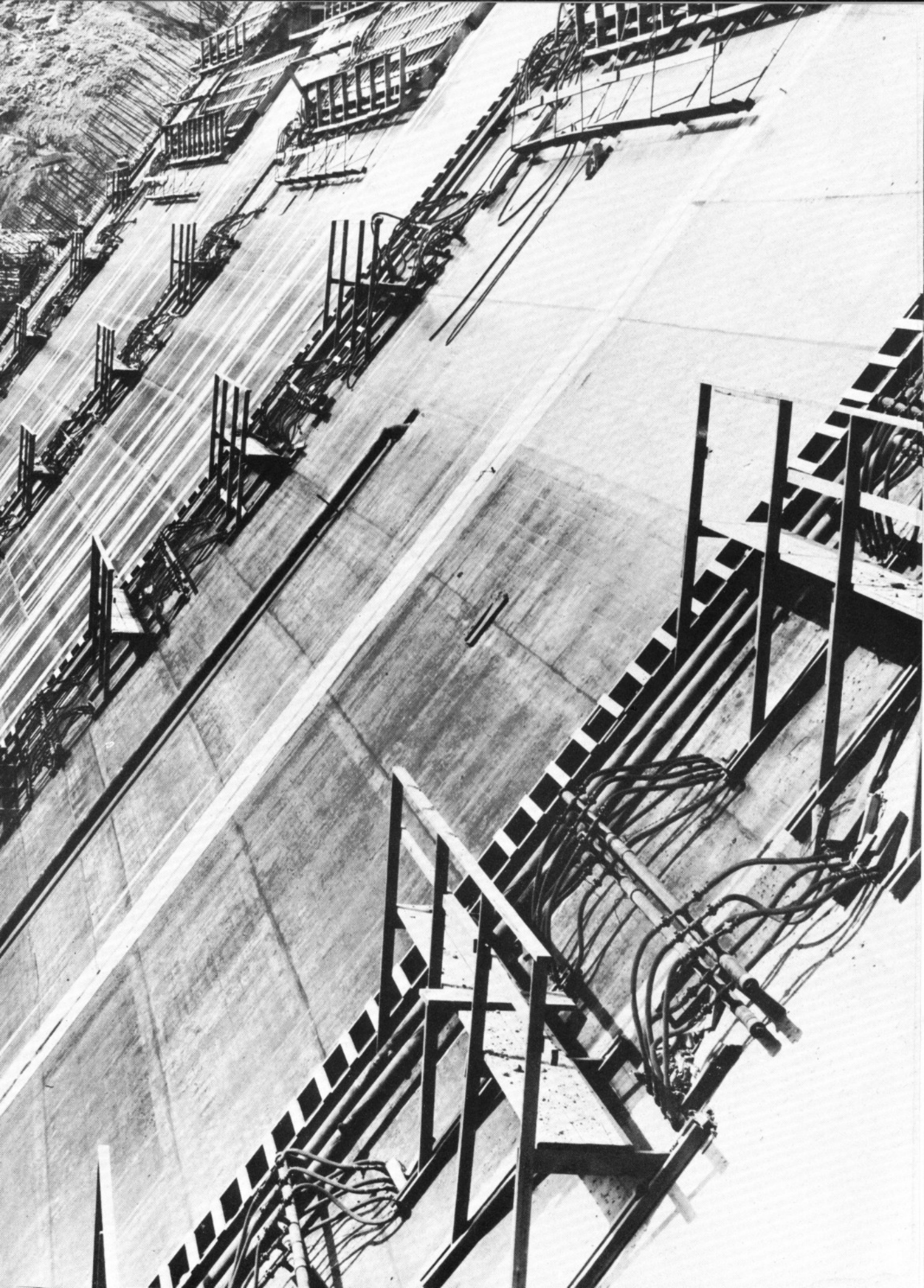
open up to their maximum width. This would delay the sealing of the joints and make it necessary to do this work after the reservoir had filled up—a difficult job at that stage of the game. Moreover, leakage would be bound to occur with its destructive results.

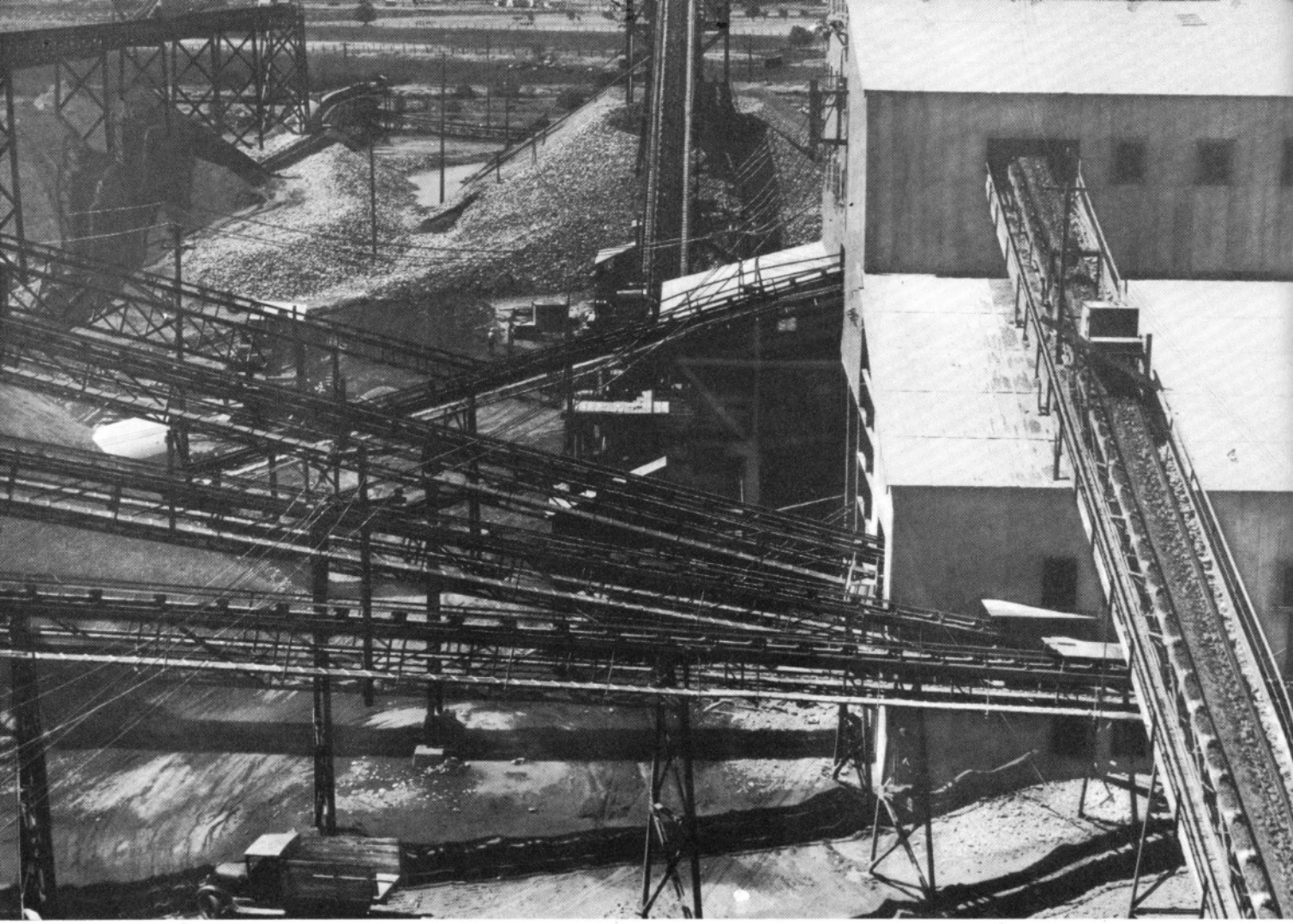
Artificial cooling of the concrete was accomplished by passing cold river water through coils of pipe imbedded in the dam. These pipes were one inch in diameter, placed on the top of each succeeding 5-foot layer of concrete. Coils averaged about 900 feet in length per block row, four being the number of coils required in each lift.

The coming of war to this country and the consequent increase in the demand for industrial power, made it necessary to step up the program for power development at Shasta Dam. This meant storing water ahead of the scheduled time which in turn meant that the cooling of concrete would have to be hurried up in order that the contraction joints could be sealed ahead of the rising reservoir. Speeding up the cooling was accomplished by the installation and use of a refrigeration plant. The water circulated by this plant went out at a temperature of about 35° (3 degrees above freezing), considerably below the normal temperature of the river water which varied between 45° and 70°, depending on the time of year.

Following are a few interesting facts about the concrete cooling system:

Cooling pipe connections—downstream face





Gravel Plant of Columbia Construction Co. in Redding

There are almost 1,300 MILES of cooling pipe in the dam.

Cooling water was passed through each coil at the rate of approximately four gallons per minute.

Lower parts of the dam and the volume around the penstocks were required to be cooled to a temperature of 48 degrees F. (expected temperature of the reservoir water at depths below 20 or 30 feet).

Upper parts were cooled to 60 degrees F. (about the average temperature of the air).

Pipe couplings were of the expansion type—tubes with rubber washers inside expanded by nuts on each end of the coupling.

Nearly half a million couplings were required for the job.

Refrigeration plants are usually rated at the number of tons of ice they can make in 24 hours. This one was rated at 250 tons.

CONSTRUCTION MATERIALS: In a dam of this type the outstanding materials, both from the standpoint of importance and volume, are of course, the cement

Section of world's longest conveyor belt system—Redding to Shasta Dam

and aggregates that go into the concrete. The United States Bureau of Reclammation furnished these items as well as all other material that went into Shasta Dam and its appurtenant works. Cement was manufactured at a plant (built on the strength of the Shasta contract), located near San Jose, California and called the Permanente Cement Company. The aggregates were produced at the site of a large gravel deposit in the City of Redding by the Columbia Construction Company.

Considerable preliminary work was necessary in the case of the aggregates to find a suitable gravel deposit within a reasonable distance of the dam. As early as 1935, and continuing for four years, a search was made for a suitable gravel deposit. During this period some sixty deposits within a radius of 100 miles of the dam were investigated and tested. The selection narrowed down to two sites—one known as the Kutras, at the bend of the river in Redding, ten miles downstream from the dam; and the other as the Hatch tract near Cottonwood, thirty miles downstream from the dam. Both of these tracts were advertised for bids. On the basis of the lower bid for the gravel from the Kutras tract, by the Columbia Construction Company, that one was chosen.

It was originally intended to deliver the aggregates to the dam by rail, but the Columbia Construction Company was given an extra work order to deliver it by belt conveyor at an appreciable saving to the government. This conveyor belt was 9.5 miles long originating at the site of the gravel plant in Redding and terminating at Pacific Constructors' receiving hoppers at Coram, one mile below the dam. This long belt conveyor system consisted of 26 flights of varying lengths, the longest of which was two-thirds of a mile. The steepest grades were set at 25%. Each flight was powered with a 200 horsepower motor and on the downhill stretches the motors acted as generators, feeding back into the power lines the power thus generated. The speed of the belt, 550 feet per minute, delivered the various sized aggregates at the rate of 1,100 tons per hour, the equivalent of a

44-car train in continuous operation between Redding and the dam. The belt width was 36 inches.

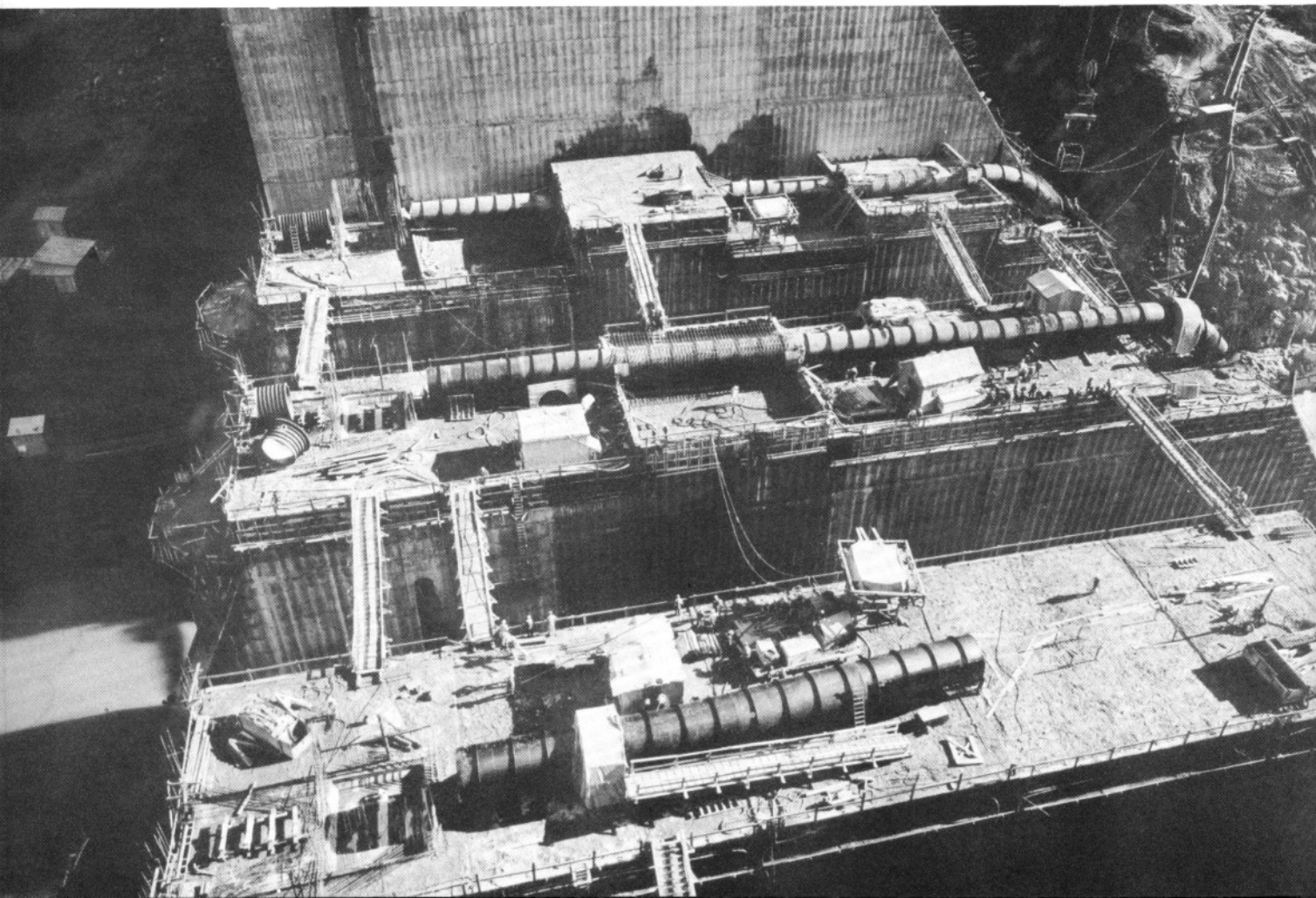
All flights of the conveyor system were remotely controlled from the Coram end. In starting the belt, the flight nearest Coram, No. 26, was first put into operation, and just as soon as this flight attained full speed, No. 25 automatically went into operation, and so on all the way back to No. 1 at the gravel plant.

Although Coram marked the end of the world's longest conveyor belt, it didn't mean the end of belt travel for the aggregates it carried, for at Coram the mile and a half long conveyor belt constructed by Pacific Constructors, Inc., took over in the job of getting the aggregates to the stock piles and thence on to the mixing plant. This belt consisted of 14 flights and travelled at a speed of 450 feet per minute, delivering 900 tons per hour to the mixing plant.

More than 12,200,000 tons of sand and gravel were carried over the systems of conveyor belts in the four years they were in operation. This was enough to fill 244,000 railroad cars which would make up a train 2,080 miles long—almost long enough to cover the distance between Chicago and San Francisco!

Cement, of a special low-heat type, was shipped from the Permanente plant in bulk state via Southern Pacific box cars. Each car had special transverse bulkheads built into it on each side of the center door. The cement would level off

102-inch diameter outlet pipes partially installed at the 742 elevation



behind these bulkheads to a depth of about 4 feet, giving the car the standard load of 300 barrels. An average of about 25 cars per day was required during the three year period of peak concrete production. Cars were unloaded at the silos by a battery of two 450 barrel-per-hour Fuller-Kinyon cement unloaders—sort of glorified vacuum cleaners on wheels operated by remote control. Rotating discs stirred up the cement and fed it to a short length of screw conveyor which in turn delivered to the spot in the machine where a jet of air would take hold for the remainder of the journey through several hundred feet of pipe to the top of the cement storage bins or silos.

Cement delivered to Shasta Dam totalled 7,600,000 barrels or 25,300 carloads. This many cars would make up a single train 215 miles long (the distance between Shasta Dam and San Francisco).

Other materials used in the construction of Shasta Dam included:

32 million pounds of reinforcing steel (320 car loads).

12 million pounds of plate steel for the 15-foot diameter penstocks.

18 million pounds of other steel items such as outlet conduits, coaster gates, large valves, structural steel and many other lesser steel features.

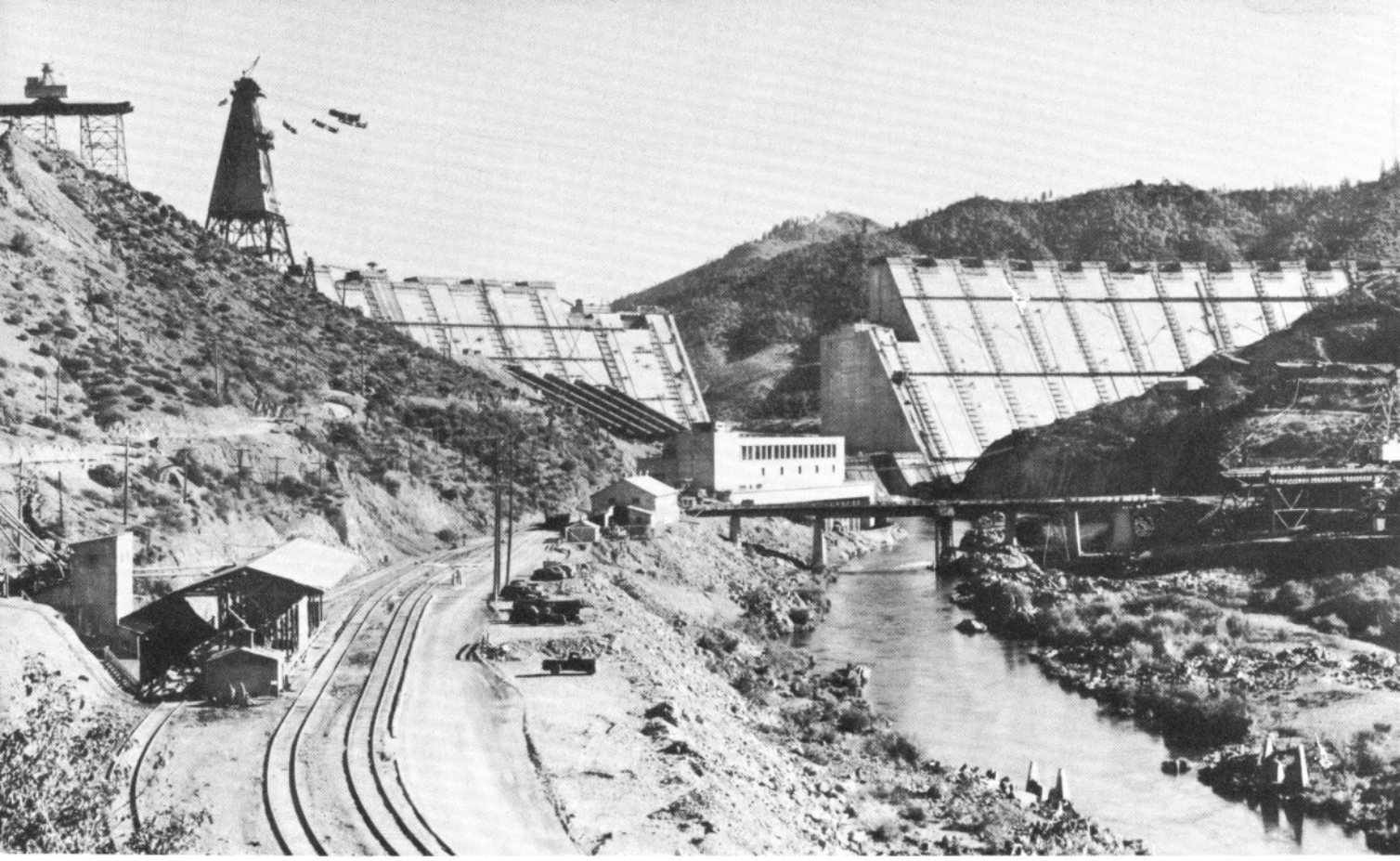
8 million pounds of pipe up to 48 inches in diameter.

SHASTA RESERVOIR: Shasta Dam forms a lake with a very irregular shore line creating arms reaching back into the canyons of the three principal tributary rivers: the Pit, the McCloud and the Sacramento. The longest arm, the Pit, reaches back into the hinterland of Shasta County for a distance of 35 miles.

Water to feed the reservoir comes from a drainage area of 6,665 square miles. This area, subject to from 60 to 120 inches of rain yearly, can produce tremendous floods during heavy storms. Records for the Sacramento River, over a period of 49 years show an average yearly run-off near the damsite of about 4,500,000 acre-feet, enough water to cover the 3,840 square miles of Shasta County to a depth of about 2 feet. The greatest flood recorded, occurred on February 26, 1940—a momentary peak of 185,000 cubic feet per second (eighty-three and a quarter million gallons per minute).

The capacity of the reservoir is 4,500,000 acre-feet. Equivalents in cubic feet or gallons run into astronomical figures—196,020,000,000 cubic feet or 1,470,150,000,000 gallons.

It is interesting to contemplate the effect of the weight of this body of water. Six and a quarter BILLION tons of NEW load presses down on an area of land which has lain more or less dormant for millions of years. This added pressure is bound to bring local reactions from time to time in the form of minor earthquakes or single and sudden shocks. The experts declare these will be minor in nature and will give no cause for alarm to the safety of the dam or buildings in nearby communities. The first of these disturbances occurred in November, 1944—a



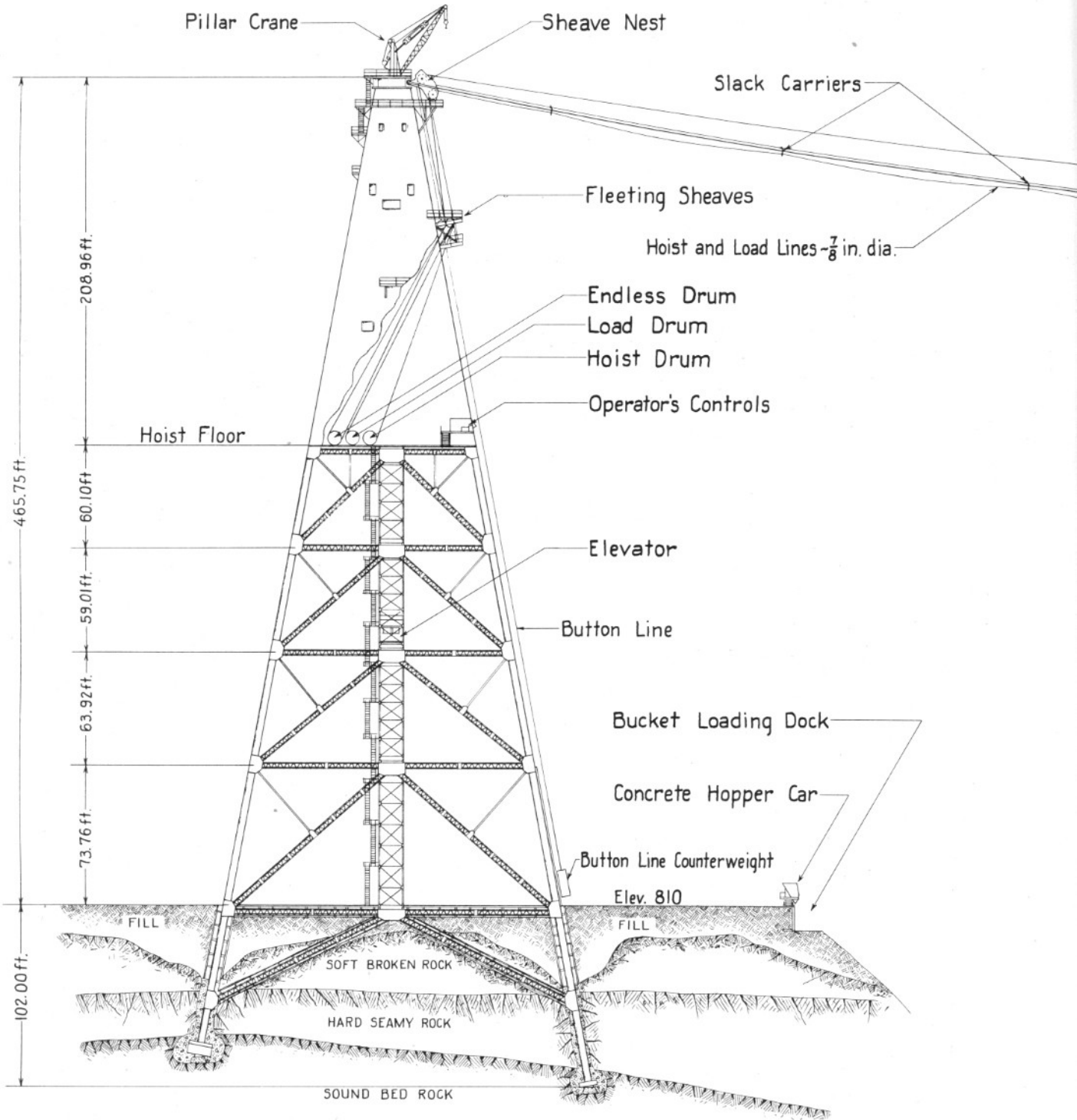
General view of Dam and Powerhouse—November, 1942

distinct single shock felt as far away as Redding. The reservoir at that time was only one-fourth full.

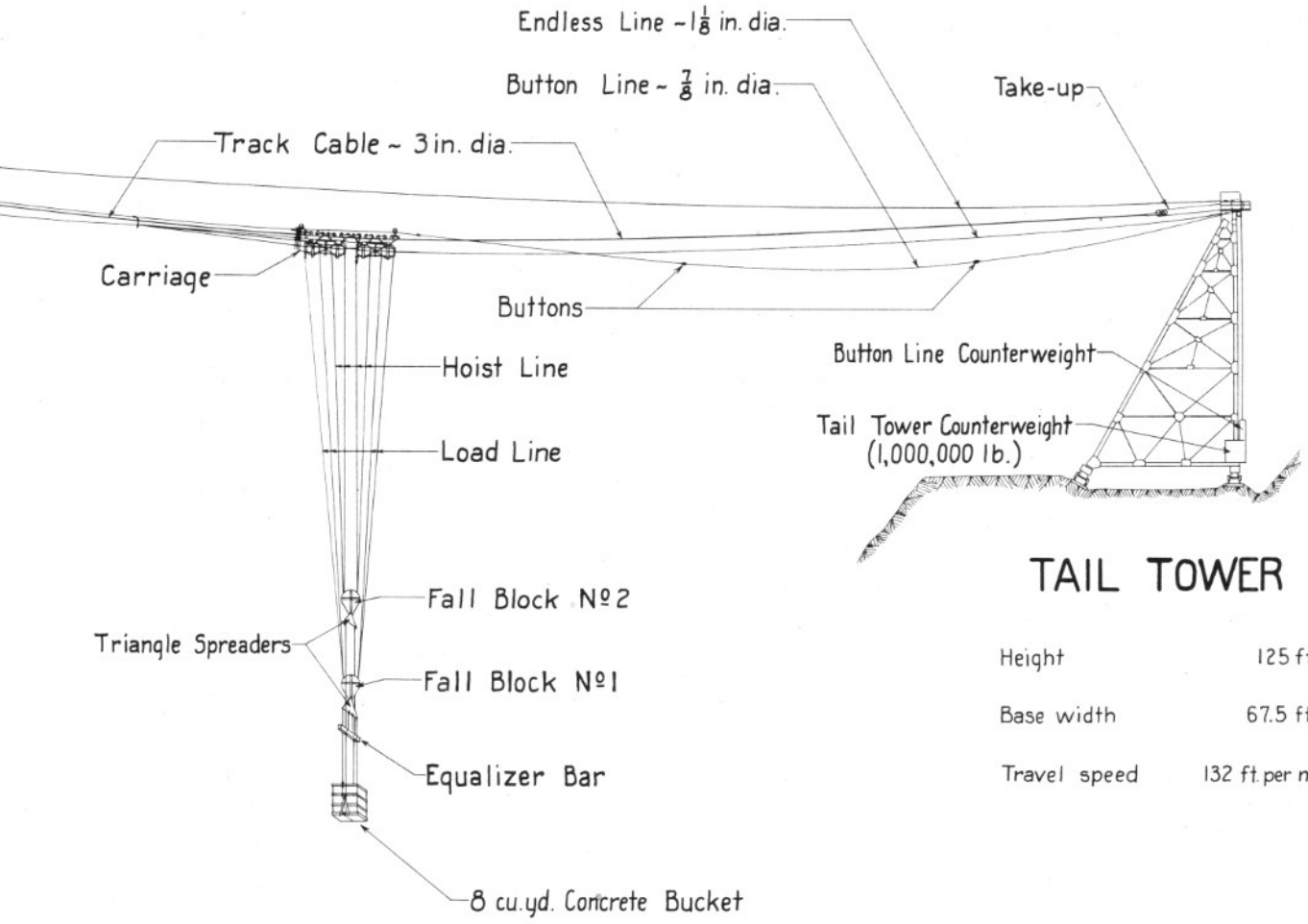
It is proposed to use the top 500,000 acre feet of storage in the reservoir for flood control. That means that at the beginning of the rainy season, say October each year, the outflow of water will have been so regulated that this 500,000 acre-feet will be available for the regulation of winter floods. In the spring of the year after danger of floods is past, the reservoir will be allowed to fill completely, providing ample capacity for the full generation of power during the summer and early fall months.

The story of Lake Shasta (or Lake McColl as it may some day be called in honor of the late State Senator John B. McColl of Redding who did so much in the early days of planning of Shasta Dam to keep the project alive) is not complete without mentioning its recreational possibilities. Although its prime functions have to do with such prosaic things as flood control and production of power, it is also a thing of beauty, enhancing an already popular area for vacationing campers, fishermen and hunters. Some day will see popular hotels and resorts springing up all along the rugged shore line, providing havens of rest for the weary business man and his family, or comfortable stopping places for the sportsman with his guns, and his rods and reels.

Two of the elevation 742 outlets in operation


Pillar Crane
Sheave Nest
Slack Carriers
Fleeting Sheaves
Hoist and Load Lines - 7/8 in. dia.
Endless Drum
Load Drum
Hoist Drum
Operator's Controls
Hoist Floor
Elevator
Button Line
Bucket Loading Dock
Concrete Hopper Car
Button Line Counterweight
Elev. 810
FILL
FILL
SOFT BROKEN ROCK
HARD SEAMY ROCK
SOUND BED ROCK
208.96 ft.
60.10 ft.
59.01 ft.
63.92 ft.
73.76 ft.
465.75 ft.
102.00 ft.

HEAD TOWER



TAIL TOWER

Height	125 ft.
Base width	67.5 ft.
Travel speed	132 ft. per min.

PARTS OF TYPICAL CABLEWAY
AS USED
AT
SHASTA DAM

Summary of Important Facts

Here are some of the facts and interesting data about the job in summary form to serve as a handy reference—maybe to settle little arguments about this and that!

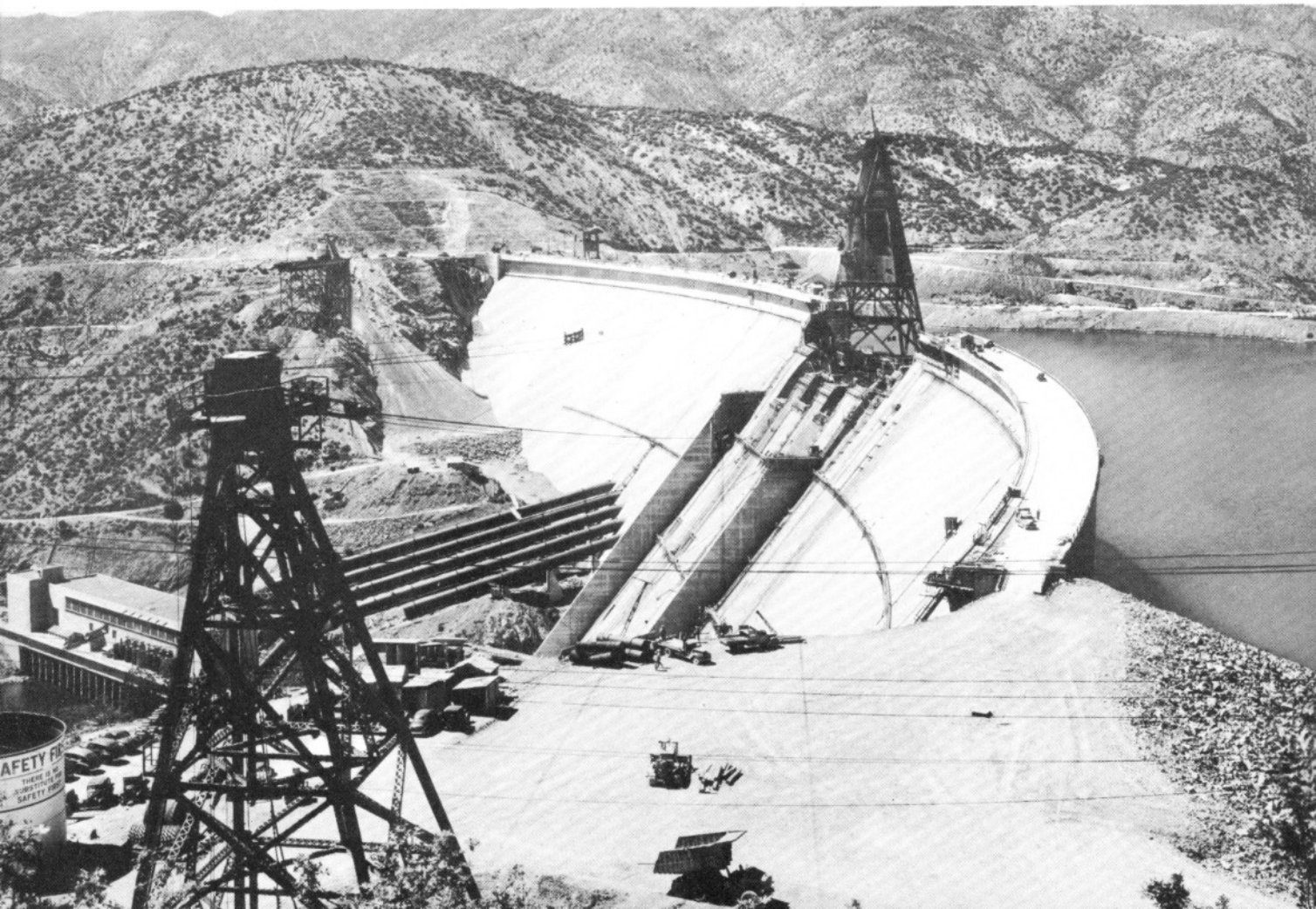
Size of Dam:

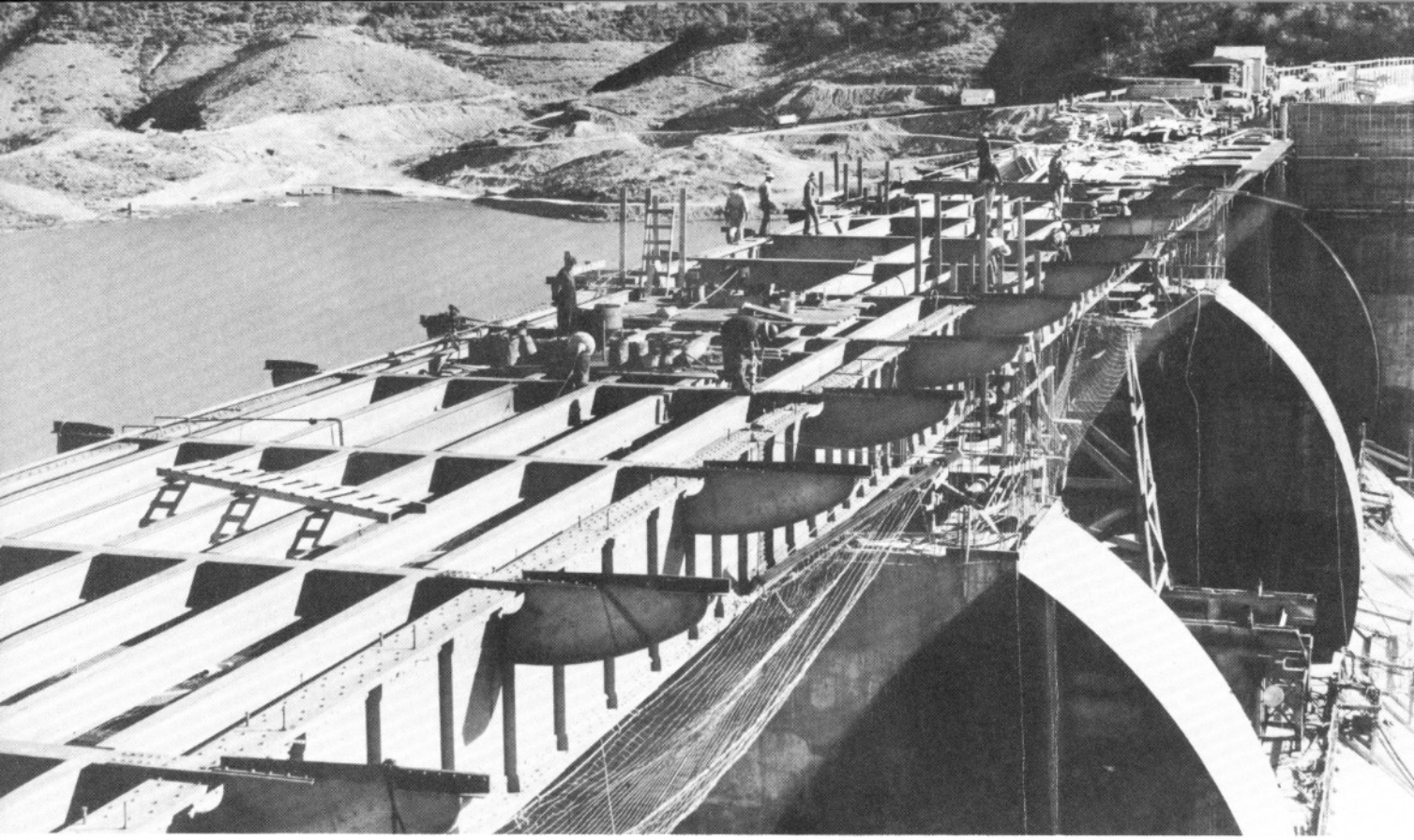
Length of crest	3,500 feet
Height above lowest point in foundation	602 feet
Base thickness—maximum	540 feet
Width of spillway section	375 feet
Width of roadway and side walks	39 feet 6 inches
Concrete content	6,246,000 cubic yards

Interesting Facts About the Dam:

Number of form panels raised and set	38,000
Number of 5-foot lifts of concrete placed	16,900
Number of 8-cu. yd. buckets of concrete placed	780,750
Total weight of dam	12,554,460 tons
Length of galleries in dam	5.3 miles
Total distance travelled by cableway carriages	378,000 miles

View from left abutment as dam nears completion—September, 1944





One of the last features to go in, the spillway Bridge—November, 1944

Size of the Power Plant:	
Length of building	453 feet
Width of building	107 feet
Height of building above foundation	156 feet
Penstock Data:	
Penstock diameter (inside)	15 feet
Minimum plate thickness	¾ inch
Maximum plate thickness	2⅜ inch
Construction—rolled plate—welded.	
Generator and Turbine Data:	
Generator rating (each)	75,000 KVA
Ultimate capacity of generators (5 units)	375,000 KVA
Turbine speed	138.5 RPM
Turbine capacity (each)	103,000 HP
Ultimate turbine capacity (5 units)	515,000 HP
Type turbine—vertical shaft-reaction type.	
Reservoir Data:	
Area of reservoir	29,600 acres
Length of reservoir	35 miles
Capacity of reservoir	4,500,000 acre feet

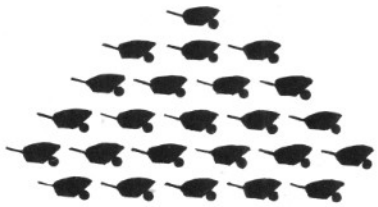
Quantities in Construction Features:

Excavation:	
Dam and apron foundation	3,770,000 cubic yards
Powerhouse foundation	210,000 cubic yards
Spillway channel below apron	321,000 cubic yards
Penstocks	120,000 cubic yards
Roads	472,000 cubic yards
Miscellaneous features	122,000 cubic yards
Total	5,015,000 cubic yards
Fills:	
Upstream embankments	1,500,000 cubic yards
Downstream embankments	550,000 cubic yards
Miscellaneous fills	22,000 cubic yards
Total	2,072,000 cubic yards
Concrete:	
Dam	6,246,000 cubic yards
Spillway apron and training walls	121,000 cubic yards
Spillway crest and piers	19,000 cubic yards
Trashracks	19,000 cubic yards
Powerhouse	70,000 cubic yards
Miscellaneous structures	60,000 cubic yards
Total	6,535,000 cubic yards

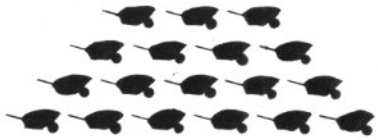
Aeroplane trippers at aggregate stock pile

HERE'S WHAT WAS IN AN 8 YD. BUCKET OF CONCRETE

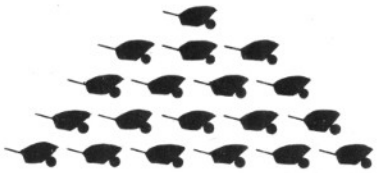
8 Barrels of cement



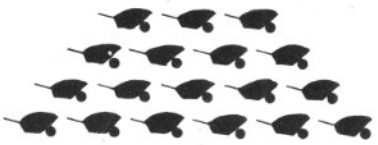
24 wheelbarrow loads of sand



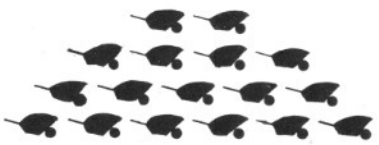
18 wheelbarrow loads of pea gravel



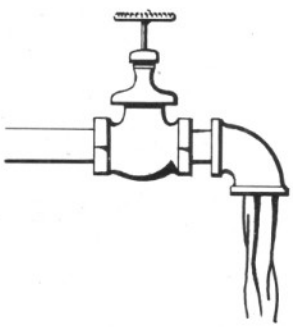
19 wheelbarrow loads of medium gravel



18 wheelbarrow loads of coarse gravel



17 wheelbarrow loads of cobbles



120 gallons of water

Random Thoughts

By Wm. A. Johnson, President Pacific Constructors, Inc.

A SIX-YEAR job—A long time—Yes, in many ways, but in other ways, the time seemed brief. Some tough worrisome years—but many pleasant recollections. 1938 peacetime—No more wars—too civilized. Yet in '41, we were plunged into the greatest war in history. We all suddenly found ourselves not only the busiest we have ever been in our lives, but also living in what was probably the most active, interesting age of all history. Economic, political and social changes—restrictions, priorities, shortages and dislocations in manpower, parts and equipment.

It was remarkable how the heavy construction industry, including P.C.I., met these changed conditions. Educating ourselves as we worked—familiarizing ourselves with the new conditions—solving new problems with one thing always in mind, keeping the project moving ahead.

At the time of bidding, it will be remembered how we weighed and discussed the facts that this contract might be the longest contract in point of completion ever let by the Bureau, and that we might have physical hazards such as earthquakes and floods—social upheavals, inflations or even deflation. In 1940 we actually did survive the greatest flood in the history of the Sacramento River (185,000 second feet). It was also in 1940 that we found wage rates rising sharply all around us and we were on a fixed price contract. It may be interesting to recollect that the average hourly rate in 1938 at the start of Shasta Dam was 99c per hour. The average hourly rate November 24, 1944, was $1.60.

It is difficult now to understand how, during the last two years of the contract, the necessary men were found to keep the job going. At times it looked as if the work would be closed down, but somehow, though slowed-down and crippled, the job was finished.

Considering the size of the job, the many difficulties encountered and the

Interior view of Power Plant—Two units installed

fact that Bureau of Reclamation relationships are loaded with tradition and rituals that age brings to any large institution, our relationships with them were remarkably happy and free from bitter contentions. The Bureau and ourselves were fortunate in their selection of Ralph Lowry as Construction Engineer—Scotch ancestry, experienced, plenty tough, but fair and with a sense of humor so that the tough doses were made nearly palatable. Those serving with him have been able and courteous although a few of the younger men were sometimes so imbued with the idea of the necessity of rigid adherence to precedent that "the old man" with his drive and his desire to get things accomplished, nicknamed one or two of them facetiously and good-humoredly, "The great delayers". On our part, I believe that the Bureau, early in our association, found that we were not trying to build up any astronomical claims for extras and were willing to settle questions on merit so that it is felt we enjoy their respect and confidence.

The twenty-two surety companies who bonded us for $7,500,000 have never had much occasion to worry. They carefully kept their eyes on us the first year, but as soon as they determined that we knew how to handle the job—knew where we were going, and that we were successfully meeting and licking the problems encountered, they left us pretty much alone. The surety committee composed of W. M. Walker, of Fidelity & Deposit Co. of Maryland, chairman of committee, together with H. C. Gillespie of U. S. Fidelity & Guaranty Co., Walter R. Whitford of Hartford Accident and Indemnity Co., R. S. Possinger of Aetna Casualty & Surety Co., T. W. Wisdom of National Surety Corporation, with Guy Leroy Stevick as "grand patron emeritus" was always helpful, cooperative and safely sympathetic.

Generally speaking, the beginning and ending of a large contract takes more time, attention and real work by all hands, than the in-between period. The fine work done by the various members of the organization as well as the various committees should be commended. In getting started, Dave Daly did a whale of a job in purchasing as did L. E. Dixon and his Engineering Committee in the engineering layout. A word of appreciation is due our directors who, though busy with their own affairs and increasingly so as we got into the war, were always willing to give whatever time was needed to help and advise. The Executive Committee for the entire six years was a bulwark of strength and helpfulness. But Frank T. Crowe, our able, experienced general superintendent, made it much easier for all of us.

I wish to express my appreciation of the fine work done for Pacific Constructors, Inc., by J. C. (Jack)) Maguire. For instance, Jack sponsored negotiations with the Unions for the Labor Agreement. The contract finally entered into was broad and fair to both parties and was greatly responsible for the peaceful labor relations enjoyed throughout the life of the job. We must give credit to the unions for scrupulously living up to their part of the agreement. Mr. Maguire's wise

The Dam nears completion—November, 1944
Note man working on face of Dam just above near end of catwalk

counsel on other matters which was always available throughout the job was invaluable to the company. It was a pleasure to work and to be associated with him.

On assembling the data, pictures, names, historical backgrounds and much other work for this book, due credit should be given to Dave May and Mrs. May. Their thoughtful and wise selections and other work done have been a real and vital contribution to our Shasta Dam book.

One of the most satisfying recollections we all have is the fine relationship established between the various associates in the work. Some of us hardly knew each other when we bid the second Coulee. We were only a little better acquainted when we bid Shasta, but after the first few weeks and months, we commenced to really get acquainted. When one considers the various companies from the East and West and from the North and South; when one further considers the different individuals and different personalities that headed these companies—that each company was outstandingly successful and capable in the construction line so that each one felt itself to be and was qualified to sponsor the contract and run it successfully—and that each head was used to giving orders and not to taking them, it is not to be wondered that some of the outside construction fraternity, and perhaps a few inside, felt that there would be trouble in the administrative waters ahead and that the individuals would soon be fighting like a bunch of Kilkenny cats. Fortunately, it did not prove to be so—we got off to a good start. We all knew these possibilities and all were particularly considerate. Everyone pitched in and everyone remembered when they were privates and they could take orders as well as give them. Last but not least, we had a good job to go to work on.

I believe it is safe to state that each and every member of our group is proud of having had a hand in the building of Shasta Dam. That is my feeling though I confess that I am prouder still of my associates, both the fellow workmen on the job and in the organization. I have never worked with a finer body of men.

W. A. Johnson

General view of Dam—November, 1944

Upstream view of Dam—August, 1943

United States Bureau of Reclamation

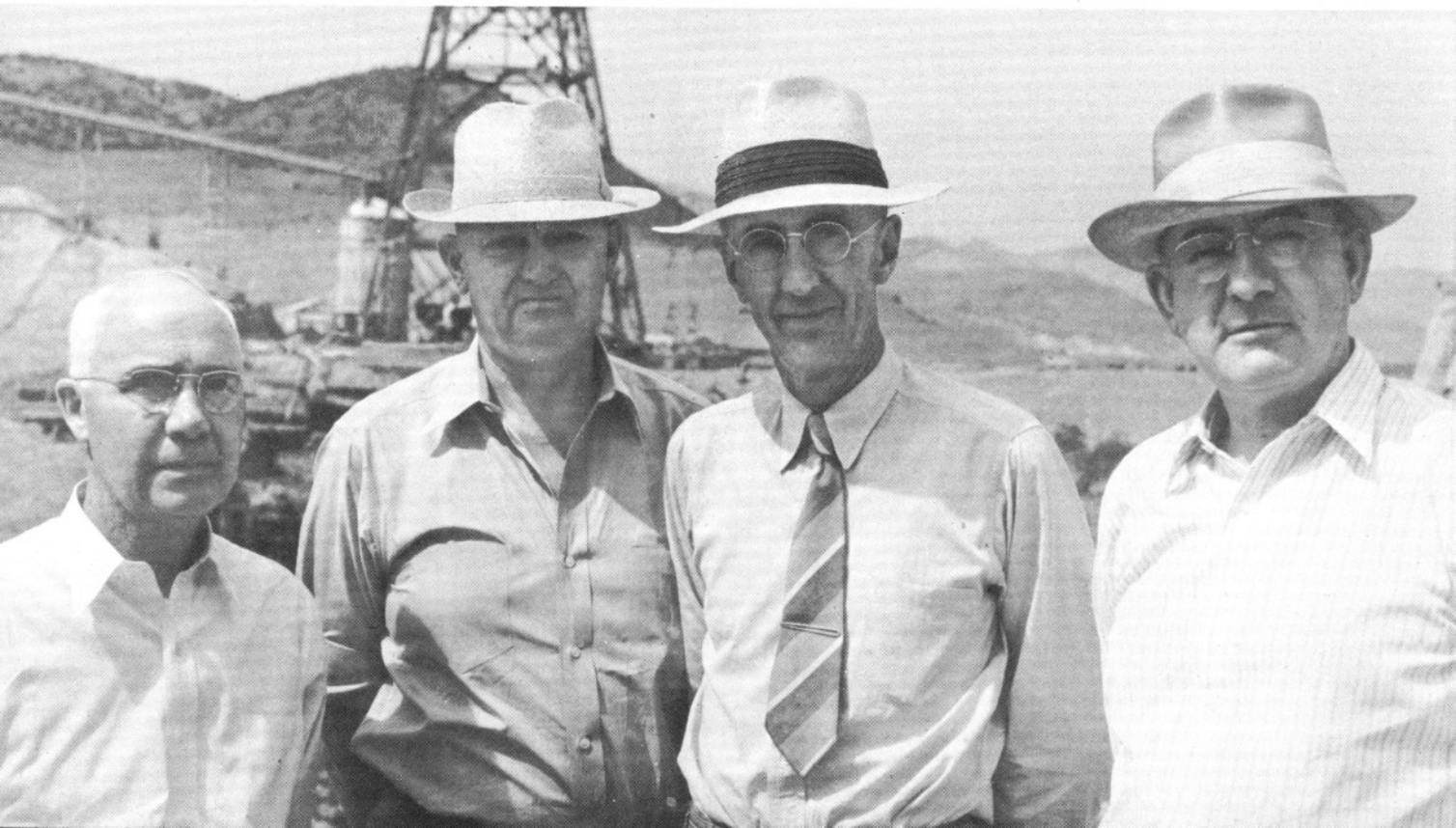
By David C. May

SHASTA DAM was built under the direction of the United States Department of the Interior, Bureau of Reclamation. For many years, this branch of the Federal Government has played a very important part in the development of irrigation projects, power projects and major flood control works in the West and Middle West.

At the time work on Shasta Dam was started, John C. Page was Commissioner of the Bureau, and he continued in that capacity until 1943 when ill health forced his resignation. At that time H. W. Bashore was appointed to fill the post.

In the Denver office of the Bureau, S. O. Harper was Chief Engineer; W. R. Young, formerly Supervising Engineer of the Central Valley Project, was Assistant Chief Engineer; and J. L. Savage was Chief Designing Engineer. On December

Left to right—J. L. Savage, F. T. Crowe, S. L. Harper, Ralph Lowry.



10, 1944, Mr. Harper retired and Mr. Young became Acting Chief Engineer.

The Construction Engineer in charge of the Kennett Division was Ralph Lowry. His was a job that covered all phases of the work, including the railroad and highway relocations, and Keswick Dam in addition to the construction of Shasta Dam. Grateful recognition is herewith given his friendly cooperation with the individuals and organizations of Pacific Constructors, Inc.

Electrical Engineer in charge of the Power Plant and Transmission lines was Irving C. Harris.

Field representatives of the Bureau were Grant Bloodgood, Assistant to the Construction Engineer, 1938 to 1942; J. Roscoe Granger, Acting Assistant, 1942 to job completion; Wilbur A. Dexheimer, Chief Inspector, 1938 to 1942; Charles S. Rippon, Chief Inspector, 1942 to job completion; Earle C. Smith, Field Engineer; and W. S. Sanford, in charge of materials.

Office representatives included Charles G. Anderson and Charles O. Wamstead; office engineers, R. C. Thaxton, in charge of estimates and quantity computations; and Fred W. Gilbert, Chief Clerk.

Local U. S. B. R. Representatives:
Left to right—Earle C. Smith, Charles O. Wamstead, Charles S. Rippon, W. S. Sanford, J. R. Granger, R. C. Thaxton, Fred W Gilbert, Irving C. Harris, Ralph Lowry
Upper left insert—W A. Dexheimer *Upper right insert—Grant Bloodgood*

U. S. B. R. Inspectors

Diverting through 44 row—June, 1943

Construction Personnel

DURING THE course of a long construction job, a veritable army of men come and go. Shasta Dam was no exception. Labor turnover was a problem here, particularly after the war started and we began losing men to jobs more directly connected with the war effort as well as to the armed forces. Considerable effort and money were expended in the recruiting of workmen from Sacramento, San Francisco, and even as far away as Los Angeles. These efforts helped to keep the job going, but the real credit for keeping work under way should go to a nucleus of faithful employees who stuck to their guns and finished the job, in spite of almost universally higher wages in other lines of war work. It is with a great deal of pride, therefore, that Pacific Constructors acknowledges the work of this group of faithful employees by publishing the following list of names. If, through oversight, any deserving name has been omitted from this list, we are indeed sorry.

The following men served on this job in one capacity or another for five years or more. Some of them have been building dams for thirty-five or forty years.

Clyde B. Akin
J. V. Allen
Andrew Anderson
Thomas A. Anderson
George Backley
Elmer R. Baker
John Barbera
Maurice O. Barcelo
Helmar O. Benson
Max Bingham
Mike S. Bischof
Gerald R. Black
Harold G. Bloom
George D. Bogovich
Murray L. Bohn
C. M. Bonney
Anthony (Si) Bous
Dale F. Bryant
Frank S. Bryant
Leonard A. Brown
Albert M. (Brownie) Brown
Charles W. Brown
Frank M. Brooks
Bristol L. Broderick
Merritt C. Butler
William F. Campbell
Gabe Castro
Robert Caton
Thomas J. Caulfield
Gerald A. Celletti
Clarence G. (Pete) Chandler
Joseph Chesnut
James H. Choate
John E. Clark

Downstream face of completed spillway—November, 1944

Howard Colby
Pete C. Conroy
Hugh C. Cox
Fred A. Crandall
Alonzo H. Crawford, Jr.
Morton L. Cross
Clifford Daniels
Arthur L. Davis
Charles M. Davis
William D. Davis
Fausto De LaVega
William N. Delorme
Mitch D. Dimich
Vijo A. Doman
Frederick G. (Dunk) Dunkel
Wilfred Emmertson
Jacob P. (Jake) Eres
C. H. Femmer
Elmer A. Foote
Pete Forte
Edgar C. Frank
Leon H. Freckleton
Fred Freed
Albert J. Gannon
Art C. Garzet
A. G. Gershanoff
France P. Gillum
William V. Greeley
Arthor J. Griffay
George S. Grosse
Willard Hamilton
Claus W. Harders
Donald W. Hart
Paul H. Hartwig
Kenneth A. Henry
James L. Hicks
Len B. Hillhouse
Clarence E. Hopper
Raymond L. Horner
Jack C. Howard
Butler T. Howell
Virgil J. Howell
John D. Hubbard
George S. Hurlburt
James R. Jackson
Lewis J. Jacobson
M. L. Jarvis
Arden O. Jensen
Omar L. Jerome
Frank A. Johnson
Leo E. Jones
Robert L. Jones
Troy D. Jones
Verbun (Joe) Jordan
Andrew M. (Spike) Jorgenson
Bert Kern
Oscar L. King
Clarence G. Kinnaman
Robert Kirkham
John E. Kirkpatric
Charlie Kitterman
Roy C. Kohl
Joseph A. Kortuem
William R. Kortuem
Ernest Lane
James Lauder
Robert S. Leslie
Edward R. London
John P. Lonnberg
Thomas N. LoVato
Earl H. McAdams
Harold E. (Pat) McCarty
Arch C. McCracken
Raymond E. McMillan
John H. McNees
David C. May
Clyde A. Mead
Thomas J. Meehan
Albert A. Miller
Joe C. Miller
Ruben H. Miller
John P. Moskoff
Henry L. Murphy
Francis D. Myers
Robert H. Myers
Oswald Nauman
Albert Norton
Herbert Nowotny
Carl Opsahl
Jack W. Orth
Lewis E. Osborn
Victor R. O'Shea
Bart H. Payne
Lamar J. Pearce
Jens Pederson
Clifford L. Peterson
Henry A. Pieper
Thomas L. Powell
Paul T. Pulley
Kenneth W. Rawlins
Ben Rementeria
Eugene P. Rendahl
J. P. Riley
Sam L. Robertson
William S. Robertson
George H. Robinson
Loy Robinson
Charles S. Rockwell
Therman T. Rogers
Elmer O. Ronning
William B. Ross
Martin G. Rude
Mike Ryan
Robert F. Sass
Marvin C. Scherz
George Schlenz, Jr.
George L. Schmidt

Felix A. Schonrock
Carl Schrupp
Albert E. Severson
Joseph F. Shea
Albert E. Sherman
Rudolph Shuhart
Clarence A. Shutt
Peter L. Sideroff
Melvin C. (Charlie) Silva
Charles H. Sims
Virgil A. Siverts
Brant Skelton
Elmo E. Skuce
Dorthy N. Small
Earl P. Smith
John L. Smith
Joseph L. Smith
Mike G. Shilakis
Alton L. Shjeflo
Dixon Snyder
L. P. Sowles
Richard H. Stackhouse
Arthur B. Stewart
Quinton D. Stokes
Earl E. Stone
Bruce S. Taylor
George E. Thompson
Louis J. Toth
Gus F. Trapp, Jr.
Gus F. Trapp, Sr.
George E. Tripp
Robert B. Tucker
C. H. (Pat) Unger
John Ures
James S. Valentine
Jacob G. Van Alstine
Walter J. Van Veghten
Douglas H. Walker
Charles R. Wallace
Gordon J. Warner
Arleigh W. Watson
Jess Wentz
Walter R. West
George D. White
Charles H. Wilson
Raleigh G. Wirth
Jessie W. Withers
Lawrence Wortley

Powerhouse takes shape

Community Service

A job the size of Shasta brings a community life with its responsibilities—schools, church, youth education and recreation. The splendid work of the following individuals and organizations is gratefully acknowledged:

School:

Trustees over the six-year construction period included: Elmer Baker, David C. May, Henry L. Murphy and Rudolph Shuhart.

Youth Organizations:

Boy Scout leadership was furnished by Bert Goodenough, Henry L. Murphy, Wm. V. Greeley, Frank Myers and Walter Van Veghten as troop committeemen, and by David C. May as district commissioner. Dr. Everett B. Myer was cubmaster and Mrs. Viola P. May and Mrs. Jack Howard, cub den-mothers.

Girl Scout leadership was in the hands of Mrs. Gay Most and Mrs. L. E. Osborn.

Church:

The local members of the Mormon Church conducted primary classes and summer Bible Schools, and Woodrow Ruble, of the electrical department, presided over a young people's Sunday School. As conducted, both of these were nonsectarian in character.

War Effort:

The women of Shasta Dam village did their share of war work. This consisted mainly of Red Cross sewing and knitting with Zella Larson, chairman, and Viola May, Viola Wirth and Grace McAdams, members of the sewing committee. Mrs. Viola Wirth was later chairman of this group. Mrs. Gay Most was knitting chairman. This committee also was in charge of the administration of the community house—a five-room residence remodelled and set aside for a meeting place for various organizations for study or recreation.

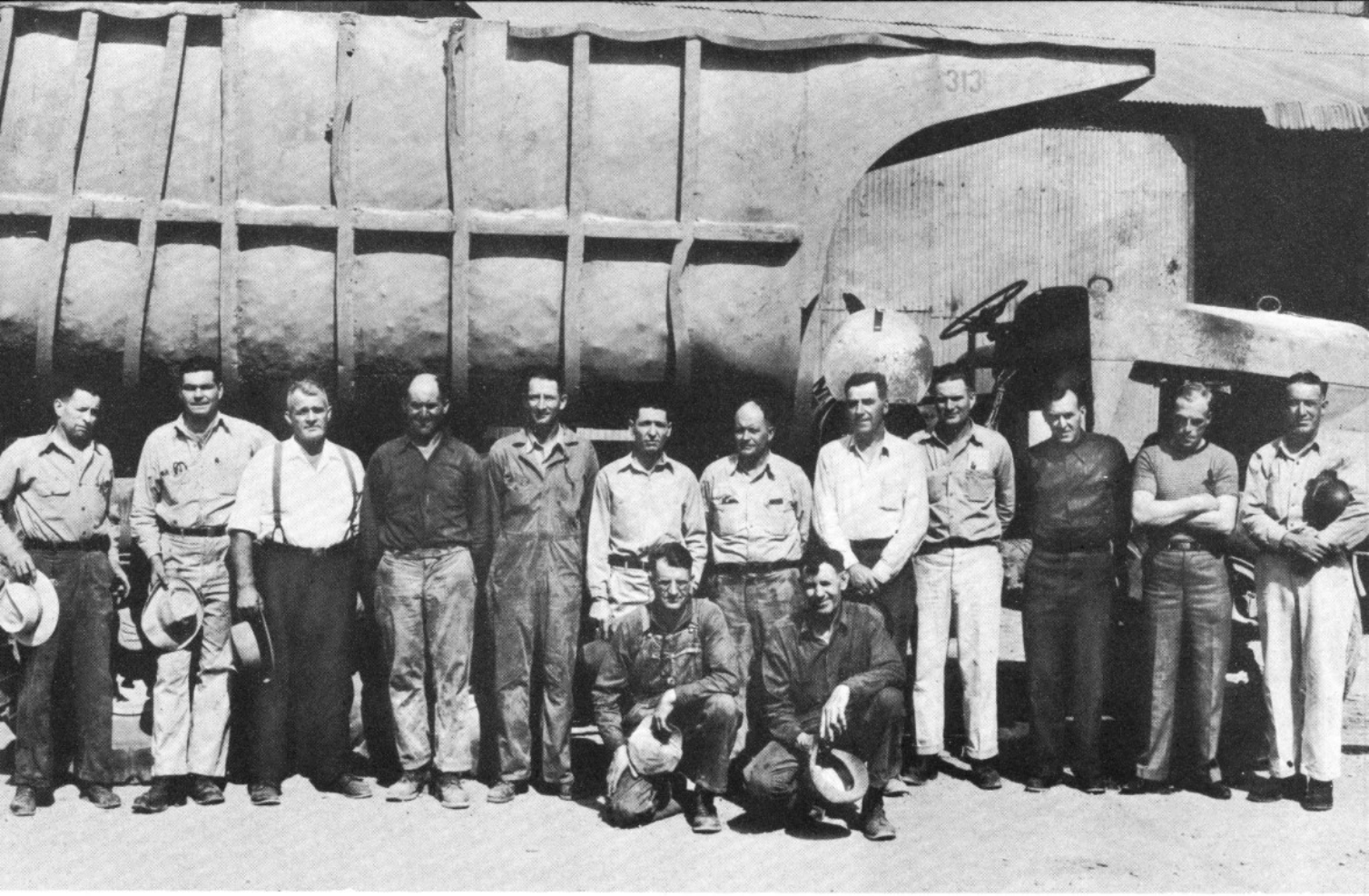
Home Nursing courses were conducted by Nurses Miriam Myer and Virginia Owens, and a First Aid Class was conducted by hospital supervisor Alex Bock.

Original P. C. I. Engineering Staff:
Left to right, rear row—B. W. Goodenough, Fordyce E. Walker, L. P. Sowles, Archie J. Vincent, Elmo E. Skuce, Harry L. Mundy, David C. May
Left to right, front row—John H. Crowe, Franch C. Wood, Jacob P. Eres, H. G. Grady, John V. Banks

"The Big Three"
Left to right—Frank Bryant, Frank Crowe, Bill Greeley

P. C. I. Engineers—1940 to end of job:
Left to right—A. L. Shjeflo, Engineer; W V Greeley, Chief Engineer; David C. May, Office Engineer; W. H. Colby, Asst. Engineer

Accounting Office Personnel:
Seated, left to right—Edna Adams, Stenographer; Virginia Armbruster, Clerk; Virginia Kellis, Stenographer; Hattie Beard, Clerk
Standing, left to right—Robert Sass, Chief Timekeeper; Elmer R. Baker, Auditor; Henry L. Murphy, Cost Keeper; Victor R. O'Shea, Stenographer; Paul T. Pulley, Bookkeeper; E. H. McAdams, Personnel Manager; T. J. Caulfield, Manager, Safety and Insurance; F. D. Myers, Office Manager



Mechanical and Electrical Foremen:
Standing, left to right—Carl Schrupp, Art Myers, George Robinson, Joe Kortuem, M. C. Ahneman, K. A. Henry, George Tripp, A. (Si) Bous, Master Mechanic; L. E. Osborn, Chief Electrician; G. B. Robinson, E. A. Erickson, L. H. Freckleton
Kneeling, left to right—George Bogovich, Raleigh Wirth

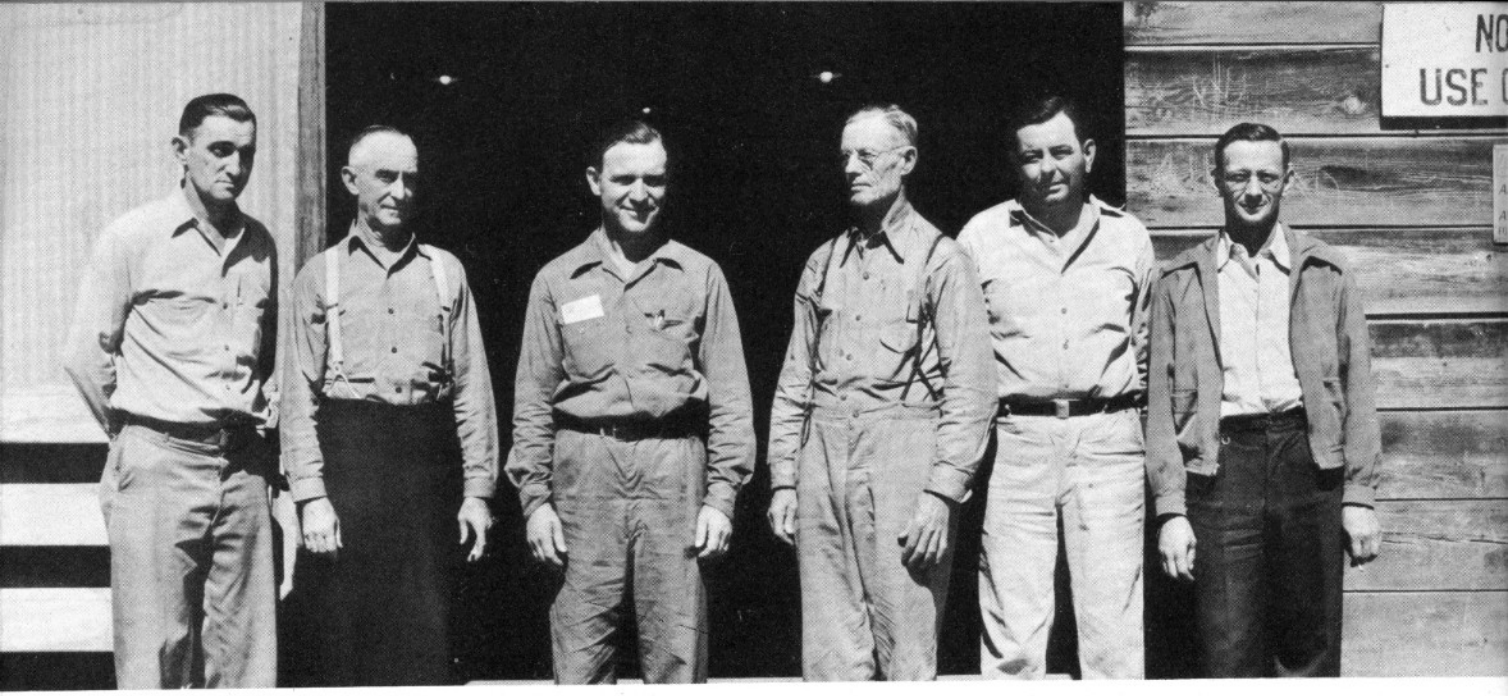
Time Office Personnel:
Left to right—Harold Bloom, Tom Sheets, Frances Stuelpnagel, Art Flyg, Chet Nelson, Blanche Miller, Earl Tenneson

Machine Shop:
Geo. Bogovich, Foreman, (Asst. Master Mechanic) third from right, rear row

Riggers:
L. P. Sowles, Cableway Superintendent, (without hat)

Commissary and Mess Hall Crew:
Steward (Pat) Unger (second from right), Assistant (Pat) McCarty (right end)

Garage Mechanics:
Geo. Tripp, Foreman (right end, back row)



Warehouse Crew:
W. A. Van Veghten, Purchasing Agent (third from left)

Excavation Crew:
J. P. Riley, Foreman (second from left, front row); Dale Bryant, Foreman (third from left, front row); A. M. Brown, Foreman (fourth from left, front row); Jess Withers, Foreman (sixth from left front row)

Concrete Crew:
Tom Powell, Foreman (fourth from left, front row)

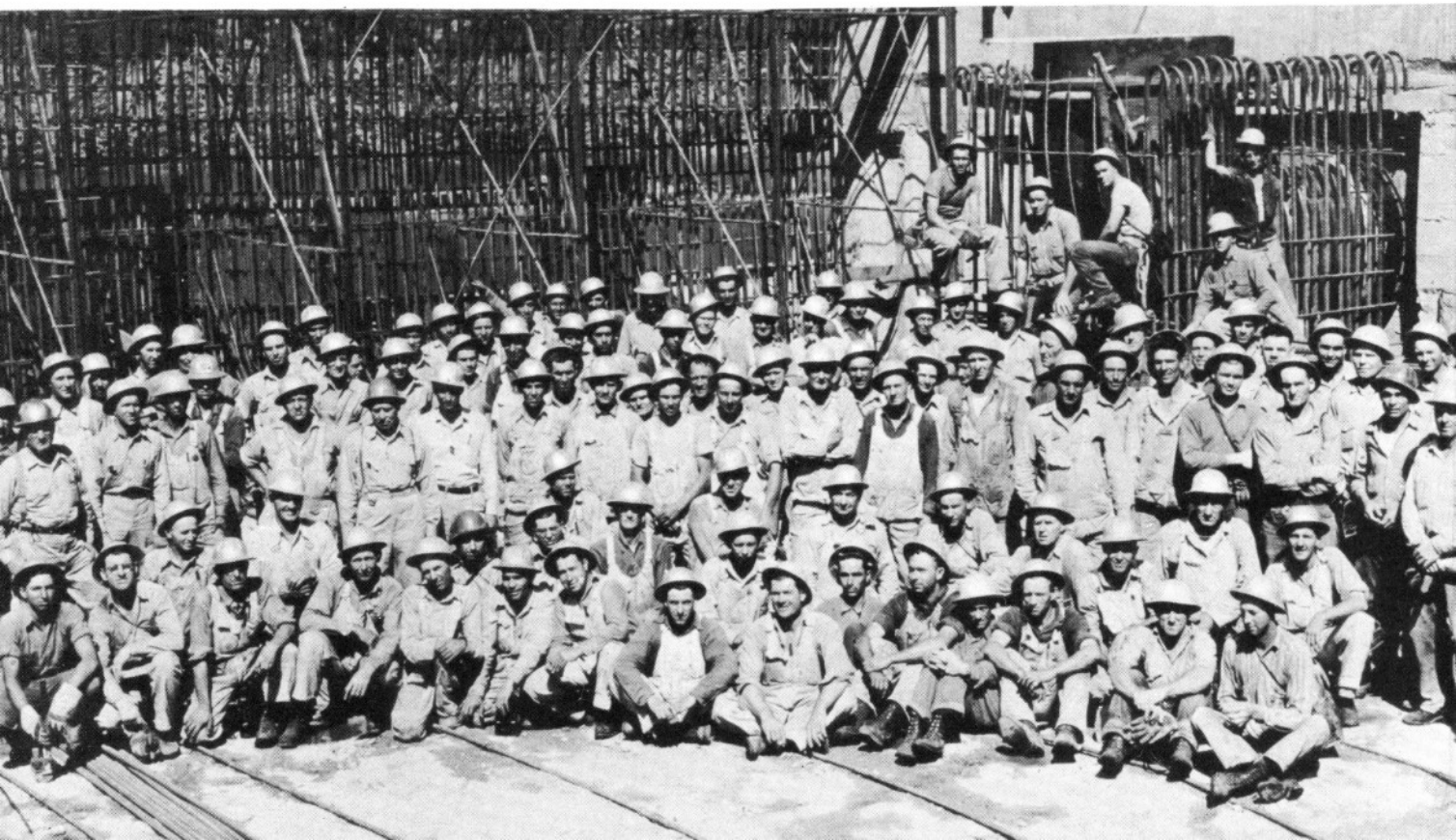
Reinforcing Steel Crew (The J. Philip Murphy Corp., Sub-contractors):
Don Rutherford, Superintendent (sixth from right, standing); Frank Skoubege, Assistant Superintendent (first at right, standing)

Electrical Department:
L. E. Osborn, Chief Electrician (fourth from right, kneeling, front row)

Diamond Drilling Crew (D. G. and J. G. Longtin, Sub-contractors):
R. E. Selby, Superintendent (right end, front row)

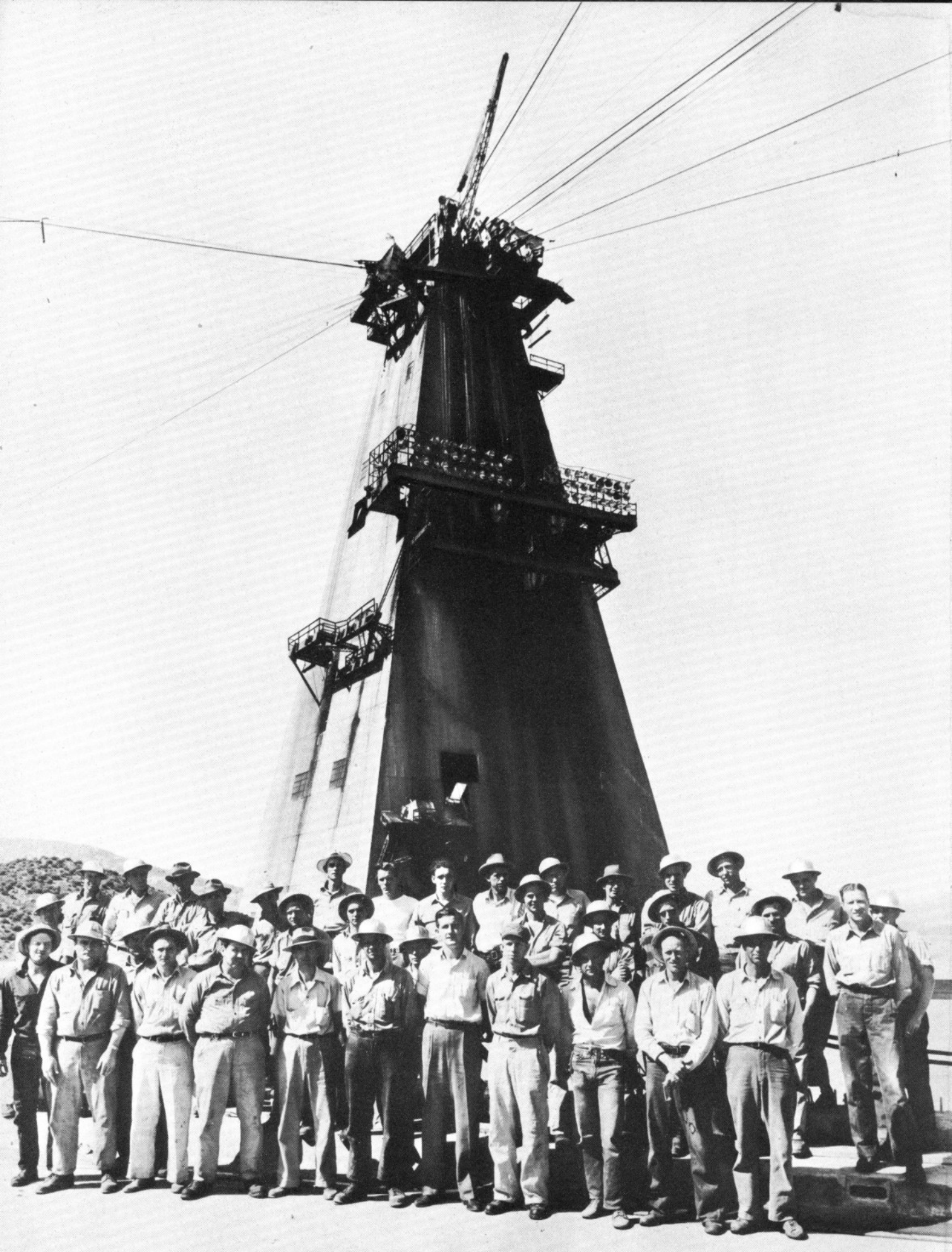
Shop Carpenters:
J. F. Dow, Foreman (left end, standing)

Form Carpenters, Dam:
Butler Howell, General Carpenter Foreman (standing, fifth from left, second row)



Pipefitters:
Spike Jorgenson, Foreman (third from left, rear row)

Powerhouse Carpenters:
Chas. Silva, Foreman (seventh from left, standing)



Bell Boys and Cableway Operators:
Ernie Myers, Foreman (second from left, top row)

"Cherry Picker" Crew:
Left to right—W. A. Beasley, C. M. Bonny, C. S. Cascio, Si Bous, R. L. Clineschmidt, Oscar Rentzell, Ed London

An Epic on Shasta

Miss Lee Walker, author of this poem, enjoys the distinction of being the first employee of Pacific Constructors, Inc.

A pall over Parker, many a worried brow,
"We didn't get the job—where to now?"
Construction work 's different—perhaps you know,
They follow their leader—in this case, Frank Crowe.
From Jackson Hole—to Boulder—30 years or more,
They'd always been together, built dams by the score.
They wanted this job, but what the hell?
There'd always be others, they could do just as well.
"Who could work for this gang that just got Shasta?
Too big a group—who could?—we ast ya."

There was Hunkin, there was Conkey, from good old Cleveland way,
And Shofner, Gordon, Hinman, from Denver and L.A.
There was Callahan and Shirley, Lee Dixon and Clyde Wood,
Jahn and Bressi and Bevanda, it's really getting good.
There was Thurston, there was Johnson—there was Lawler and Maguire,
With Steve Griffith—Black and Hogan—the list mounts even higher.
Foley Brothers from New York and Foley Brothers from St. Paul,
Harry Mundy and Bob Knox—all answered the roll call.

And then they got together—really pretty neat,
A group of dam builders that simply can't be beat.

So! Up in a lazy canyon on a quiet summer day,
A myriad of workmen got busily under way.
Houses sprang up over night, and office buildings too;
Amazing what can be done—what these men could do.
Shovels and "cats", grinding away,

Trucks busy hauling the muck away.
Things hummed so fast, a person's head swam,
But that was the way they started a dam.
To feed this gang, make sure they ate,
The mess hall crowd worked early and late;
We'll have to admit they fed us well—
In spite of our griping and giving them hell.

It takes men with guts, and men of steel,
To do this job—their hand at the wheel
Of every conceivable device and control,
Where one misstep would take its toll.
The blasting operations, tho dangerous as can be,
Were handled with care—practically accident-free.

The engineers and draftsmen, worked hour after hour,
Laying out plant and designing the head tower;
Finally getting a system that was most complete,
For a very different way of placing the concrete.
Our electricians and our shop boys, tho perhaps a bit profane—
Kept everything a rolling—in snow and sleet and rain.
The compressor house—'twas always such a treat,
To see a mechanized parlor—so meticulously neat.

The extreme coordination—a constant steady flow,
To mixing plant and batching plant, from the far silo.
Every move, one of decision,
Made with utmost of precision.
The speed—the rhythm—timing,
Are beyond such silly rhyming.
The giant mixer, belching its load
Into waiting buckets, ready for the road;
And then the ride out on the skip,
Over twenty ton every trip.
This intricate mass of cableways,
Pouring concrete in an endless maze.

Gone the lazy canyon, we had of yesteryear,
Workmen by the hundreds, from everywhere, did appear.
The hills resound, to the joyous sound
Of bells ringing, buckets hitting the ground.
Step-by-step—each phase a part—
Of skillful hands—of a workman's heart.
Each block as carefully laid,
As a jewel cutter cutting a rare piece of jade.
Building forms—scaling the wall,
Utterly fearless—no thought of a fall.
The hoist men and riggers, with greatest of ease,
Were a far better show than the flying trapeze.

For six long years, men worked day and night,
To harness a river for power and light.
And now there is a certain pride—
A job well done—his tools laid aside,
Another job is his only goal—
May he find one as satisfying to the soul.

A majestic mountain—a massive dam—
Child of God—child of man.
Both from that strange unknown source—
Where springs all such strength, such powering force.