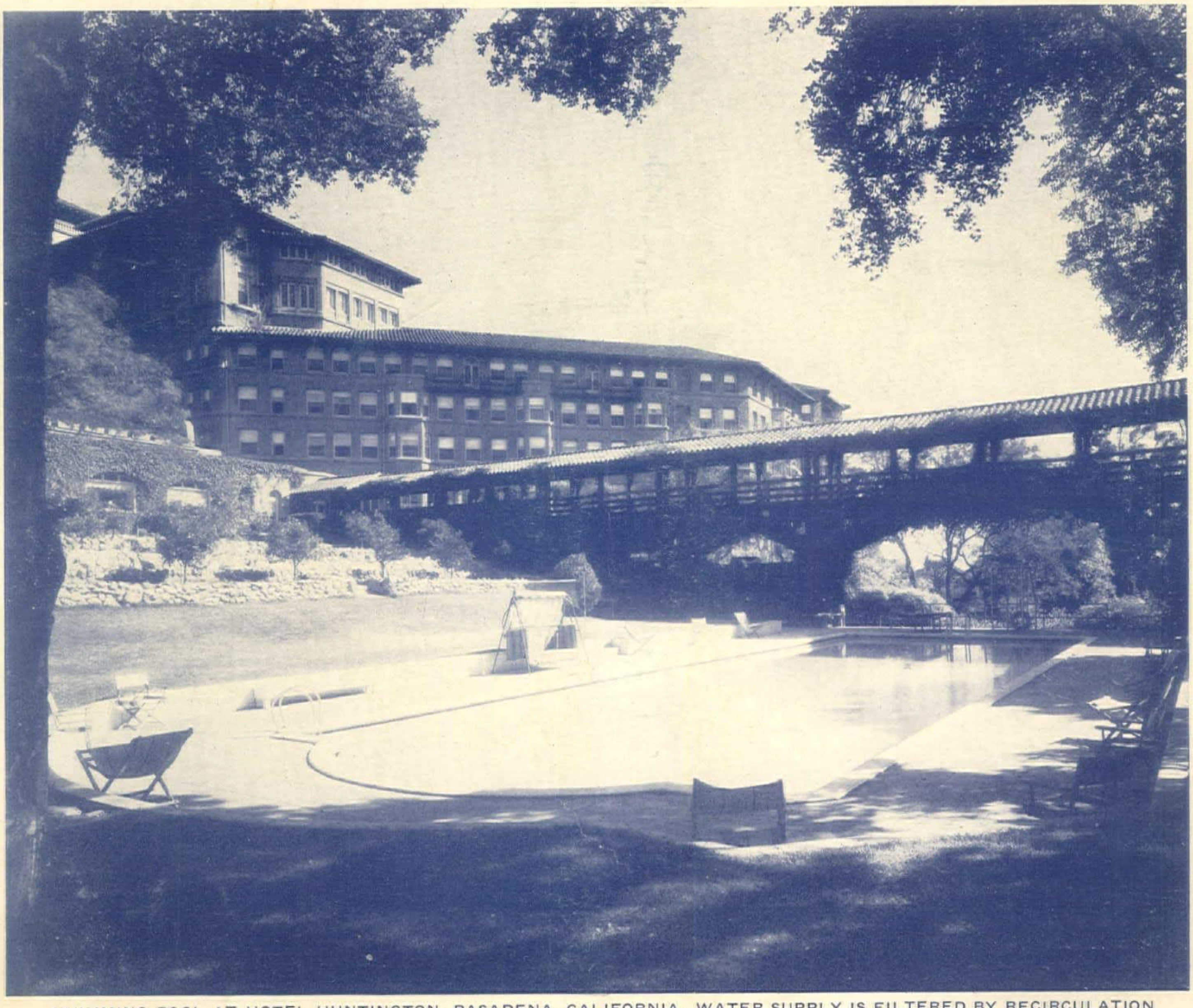
WESTERN CONSTRUCTION NEWS

ENGINEERING CONSTRUCTION IN THE FAR WEST

PUBLISHED SEMI-MONTHLY
VOLUME V NUMBER 20

SAN FRANCISCO, OCTOBER 25, 1930

25 CENTS A COPY
$3.00 PER YEAR

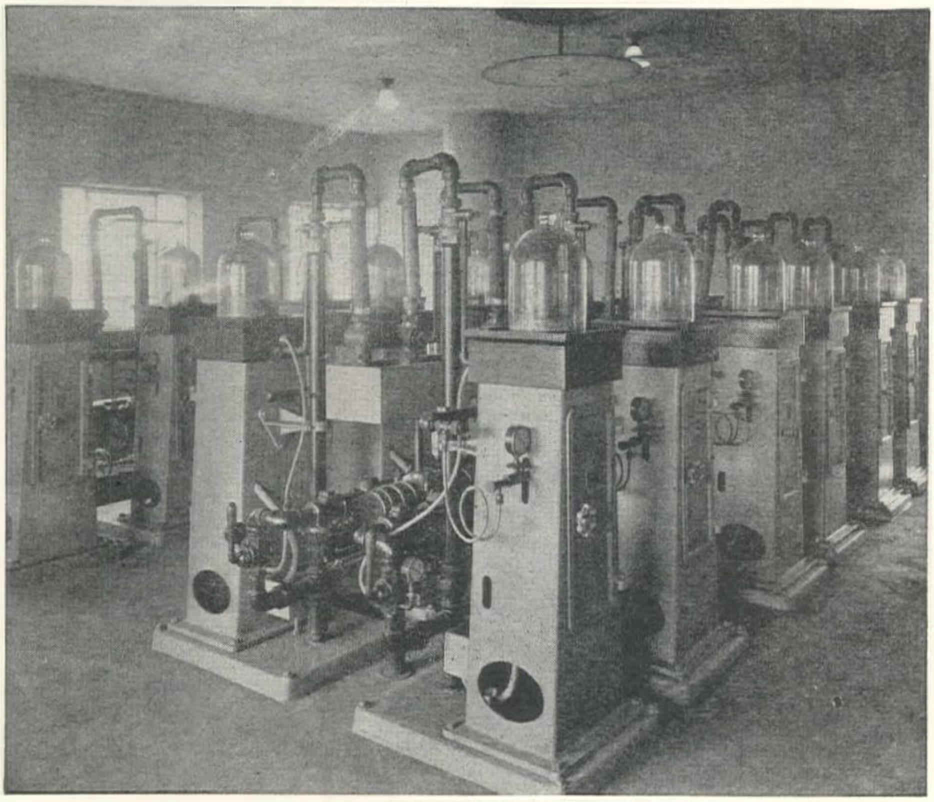


SWIMMING POOL AT HOTEL HUNTINGTON, PASADENA, CALIFORNIA. WATER SUPPLY IS FILTERED BY RECIRCULATION AND CHLORINATED—A THOROUGHLY SANITARY AS WELL AS PARTICULARLY ATTRACTIVE INSTALLATION

WATER WORKS CONVENTION NUMBER

SPEED UNHEARD OF BEFORE
IN SHOVELS
OF THIS SIZE
Here are two big shovels with very fast line and swing speeds—much faster than have ever before been employed in shovels of this size. Think what these fast speeds mean in terms of increased production.
And, in addition, these shovels with their steering brakes operated from the cab, have mobility never before considered possible in machines of 2 and 3 yards capacity. In fact they maneuver as easily as machines of one-yard capacity.
To withstand these high speeds and the tremendous stresses of Diesel operation, all frames are extremely heavy single-piece steel castings. The engine is mounted directly upon the cast steel revolving frame, not upon structural sills. Permanent alignment is thus assured. All bearings above the deck are roller bearings for efficient power transmission.
Complete Bulletins Upon Request
HARNISCHFEGER SALES CORP.
Established 1884
4490 W. National Ave., Milwaukee, Wis.
32 Beale St., San Francisco
2025 Santa Fe Ave., Los Angeles
ROBERT M. TAYLOR, Pacific Coast Manager
Service Stations, Complete Repair Part Stocks and Excavators at San Francisco, Los Angeles and Seattle
A COMPLETE LINE GAS DIESEL ELECTRIC 1/2 TO 3 1/2 CU. YDS.
MODEL 900
3-3 1/2
YARDS
MODEL 800
2-2 1/2
YARDS
CONVERTIBLE TO CRANE OR DRAGLINE
P&H Diesel SHOVELS

LESS THAN 1% FOR MAINTENANCE



20 minutes . . .
a small wrench . . .
a screw driver . . .
to take apart
a W & T unit,
clean and
re-assemble it.

Seven years ago the largest chlorinating installation in the world was made at the Easterly Sewage Disposal Plant, Cleveland, Ohio. In seven years annual maintenance costs have never exceeded 1% of the low initial investment! Today these machines are in perfect working order.

The simplicity of the W & T Vacuum type Chlorinator is largely the reason for this admirable record. A small wrench, a screw driver—and in 20 minutes this machine can be dismantled, cleaned and re-assembled —all ready for duty. No special skill, no technical knowledge is necessary.

Day in and day out, in more than 6,000 American municipalities, W & T equipment is giving this same satisfactory, practically cost-free service.

Our engineers will gladly tell you more about these installations, recommend suitable equipment to meet your specific requirements and to figure for you exact installation and operating costs.

For the sake of safety as well as saving, let our staff be of service. There is no obligation.

WALLACE & TIERNAN CO., Inc.
Manufacturers of Chlorine Control Apparatus
NEWARK, N. J.
Branches in All Principal Cities

A PRODUCT OF

WALLACE & TIERNAN

The Only Safe Water is a Sterilized Water

ON 8 jobs described in the Sept. 25th issue of *Western Construction News* ("Construction Review" section) as using Compressors, 6 are using RIX *exclusively*, 1 using a RIX and one competitive make, only 1 out of the 8 not using a RIX. What could more positively demonstrate RIX superior *Efficiency, Economy, Dependability?* Think it over. Jobs on which RIX is described as being used are:

7 out of 8 use RIX

1. "BERKELEY STORM DRAIN SYSTEM"- - operating air tools for removing paving.
2. "SAN FRANCISCO 15TH STREET SEWER, SECTION A" - - operating air hammer for driving lagging.
3. "SAN FRANCISCO FILLMORE ST. SEWER, SECTION B" - - operating air hammers for driving lagging.
4. "SAN FRANCISCO FILLMORE ST. SEWER, SECTIONS C & D" - - operating air guns for driving lagging.
5. "SAN FRANCISCO GEARY ST. AND 23RD AVE. SEWER" - - operating air hammers for driving lagging.
6. "KLAMATH FALLS SEWER SYSTEM" - for operating air hammers, etc.
7. "LIDO ISLAND IMPROVEMENTS, CITY OF NEWPORT BEACH" - - for operating pumps, pavers, trenchers, etc.

SINCE 1877

RIX *Pioneer* line includes compressors of *all* sizes for *all* purposes. Rix Co. are also agents for COCHISE Drills, and exclusive distributors for THOR Pneumatic Tools in Seattle territory.

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● ● The Compressor with the SUPER-CHARGER ● ●

RIX "6"

PORTABLE AIR COMPRESSORS

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DEVOTED TO ENGINEERING CONSTRUCTION IN THE FAR WEST

VOLUME V OCTOBER 25, 1930 NUMBER 20

CONTENTS

SUBSCRIPTION RATES

THE annual subscription rate is $3 in the United States and foreign countries where extra postage is not required. To Canada $4 and to foreign countries where extra postage is necessary the annual rate is $5. Single copies 25 cents.

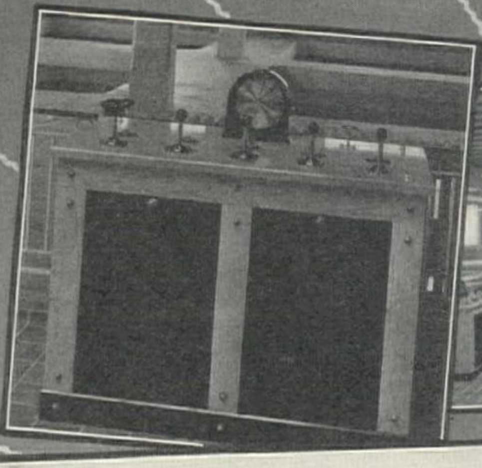
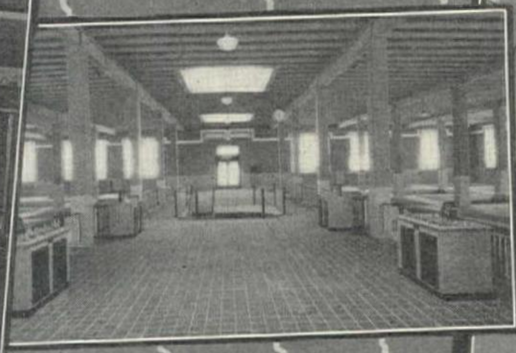
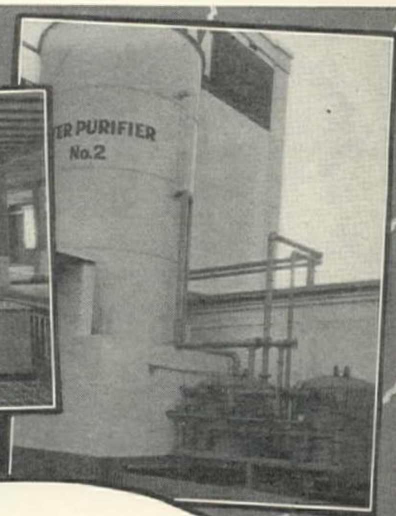
Published semi-monthly by
WESTERN CONSTRUCTION NEWS, INC.

Main Office:
114 SANSOME STREET
SAN FRANCISCO, CALIF.

Eastern Representatives:
F. R. JONES, 201 N. Wells Street
Chicago, Ill.
H. B. KNOX, JR., 101 Park Ave.
New York, N. Y.

Branch Office:
455 WESTERN PACIFIC BDG.
LOS ANGELES, CALIF.

S. H. WADE, *President and General Manager*
S. J. SANDERS, *Vice-President* PHILIP SCHUYLER, *Managing Editor*
Entered as second-class matter at the postoffice at San Francisco, California, under the act of March 3, 1879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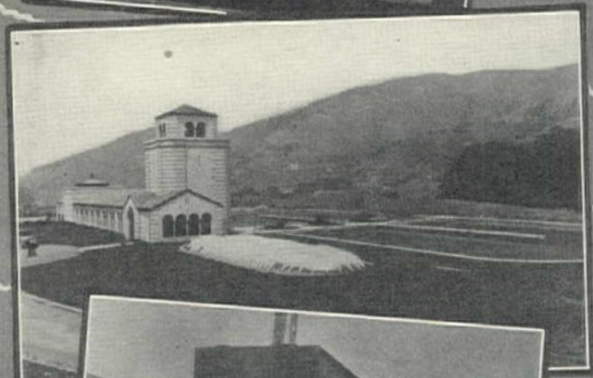
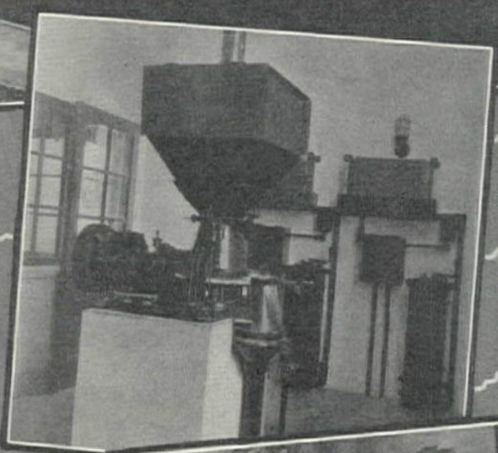
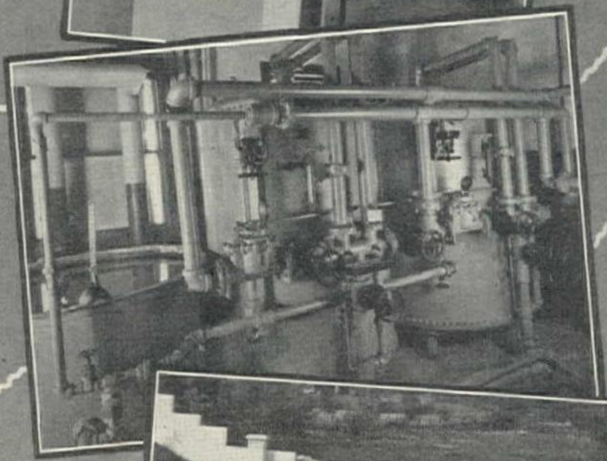

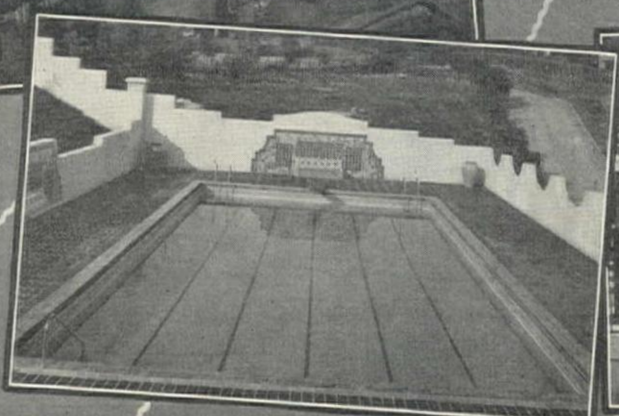
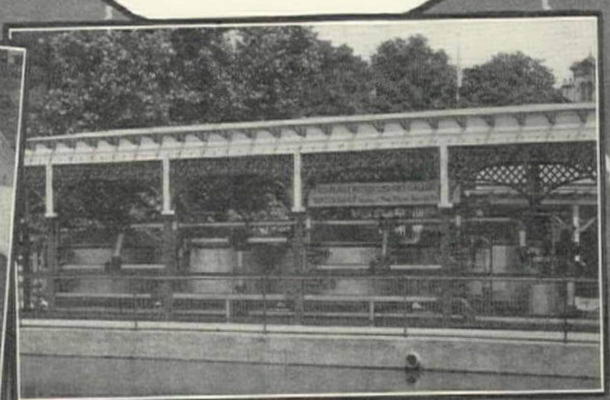

"'ECONOMIZING' AGAIN, EH!"

"I know it's a temptation in these so-called 'hard times' to cut a corner on first cost of pipe.

"But where's the *economy* when rust starts to work on it?

"Real economy is something else—laying McWane-Pacific cast iron pipe in the small sizes. They make everlasting cast iron pipe now as small as 1¼, 2, and 3 inches. It never has to be laid but once. Its first cost is also its last cost. It makes the small mains and services as permanent as the big mains.

"Let's think about that next time we start to buy perishable pipe in small sizes—and get enduring McWane-Pacific cast iron pipe instead."

Think about this picture next time YOU *have small-diameter pipe to buy. The nearest Pacific States Cast Iron Pipe office will gladly quote prices and furnish full data on this Western-made cast iron pipe.*

Write for new Small Cast Iron Pipe booklet.

McWANE CAST IRON PIPE CO. BIRMINGHAM ALABAMA

WHOLE PIPE POURED SIMULTANEOUSLY

McWANE PIPE

SAND MOULDED INSIDE AND OUTSIDE

PACIFIC STATES CAST IRON PIPE CO. PROVO, UTAH

Sizes: 1 1-4 thru 12 inch.

Precalked or open bells

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208 S. LaSalle Street, Chicago
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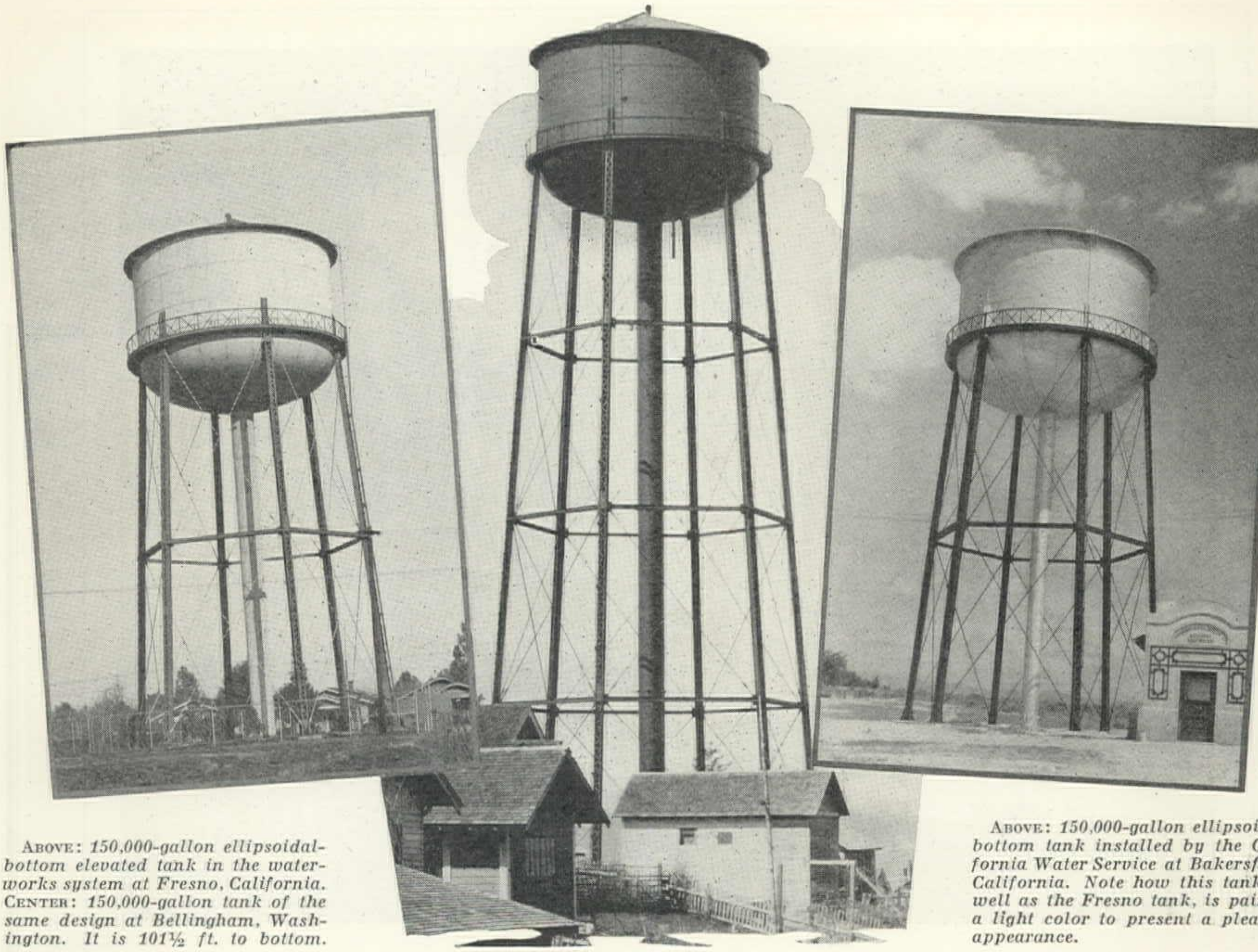


ABOVE: *150,000-gallon ellipsoidal-bottom elevated tank in the water-works system at Fresno, California.* CENTER: *150,000-gallon tank of the same design at Bellingham, Washington. It is 101½ ft. to bottom.*

ABOVE: *150,000-gallon ellipsoidal-bottom tank installed by the California Water Service at Bakersfield, California. Note how this tank, as well as the Fresno tank, is painted a light color to present a pleasing appearance.*

The ellipsoidal-bottom type of Elevated Tank is popular in Municipal Service

THE ellipsoidal-bottom type of elevated storage tank is popular in municipal service because it gives better service than tanks of other designs. The ellipsoidal-bottom tank has a relatively large diameter and shallow shell height. It has less variation in head than a tank with a smaller diameter.

Consider, for instance, a case where a minimum of 32 pounds pressure is required to maintain good service. The entire capacity of a 150,000-gallon ellipsoidal tank 100 feet to top would be effective. On the other hand, with a tank of similar capacity and height and a diameter of 26 feet, three-fifths of capacity would be delivered at less than 32 pounds and would be ineffective.

Minimum variation in head also has other advantages. The average head against which pumps must work to fill the tank is less as the variation decreases. The efficiency of pumping equipment is increased and operating costs decreased.

The ellipsoidal-bottom tank has pleasing proportions. Installations may also be made to harmonize with surrounding structures or blend into the landscape by using light-colored paint.

We will be glad to give you information or quotations on any size of elevated tank to meet your requirements, erected complete with our own Pacific Coast forces.

B-181

Ask for a Copy of this Booklet

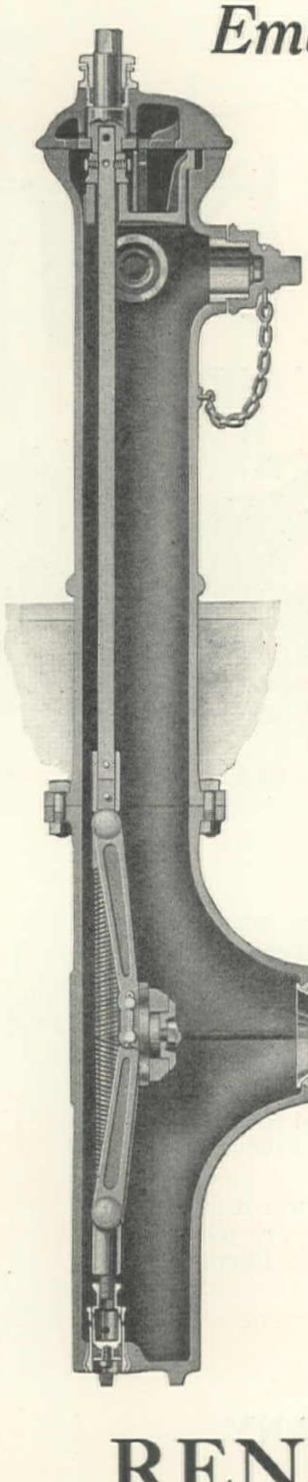
Chicago Bridge & Iron Works

1013 Rialto Building, San Francisco, Calif. 4301 Smith Tower, Seattle, Wash.

HORTON TANKS

Genuine Improved "COREY" Fire Hydrants

Embody these Modern Principles



Standpipe can be removed and replaced without shutting off water in main.

Standpipe can be revolved quarter turns. Nozzles always in right direction.

Main valve replaced without disturbing standpipe or barrel and accomplished in 10 minutes with regular Corey operating wrench.

Can be lengthened without shutting off water.

Only extension section and rod of corresponding length required to extend hydrant for changing grade levels.

Nozzles screwed in—not leaded.

Operating Rod and Valve DO NOT obstruct flow.

Operating Sleeve can be replaced WITHOUT SHUTTING OFF water.

Speed in operation, full flow in less time.

WATER HAMMER eliminated.

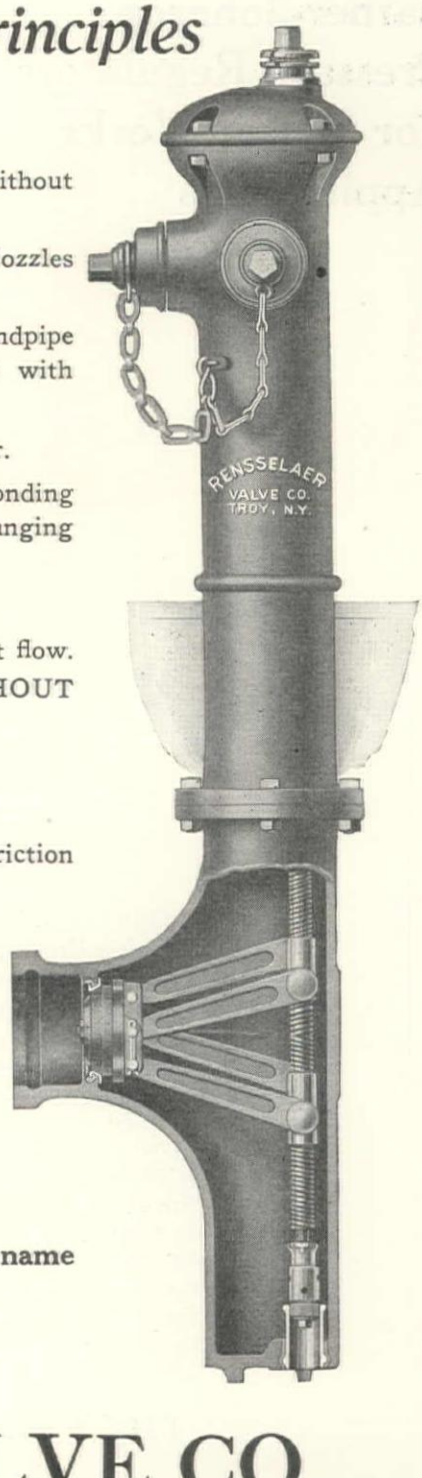
Water DEFLECTED into nozzles, least friction loss head.

WILL NOT FLOOD.

Stuffing Box accessible WITHOUT REMOVING HEAD.

Ease and dependability of operation insured by balanced knuckle joint.

Positive drain—cannot freeze.



3000 Cities Using Over 150,000

Genuine "COREY" Fire Hydrants have name "COREY" cast in the head

MADE BY

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Branch Offices and Stocks

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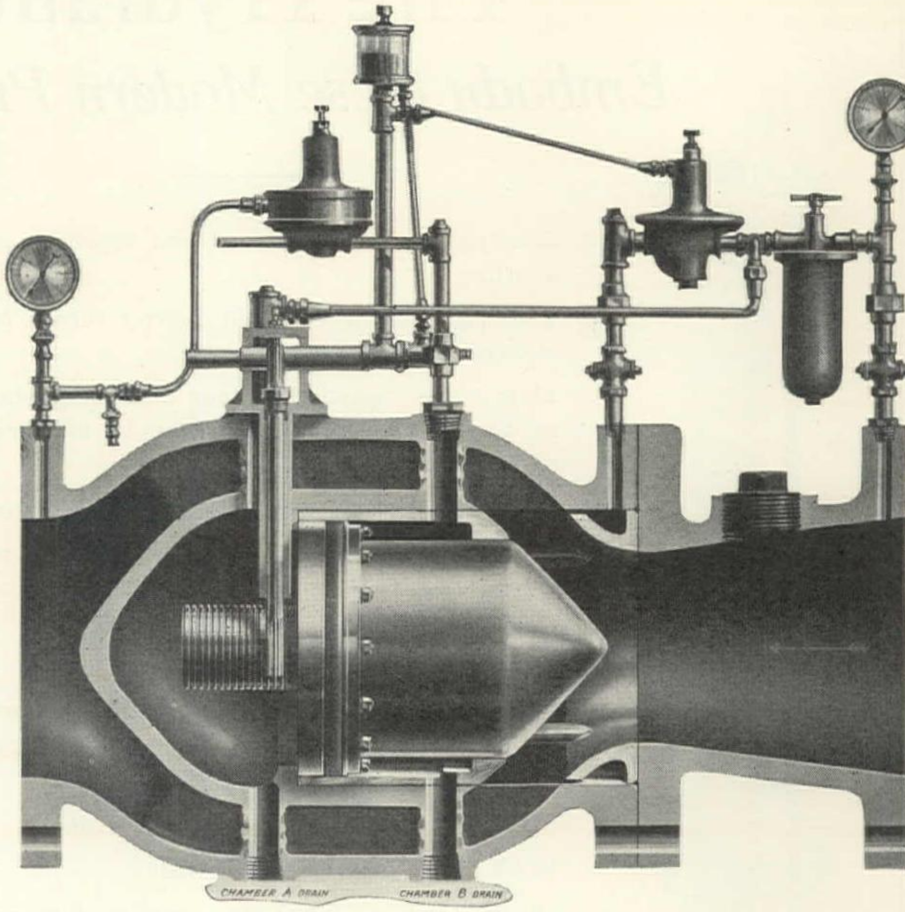
PELTON

Study the Operating Sequence

Larner-Johnson Pressure Regulators For Water Works Applications



CLOSE examination of the operating characteristics is one way by which the superior features of Larner-Johnson pressure regulators become most apparent.

Downstream pressure is held constant within close limits by pilot valve control of chamber A pressure. Changes in demand alter the downstream pressure, causing the pilot to alter the plunger position and restore normal pressure. Chamber B relief valve opens in emergencies to effect closure if the downstream pressure rises appreciably, the relief valve closing again when normal downstream pressure has been restored.

Surges, oscillations and objectionable water hammer in the conduit —heretofore a serious menace in pressure regulation service—are positively eliminated by a restoring mechanism which is unique in Larner-Johnson design.

Complete operating details, construction features and references to installations, will be promptly given on request.

THE PELTON WATER WHEEL COMPANY

HYDRAULIC ENGINEERS

2985 Nineteenth Street, SAN FRANCISCO 33 Rector Street, NEW YORK

ASSOCIATED COMPANIES: I. P. Morris & De LaVergne, Inc., Philadelphia, Pa.; Dominion Engineering Works, Ltd., Montreal. PACIFIC COAST REPRESENTATIVE for Larner Engineering Co., Philadelphia, Pa.

PELTON

Iowa Fire Hydrants
and
Water Works Valves

Iowa improved Corey Fire Hydrants are built for those who demand that value be founded on design, material, workmanship and service.

That is the reason many of the country's leading water works engineers, superintendents, and fire chiefs recognize the Iowa Fire Hydrant's superior features, and have continually demanded its exclusive installation.

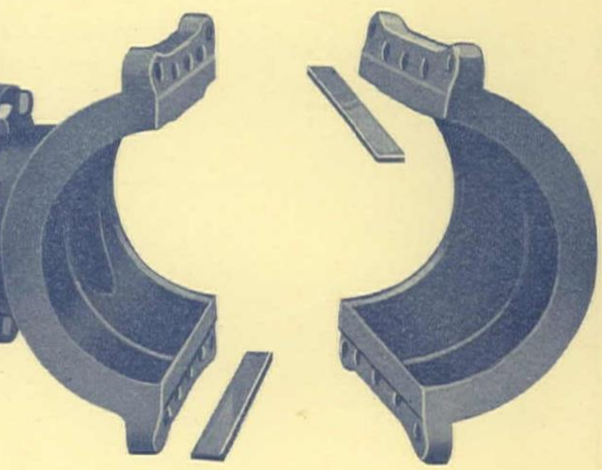
Iowa valves and hydrants are built to the standard specifications of the American Water Works Association.

TAPPING SLEEVES AND VALVES

Recommended for durability, efficiency and economy. Becoming most popular on the market.

We strongly recommend *ALL BOLTED TYPE* shown.

Made in all sizes up to and including 30″ diameter pipe.



Visit our exhibit at the A.W.W.A. Convention, California Section, Hotel Huntington, Pasadena, October 29th-November 1st

Water Works Supply Co.

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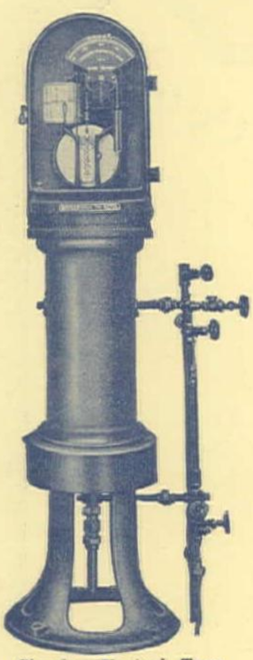
LOS ANGELES

PLAYING SAFE



Simplex Venturi Type Meter

Indicates Records and Totalizes the Rate of Flow, with any type of venturi tube orifice or pitot tube; may also be used with weir or flume. Accurate over a wide range, with provision to check while in service.

In the selection and buying of equipment, such as Controllers, Gauges and Meters for the Water Works or Filter Plant, accuracy, dependability, quality and simplicity are all of great importance.

Equally important is the background and experience of the Manufacturers who offer such equipment.

Simplex Air and Vacuum Valve

For use on large mains, where there is danger of collapse, due to a vacuum; the valve breaking the vacuum and preventing collapse. Facilitates the filling of the main, since wide open until main is full of water.

SIMPLEX

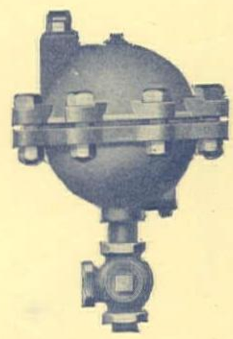
Equipment for the Filter Plant

Built into the design of SIMPLEX Equipment is the experience of over twenty years of an organization which has specialized in studying the requirements for such apparatus.

The combination of this experience, with constant research work, and the general policy of manufacturing only the best assures you in the selection of SIMPLEX equipment, these important details.

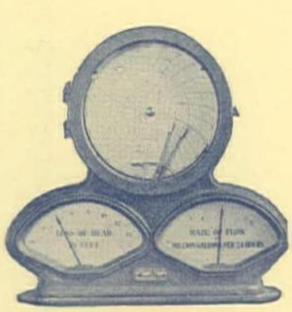
The successful performance of thousands of installations are your added guarantee and safeguard. . . .

Why not insist on SIMPLEX?



Simplex Automatic Air Release Valve

Automatically releases accumulations of air at pipe line summits. Simple and dependable. May be used in combination with air and vacuum valve.



Simplex Filter Gauges

May be had in many combinations of Indicating, Recording and Totalizing.

—Be Safe—

Simplex Valve & Meter Co.

Measuring and Controlling Equipment for Water, Sewage, Power and Industrial Plants

Water Flow and Water Waste Investigations
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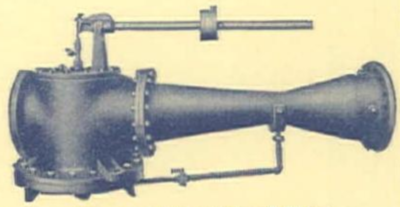

Simplex Filter Rate of Flow Controller

Adaptable to large and small filter plants from 30-in. effluent to 3-in. "The Standard controller."

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SEATTLE: Water Works & Power Equipment Co., White Building

LEADITE

Trade Mark Registered U.S. Pat. Office

"Unusual Water Pressures"

JOHN C. PRITCHARD, DIRECTOR
LEONARD A. DAY, WATER COMMISSIONER

DISTRIBUTION SECTION
THOS. J. SKINKER, ENGINEER IN CHARGE
W. A. FOLEY, ASS'T ENGINEER

CITY OF ST. LOUIS
DEPARTMENT OF PUBLIC UTILITIES
WATER DIVISION
312 CITY HALL

July 27,1928.

Mr.Geo. McKay, Jr.
c/o Leadite Co.
Land Title Bldg.
Philadelphia, Pa.

Dear Mr.McKay:-

Sometime in February I took a piece of 6" Class "C" pipe about 4 ft. long and capped the spigot end and ran this joint solid with leadite, that is, there was no yarn used. The bell end was plugged and run solid. It was my intention at this time to see how much pressure the cap and plug would withstand. I was especially interested in seeing if a cap put on in this way would have to be blocked carefully to prevent blowing off.

The piece of 6" pipe had been in one of our buildings and had never had any water in the pipe until a few days before July 18th. The Mueller Co. had a pressure gauge in making their tests that was calibrated up to 1000 lbs. and I availed myself of this opportunity to make the tests on the leadite joints. I tapped the pipe and installed two (2) corporation cocks, one to let in water and the other to release the air. Then the pressure was applied. We ran the pressure up to 1200# and both joints held perfectly; we slowly increased the pressure and when it had gotten between 1200 and 1300 lbs. the joint at the spigot end of the pipe developed a slight sweat. We continued boosting the pressure until it was approximately 1400 lbs. at which time the end of the cap blew off; neither of the leadite joints were affected, and no leak developed in either joint except for the slight sweat mentioned above.

The opportunity never presented itself for me to make this test until July 18th at which time the Mueller Co. was making a demonstration at our Pipe Yard, on their copper service pipe.

This test was made in the presence of a number of local Contractors and Engineers among them were- Fred Luth, Mr.Fuller and Mr.Merkle of St.Louis and Mr.W.C.Heinrichs of the Mueller Co. of Decatur, Ills. Mr.Heinrichs took some pictures of the piece of pipe which I will send you.

Hoping this may be of interest to you and with kindest regards, I am,

Yours very truly,
Thos J. Skinker
Engineer-in-charge
Distribution Section.

The above is pounds per square inch or 39400 lbs. on the cap.
Thos J Skinker

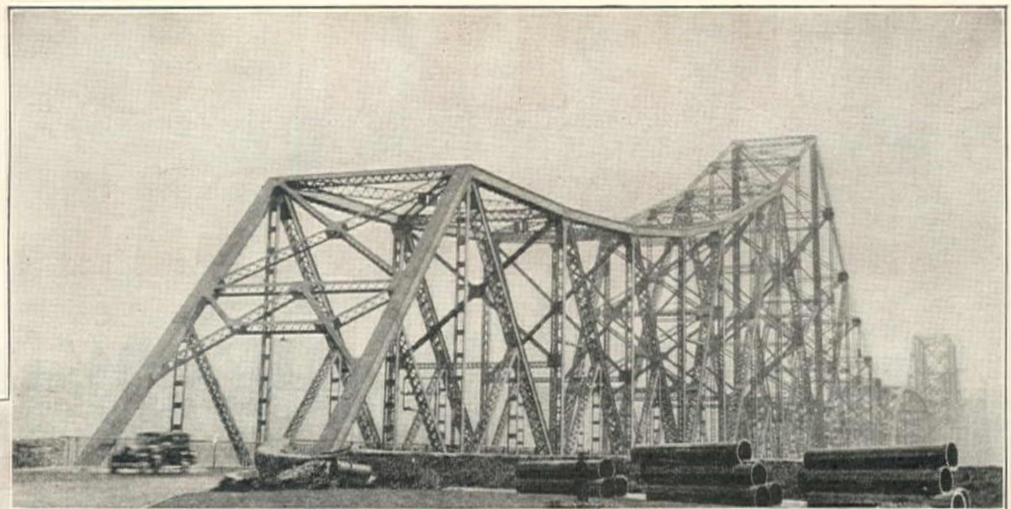
TJS/J.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 30 years.
Saves at least 75%

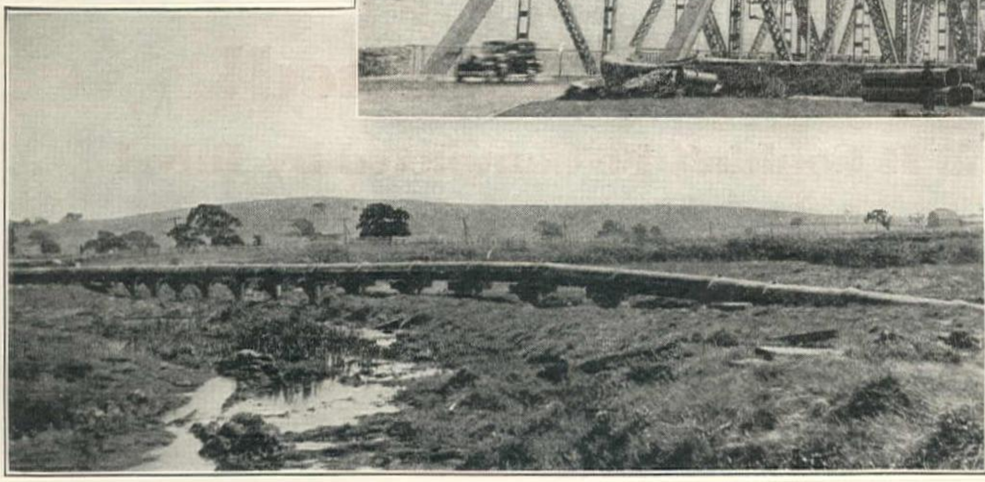
WATER WORKS SUPPLY COMPANY

501 Howard Street, San Francisco — 2326 E. 8th St., Los Angeles
Water Works & Power Equipment Co., White Building, Seattle
THE LEADITE COMPANY—LAND TITLE BLDG., PHILADELPHIA, PA.

No Caulking



DeLavaud Pipe piled beside the Carquinez Bridge awaiting installation.



The 20-inch deLavaud pipe line of the California-Hawaiian Sugar Refining Co. crossing a salt marsh.

To withstand vibration and constant exposure–sturdy deLavaud Pipe

For fifteen miles, up hill and down dale, over long stretches of marsh land and finally across the famous Carquinez Bridge there runs this 20-inch deLavaud pipe line of the California-Hawaiian Sugar Refining Company.

This installation is of special interest to water engineers for two distinct reasons: first, because of the conditions which the pipe was called upon to withstand; second, because of the kind of pipe specified. After thorough investigation, deLavaud Pipe was chosen as the most efficient from every standpoint. Here is another noteworthy endorsement of the strength and durability of deLavaud centrifugally cast pipe.

DeLavaud Pipe is formed by pouring molten iron into a rapidly revolving metal mold. Centrifugal force holds the melted iron against the sides of the mold and drives out impurities at the center with a pressure many times greater than gravity. The action of the metal mold also brings about an extremely fine grained condition in the iron. All coarse particles are minutely divided and evenly distributed. Exhaustive tests have proved that deLavaud Pipe is at least 25% stronger than pit cast pipe.

DeLavaud Pipe is made in accordance with U.S. Government specifications. We are also furnishing this product in the various thicknesses and weights shown in the specifications of the American Water Works Association and the American Gas Association. The deLavaud Handbook gives complete information. Write for a copy today

United States Pipe and Foundry Co., Burlington, N.J.

Our pipe bears the "Q-Check" trademark of The Cast Iron Pipe Research Association

Sales Offices: New York, Philadelphia, Pittsburgh, Cleveland, Buffalo, Chicago, Dallas, Birmingham, Kansas City, Minneapolis, Seattle, San Francisco, Los Angeles

SUPPLYING WATE THROUGH FEDE

Augmenting Seattle's Water System

A Record Established!

They Said It Couldn't Be Completed by July 1

The new Lake Youngs source of supply was completed and ready for service fully eight weeks ahead of schedule. This remarkable feat of engineering efficiency was accomplished despite the severe winter freeze-up and subsequent thaw, which materially handicapped installation.

This mammoth undertaking emphasizes in no uncertain way the ability of the Federal Pipe & Tank Company to accomplish what to others appeared to be almost impossible. Herein lies the advantage of dealing directly with the outstanding pipe concern of the country, equipped to handle the biggest work of this character despite handicaps and obstacles and do it in record time.

The Line Is 10 1-2 Miles Long

78″ (six feet, six inches) is the diameter of the huge Federal Continuous Stave Creosoted Pipe that insures Seattle an adequate water supply. There is a maximum head of 160 feet. Staves are made of selected Douglas Fir and are 2½ inches thick. Staves are creosoted by the 8-pound vacuum and pressure process. Bands are ⅝ inch and ¾ inch round steel. Ends of staves are jointed together with a special malleable joint, which prevents leakage and precludes injury from freezing.

Illustration shows a portion of new Everett water supply line. This line is full of difficult curves, contours and grades, but all obstacles were successfully overcome with Federal Wood Pipe.

This pipe line and its connections, together wi 3,000 feet of tunnel, extends from the new dam Landsburg, Washington, to Lake Youngs, whe a portion or all the water may be discharged.

This by-pass—all wood pipe—also extends arour Lake Youngs and discharges into pipe line lea ing out of control works, permitting flow of wat to be diverted directly into city mains or rese voir. This is to insure cold water in warme summer weather. The new line will flow 100 000,000 gallons a day—half again as much as th present supply.

Our Engineering Department is available at a times to advise and counsel with you on you water-carrying problems. No undertaking to large—none too small to receive prompt, carefu attention.

FED

FEDERAI

R FOR 2 CITIES
RAL WOOD PIPE!

Building and Banding 78" Federal Continuous Stave Creosoted Wood Pipe on Seattle's new Lake Youngs water project. Note huge size of pipe in comparison with the man. Also how adaptable this wood pipe is on difficult curves and contours.

Everett to Have Adequate Supply—

In adding to its present water system, Everett made ample provision not only for domestic use but also to take care of commercial needs, especially pulp and paper mills, which are exceptionally heavy water users.

The new construction, which is five and one-half miles long, is part of the system from the Sultan River Basin to the City of Everett. It will supply 50,000,000 gallons of water daily.

Federal Continuous Stave Creosoted Pipe, 52 inches in diameter, to take care of a maximum head of 160 feet, was installed.

Staves are of selected Douglas Fir 1⅝ inches thick, banded with ⅝ inch round steel. Staves are jointed by means of malleable joint, insuring against leakage or damage from freezing at joints. Creosoting is by the 8-pound vacuum and pressure process.

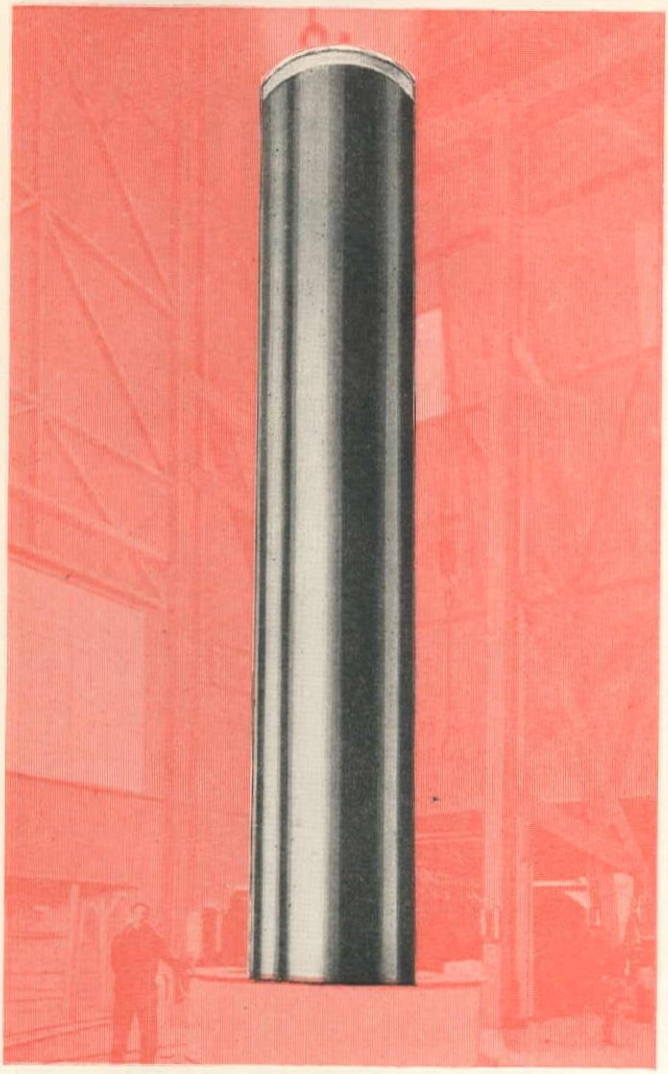
Despite the severe curves, both vertical and horizontal, and the rough and rugged contours, the work was completed fully two months ahead of schedule.

More than 75 men were employed regularly and all materials except malleable iron were purchased and manufactured right here on the Pacific Coast.

ERAL PIPE

PIPE & TANK COMPANY

332 24th AVENUE N. W., SEATTLE



Dipping equipment in plant of Steel Tank & Pipe Co., San Francisco, used for coating the 65 in. steel main of the Mokelumne Aqueduct.

An Easy Way
to Protect Steel Pipe

HERMASTIC

REG. U.S. PAT. OFF.

PIPE DIP

THE MOKELUMNE AQUEDUCT of the East Bay Municipal Utility District—ninety miles in length—is outstanding among many Western water works projects assured of complete protection against corrosion by HERMASTIC PIPE DIP. This coating is easily and economically applied by the hot dip method in the shop of the pipe manufacturer. In fact, practically all of the large steel pipe manufacturers are equipped with dipping tanks filled with Hermastic coating.

Take the easy way to insure against corrosion and tuberculation with this positive preventive known the world over. Write our nearest office for standard specifications, and

INCLUDE THESE SPECIFICATIONS IN YOUR PIPE ORDER

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17 Battery Place, New York

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START YOUR
WATER LINE CONSTRUCTION
WITH
DRESSER COUPLINGS
You can
Here is the last word in water line construction—*Dresser Couplings.* Advanced engineering dictates their design. Conformity to today's high standards of speed, economy and endurance requires their use. Join good plain-end pipe with the right style, weight and size of Dresser Couplings. Then you'll have modern, flexible, permanently tight joints—without maintenance. Ask for new Catalog.
S. R. DRESSER MFG. COMPANY
BRADFORD . . . PENNSYLVANIA
Depend on
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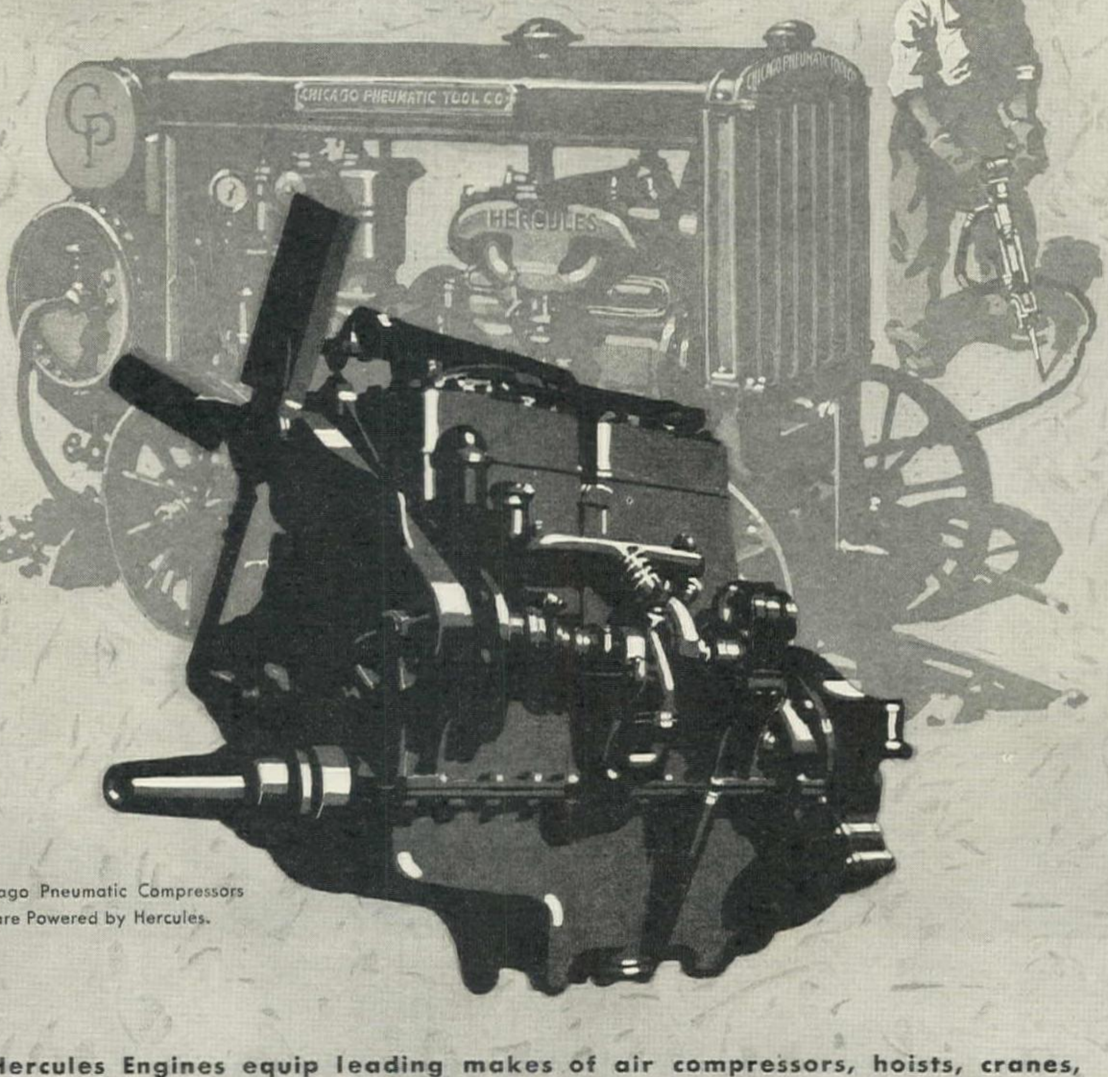
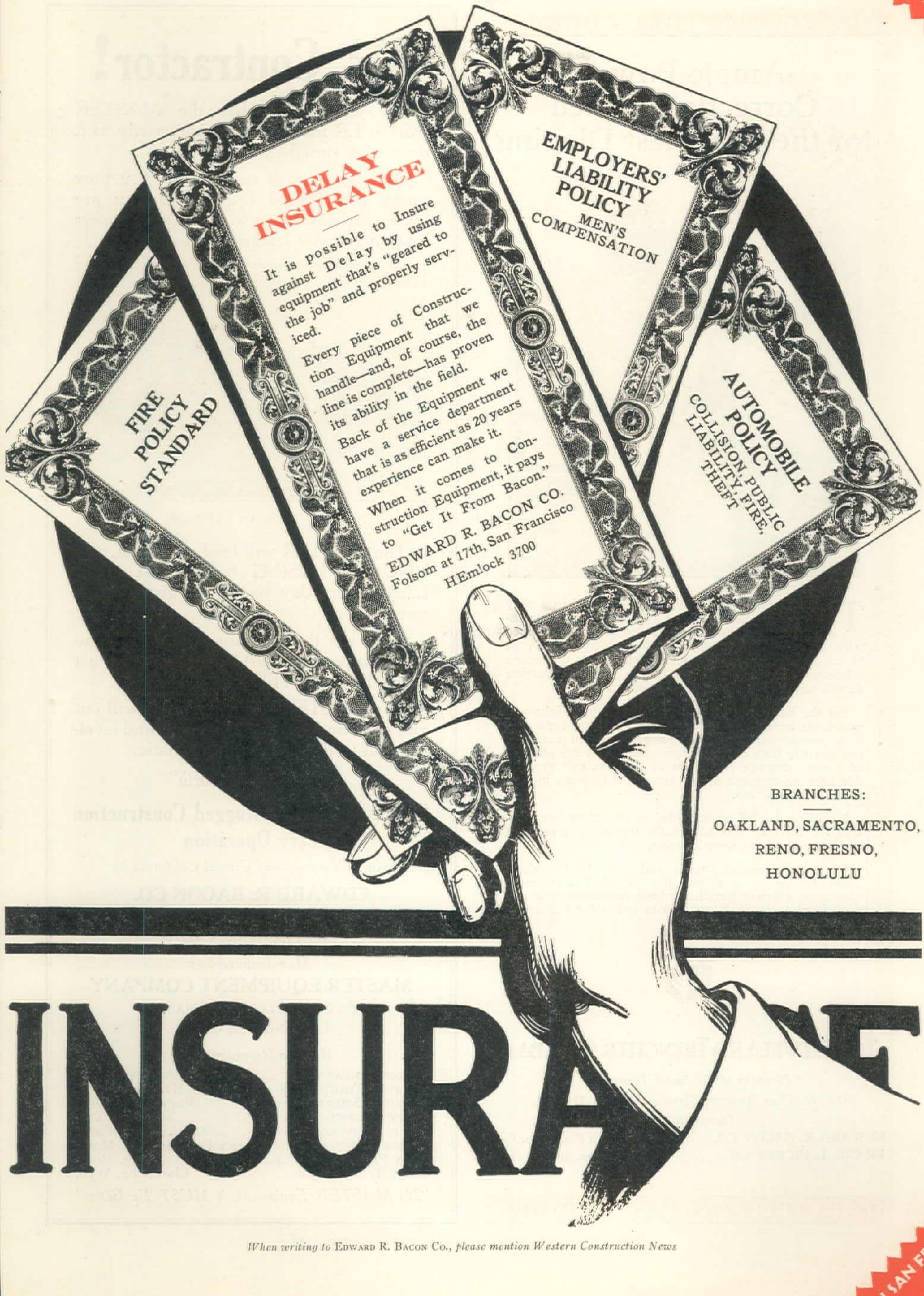


Chicago Pneumatic Compressors are Powered by Hercules.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It is possible to Insure against Delay by using equipment that's "geared to the job" and properly serviced.
Every piece of Construction Equipment that we handle—and, of course, the line is complete—has proven its ability in the field.
Back of the Equipment we have a service department that is as efficient as 20 years experience can make it.
When it comes to Construction Equipment, it pays to "Get It From Bacon."
EDWARD R. BACON CO.
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THE CLEVELAND BABY DIGGER

Ample Power Correctly Applied for the Toughest Digging

THE Cleveland Baby Digger is more than amply powered for any imaginable work which a trenching machine might be expected to do. It is equipped with a 4-cylinder engine developing 31½ H.P. at 90 r.p.m. This power is transmitted with maximum efficiency through a type of design and construction that is unparalleled in the excavating field.

Set the Baby Digger down on any of your jobs and watch its performance. See how its wheel-type digging mechanism and wide range of speed maintain consistently high daily footage. Note how the absence of excess tonnage enables it to traverse soft ground. See how its compact design enables it to work in narrow, confined areas.

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Compact, powerful, sturdy and fast, the Cleveland Baby Digger is a thoroughly practical, extremely adaptable, efficient trencher whose economies you can not afford to be without. Write today for full information and details.

THE CLEVELAND TRENCHER COMPANY

"Pioneers of the Small Trencher"

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THE CLEVELAND BABY DIGGER

Mr. Contractor!

Do you know that the MASTER SCRAPER loads on a turn as easily as it does on a straight pull?

And has it ever occurred to you how many hard-earned DOLLARS you are losing whenever you work tractor scrapers that you cannot load on the turn?

FULL Loads Are PAY Loads

The MASTER will load on a turn, and YOU are LOSING hard-earned DOLLARS every day you move dirt without one.

Why not throw away those old, obsolete scrapers, TODAY, NOW, and get yourself a MASTER?

The MASTER Rotary Scraper will cut and skip, underspill, finish grade and level. Manual load control or Automatic.

"It moves the Earth"

Simple Design Rugged Construction Easy Operation

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"It's MASTER Equipment, it MUST Be Better"

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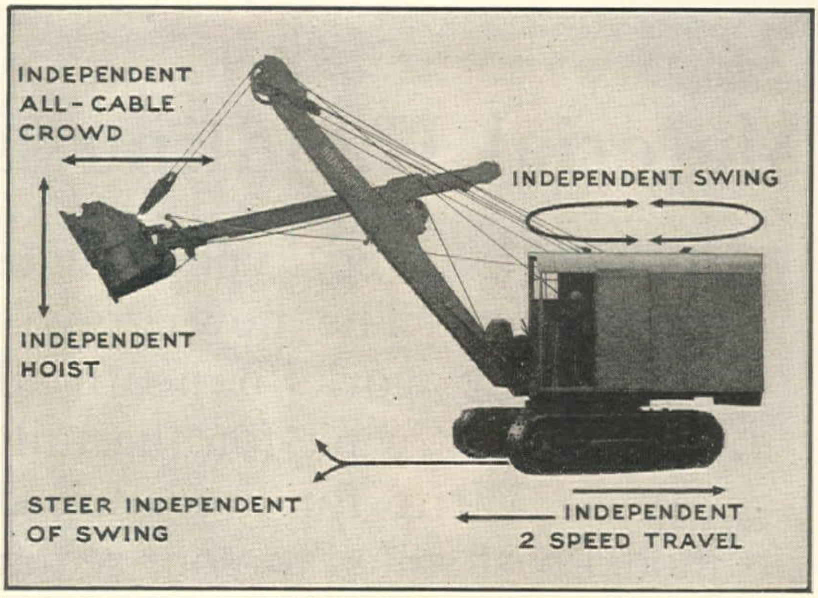

Operating advantage is always with the shovel or crane that has Independent Motions!

Every operating motion on Byers shovels and cranes is independent of every other motion!

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A Complete line of Shovels, Cranes, Draglines, Trenchers, Skimmers

THE NORTHERN "BUILT BETTER" MATERIAL HANDLING EQUIPMENT

Material Handling Equipment

A model for every type of industrial and contractor use. The new gravel car unloader successfully works beneath all drop bottom cars without a pit for the unloader or conveyor. Write for literature describing the model best suited to your requirements.

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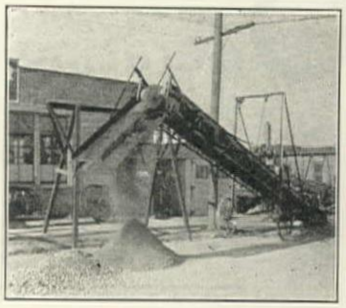
IN THE GRAVEL PIT



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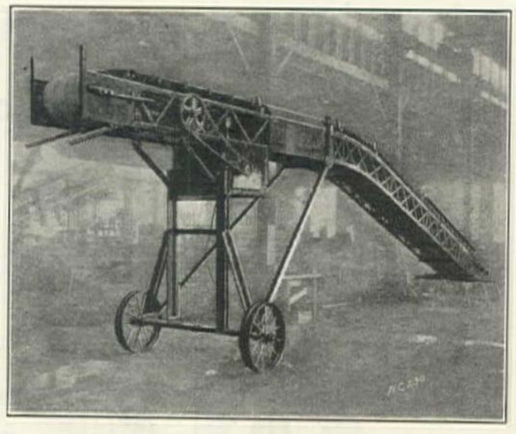

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SOLD ON CONVENIENT TERMS AND BEARS OUR FIVE YEAR GUARANTEE

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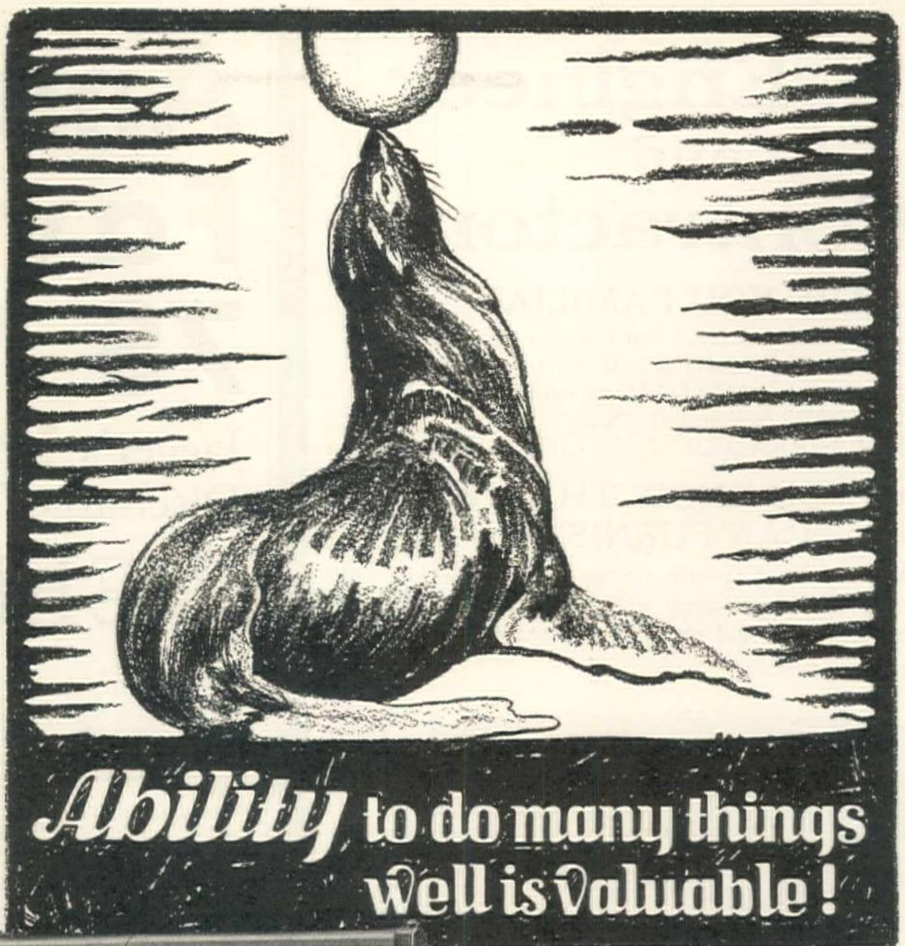
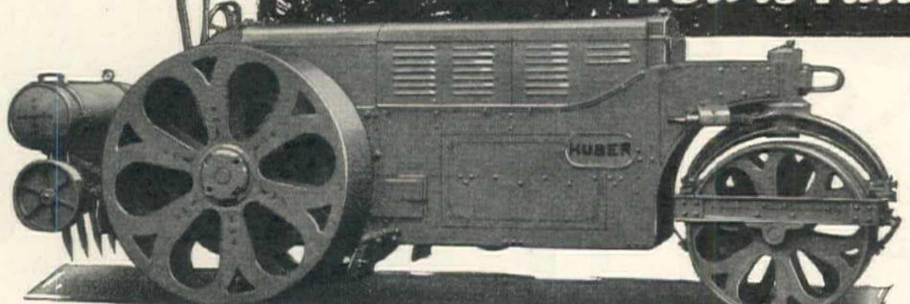
Janesville, Wisconsin

IT'S BACON IN SAN FRANCISCO





You'll like a *Huber* because of its all-round ability to do all types of road work. It takes the place of a number of different pieces of equipment — and does the work efficiently and economically! A *Huber* with sprinkling attachment is ideal for rolling hot asphalt—with scarifier it tears up old roads and streets to any accurate depth —with grader blade it levels off old roads in a hurry—many operations *with one machine.* Made in sizes from 5 to 15 tons.

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EDWARD R. BACON COMPANY

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HUBER
MOTOR ROLLERS

When writing to The Huber Mfg. Co., *please mention Western Construction News*

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Mr. Engineer
and
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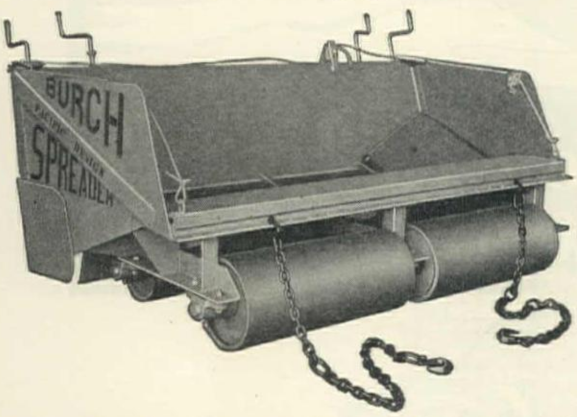
ARE YOU FAMILIAR

with the "uniformity," both as to the DENSITY and THICKNESS, that it is possible to lay either MACADAM or ASPHALTIC CONCRETE pavement with this NEW BURCH SPREADER *"PACIFIC DESIGN?"*

DO YOU KNOW THAT WE CAN FURNISH

an Automatic Adjustment on the Strike-off Blade for the placing of the LEVELING Course over the old existing pavement?



Exclusive "*Pacific Design*" Features

Spreads 7-8-9 or 10 feet wide, from ¾ to 12 inches thick. Adjustable END WINGS double spreads, when joining material previously laid.

Entirely supported on **ROLLERS** mounted on Roller Bearings. No shoes to drag through the material being placed.

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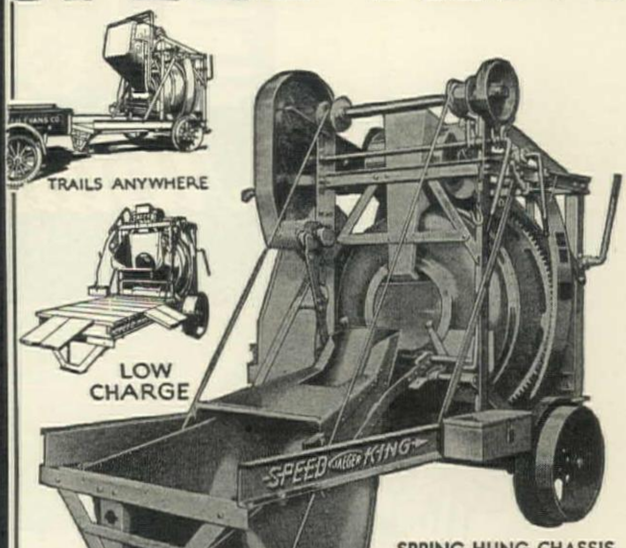
America's Favorite 7S Mixer

Jaeger's IMPROVED End Discharge TRAILER . . . .

SPEED KING



Speed King requires only about 6 ft. of street space. Charges in 5 seconds (Jaeger pat'd Skip Shaker), discharges stickiest concrete in 7-10 seconds. Real speed! You get all advantages of a trailer and side discharge outfit plus advantages of an end discharge.

All-steel light weight construction, springs, oversize axle and roller bearing dual tire wheels take care of it on any roads. Traction sheave and niggerhead standard equipment. Get our catalog and prices. You'll see why it outsells all others.

Jaeger offers all sizes, types of mixers, pumps, screw thrust hoists. Send for catalog!

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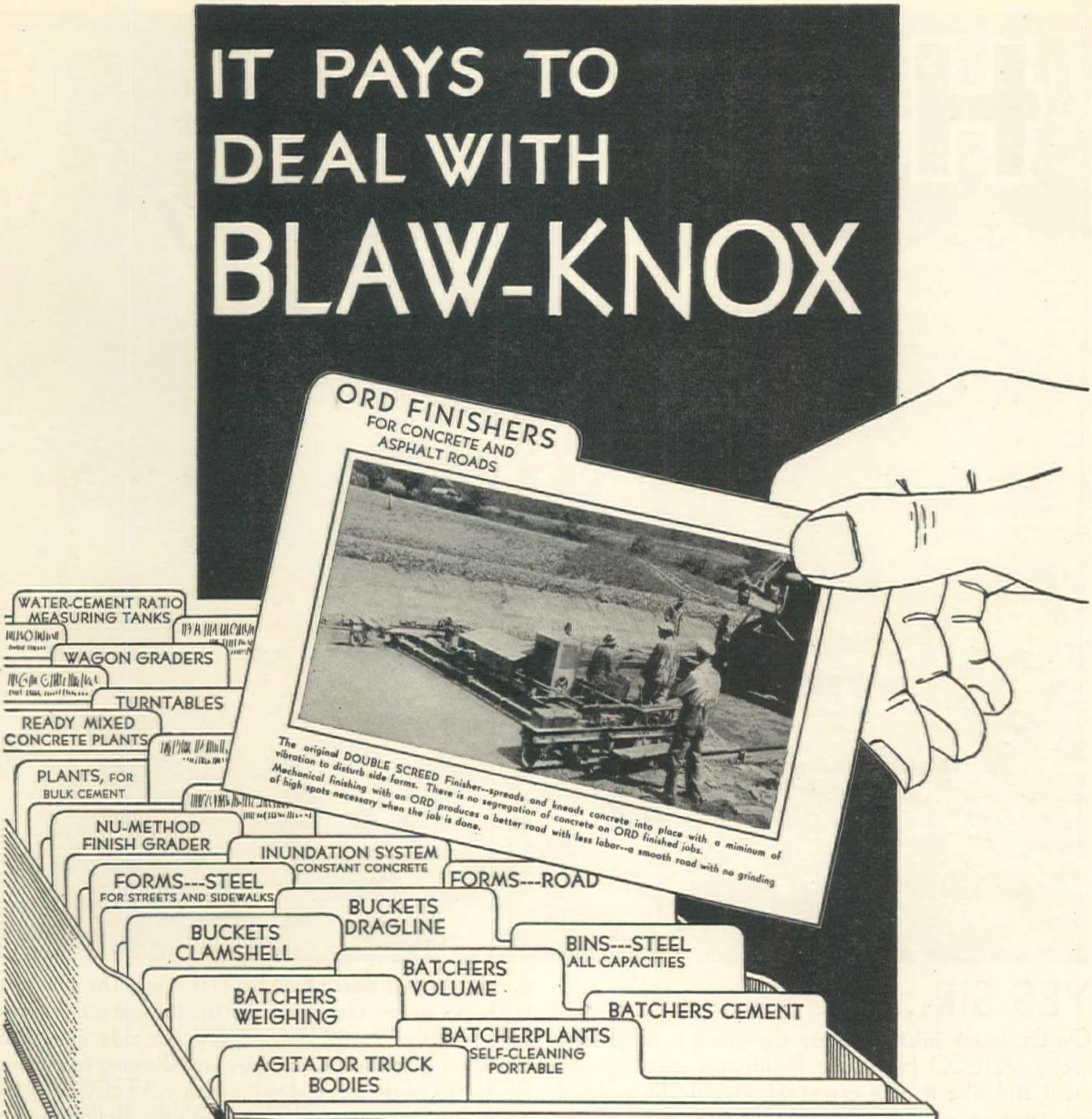

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Descriptive literature on any or all items of BLAW-KNOX CONTRACTORS EQUIPMENT will be sent to you.

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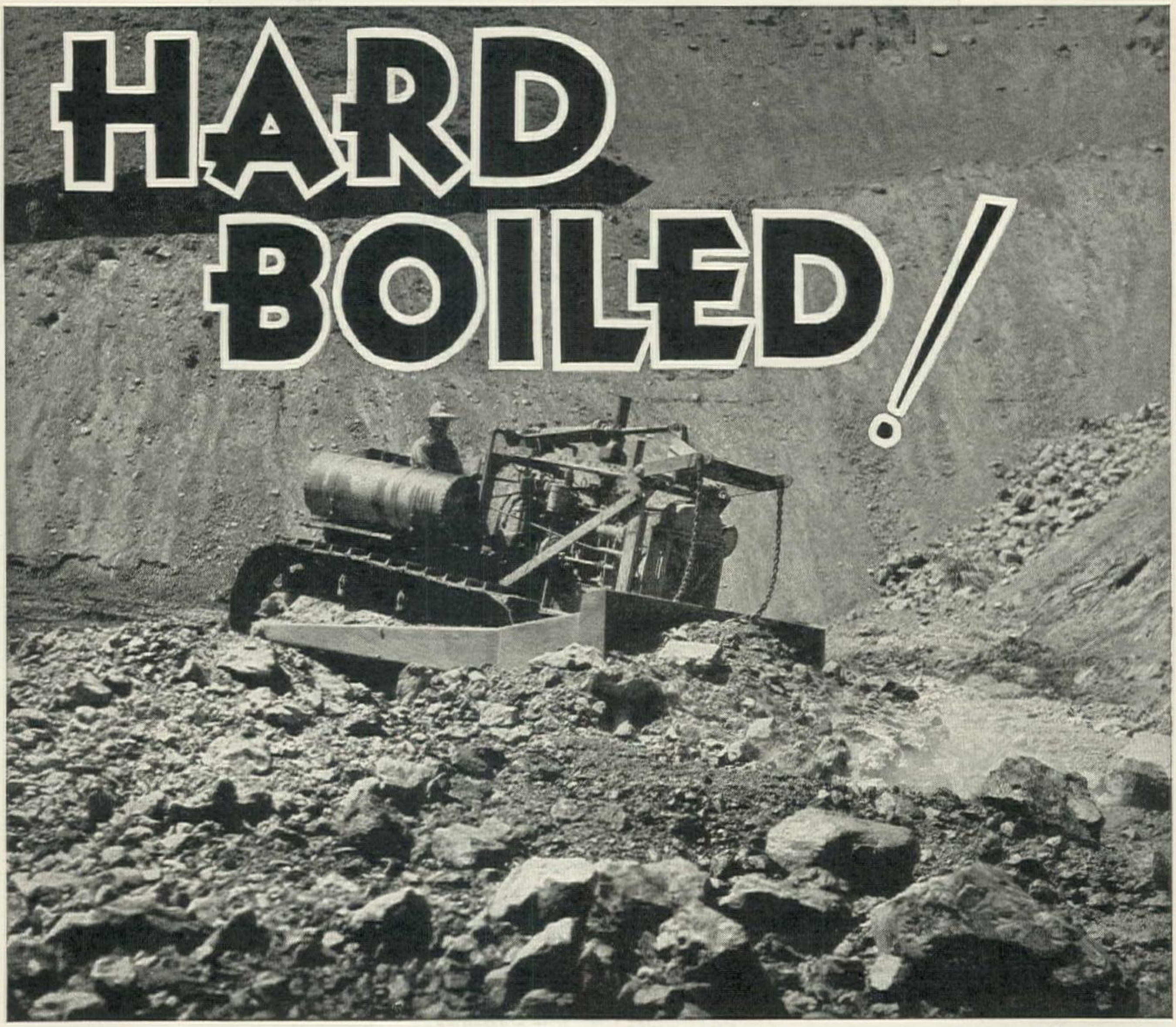

YES SIR...

On the tough jobs » » where the going is rough ana rocky, ATECO Hydraulic Bulldozers take punishment and like it. The cast steel, electrically welded construction easily withstands the maximum power of the tractor, and the huge bowl means big yardages. The ATECO Hydraulic One-Man Control instantly sets the bowl at any height to push a capacity load or spread and compact the earth in layers of any required thickness.

The framework does not interfere with the accessibility of the engine and no part of the Bulldozer extends at the rear. The drawbar is always in the clear and the tractor instantly available for other work. If necessary, the side arms and bowl are quickly detached by withdrawing four pins. By means of the special valve, other ATECO Equipment can be operated along with the Bulldozer by the One Pump and One-Man Control.

AMERICAN TRACTOR EQUIPMENT CO.

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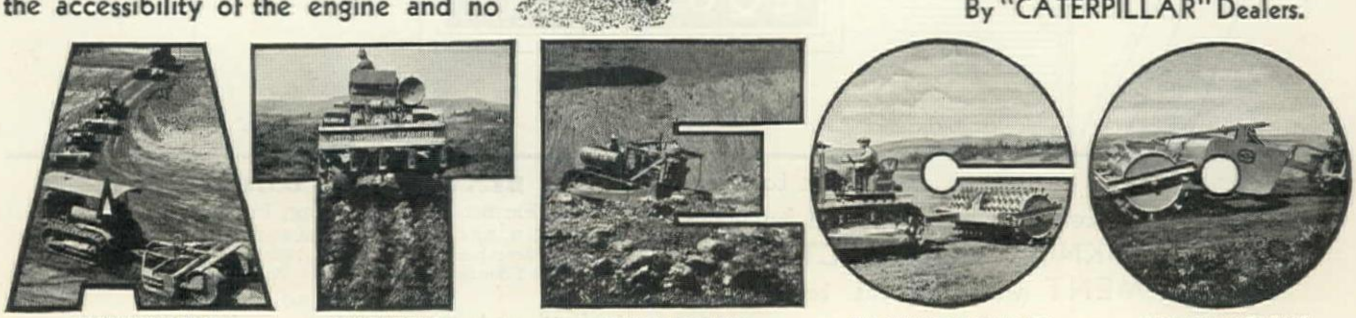
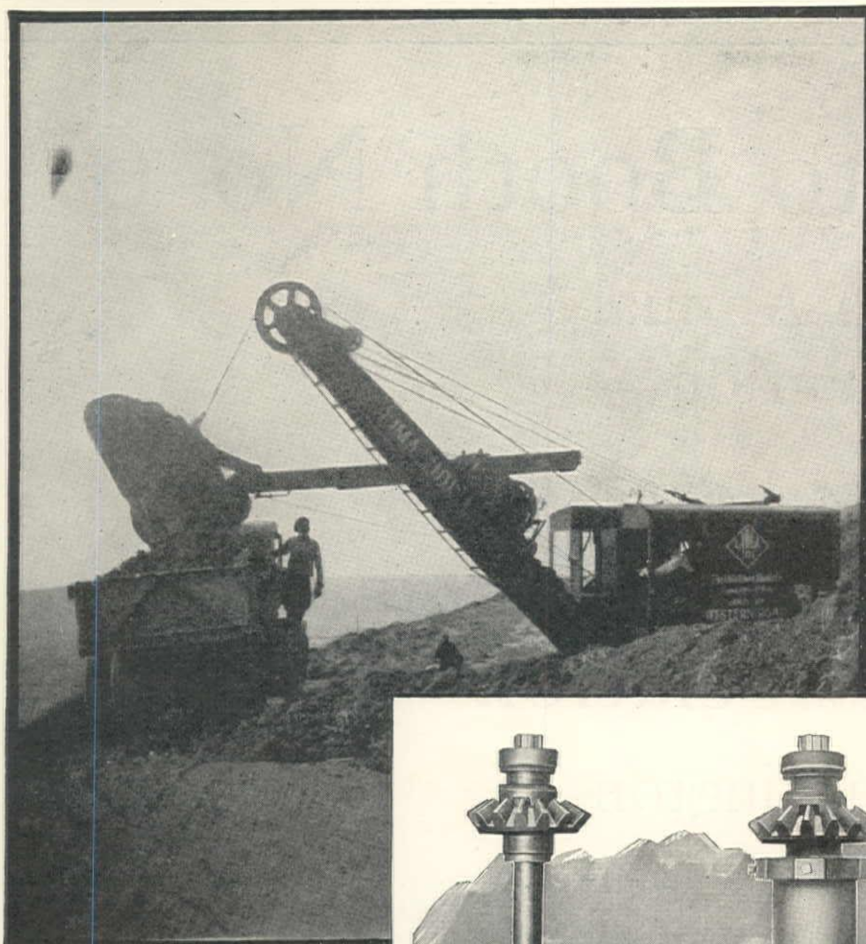
Sold Throughout The World By "CATERPILLAR" Dealers.



DIRT MOVERS | SCARIFIERS | BULLDOZERS | TAMPING ROLLERS | COMBINATIONS



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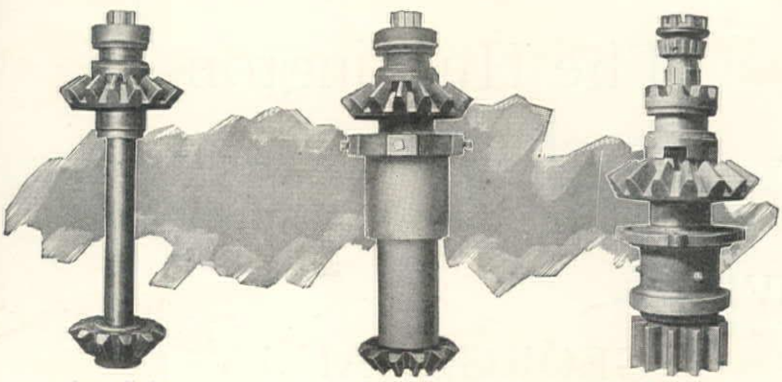

Center Shaft Center Pin Swing Shaft

Sturdy Construction is Assurance of Long Life

The center shaft, center pin and swing shaft—three vitally important units of any shovel, dragline or crane are made larger in the LIMA "101" than on any other machine of similar capacity. This sturdy construction and simplicity of design is just another assurance of longer life and low maintenance which is characteristic of all LIMA "101" Shovels, Draglines, Cranes and Drag Shovels. Write for Bulletin No. 301.

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Division Lima Locomotive Works Incorporated

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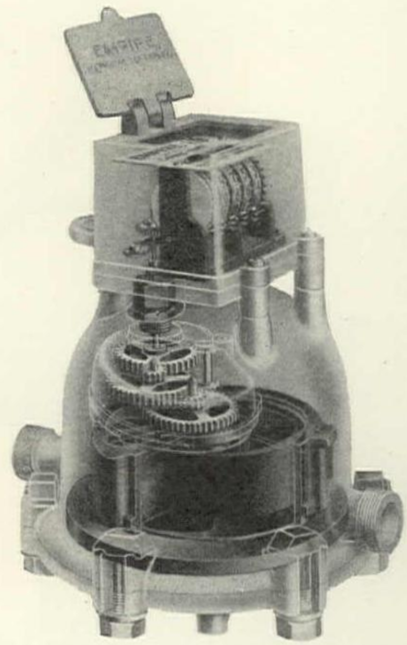
will be, as usual,
"always at your service"



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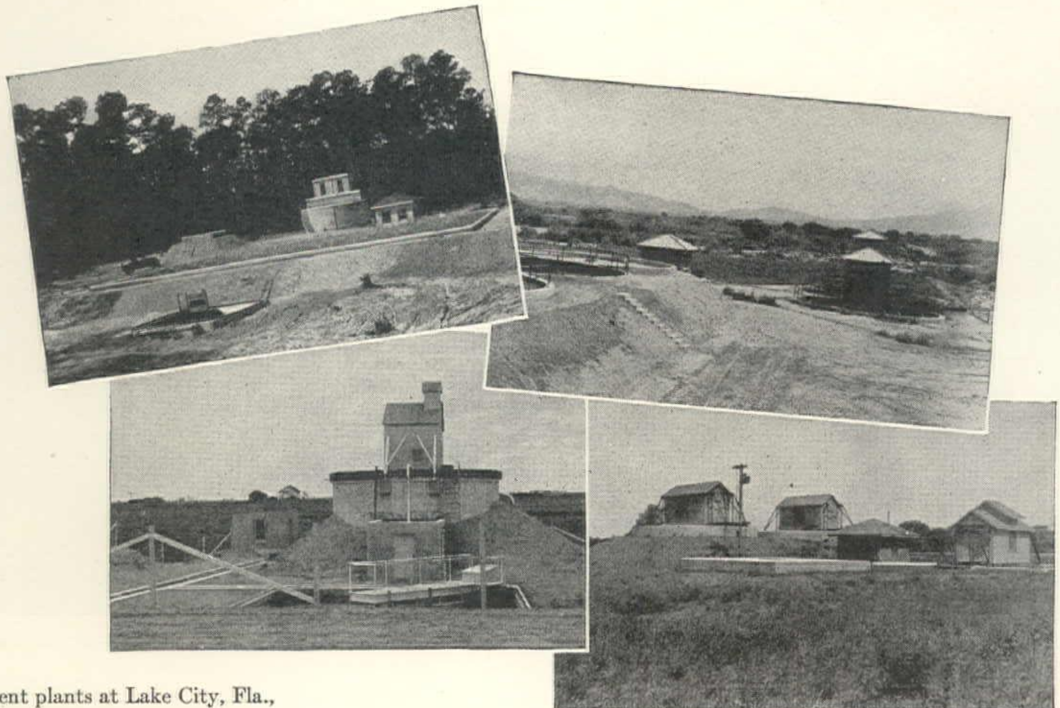
SEWAGE TREATMENT . . . .
for the city of moderate size



Sewage treatment plants at Lake City, Fla., (*upper left*); Tucson, Ariz., (*upper right*); Aurora, Colo., (*lower left*); Sedalia, Mo., (*lower right*)

Dorr-equipped separate sludge digestion plants are often used . . .

Of course Dorr-equipped separate sludge digestion plants are also applicable to larger cities. Toledo, O., Grand Rapids, Mich., and Erie, Pa., are among the cities which are now installing plants of this type.

DORRCO

Dorr-equipped separate sludge digestion plants, combining efficiency with economy, are especially suited to the needs of smaller cities. Such plants present an attractive appearance and construction costs are reasonable. In operation they are odorless and efficient. The gas from the sludge in the Dorr Digester is collected and burned. This provides heat around the plant as well as maintaining proper temperature for digestion inside the Digester.

We will be glad to furnish consulting engineers and municipal officials with full information on the operation of separate sludge digestion plants in various parts of the country. Write to our nearest office.

Bulletin 6001

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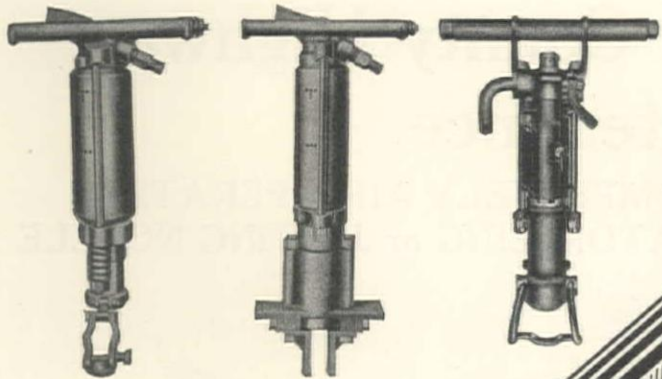
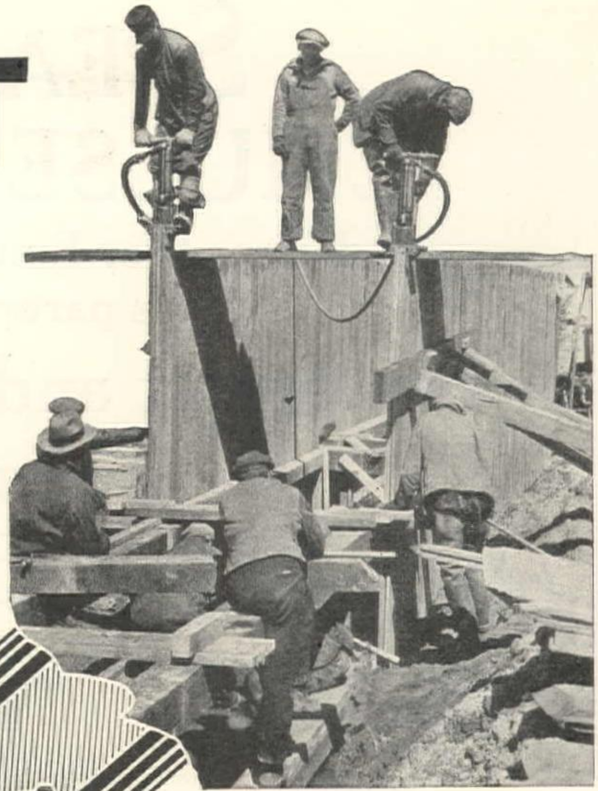
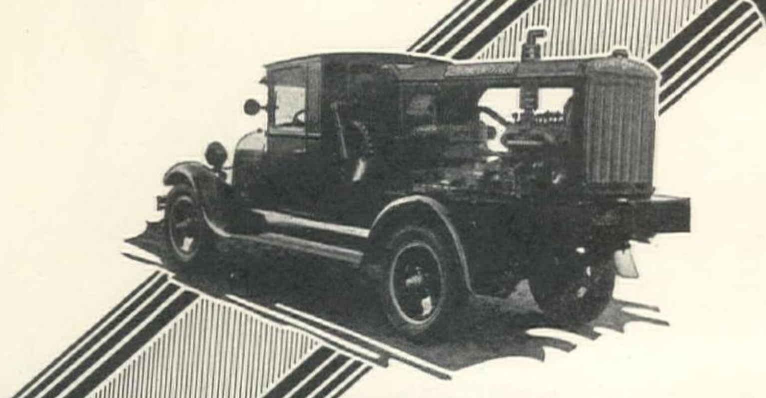
NO LOST TIME







getting from one job to another if you have a Gardner-Denver Truck Mounted Portable Air Compressor. Many contractors find they can save the cost of an extra compressor by using our truck mounted units for their small jobs. We can supply our portable compressors in six other styles of mounting to suit any job. We also supply rock drills and industrial tools for all purposes. Write for bulletin or better still let our local representative explain our latest products for reducing demolition and construction costs. ✧ ✧ ✧

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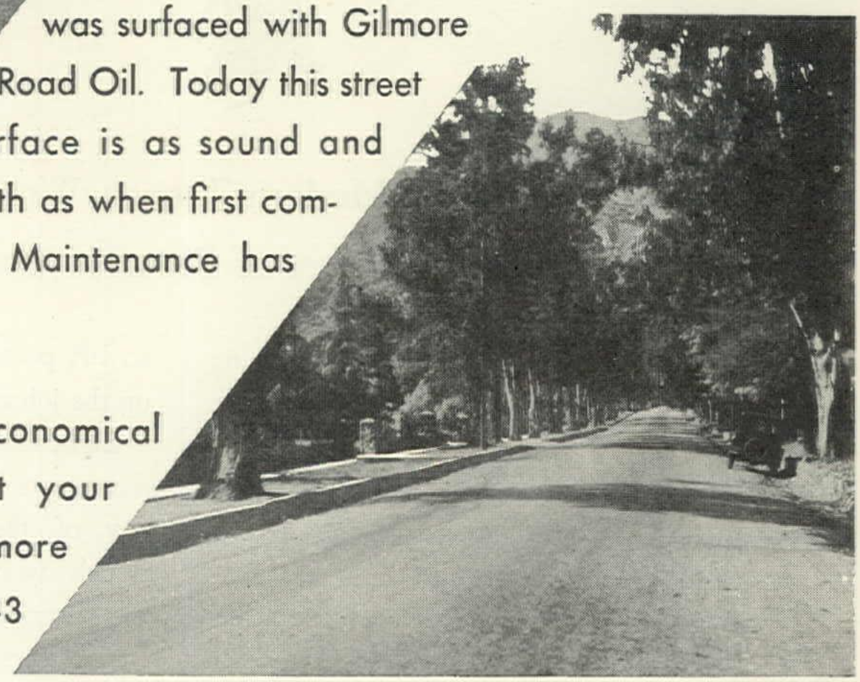
25 YEARS... AND STILL PERFECT

We don't know how long a Gilmore Road Oil surfaced street will last. We have been building them for only 25 years.

In 1904 North Baldwin Avenue in Sierra Madre was surfaced with Gilmore Road Oil. Today this street surface is as sound and smooth as when first completed. Maintenance has been nil.

Another drive in Sierra Madre . . . . recently surfaced with Gilmore Roadamite Road Oil.

Photograph of North Baldwin Ave... Sierra Madre, California... 25 years after surfacing was completed.



For durable, economical surfacing, submit your problem to the Gilmore Oil Company, Ltd., 2423 East 28th St., Los Angeles.

GILMORE

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ASPHALTIC ROAD OIL

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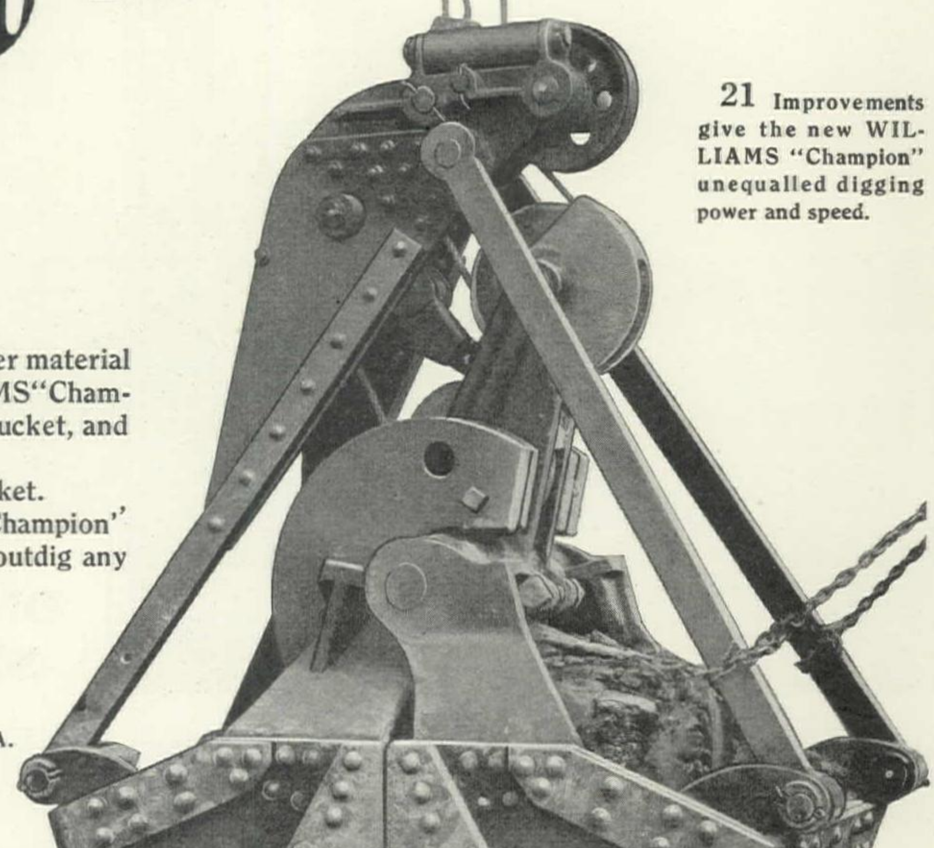
"For your real digging!"



21 Improvements give the new WILLIAMS "Champion" unequalled digging power and speed.

YOU can dig much harder material with the new WILLIAMS "Champion" than with any other bucket, and save dynamite, because

The dynamite's in the bucket.

The new WILLIAMS "Champion" is definitely guaranteed to outdig any other bucket built.

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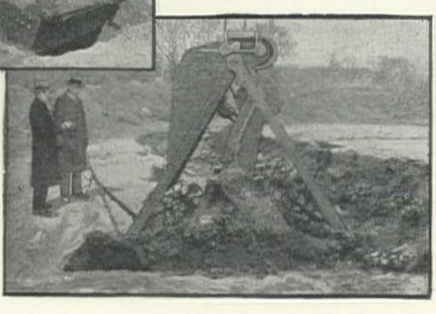
Make any tests you want, on your own work. A real Champion welcomes competition.



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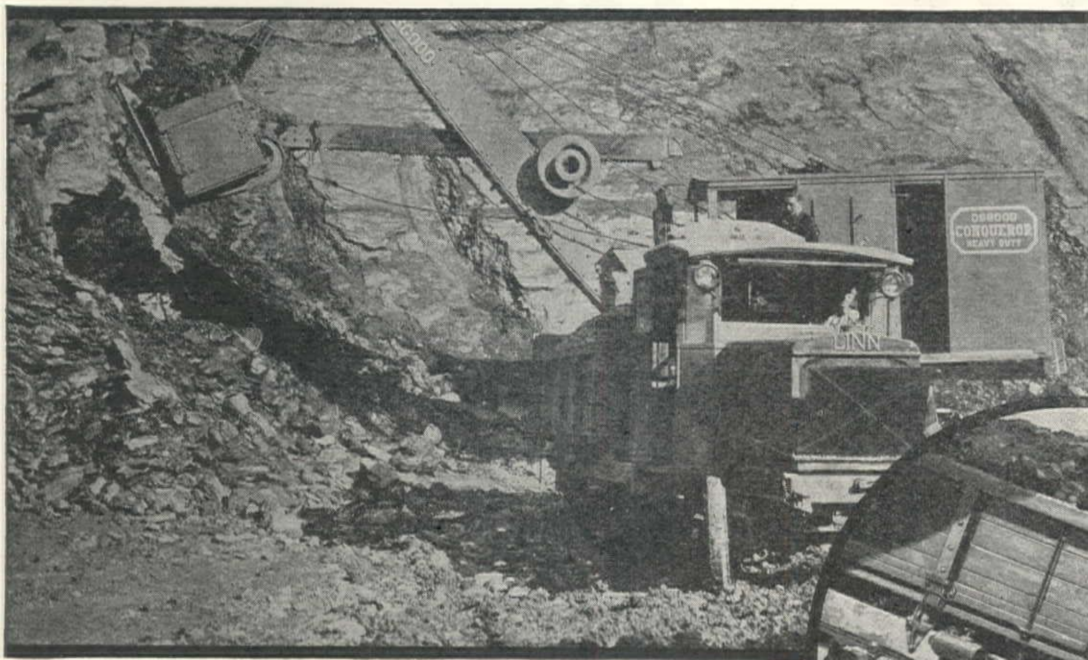
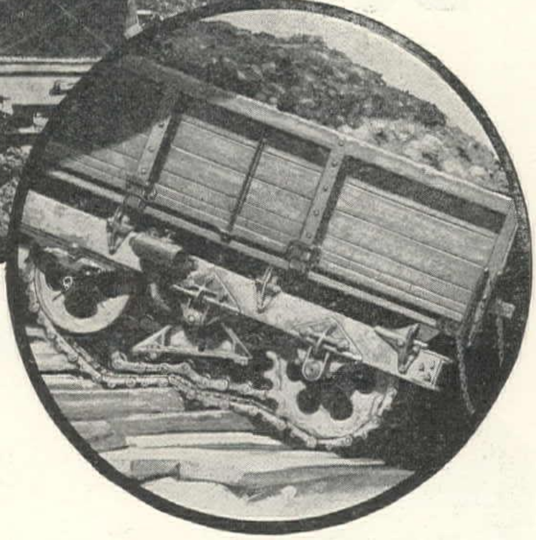
WILLIAMS
BUCKETS—TRAILERS

Another Certified Performance Survey Made by Independent Cost Engineers



One of two tractors operated by the P. B. Brown Excavating Company, Hazelton, Pa. These tractors for two years have given low cost performance over jagged rocks, through deep pit mud and with grades up to 37 per cent.



HERE ARE FACTS OF POCKET BOOK $ INTEREST TO *EVERY* EXCAVATING CONTRACTOR

A. C. Nielsen Company, Independent Cost Engineers, gives these facts after a survey of the strip mine operation of the P. B. Brown Excavating Company.

Fact 1. Two Linn tractors have moved all the coal from shovel to chute for the operators of a strip mine near Hazelton, Pa., since September 1928.

Fact 2. Pay loads averaged from 5½ to 7½ tons under all conditions.

Fact 3. No time lost for repairs of any kind during the first years of service.

Fact 4. Hauling costs per ton ranged from .110 on rock and mud bottoms to .243 in three feet of mud.

Tractors work in such close quarters that often the trip ⅛ to ⅝ mile one way has to be made in reverse. The Linn 4-speed reverse permits speeds of from one to six and three-quarters M.P.H. We shall be glad to send complete copy of this independent survey and other interesting data on request.

Hauls Pay Load As It Makes Its Own Road

1. *Patented Flexible Traction* that grips any surface under all weather conditions.
2. Tremendous hauling power—100 horsepower to take full advantage of Linn Traction.
3. Ten ton capacity on its own chassis.
4. Extra traction and power for additional tow loads.
5. Easy on men—steers like a truck.
6. Four speeds forward with four speeds reverse optional.

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105 direct distributors located throughout the United States and 49 distributors located in 30 foreign countries

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Patent No. 1,685,676
Patent No. 1,701,979
Other Patents Pending

LA FRANCE REPUBLIC — LINN TRACTORS

Two Ransome 56-S

STANDARD BUILDING MIXERS

SPEED up the new Mississippi River Lock at Minneapolis - - - 64,000 cu. yds. to be poured in 8 months.

Work is progressing rapidly on the new lock on the Mississippi River which will extend navigation up to the docks of Minneapolis, Minn. The Northern States Contracting Company is shown here using two Ransome 56-S Mixers in building the lock, which will be 500 ft. long and 56 ft. in height.

The work is to be completed in 8 months, and there will be 64,000 cubic yards of concrete in the walls.

The concrete mixing plant, located on the river bank, consists of two 250-ton steel bins and underneath each bin is a 56-S Ransome Standard Building Mixer. Bulk cement, stored in a wood bin projecting above the mixing plant, is being used.

RANSOME BIG MIXERS FOR BIG CONSTRUCTION JOB.

Bulletin No. 122 tells about Ransome Big Mixers.

Ransome Concrete Machinery Company

1850 — Service for 80 Years — 1930

Dunellen New Jersey

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1st

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And Neptune will continue to pioneer in every worthwhile development in water meter design and construction. Future advertisements will discuss above parts in detail.

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VOLUME V | OCTOBER 25, 1930 | NUMBER 20

California Section, American Water Works Association

CHAS. S. OLMSTED
Superintendent, Monterey County Water Works, and President, California Section, American Water Works Association

As water is rapidly becoming the most priceless of commodities in the Far West, it is but natural that the conservation, distribution, and use of water should be the most important if not the major industry. Therefore, the American Water Works Association is yearly attracting more interest and recognition. The Eleventh Annual Convention of the California Section at Pasadena, October 29 to November 1, should set a record for attendance and achievement.

WM. W. HURLBUT
Engineer, Distribution and Operation, Bureau of Water Works and Supply, Los Angeles, and Vice-President, California Section

WM. F. GOBLE
Superintendent of the San Gabriel Valley Water Co., and Member Executive Committee, California Section

LOUIS L. FARRELL
Superintendent, Construction and Operation, East Bay Municipal Utility District, Oakland, and Secretary-Treasurer of California Section

GEO. W. TRAUGER
Superintendent, Lindsay-Strathmore Irrigation District, and Member Executive Committee, California Section

Colorado River-Los Angeles Aqueduct

Probably in April, 1931, the Metropolitan Water District of Southern California will hold an election to authorize the issuance of about $225,000,000 in bonds for the construction of an aqueduct from the Colorado river to Los Angeles and environs. About the first of November, 1930, the engineering board of review of this district will select one of four routes which have been most carefully surveyed and analyzed and which are briefly described by F. E. Weymouth elsewhere in this issue. The routes vary in length from 200 to 300 miles, some with tunnels 80 to 100 miles long, and with diversion dams from 700 to 900 ft. high. All the routes cross rough desert terrain, with earthquake faults, and deep detritus basins filled with water.

This aqueduct project is almost staggering in its size and obstacles to overcome, but it must and will be built in order that the world-record growth of Southern California may not be retarded.

The construction of the Colorado river-Los Angeles aqueduct together with the Hoover dam and the All-American canal represents a total expenditure of $400,000,000 over a period of six years, which will do much to stabilize engineering construction in the Far West.

Probably before these projects are well under way, the proposed water conservation program for Northern and Central California will be started, and also the Columbia river development in Washington—both projects of equal or greater magnitude.

Certainly engineering construction in the Far West has a promising future.

Sewage Reclamation Forward, MARCH!

Unquestionably, the greatest forward step in the art and progress of sewage purification and disposal is the reclamation of sewage for the replenishment of underground water supplies, as is being successfully undertaken by the Bureau of Water Works and Supply, Department of Water and Power, city of Los Angeles.

In the September 25th issue, we published a preliminary article on this project, by Carl Wilson, outlining the unusually comprehensive program of water reclamation studies which the Bureau has started. In the current issue, we are most fortunate in being able to publish a detailed description by R. F. Goudey of the experimental sewage treatment plant, where within a span of 80 feet raw sewage is converted into sparkling clear, palatable drinking water. This water was recently drunk and relished by 150 visiting members of the California Sewage Works Association and the League of California Municipalities.

The viewpoint of everyone of these engineers and city officials was thereupon changed, and hereafter they will look upon sewage purification in the light of water conservation instead of sanitation. Thus, more progress will be made in the next few years than could be accomplished from the sanitary angle alone.

Also, another economic angle was brought forcibly forward at the convention of these aforementioned associations, which should be another incentive for sewage and trade waste reclamation—fertilizer. The manufacturers and distributors of fertilizer in Southern California, who are buying both dried and moist sludge from several sewage treatment plants, and reselling the same as fertilizer to orchardists and also gardeners who find it of great value, pointed out the urgency for reclaiming this sewage residue as a means of making up the rapidly growing deficiency in fertilizer.

Now that we have two economic necessities for sewage and trade waste reclamation, progress in the art will be accelerated and, furthermore, it will be looked upon with less repugnance and not be relegated to 'out of sight, out of mind'.

Pressure Toilet Flushers—a New Menace

We no sooner pride ourselves on our great achievement of eradicating water-borne typhoid by the purification and safeguarding of our water supplies, than some new, unlooked-for demon appears to threaten us. This time it is a cross-connection between the water supply and the sewer by means of a new pressure flush valve for toilets, which has in a few known instances recently siphoned the sewage back into the water supply. The water works superintendents at the coming convention of the California section, A.W.W.A., will probably take action to stop further installations of this type of valve. Let us hope that those already installed can be replaced or rectified before any serious damage is done.

Safe Swimming Pools

We doubt if anyone appreciates the rapidity of growth of swimming pool installations. The number of these pools is legion and no one appears to have even a meager record of their number or location. They are and should be under state and city supervision—and this supervision should be frequent, as well as strict. But, state and city agencies have neither sufficient funds nor personnel to cope with this rapid growth.

Swimming, without question, is the most healthful of exercises in which both old and young can participate. But, many refrain from going to swimming pools for fear of contracting some eye, ear, throat, or foot disease; although, probably, many of the cases attributed to swimming pools are contracted elsewhere.

Most pools maintain 'safe' water by constant recirculation and chlorination, but some are careless in their maintenance of walkways, dressing room floors, etc.

Swimming pools can be maintained absolutely sanitary in every department, as pointed out by A. C. Beyer in his article on the subject in this issue. Every pool, municipal or private, should itself, without state or city control, aim for the 'Red Seal' of purity as an incentive to greatly increased patronage.

The Montecito County Water District (described elsewhere in this issue) is a historical record of the struggle of another semi-arid community in the Far West to secure an adequate water supply. Each water works issue has contained a similar article.

Water Supply for Montecito County Water District, California

Cast-Iron Pipe Distribution System 35 miles Long, 9 Miles of Welded Steel Pipe in Supply Mains, 340 Fire Hydrants, Three Concrete Reservoirs, with 3,600,000 gal. Total Capacity. One 60,000,000-gal. Reservoir Behind 100-ft. Hydraulic-Fill Dam, 2.2-Mile Tunnel Serves as Horizontal Well, Auxiliary Dam 50 ft. High and 1200 ft. Long and Main Dam 160 ft. High and 440 ft. Long on Crest, Form Juncal Reservoir.

By CARL WYANT*

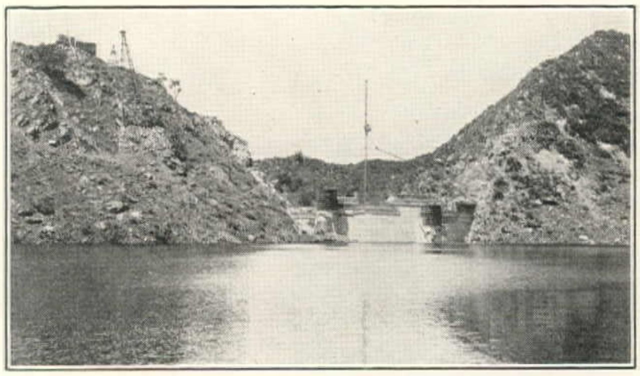
Chief Engineer and General Manager, Montecito County Water District, Santa Barbara, California

Editor's Note—Carl Wyant was born in Montecito, California, and graduated from Stanford University in 1913 with the A.B. degree in civil engineering. During 1911-12, he was chainman and rodman for the O.W.R.& N. on bridge construction at Aberdeen, Washington, and in 1913, instrumentman and draftsman for the Standard Oil Co. of California. Wyant was instrumentman for the Sierra & San Francisco Power Co. on construction of the Strawberry rock-fill dam during 1913-14; and from 1914 to 1918, a draftsman on bridge design, assistant engineer, and chief inspector for the city engineer's office, Santa Barbara. He then served three months as a private at the engineer officers' training camp, Humphreys, Virginia. During 1919-20, he was a member of the firm of Cook, Wyant & Moore, engineers of Santa Barbara, on design and construction of streets, sewer systems, and water supplies, since which date he has been resident engineer and general manager of the Montecito County Water District. Wyant is a member of the American Water Works Association.

The Juncal dam for the Montecito County Water District of Santa Barbara, California, was dedicated August 28, 1930, completing a construction program which began in 1921. This program required the development of a complete water supply for the district, including: 35.64 miles of cast-iron pipe distribution system; 9.02 miles of welded steel pipe in supply mains; 340 fire hydrants; one 1,000,000-gal, reinforced concrete reservoir, counterfort type; one 1,000,000-gal. concrete reservoir, circular type; acquiring a private reservoir by donation; one 60,000,000-gal. reservoir formed by the construction of a 100-ft. hydraulic-fill dam; an 11,376-ft. tunnel; 3 miles of narrow-gauge construction railroad; 6 miles of 15,000-volt transmission line; a 1000-ft. tunnel; an auxiliary dam 1200 ft. long and 50 ft. maximum height, of multiple arch and gravity design; a variable-radius arch dam 160 ft. high and 440 ft. long on crest; 12,000 lin.ft. of 18-in. welded steel pipe-line; a 760-ft. diversion tunnel; 1250 lin.ft. of metal flume; and a small diversion dam. The program was financed by the issue of $2,606,000 of 40-year, 5% bonds, voted in four issues and sold as needed. The total cost of the work has come within the estimate.

The Montecito County Water District was organized November 10, 1921, under the California County Water District Act of 1913 and, including a later annexation, contains 7790 acres. The district serves a high-class residential section lying immediately east of the city of Santa Barbara for 5½ miles and extending inland 3½ miles. The coast line at this point is in an east and west direction and forms the south boundary of the water district. From the coast, the land rises toward the north in undulating hills, reaching an elevation of 800 ft. at the Coast range foothills in the Santa Ynez mountains. From this point the mountain range rises abruptly to an elevation of 4000 ft., and practically all of the land suitable for building purposes lies below the 800 ft. elevation.

As the number of large residences in the area increased, the struggle for water became acute and in 1921 the limit of growth had been reached. In fact, several homes had to be closed during the summer months because of water shortage. Until 1921, the main source of supply was from wells, although several short tunnels provided some water, and a small amount of surface flow was obtained from streams. It was not unusual for a single residence to have three or four small pipe-lines furnishing an insufficient water supply from as many sources.

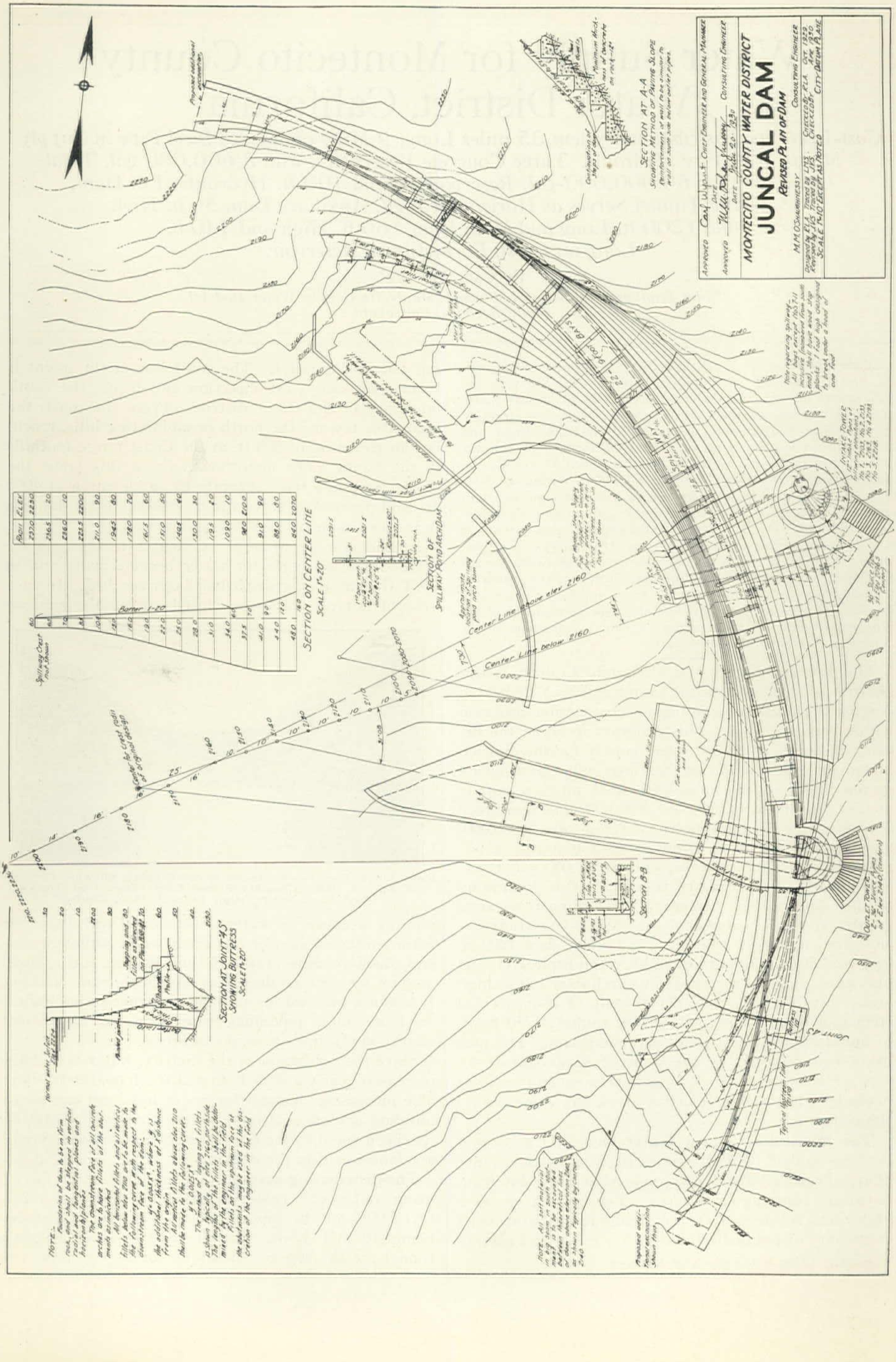


Main Juncal Dam for Montecito Water District, Showing Progress to April 1, 1930. Concrete Placed from Insley 1-yd. Heavy Mast Plant 280 ft. High Through 14-in. Chutes

Since the formation of the district, water sales have increased yearly and in 1930 will reach 60,000,000 cu.ft. The increasing demand for water has been caused by building activity. It is estimated that over $1,000,000 has been spent in the past year for the construction of residences within the district.

The distributing system was laid with district forces, using deLavaud cast-iron pipe and cement joints. Over 90% of the pipe is 6 and 8-in., the remainder being 10 and 12-in. Juncal reservoir and Doulton tunnel are the sources of supply for this system. As

*Member, American Society of Civil Engineers.


MONTECITO COUNTY WATER DISTRICT
JUNCAL DAM
REVISED PLAN OF DAM
SECTION AT A-A
SHOWING METHOD OF PAVING SLOPE
SECTION ON CENTER LINE
SCALE 1"=20'
SECTION OF SPILLWAY TO ARCH DAM
SECTION AT JOINT 45
SHOWING BUTTRESS
SCALE 1"=20'
SECTION B-B
Center Line above elev 2160
Center Line below 2160
INTAKE TOWER
OUTLET TOWER
JOINT 45
SPILLWAY
NOTE

the south portal of Doulton tunnel is at elev. 1921 ft. on the east edge of the district, a supply main had to be constructed from the tunnel along the upper edge of the district to a balancing reservoir at the west edge. This supply main is connected with small reservoirs at the heads of the north and south roads, and the distribution system is carried down these roads to the ocean, interconnecting with all existing crossroads.

Kennedy fire hydrants were installed at 500-ft. intervals. The main problem in designing the distribution system was to reduce the pressure and was met by Ross mechanical pressure regulators. The system received a severe test during the 1925 earthquake, but no leaky joints occurred. There was only one pipe broken during the earthquake and this occurred at a point where a 12-in. earth crack opened across the line.

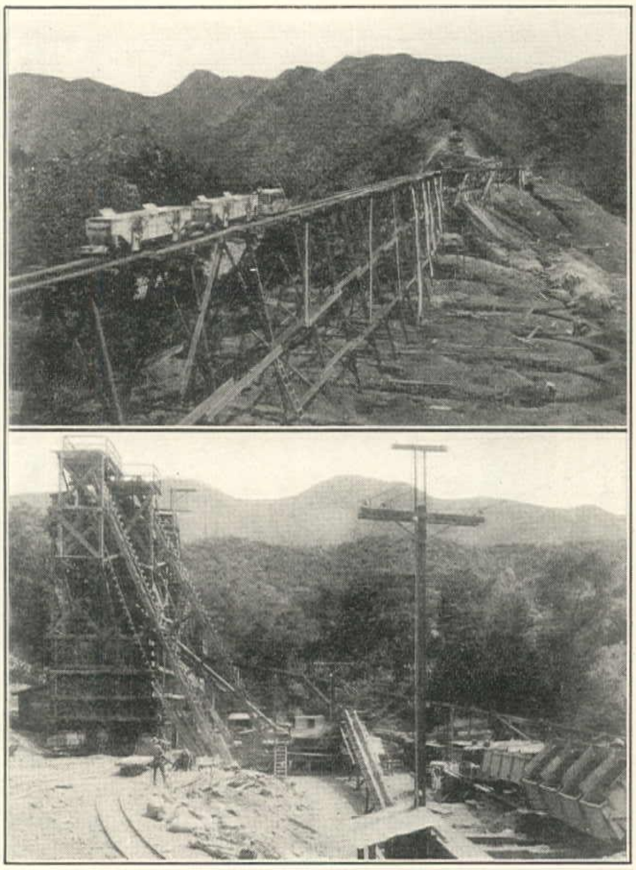
Trenching, pipe-laying, and backfill—including repairs—was done at an average cost of $0.65 per lin.ft. on the distribution system.

Reservoirs—Bothin reservoir at the west end of the supply main was built by contract and is of the counterfort type, 60 by 100 by 23 ft. deep, with wooden roof. It has a capacity of 1,000,000 gal. and is provided with a 4-ft. center partition to permit cleaning without interruption of service. San Ysidro reservoir is situated near the center of the supply main and was built by contract. It is a circular reinforced concrete tank 80 ft. diam. by 23 ft. deep, capacity 1,000,000 gal., and has a wooden roof. The Carpenter reservoir, donated to the district, has a capacity of 1,600,000 gal. This is a rectangular, cantilever type structure 12 ft. deep and was repaired and roofed by district forces.

Buell reservoir, formed by the construction of a 100-ft. hydraulic fill dam, has a capacity of 60,000,000 gal. This reservoir was built between November, 1926, and December, 1927, by Kraner & Haskell, of San Francisco and Santa Barbara, under a modified cost-plus contract, taking water for sluicing from Doulton tunnel under 800-ft. head. A detailed description of this reservoir was published in the August 10th, 1927, issue of **Western Construction News.**

Doulton tunnel, formerly called the Toro tunnel, was renamed for H. J. Doulton, president of the board of directors of the district, who died just prior to its completion. This tunnel enters the Santa Ynez mountains in Toro canyon at elev. 1921 ft. and extends 11,376 ft. northeasterly to a point 170 ft. above the bed of the Santa Ynez river. It was driven 7 ft. wide by 9 ft. high and is 4 ft. 10 in. wide by 6 ft. 6 in. high above the track in the lined sections. The track was carried 1.5 ft. above the bottom to allow passage of water underneath the rails. The tunnel is on a grade of 0.002%. It was holed through April 18, 1928, and the concrete lining was completed in January, 1929. The best driving progress was 479 ft. in one month and 21 ft. in one day.

The tunnel line was located by triangulation, brushed out, and then gone over by Bailey Willis, consulting geologist, to determine its water possibilities as well as the nature of the rocks to be encountered. The Coast range consists of sandstones and shales which have been tipped on edge and more or less shattered. These rocks form a collecting ground for rain water which percolates through their interstices, and a tunnel serves as a horizontal well. It was predicted from the geologic study that large quantities of water would be encountered in driving and that a permanent supply of 75 miners' inches would probably be obtained—a prediction which was actually borne out. At one time the tunnel yielded 9 c.f.s. of water and considerable difficulty was encountered in maintaining good driving progress. The water had considerable head behind it and at times stopped air drills operating under 100 lb. pressure. It was necessary in one place



(Upper) Hauling Concrete for Auxiliary Dam With Plymouth Gas Locomotive and Train of Assembled Mine Cars; 50-ft. Trestle Along Axis of Dam. (Lower) Aggregate Plant for Juncal Dams, Capacity 300 cu.yd. Per Day

to drive a side drift to relieve the water pressure from the face, and often the holes had to be loaded with dynamite in tin tubes. Hercules 40% gelatine was used on the work. No gas was encountered during the driving of this tunnel.

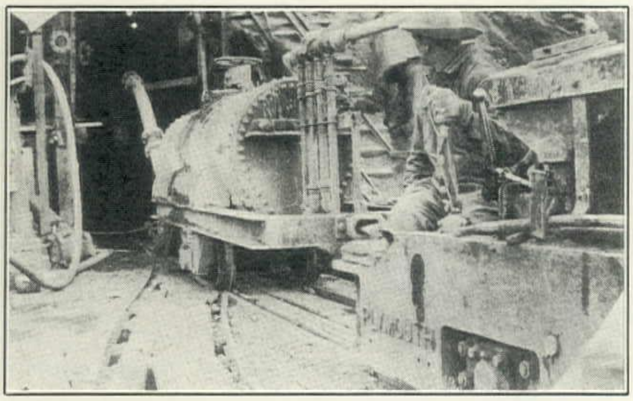
The water needs of the district were entirely supplied from Doulton tunnel between 1924 and 1927. Since that time the tunnel has been the chief source of supply, its present yield being 70 miners' inches.

The tunnel had to be driven entirely from the south end, as the only access to the north portal was by horse trail over a steep mountain range. Tunnel driving and lining was done by district forces. A power shortage existed and all power for construction purposes had to be developed locally, using semi-diesel engines. Two 50-hp. Chicago-Pneumatic direct-connected compressors were used. A 50-hp. Chicago-Pneumatic engine drove a Connersville blower, a General Electric A.C. generator for lighting the tunnel and camp, and a Westinghouse D.C. generator for charging batteries. The hauling equipment consisted of one Mancha 'Titan B' storage-battery locomotive, one Mancha 'Little Trammer', and 23 Matheson 1-ton mine cars. Drilling was done with Ingersoll-Rand N.R. 72 drifters mounted on a horizontal bar. Three 8-hour shifts were used with the exception of the first part of the work; mucking was done by hand. The usual procedure was to drill and shoot a 6-ft. round per shift. Ventilation was furnished through a 10-in. slip-joint riveted steel pipe-line.

Progress in tunnel driving was as follows:

Period	Lin.Ft. Advanced
August 15, 1924-January 1, 1925	555
1925	2,945
1926	2,517
1927	3,896
January 1, 1928-April 18, 1928	1,463
Total	11,376

About 4000 lin.ft. of timbering was necessary, a 3-segment arch set of 8 by 8-in. timbers being used, ordinarily spaced 4 ft. on centers. The track was kept



Plymouth Locomotive and 2-yd. Hackley Concrete Gun at Completion of Doulton Tunnel Lining

to grade behind the heading by laying two 4 by 6-in. redwood mudsills longitudinally and blocking up the ties from these. The last 2000 ft. of the tunnel was in a heavy Franciscan formation and there the timbers had to be constantly relieved.

Lining was necessary on 4000 ft. of tunnel, of which 2000 ft. was distributed in 33 small sections in the first 9000 ft., the last 2000 ft. being lined solid; the remainder of the tunnel was unlined. For lining operations the camp was moved through the tunnel to the north portal and a Bodinson wet-rock plant was installed, using a P&H ½-yd. shovel to dig aggregates from the riverbed and gas locomotives to haul them in side-dump cars to the crusher. Rock and sand were elevated to bunkers at the foot of an inclined railway where loaded muck cars made up in trains of four were hauled by means of a hoist to a second set of bunkers over the north portal of the tunnel. A Rex 1-yd. mixer was set under the upper bunkers, discharging directly into Hackley 2-yd. concrete guns which were then hauled by gas locomotives into the tunnel. The sides of the lining were placed by hand to a height of 40 in. from the bottom and Hackley collapsible steel forms, manufactured by the Western Pipe & Steel Co., were used for the remainder of the sides and for the arch. One 50-hp. Ingersoll-Rand and one 50-hp. Gardner-Denver compressor supplied air for the guns through a 2½-in. galvanized steel pipe-line. This pipe was later used for air lines on dam construction and finally for the handrail on the main dam. Weep holes were left every 10 ft. to permit infiltration of groundwater. The ends of the short sections which required lining were first bulkheaded with precast concrete blocks, mortared in place, leaving just enough room at one end for inserting the gun discharge pipe.

Construction Railroad and Transmission Line—The north portal of Doulton tunnel is 3 miles downstream from the damsite. Several methods of transportation were studied and the one adopted was to continue the narrow-gauge railroad from the bottom of the incline up the canyon to the damsite. Work on this railroad was carried on while the tunnel was being lined and involved the construction of 3 miles of 24-in. gauge, rock-ballasted track, using 20-lb. rail; construction of two small bridges; three switchbacks on a 6% grade; and a 1000-ft. tunnel. This short construction tunnel was later lined with the same equipment employed on the Doulton tunnel and is now used to transport water from the dam. The pipe-line from the dam discharges into the upper end of this tunnel and the water flows by gravity through the tunnel and is picked up by the pipe-line at the lower end, saving 1½ miles of line over rugged terrain.

To obtain power for all of the work on the north side of the mountains, it was necessary to build a 15,000-volt transmission line, about 6 miles long, over the Coast range. To do this required the construction of trails and packing in equipment, supplies, and water by mule back. The line was carried on sectional steel towers furnished by the Pacific Iron & Steel Co. of Los Angeles, using maximum spans of 3000 ft.

Auxiliary Dam at Juncal Reservoir—When the railroad was completed, camp was moved from the north portal of Doulton tunnel to the Juncal reservoir and work started on the auxiliary dam. This dam was required to close a saddle on top of a ridge forming the westerly boundary of the reservoir. The dam has a maximum height of 50 ft. and is 1200 ft. long, 600 ft. being a multiple arch design with buttresses spaced 36 ft. on centers and the remainder a concrete gravity section. As the ridge at the gravity section was thin, the upstream side was paved with concrete averaging 7½ in. thick for a considerable distance below the crest. This paving terminates in a concrete cutoff wall in solid rock.

The rock plant was moved from the north portal of Doulton tunnel to a permanent location in the riverbed at the damsite and was enlarged to a capacity of 300 cu.yd. of concrete aggregates per day. The plant includes a 15 by 38-in. Wheeling roller-bearing jaw crusher, a 9 by 38-in. and a 9 by 28-in. 'Rollerbear' crusher, Allis-Chalmers sand rolls, a 24-in. conveyor belt, two bucket elevators, four conical screens, and two drag sand-washers.

An incline track was constructed from the bunkers to a point on top of the ridge at one end of the auxiliary dam and a Fulton single-drum 25-hp. hoist powered by a variable-speed motor was installed to elevate the aggregates to small bunkers. This hoist was later used as the tower hoist on the main dam construction. The Rex 1-yd. mixer was set under these bunkers and concrete was hauled by gas locomotives over a wooden trestle 50 ft. high constructed along the axis of the dam.

The auxiliary dam contains 10,300 cu.yd. of concrete.

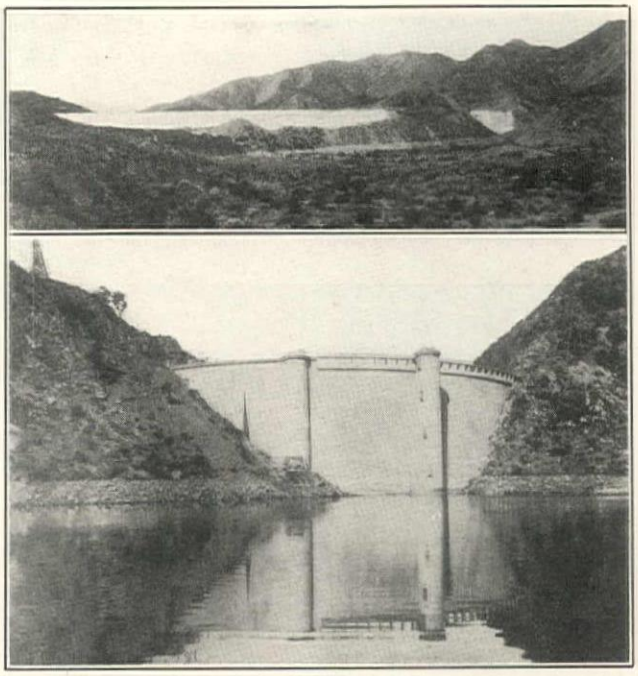
Main Juncal Dam—The main damsite at Juncal reservoir is in a narrow gorge which the river has cut through a sandstone ridge. The design adopted was a variable-radius arch with overflow spillway. The base width of the dam is 64 ft. at the crown of the arch, with flaring abutments. The crest width is 6 ft., the maximum height 160 ft., and the crest length 440 ft. The dam contains 34,400 cu.yd. of concrete. The spillway is designed to pass a flood of 300 c.f.s. per square mile of drainage area.

A double row of grout holes 30 ft. deep was drilled in the bedrock for the entire length of the dam near the upstream face. These holes were on 5-ft. centers and were grouted under 75-lb. pressure. Copper water stops were installed at vertical construction joints, spaced 40 ft. apart, and were also placed horizontally at each 5-ft. lift between daily pours. These daily pours were finished in vertical steps, with the downstream face 10% of the thickness of the dam higher than the upstream face. The surface of the concrete was picked off and cleaned with air and water before placing the next lift. The 'Perfection' grouting system was installed in order to grout the expansion joints after the dam had cooled. Drainage wells 3 in. diam. were left at the upstream edge of each expansion joint. These wells are connected to porous concrete drains placed on the bedrock in two longitudinal rows. The concrete drains are bled by 6-in. cast-iron pipes laid through the bottom of the dam.

The main control tower has wet and dry compartments, with 12-in. inlets spaced 30 ft. vertically. These inlets are controlled from the dry well with double gates; a sluice gate on the outside of the tower and a gate valve on the inside of the dry well. Both gates have short stems and discharge into the wet well, where the water is carried through the dam in a 24-in. cast-iron pipe and controlled by a Pelton valve in a weir house downstream from the dam. In operation, the water in the wet well will stand at the lake level and will be drawn from the highest gate. The amount of water sent to the district will be measured at the weir house over a 42-in. rectangular weir, fitted with a lever indicating arm to show the depth of water over the weir. At the bottom of the dry well is a tunnel leading to a gate-operating chamber which serves a 36-in. cast-iron sluice pipe near the bottom of the dam. This sluice pipe has a 36-in. Coffin sluice gate on the outside of the dam and a 36-in. Rensselaer gate valve in the operating chamber. In addition to the main control tower, an auxiliary gate tower was constructed. This tower contains two 36-in. Rensselaer gate valves connected to 36-in. steel pipes extending through the dam 90 ft. below the crest and intended for emergency use only.

Several changes in the original design were made to fit bedrock conditions. The crest of the dam was moved upstream 10 ft. at the abutments by using a longer radius. This caused considerable upstream overhang at one haunch and was made safe for reservoir empty by a buttress 10 ft. thick. The buttress was placed before the dam was constructed and the joint was painted with asphalt so that there would be no interference with arch action.

About 21,000 cu.yd. of excavation was necessary for the main Juncal dam, 4000 cu.yd. being removed by



(Upper) General View of Auxiliary and Main Dams from Juncal Reservoir. (Lower) Main Juncal Dam Completed and Reservoir Being Filled

hydraulic sluicing. The unwatering of the bedrock was a simple matter and was controlled by means of a small concrete arch dam placed immediately upstream from the main structure. Water was pumped across the excavation. The P&H ½-yd. shovel began deepening the river channel one-fourth mile downstream from the dam, excavated material being used for concrete aggregates in the auxiliary dam. The channel was carried upstream to the main damsite. By the use of this channel, bedrock at the damsite was placed practically in open cut, allowing gravity drainage.

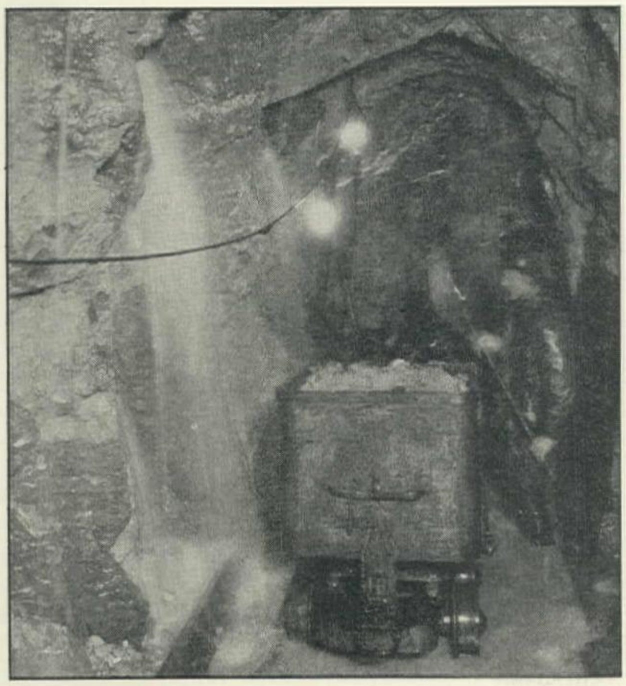
Concrete was placed from an Insley 1-yd. heavy-mast plant 280 ft. high, with 14-in. chutes hung from a high line. An 80-ft. wooden tower was required on each end of the high line. Small bunkers were erected at one side of the mast, and aggregates were hauled from the main bunkers by gas locomotives and mine cars. The cars were assembled on the job by using the tunnel muck-car bodies and placing them in trains of eight cars on two trucks. The mixer was set under the bunkers and fed through a Rucker weighing hopper. Water was controlled through a 2-in. Neptune meter equipped with a special dial. The monthly concrete yardage placed was as follows:

Period	Concrete Placed (Cu.Yd.)
November 14, 1929-December 1, 1929	2,307
December, 1929	2,536
January, 1930	3,937
February, 1930	6,110
March, 1930	3,266
April, 1930	6,223
May, 1930	5,252
June, 1930	3,427
July 1-July 16, 1930	734
Total	33,792

In addition, 600 cu.yd. of concrete was placed for rock protection downstream from the dam, and in a small arch dam constructed to form a water cushion for the spillway. The concrete was designed for a strength of 2000 lb. per sq.in. at 28 days by careful proportioning and the use of a 5-sack mix. The high proportion of cement necessary to give this strength was due to the nature of the sandstone aggregate available.

Juncal reservoir covers 160 acres and will contain 7000 ac-ft. of water, the net safe yield being 1600 ac-ft. per year. The drainage area for this reservoir is 17 sq.mi.

Welded Steel Pipe-Line—An 18-in. diam. welded steel pipe-line was constructed from the dam to Doulton tunnel, a distance of 12,000 ft. This line is composed of ¼-in. plate with electric-welded shop joints and gas-welded field joints, and has a soil-proof wrapping; it is an inverted siphon for practically the entire length and will deliver 8,000,000 g.p.d. The pipe was furnished by the Western Pipe & Steel Co.



Heading for Doulton Tunnel, April, 1926. Ingersoll-Rand Drifters and Matheson 1-Ton Mine Car in Use. Note Ground Water Infiltration

Diversion Works—To increase the safe yield of the reservoir, it was decided to divert Alder creek into the lake, bringing in 4 sq.mi. additional drainage area. To effect this diversion, it was necessary to drive a 760-ft. tunnel through a low ridge. This tunnel was later lined by hand and is 4 ft. by 5½ ft. in cross-section. At the upstream end of the tunnel, a 1350-ft. Armco Lennon-type flume 4 ft. 7 in. diam. furnished by the California Corrugated Culvert Co. was constructed on wooden substructures, 300 ft. being on a 60-ft. trestle. A small diversion dam was built at the head of the flume, using rubble concrete with the maximum amount of rock.

All materials for the diversion works had to be hauled to the main Juncal dam in the usual manner, lifted over the dam, carried up the lake on a barge equipped with an outboard motor, hauled 1 mile by team, and then pushed through the 760-ft. tunnel by hand.

Transportation on the whole project was an interesting problem and, as worked out, functioned satisfactorily.

The major item was cement haul, 'Riverside' cement being transported from freight cars in Santa Barbara 12 miles by truck (mostly 5-ton Whites and Internationals) to the south portal of Doulton tunnel. The trucks hauled 100 sacks per trip, the grade reaching 18% in some places. Cement was unloaded onto flat cars at the south portal. The flat cars were made on the job by using two mine car trucks and had a capacity of 100 sacks each. Two flats at a time were hauled through Doulton tunnel, then they were lowered down the incline by a 50-hp. Clyde hoist. At the bottom of the incline the flats were picked up with a second gas locomotive and hauled to the dam and unloaded into chutes which fed the cement shed at the mixer. As many as 1900 sacks were handled in this manner in 8 hours.

All equipment had to be purchased with the size of the tunnel in mind, dismantled, and then reassembled after reaching the work. Five 4½-ton Plymouth locomotives did all of the hauling on the job. All other rolling stock was made from tunnel muck cars.

Personnel—Leeds & Barnard, Los Angeles, were consulting engineers for the construction of the distribution system, Buell dam, and the driving of Doulton tunnel. M. M. O'Shaughnessy, San Francisco, was consulting engineer on design and construction of the Juncal dams. Bailey Willis, Stanford University, was the consulting geologist on the tunnel and dams. C. D. Marx of Stanford University assisted in preliminary economic studies. A consulting board consisting of F. C. Herrmann, San Francisco, and L. C. Hill, Los Angeles, was called in by the state engineer on certain features of the dam. All of the work on Juncal dam was inspected and approved by the State engineer and the district engineer of the U. S. Forest Service and Federal Power Commission.

R. J. Westaway was in charge of construction of the distribution system, F. E. Evans of the Doulton tunnel driving, and E. V. Taylor was general superintendent on all the work on Juncal dams and appurtenant structures. J. V. Spielman was in charge of design of structures and was resident engineer on the Buell and Juncal dams. All of the above work was under my immediate supervision.

CALIFORNIA STATE EMPLOYEES RETIREMENT ACT

At the general state election on November 4, California voters will have the opportunity of approving a worthwhile measure which will increase the operating efficiency of state government without increasing taxes (the bill carries no appropriation). By this act every employee of the state will be required to participate in a systematic plan of saving in order to provide a fund for retirement on pension of employees who have passed their period of efficiency. According to W. A. Johnstone, president of the State Civil Service Commission, this act will result in an annual cash saving to the taxpayers of California of $700,000 to $800,000.

Vote Yes on No. 5.

Colorado River Aqueduct for the Metropolitan Water District of Southern California

By F. E. Weymouth*
Chief Engineer, The Metropolitan Water District of Southern California, Los Angeles

Now that construction on the Hoover dam is actually under way, the attention of Southern California is naturally being drawn to the correlated Colorado River-Metropolitan Water District aqueduct project. Much interest is being evidenced in the pending report which it is proposed soon to submit to the board of review for study and criticism. The board of review is composed of Thaddeus Merriman, chief engineer of the New York City Water system, A. J. Wiley, consulting engineer of Boise, Idaho, and Richard R. Lyman, consulting engineer of Salt Lake City.

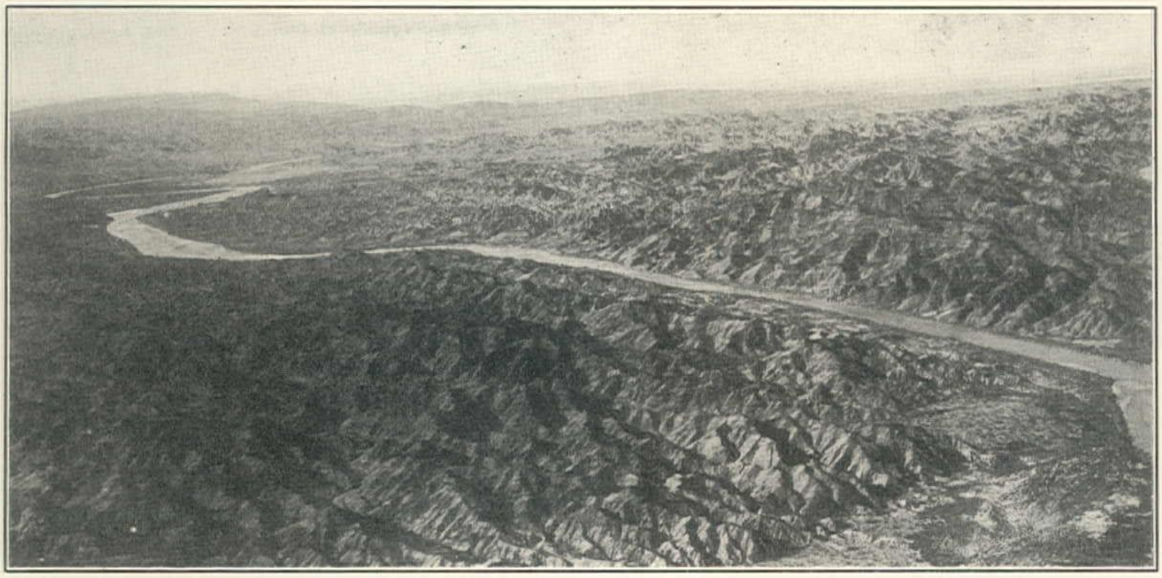


FIG. 1. COLORADO RIVER IN THE VICINITY OF THE PICACHO DAMSITE
(© Spence Air Photos)

Present Water Supply in Southern California—Attention is often called to the fact that the region generally referred to as the 'South Coastal Plain' contains one-half of the population of California, while its water resources, exclusive of importations, constitute less than one per cent of the water resources of the State. In spite of its lack of natural water supply, the development of the district has gone rapidly forward in the last two or three decades and an important agricultural region, specializing in highly valuable types of crops, has been built up. Also, numerous industries have been established and the region has enjoyed marked prosperity. It is, at the present time, expanding rapidly in population and wealth.

Unfortunately, this development has already absorbed the local water supply and, unless some new outside source can be tapped, retardation of growth is inevitable although soil resources, industrial opportunities, climate, and other natural assets are hardly touched. Actually, the local supplies are already overdrawn and present development is possible only because of the importation of Owens river water by the city of Los Angeles, coupled with the most careful development of local waters by other communities. Steps are now being taken to extend the Owens river aqueduct into the Mono basin, thus increasing the water supply of Los Angeles sufficiently to avoid suffering for the time being. Other communities are reaching out into all of the corners of the watersheds with plans for the most careful conservation of the small flows now running away to the ocean. Looking further into the future, all eyes are turned to the Colorado river.

Future Water Supply—The present situation has been foreseen for many years and the entire Colorado river problem has long been studied by public-spirited individuals and by the public generally. The needs of Los Angeles basin cities for domestic waters added an important item to other weighty arguments leading to the passage of the Boulder canyon act and the actual inauguration of the great Colorado river development.

Actual surveys for an aqueduct from the Colorado river were begun by the city of Los Angeles in 1924. At that time the barren and rugged region between San Bernardino and the Colorado river was largely unsurveyed. Reliable contour maps from which even preliminary estimates might be prepared were not available. It so happened that there were no important topographical features clearly limiting a possible aqueduct route to one location. The problem was not, at that time, entirely new. Many men had given thought to the possibility of a Colorado river-Los Angeles aqueduct, and there were many proposals for lines diverting from the river at numerous points. It

*Member, American Society of Civil Engineers.

was not possible with the information at hand to judge with certainty between these various proposed routes or to pass upon the merits of other possible lines. For this reason, a general topographical survey of the entire unsurveyed portion of the area was undertaken.

Water District Formed—It was realized from the beginning that all of the coastal plain area was in need of water and that a project of such gigantic magnitude involving so many important cities should have the support of the entire economic area. Therefore, while Los Angeles was carrying on the first preliminary work, agitation was under way to secure the enactment of legislation which would make it possible for non-contiguous municipalities and water districts to join together in a united water supply project. This agitation resulted in the passage, by the State Legislature, of The Metropolitan Water District Act of 1927. Under this Act 'The Metropolitan Water District of Southern California' was formed, and the work already started by the city of Los Angeles was taken over. The maps and preliminary surveys thus made available were extended and supplemented by the District and estimates for a great number of possible aqueduct routes were prepared.

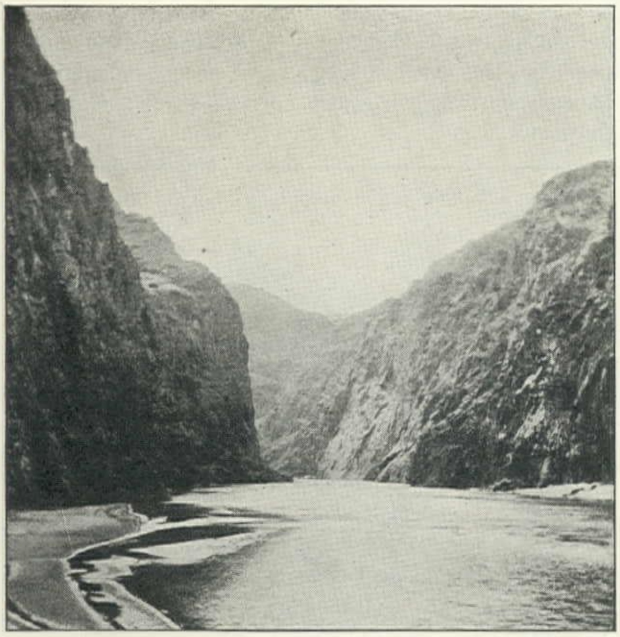


Fig. 2. Lower Black Canyon Damsite on Colorado River, Looking Downstream from Arizona Side

A report based upon the results of these studies was made and presented to the board of review in the fall of 1929. After carefully examining the data submitted and going thoroughly over the ground traversed by the most promising lines, the board of review recommended that all further studies be concentrated along a limited number of the most favorable routes. Parties were then sent into the field and actual preliminary locations were made, with the result that the problem has finally been narrowed down to four comparatively definite lines, the locations of which are shown on the map, Fig. 4.

Physical Problem—It is impossible to show, even approximately, on a map of reproducible size, the great multitude of difficulties encountered in the selection of an aqueduct route across this region. The area to be traversed is largely a broken, mountainous desert, traversed by earthquake faults, fissures, and zones of structural weakness.

In general, the more nearly level parts of the higher lands consist of loose, detrital materials filled into deep valleys between the mountain ranges. In numerous cases, these valleys are hemmed in by rock formations and the detrital materials are filled with water. Tunneling through these formations is impracticable, and the lines must be lifted over, or taken around them. The mountain ranges themselves are often badly broken and faulted. One of the chief geological features is the great San Andreas rift, California's most important living fault, which any aqueduct line from the Colorado river to Los Angeles must cross. A typical view of this fault line is shown in Fig. 5. The active San Jacinto rift must also be crossed. In addition to these major fault lines, there are numerous smaller faults and many areas filled with crushed and broken material.

Fig. 3. Typical Desert Scene Along Line of Colorado River Aqueduct

The selection of a line passing over or around all these difficulties in such a way that it may be constructed with safety at a reasonable cost is one of the important engineering problems of the project. Detailed geological examinations have been made of all parts of the region through which it appears to be likely that an aqueduct line might be constructed. The results of these studies have materially influenced the tentative selection of routes shown on Fig. 4. The most recent studies reveal that several safe and economical locations are available, which avoid the most difficult areas, and cross the unavoidable faults in surface conduits subject to ready repair. Fig. 3 is typical of the country to be crossed.

Four Routes Proposed—Each of the proposed lines possesses certain favorable and certain unfavorable features. It will be noted that one of them diverts from Bridge canyon (Line 1, Fig. 4), entirely above and independent of the Boulder dam development. Next in order, down the river is a proposed diversion directly from the Boulder canyon reservoir (Line 2), with an alternative intake for practically the same line further down the river at Bulls Head (Line 3). A third possible line takes out of the river at a point near Parker, Arizona (Line 4), and a fourth has its diversion at Picacho (Line 5), about 20 miles north of Yuma, Arizona.

The Bridge canyon scheme, as might be expected, is the most expensive of all the proposed plans. It involves very long and deeply buried tunnels, some of which traverse areas not geologically suited to tunnel work. It is thought that the construction of this line would be hazardous. This line has the advantage of furnishing water without pumping, and of releasing a large block of power for commercial use if a market for it could be found. However, it would involve heavy fixed charges, and a high annual tax payment to Nevada and Arizona. It also involves the construction of a diversion dam on the Colorado from 600 to 900 ft. high.

FIG. 4. FOUR ALTERNATE ROUTES FOR COLORADO RIVER AQUEDUCT RECOMMENDED BY ENGINEERING BOARD FOR CONCENTRATED STUDIES

Generally speaking, the cost of construction and the geological difficulties and uncertainties decrease as the point of diversion is moved down the river. Thus, excluding the Bridge canyon line, the Black canyon aqueduct is the most expensive of all those shown on Fig. 4, and the Picacho line is the cheapest. However, the difference in cost between successive lines, excluding Bridge canyon, is not enormous. When the probable cost of future operation, properly evaluated, is added to the construction cost, it is believed that an index will be furnished which, when applied to the intangible features, such as security of operation, purity of water supply, etc., will furnish a sufficient definite guide for the selection of the project best suited to the financial ability and physical requirements of the district.

Status of Metropolitan Water District—The district, at the present time, is composed of eleven cities, as follows:

Name	Population (1930 Census)
Anaheim	10,997
Beverly Hills	17,428
Burbank	16,429
Colton	8,013
Glendale	62,607
Los Angeles	1,231,830
Pasadena	75,875
San Bernardino	37,453
San Marino	3,719
Santa Ana	30,332
Santa Monica	36,993
Total	1,531,676

Ontario, Fullerton, and Torrance have formally applied for membership and plan to vote on the matter at an early date. The question of joining the district is now under consideration by practically all the municipalities so situated as to be able to conveniently participate in the benefits of the proposed project. It is expected that the present number will be much increased before construction is begun.

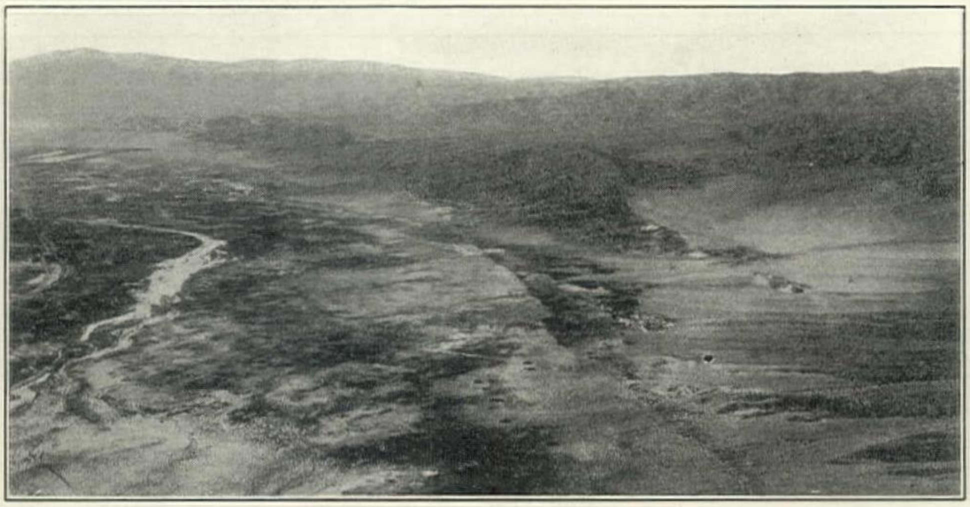


FIG. 5. SAN ANDREAS FAULT NEAR INDIO. FAULT LINE EXTENDING ACROSS COUNTRY OBLIQUELY FROM LOWER RIGHT HAND CORNER OF ILLUSTRATION

The district is governed by a board of directors composed of at least one director from each city, the voting power being distributed among the member cities on the basis of one vote for each $10,000,000 of assessed valuation, with the provision that no city shall have more than 50% of the voting strength of the board. Each city has the right of appointing an additional director for each $200,000,000 of its assessed valution without, however, increasing its voting power.

W. P. Whitsett is chairman of the board of directors. Engineering is under my direction, as chief engineer. Julian Hinds is designing engineer.

Los Angeles to Vote $6,000,000 Bonds for Sewers

Like the boy who is constantly outgrowing his clothes and requiring new ones, Los Angeles often faces the necessity for expanding her public service facilities to care for great increases in population. At the present time an acute phase of this problem is apparent in the sewer system, which is overtaxed and requires immediate extension and relief.

In 1922, the voters of Los Angeles authorized a $12,000,000 bond issue for constructing an outfall sewer to supplement the old central outfall, and this was built with ample capacity for many years to come.

The interior system of collecting sewers was originally built for a much smaller residential population than it now serves. At the time these sewers were designed, it was impossible to forecast the building of large numbers of apartment houses, which in some sections have increased the density of population a thousand per cent. As a result, sewers which were entirely adequate for bungalow districts are now overflowing into storm drains, streets, and basements. Residents of many other sections of the city are unaware that their sewers are running full and that a slight increase in the flow would cause them to spew into the streets through manholes, introducing a serious health menace.

Present conditions call for quick remedial action through the construction of relief sewers in every councilmanic district at an estimated cost of $3,237,000. In addition to relief sewers, the proposed bond issue will finance six other needed projects, as follows:

San Fernando valley intercepting sewers	$863,400
Harbor district collecting system, to complete	303,200
Treatment plant and disposal, harbor district	1,130,500
Repair central outfall sewer	98,100
North outfall sewer chlorination plant	98,100
Grease-skimming tanks, Hyperion plant (Includes research in disposal of sewage and industrial wastes)	270,000
Required to finance projects outlined, including $3,237,000 for the relief sewers	$6,000,000

The relief sewers might be financed under the Act of 1911, assessing the cost against each individual lot (average $10, payable in cash). Several difficulties in administering this method indicate that the matter can best be handled by bond issue, in which event the other projects are possible. The $6,000,000 required for all projects is about $4.80 per capita for residents of Los Angeles. Approval of the bond issue by a two-thirds vote at the general election on November 4 would authorize the city to issue 4½%, forty-year bonds.

J. J. Jessup is city engineer and W. T. Knowlton is sanitary engineer for the city of Los Angeles.

Colorado River Water Suitable for All Uses

The following is an abstract of a paper presented by Carl Wilson, biologist and director of sanitation, Bureau of Water Works and Supply, City of Los Angeles, before the School of Citizenship and Public Administration, University of Southern California, April 14 to 19, 1930. The subject of Wilson's paper was 'Quality and Effect of Colorado Supply in Reference to California Waters', and was written to set at rest the various criticisms in the press and elsewhere as to the suitability of this supply for Los Angeles and environs. Some have claimed that the silt—the Colorado river water carries the maximum of any river in the world—could not be settled out or filtered except at great outlay. Others have claimed the great salt beds in the Boulder canyon reservoir site would be dissolved and make the water unusable. Still others have claimed that the total mineral hardness was excessive. Wilson very logically proves all these conjectures false.

The Colorado river began to be studied by the U. S. Government 30 years ago, as to volume, silt content, etc. Since 1925, the U. S. Geological Survey has taken samples of the water for chemical analysis every day at three points—Grand Canyon, Topock, and Yuma; these being composited weekly, and more recently in ten-day periods, and then analyzed. Furthermore, these analyses have been studied with a view to determining the probable character of the water as will be impounded by the Hoover dam. Colorado river water has for thirty years been used for both irrigation and domestic uses in the Imperial valley, and this has also been taken into consideration.

Salt Content—When the Hoover dam is built, the Virgin river valley will be flooded for 25 miles and large beds of salt—some pure and some low grade—totalling 25,000,000 tons, will be submerged. To the laymen this is a stupendous quantity, and a number of people, including engineers, have published articles on how the water in the reservoir will contain more salt than the Dead sea. Wilson proves this entirely erroneous by a few simple calculations. The reservoir when full will contain 26,000,000 ac-ft., or 8.67 million million gallons of water—enough to inundate the 400 square miles within the city of Los Angeles, 101 ft. deep; or blanket the state of California 3 in. deep. The smallest quantity of salt in water recognizable by the average person's taste is 23.2 gr. per gal., or in terms of the chloride radical, 14.5 gr. Therefore, to produce a taste of salt in the Colorado river reservoir it would be necessary to dissolve 14,427,000 tons of salt, or more than half the total deposits. But, as a matter of fact, most of these deposits are covered, or will be, with a heavy overburden, and but little will ever be dissolved. Eminent authorities claim the chloride content will not be increased more than 20 p.p.m., or from 60 p.p.m. to 80 p.p.m., which is inconsequential.

Mineral Characteristics—Unfortunately, no rigid standard has ever been adopted for measuring the mineral content of drinking water. However, the U. S. Treasury Department, in its standard of quality for waters used on interstate carriers, has tentatively set the following limits for certain radicals:

	Max. p.p.m. Desirable		Max. p.p.m. Desirable
Lead (Pb)	0.1	Sulphate (SO_4)	250.0
Copper (Cu)	0.2	Magnesium (Mg)	100.0
Zinc (Zn)	5.0	Chloride (Cl)	250.0
Iron (Fe)	0.3	Total solids	1000.0

Comparing the mineral characteristics of the various domestic water supplies of Southern California cities with the foregoing table, only two—2 wells in Venice—are found to approach these limits. Colorado river water at Grand canyon contains only half the permitted total solids, and no single radical in excess.

Colorado river water has demonstrated its value for irrigation in the Imperial valley. The minimum accepted value of 'k', the alkali coefficient for irrigation water, is 18, whereas for Colorado river water k=30.

It is true that Colorado river water can be classed as a hard water, but no harder than many of the waters in use in Southern California and elsewhere.

When the Metropolitan Water District builds the Colorado river aqueduct, the water will be mixed with the present local supplies of the various communities, in most cases improving the quality. As the public is becoming more exacting, it is natural to expect that all waters exceeding 125 p.p.m. in hardness will be softened. Colorado river water, which predominates in calcium and magnesium hardness, can be softened for only $5.00 per million gallons. Analyses follow of Colorado river water at Grand canyon and domestic supplies used in Southern California, including hypothetical blends in 50% admixture:

All figures in parts per million—for grains per gallon multiply by 0.058

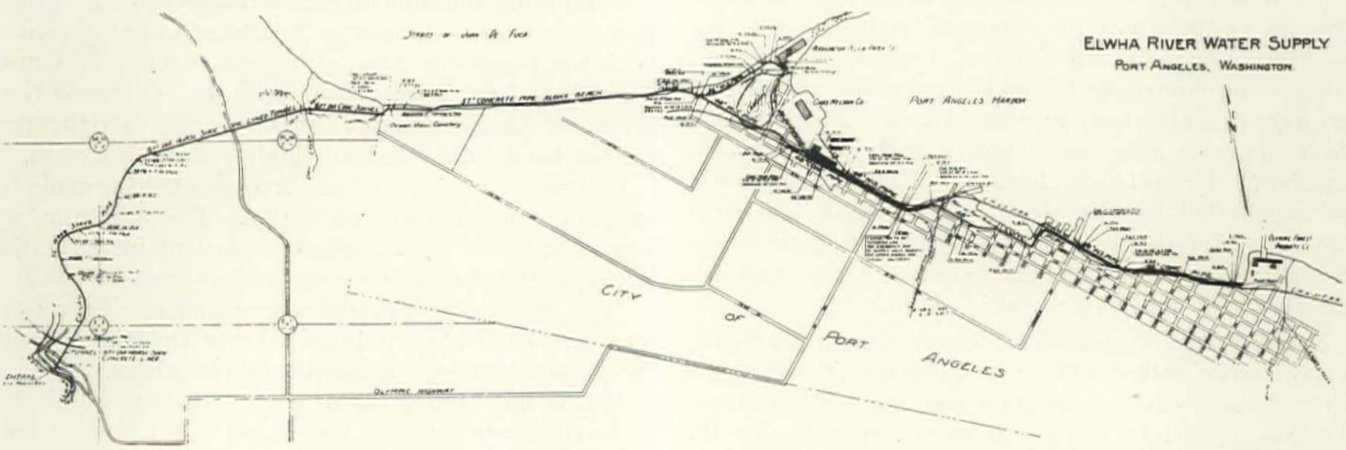
	Ca	Mg	Na+K	HCO_3	SO_4	Cl	Total Salines	Total Hardness	k
Colorado, weighted analyses, year ending September 30, 1926	66	21	80	159	201	56	523	251	29.7
Colorado, weighted analyses, year ending September 30, 1927	77	22	82	162	235	53	569	285	30.0
Colorado, weighted analyses, year ending September 30, 1928	66	22	69	162	187	48	491	254	34.5
Los Angeles river, L. A. water supply	51	19	27	201	68	21	304	205	81.0
Los Angeles river with Colorado (analysis No. 2)	65	21	55	181	151	38	436	248	43.0
Owens river aqueduct, L. A. water supply	38	14	38	178	48	29	288	152	58.0
Manhattan wells, L. A. water supply	72	18	39	250	88	30	390	254	57.0
Slauson wells, L. A. water supply	98	26	49	299	130	56	530	352	34.0
Beverly Hills, treated supply	36	21	118	197	75	110	487	176	13.3
Beverly Hills with Colorado (Analysis No. 2)	57	22	100	179	154	82	528	233	21.0
Venice consumers' well	178	55	65	366	324	124	964	670	16.4
Venice consumers' well with Colorado (analysis No. 2)	128	38	73	264	279	89	766	476	21.7
Otay system, San Diego supply	38	10	53	202	79	48	273	136	22.6
Otay with Colorado (analysis No. 2)	58	16	68	182	127	51	421	210	33.0

Elwha River Water Supply Project for Industries at Port Angeles, Washington

By W. B. McMillan*
Construction Engineer, San Francisco, California

The Elwha river municipal water supply project was constructed under an $800,000 bond issue to furnish industrial water to the city of Port Angeles, Washington, particularly for the pulp and paper mills which require large amounts of water. The three present mills have a combined capacity of over 500 tons of pulp and paper per day and are now using close to 35 m.g.d. of water, which is about one-half of the designed capacity of the water system and close to one-third of the ultimate capacity to be made available with additional or parallel lines through the city. This ultimate supply insures sufficient water to meet the expected growth of the paper industry at Port Angeles. The contract for the first stage of the project was let November 15, 1929, and delivery of water was made on June 6, 1930.

Conduit and Accessories—The water is diverted from the Elwha river 2½ miles from the Straits of Juan de Fuca at elev. 68 ft. above sea level. Diversion is made directly through a 5 by 5-ft. Broome gate to a concrete-lined tunnel 6 ft. diam. and 1000 ft. long, which discharges into a canal 2000 ft. long, with spillway and wasteway structures; thence through 4500 ft. of 72-in. wood-stave pipe to a second concrete-lined tunnel 7300 ft. long, of horseshoe section 6 ft. diam. The outlet of the second tunnel is within the city limits of Port Angeles and from this point the conduit consists of 9000 ft. of 57-in. concrete pipe laid in a trench along the shore of the Straits to the base of Ediz spit, at which point a 36-in. wood-stave branch line leads to the Washington Pulp & Paper Co. mill 2000 ft. distant. The pipe-line from this branch point to the new Olympic Forest Products Co. mill is 48-in. diam., consisting of 7000 ft. of wood-stave pipe on trestles and 11,000 ft. of concrete pipe in trench. This pipe-line passes through the business section of the city and generally parallels the harbor front. The total length of the line from the intake to the Olympic mill is 8.1 miles.



Water is delivered to the Washington Pulp & Paper Co. mill filter plant by gravity, thence pumped to the elevations required. The Fibreboard Products Co. plant takes water from the line and boosts directly to an elevated tank. At the Olympic mill, the pipe-line terminates in a pump-house from which the water is boosted to a filter plant at an elevation sufficient to serve the entire mill, excepting a small amount of high-pressure water stored in an elevated tank. A surge tank was erected directly in front of the pump-house, consisting of a 30-in. steel riser surrounded by a steel shell 5 ft. diam. which catches the overflow and discharges it laterally to the bay.

The system will deliver 65 m.g.d. or more, depending upon the amount of pumping, and will ultimately deliver 100 m.g.d. or more, with enlarged or parallel delivery lines at the lower end of the project.

Intake—The intake is a concrete structure in two parts—the trashrack piers with side and cutoff walls to rock, and a gate tower 20 ft. behind at the entrance to the tunnel.

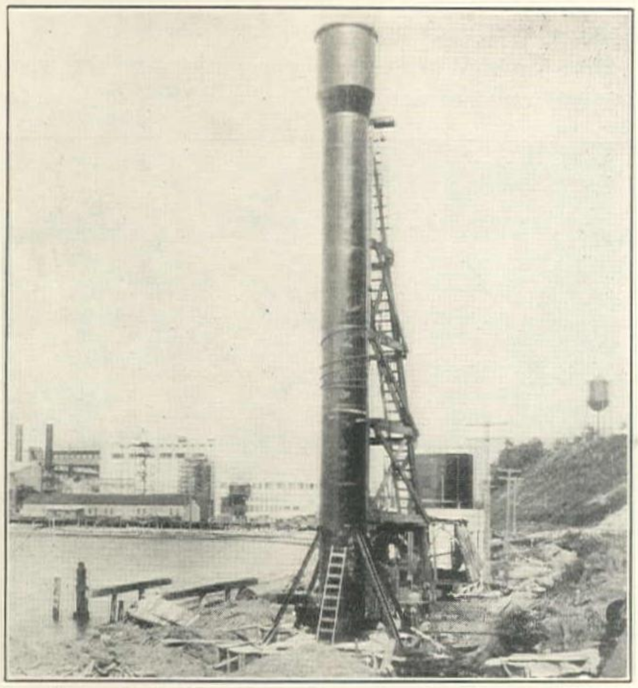
River diversion was handled without difficulty. A cofferdam was constructed of logs and sheathing, together with an earth and broken-rock embankment obtained from the intake excavation. This embankment was later enlarged with tunnel muck and the whole was finally removed with a Northwest 2-yd. dragline which, at the same time, dredged gravel and boulders from the river channel in front of the intake works. A timber bulkhead was built against the trashrack piers and this cut off the water almost entirely, at the same time safeguarding the tunnel excavation and lining.

Two 6-ft. Diam. Tunnels—The first or intake tunnel is driven through rock, for the most part a black shale which oxidized shortly after being exposed and was

*Member, American Society of Civil Engineers.

quite different from the surface indications. This tunnel was timbered for safety during construction, except for a short section near the river portal which passed through a conglomorate resembling concrete. The tunnel is entirely below low-river level and is concrete-lined to protect the rock. It is unreinforced except at the lower portal, where heavy overburden was encountered. Some water was intercepted by a cut in loose gravels at the lower heading of the intake tunnel, but in general the rock was fairly tight. Progress in driving the intake tunnel through rock was 10 ft. per day, two shifts being used, with a sustained maximum progress of 14½ ft. per day.

The second or 'flow' tunnel, 6600 ft. below the intake tunnel and separated therefrom by the canal section, extends from the Elwha river valley to Dry creek, a

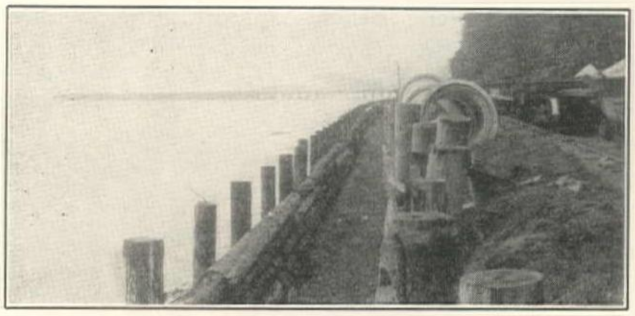


Surge Tank Near Pump House Serving Olympic Mill

distance of 4950 ft., and thence 2350 ft. to the shore of the Straits of Juan de Fuca. This tunnel also penetrated formations quite different from those expected. Cemented gravels were found in the lower section from Dry creek to the Straits, but the section from Elwha river to Dry creek—two-thirds of the entire distance—was in damp sand and loose pea gravel. Through the cemented gravels it was possible to excavate with light jack-hammers and gads 4 to 6 ft. ahead of the timbering, which was placed readily in solid 4 by 12-in. ten-segment sets.

The section through sand required square timber sets with driven lagging in the roof and generally to the floor, also the frequent use of breastboards and excelsior. To hold the face while driving through sand, a core was maintained in the heading. In this section, cemented gravels in horizontal deposits overlaid the roof 10 to 15 ft., thus preventing any great weight in running ground. After driving, the square sets were sheathed and backfilled with sand so as to save concrete. The backfill was packed solid and all of the timber left in place when concreting the lining.

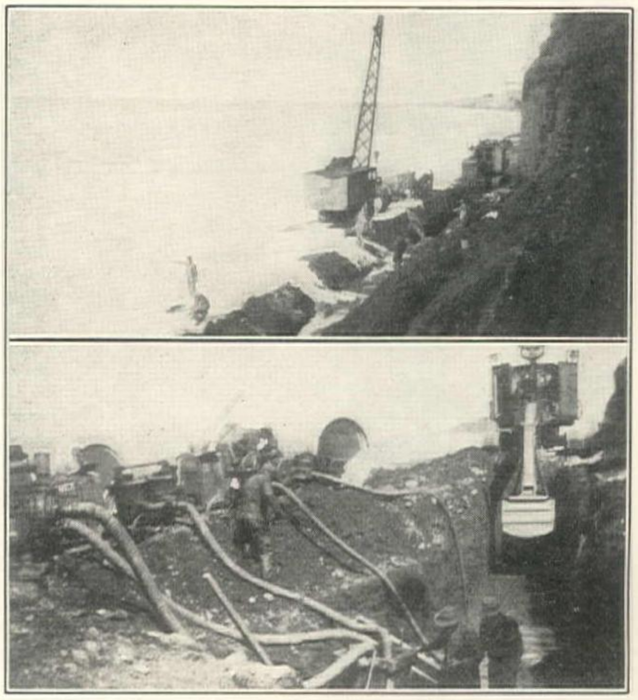
Average progress in the lower end of the second tunnel through cemented gravels was 15 ft. per heading per day (3 shifts working from two headings), the maximum progress per shift being 12 ft. The sustained maximum progress for three shifts in one heading was 22½ ft. per day. The tunnel section between Elwha valley and Dry creek through loose sand and gravel was worked from six headings and the average progress was 11 ft. per heading per day, the work being carried on from only four headings at a time.



Pipe-Line Along Straits of Juan de Fuca

The maximum progress in one heading per shift was 12 ft., and sustained progress 20 ft. per day.

Side panels for the tunnel forms were of wood in 8-ft. lengths, with a steel channel rib as the top piece. Semicircular bent channels were placed on the top piece at 4-ft. centers to support 2 by 6-in. lagging cut



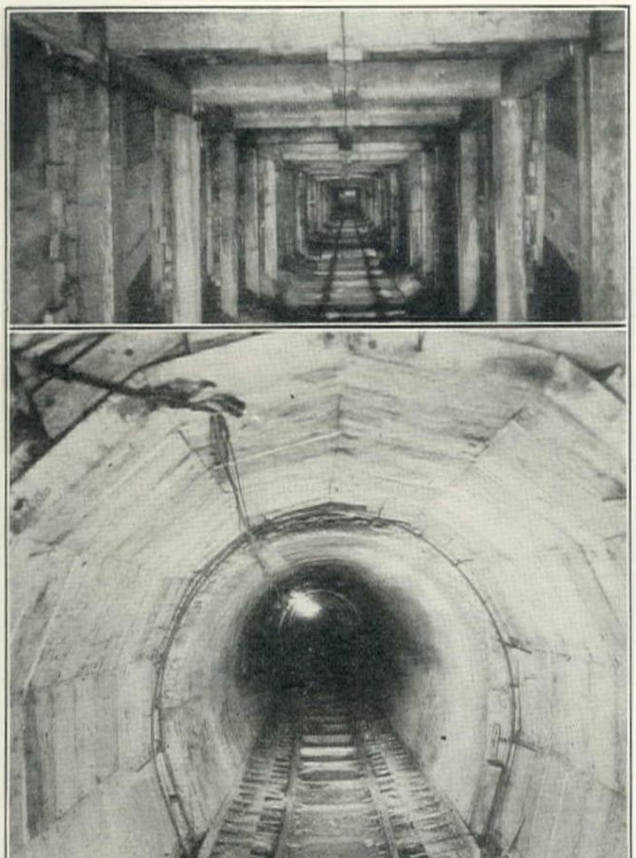
(Upper) Trenching and Laying Pipe Under Difficulties Along Beach.
(Lower) Northwest Hoe-Shovel and Rex Pumps in Trench

to the outside diameter and extending to within 20 in. of closure at the roof. The closure was made with curved steel plates 2 ft. long, beveled on the edges. Each piece of side lagging was inserted separately as the level of fresh concrete was raised.

The concrete lining of the intake and flow tunnels was hand mucked, shoveled from steel plates into the combination steel and wood forms, and worked with steel bars. This concrete was premixed at Port Angeles and hauled by truck a maximum distance of 7½ miles. The sides and roof of the tunnel were lined at average and maximum daily rates of 114 and 208 ft., respectively, corresponding rates per shift for the floor being 285 and 375 ft. The sustained maximum average lining for the sides and roof was 135 ft. per day, using 250 ft. of forms.

Canal—The canal is constructed in a river flat through sand and gravel. It has a bottom width of 8 ft., side slopes of 1½:1, a depth of 5 ft. with 4-ft. normal freeboard, and is unlined.

Pipe-Line Along Beach—An interesting feature of the project was the installation of 57-in. concrete pipe



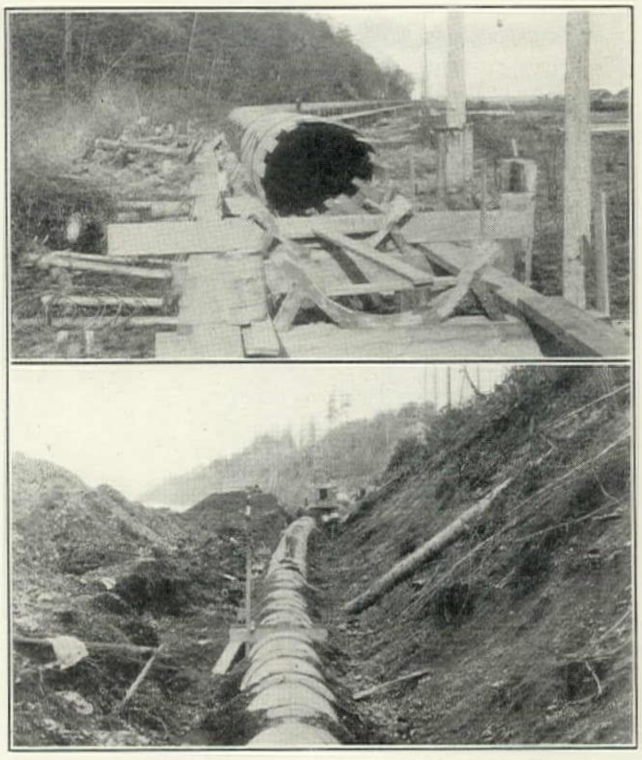
Flow Tunnel from Elwha River to Dry Creek. Square Timbering Through Sand, Segmental Timbering and Lining Through Gravel

on the beach along the Straits. This beach, while subject to severe pounding during heavy weather, proved upon investigation to be a safe location. The shore line is banked with almost vertical bluffs of cemented gravels, over 150 ft. high. These bluffs are being constantly but slowly cut back by the action of the sea water on the base for short intervals during the winter months. The carving action does not extend to any depth, as the beach is covered with 2 ft. of sand and gravel overlying cemented gravels.

Concrete pipe was selected for this section of the line as best fitted to withstand the weight of slides and to resist the action of salt water which penetrates the backfill at high tides. The pipe is laid entirely below the surface of the cemented gravels. On only a few occasions was it possible to work through the tides. Constant pumping was necessary and there was always the menace of slides and detached boulders, particularly during thawing weather. The pipe was hauled by truck and laid with a crane. Trenching was done with a Northwest 2-yd. dragline, later converted to a hoe-shovel. The cemented gravel and hardpan was excavated without shooting.

Line Below Ediz Spit—From the base of Ediz spit through town to the Olympic mill, the wood-stave pipe was installed on trestles and the concrete pipe was buried. Trestle No. 1 carries the wood-stave pipe over and along a lagoon and across marshy ground, while trestles No. 2 and 3 parallel the railroad along the waterfront. The concrete pipe for a great part of the distance is laid either in a peat soil or close to the water's edge where it is subject to contact with salt water. The peat soil under the bottom of the trench proved to be quite unstable and it became necessary to consolidate the foundation with coarse gravel, dumped into the deepened trench and packed. This expedient was satisfactory as opposed to piling, which might have been considered necessary.

Division of Work—Canal excavation and the trenching was subcontracted to the E. T. Fisher Construction Co. of Seattle and San Francisco, this work being carried on with three Northwest 2-yd. draglines convertible to hoe shovels and clamshells. Hume centrifugally spun concrete pipe was furnished by the American Concrete Pipe Co. from its Tacoma plant and was barged to Port Angeles. Redwood-stave pipe was furnished by the Pacific Tank & Pipe Co. of San Francisco. Tunnel excavation was sublet to stationmen, the equipment being furnished by the general contractor. Concreting of the tunnels and various structures, including the intake, diversion works, miscellaneous timbering, etc., was also done by the general contractor under my direction, with Arthur T. Schunk as superintendent. T. W. Owen is city engineer and R. E. Thomson consulting engineer for Port Angeles.



Redwood-Stave Pipe-Line on Trestle and Concrete Pipe-Line in Trench, Elwha River Water Supply

Sewage Reclamation Plant for Los Angeles

Bureau of Water Works and Supply Designs and Constructs 200,000-g.p.d. Activated Sludge Plant Employing Separate Sludge Digestion, with One-Third of Final Effluent Carried Through Complete Treatment—Extensive Study of Sewage Reclamation Brings New and Important Discoveries—Construction and Operation Costs Obtained

By R. F. GOUDEY*
Sanitary Engineer, Department of Water and Power, Los Angeles, California

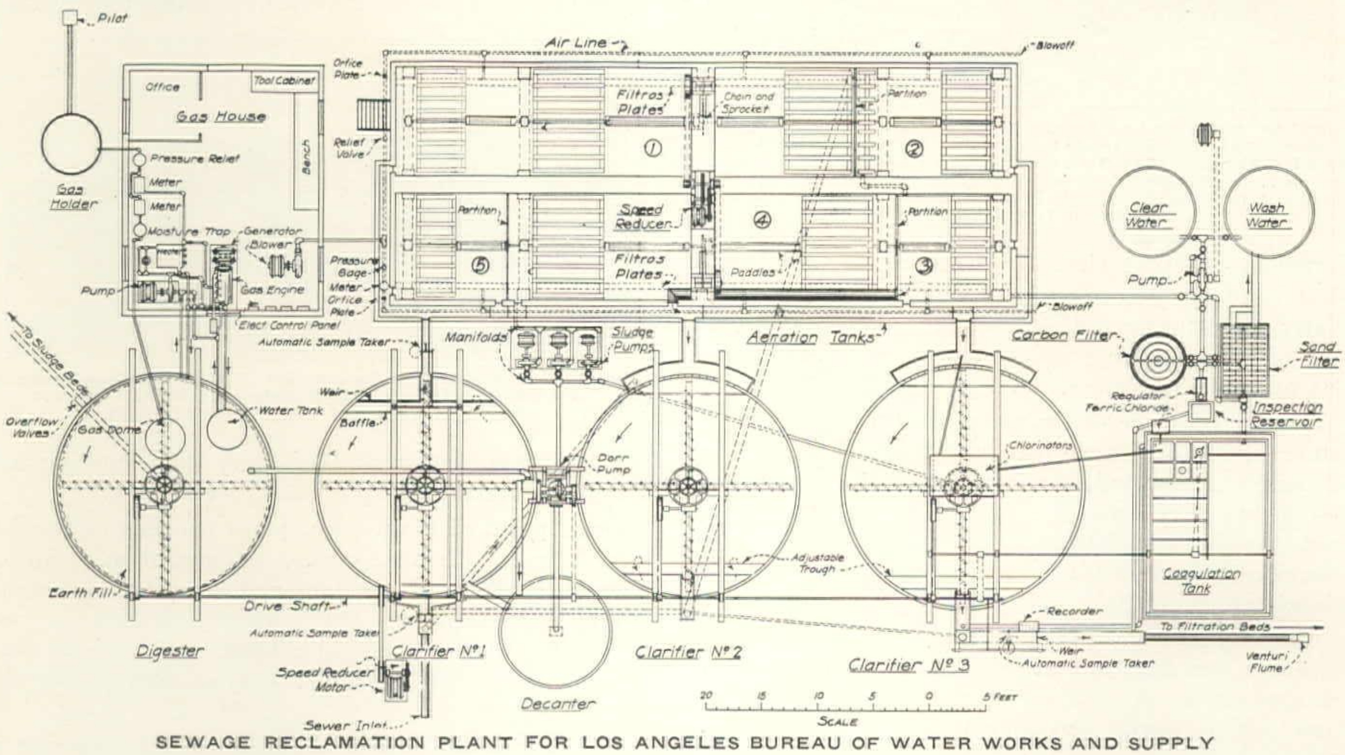
In its comprehensive program of studying sewage reclamation, the Bureau of Water Works and Supply of the City of Los Angeles, through the direction of H. A. Van Norman, general manager and chief engineer, and Carl Wilson, director of sanitation, and myself has designed, constructed, and placed in operation a complete sewage treatment plant of 200,000 g.p.d. capacity. The plant has been in continuous operation since May 12, 1930.

This treatment works is the first large-scale, complete demonstration plant ever constructed on the Pacific coast and is fully designed and equipped for a thorough and exhaustive research into the art of sewage treatment. In addition to demonstrating accepted methods of treatment, it is planned to investigate new angles of the science and to continue the treatment further than has ever been attempted elsewhere.

A new and fully equipped sanitary chemical laboratory has been built, and already the schedule of tests requires a greater number of sanitary chemical analyses than are handled by the combined laboratories of the state.

Purpose of Plant—The ambitious purpose of this experimental plant virtually covers all phases of sewage treatment. For instance, it includes:

1. Development of a scheme of treatment which will not be a nuisance nor produce any odors, and will advance utilitarian values to a maximum.
2. Embodiment into one plant of all the best ideas as obtained from visiting other plants throughout the country and gleaned from accounts in the literature of foreign plants.
3. Utilization of mechanical equipment to the fullest possible extent.
4. Investigation into the treatment of industrial wastes.
5. Determination of basic design data for known processes of treatment adapted to local conditions of climate, degree of treatment required, and character of sewage to be treated.
6. Demonstration of the degree of treatment required for each proposed scheme of reclamation.
7. Selection of a compact design consistent with simplifying operation.
8. Investigation of any harmful constituents in sewage which might interfere with various schemes of reclamation.
9. Reduction of operation costs to a safe minimum, with installation costs kept within reason.
10. Determination of installation and operation costs applicable to large plants, including labor, power, chemicals,



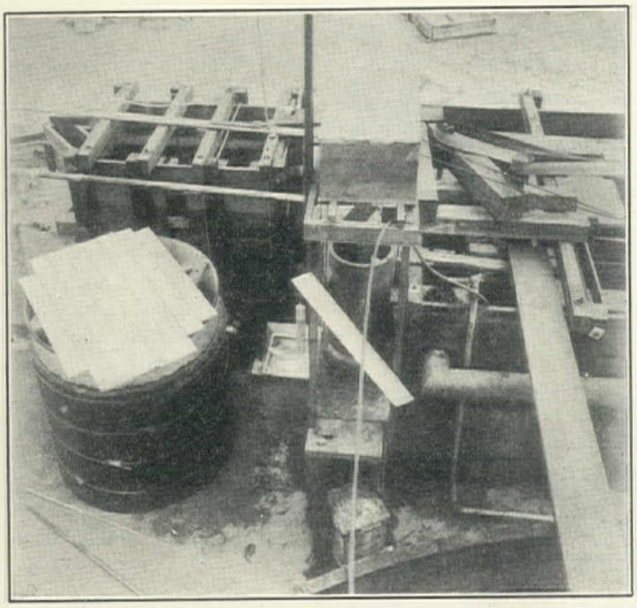
SEWAGE RECLAMATION PLANT FOR LOS ANGELES BUREAU OF WATER WORKS AND SUPPLY

*Associate Member, American Society of Civil Engineers.

depreciation, research, maintenance, miscellaneous items, and contingency.

11. Studies on the recovery of power from gas, fertilizer from digested sludge, and the value of nitrogen in the activated sludge effluent.
12. Construction of a plant such that inspection by the public would gain their confidence and support.

Location of Plant—The treatment plant is situated in Griffith park on the west bank of the Los Angeles river, opposite Burbank. It is at the outlet of San Fernando valley at elev. 475 ft. above sea level. The plant is adjacent to one of the pumping stations of the Water Department and is well isolated. This site was selected after studying many other locations as the one best fitting in with the general plan.



Filtration Works at Los Angeles Sewage Reclamation Plant. Inlet Is Horizontal Pipe Entering from Right; Ferric Chloride Machine Mounted Above Inlet to Mixing Tank. Small Vertical Pipe Is Sludge Return Line. Square Tank Is Sand Filter and Round Tank Activated Carbon Filter. Final Product—Sparkling Clear Drinking Water—in Tile Box in Center

The site is at one of the many favorable locations for future plants of large capacity. It intercepts the San Fernando valley trunk sewer, which is 48 in. diam. and designed to carry a maximum flow of 60 c.f.s., the present discharge being 1,000,000 g.p.d. Over 85% of the sewage of the city of Glendale can be pumped to this site with a 35 ft. lift.

The sewage from this outfall is septic and is subject to severe seasonal loads of peach, tomato, and vegetable cannery wastes in addition to receiving the discharge from pickling works, film laboratories, and a large soap factory.

By constructing an intercepting line 800 ft. up the trunk sewer, it was possible to provide a gravity flow to the treatment plant, built for the most part 6 ft. above ground level, which not only did away with the trouble of pumping sewage to the plant but reduced the cost of installation.

The final reason for selecting the site in question was to spread the effluent on natural sand beds adjacent to the river and at a point 1½ miles above one of the main infiltration galleries feeding the city. Fourteen wells driven on the site fitted in with a large number of similar test wells maintained by the Department in studying the underground flow from San Fernando valley.

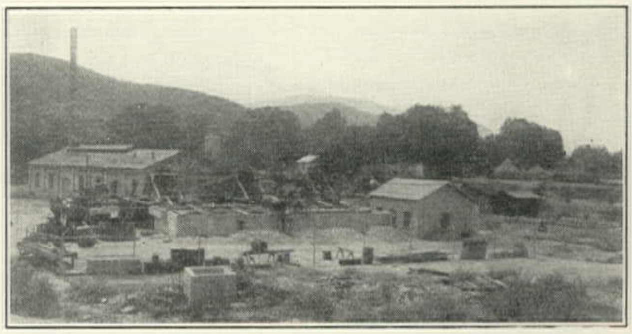
Design of Plant—The plant is essentially an activated sludge plant employing separate sludge digestion with one-third of the final effluent carried through complete treatment including coagulation, superchlorination, sedimentation, sand filtration, and dechlorination with activated carbon.

In the first place, the plant is designed to operate along standard lines but with far more conservative factors than ordinarily used. The layout is such that variations can be made in settling periods, aeration and reaeration detentions, air and power requirements, and all other factors subject to regulation.

These same units, moreover, are made flexible enough to test schemes of treatment radically divergent from standard practice, and also more complete from the standpoint of producing a more acceptable effluent. All degrees of treatment from settled sewage to drinking water are produced.

Everything subject to measurement is fully metered, such as: sewage flow, gas production, gas utilization, power produced, air consumption, aeration power, sludge pumps, clarifier motors, and wash water pump operation. Composite samples are collected continuously by automatic sampling devices which take samples approximately proportional to the sewage flow.

Operation has been simplified, enabling the operator to keep a complete record of every item entering into a full interpretation of the plant performance.



General View of Sewage Reclamation Plant. Aeration Tanks in Center with Clarifiers and Digesters at Rear, Filtration Works at Left, and Sludge Beds at Right

Description of Plant—The plant consists of the following units: Intake works; sedimentation, with or without coagulants; aeration and final sedimentation; coagulation, filtration and superchlorination works; spreading beds for the final effluent; and sludge conditioning, digestion, filtration, drying, and power development.

Intake Works—The intake is a vertical diversion in a 48-in. sewer 9 ft. below the surface, which normally diverts one-quarter to one-third of the entire flow to the plant by gravity.

The minimum flow reaches the plant at 8 a.m., the peak flow arrives from 11 a.m. to 3 p.m., and the average flow holds until midnight.

During August, the suspended solids in the raw sewage varied from 272 to 1570 and averaged 530 p.p.m. The oxygen demand value (5-day) averaged 680 p.p.m. It is evident that strong sewage, and what might be considered by some as difficult to treat, is being received by this plant. Even when the canneries are not in operation, the suspended solids and oxygen demand values are higher than the sewage at Hyperion, which is the ocean end of the Los Angeles outfall.

Sedimentation Works—The sewage can be settled once or twice and coagulants can be applied between the two clarifiers used for this purpose. These clarifiers are 20 ft. diam. and 7 ft. deep. They are equipped with Dorr mechanisms. Each provides a 2-hour detention for the average flow, with an overflow rate of 635 gal. per square foot per day. Clarifier No. 1 alone is used in standard treatment for preliminary clarification.

It has been definitely proven by others that 50% removal of suspended solids by sedimentation gives better aeration efficiency than 10% removal by screens. It then follows that greater removals than 50% are desirable. Already this is proving out, and it is proposed to use chemical precipitation to secure the highest possible removals. The sewage in this case will be settled in clarifier No. 2 and ferric chloride will be applied before sedimentation in clarifier No. 1. The latter clarifier will be equipped with sludge recirculation.

During periods when the suspended solids in the sewer ran high, it was noticed that poor sedimentation was secured even with overflow rates as low as 500 gal. per square foot per day—whole peaches and tomatoes passed through the clarifier. The pH dropped to as low as 6.4 day after day. It was obvious that the carbon dioxide caused a buoyancy which defeated sedimentation to a considerable extent. This was entirely overcome by feeding a small amount of lime into the raw sewage to absorb the carbon dioxide. It raised the pH to 6.8 and good sedimentation seemed to be restored at 6.7 and above. The correction of the pH value to secure good sedimentation and prevent bulking is one of the tricks already discovered by us in the successful treatment of peach and tomato cannery wastes.

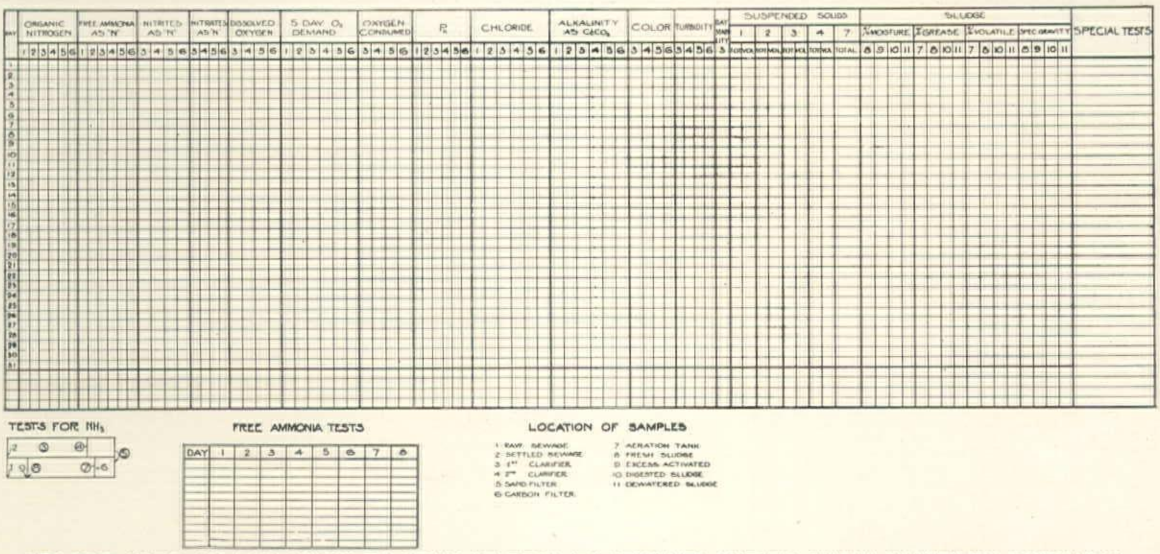
The Dorr mechanisms are kept in continual operation and sludge is removed twice daily. The constant squeegeeing of the sludge thickens it far more than results from intermittent operation. The sewage enters the tank at the surface but drops down behind a baffle extending 3.5 ft. from the top. The outlet consists of a series of small Cipolletti weirs 2 in. wide and spaced 6 in. on centers. Scum is floated off into the decanter tank.

The preliminary clarifier, because of the strength of sewage, use of low overflow rates, efficient inlet and outlet details, and control of pH in the raw sewage, gives exceptionally high removal of suspended solids, averaging 82%, with daily variations from 69 to 91%; the oxygen demand value is reduced 60%.

Aeration and Sedimentation—The aeration tanks, two in number, are 55 ft. long, 10 ft. wide, and 10 ft. deep with a semi-circular bottom. The tanks are equipped with Imhoff paddles which revolve at 6.5 r.p.m. against air admitted from a single row of 'filtros' plates 5 in. wide set 1.5 ft. from the side of the tanks and 9 ft. below the top. The amount of air added varies from 0.2 to 0.4 cu.ft. per gal. of sewage treated.

The tanks are subdivided into compartments for use in various combinations. In standard treatment, 6 hours aeration is secured in tanks 1, 2, 3, and 4 and 4 hours reaeration is obtained in tank 5. For cannery wastes, aeration is secured in 5, 1, 2, and 3, with reaeration in tank 4. In multi-stage treatment, primary aeration will be secured in tank 5, sedimentation in clarifier 2, reaeration in tank 4, secondary aeration in tank 2, final clarification in clarifier 3, and reaeration of secondary sludge in tank 3. The principle in this scheme is to first aerate the sewage with a large volume of well-aerated sludge for a short period, and to provide a second aeration with a small volume of sludge but for a longer period. In this case, tank No. 1 will not be in use and this measures the extent of the saving which follows if the process proves successful.

A number of minor experiments are being conducted on aeration. The best measure for the efficiency of aeration appears to be the use of the free ammonia test. By taking these tests in the different tanks, a good measure of the rate of purification is obtained. The major portion of the work is done in the first half-hour of aeration. This shows conclusively the fallacy of adding all of the sludge to the raw sewage with continuous aeration for six hours. There is ample reason on this score alone to advocate multi-stage treatment. But, another scheme was suggested through accident. One of the gates leaked and led to the discovery that if the sludge is fed at different points, still better aeration efficiency



RECORD USED AT LOS ANGELES SEWAGE RECLAMATION PLANT TO SHOW SANITARY CHEMICAL ANALYSES AT HEADWORKS is secured and far better sedimentation is obtained. This is being followed up. Other experiments involve studies of bulked sludge, return of various percentages of sludge, manipulation of sludge by chlorine, lime, acid, and ferric chloride to alter the percentage volume of sludge in the aeration tanks, correlation of air used to oxygen demand reduction, horsepower requirements, and maximum production of nitrates in the effluent.

Sludge is returned for reaeration by a series of pumps, 15, 60, and 90 g.p.m. which are so connected by manifold suctions and manifold discharges that all variations in volume of sludge to be returned from any clarifier and pumped to any tank for separate or combined reaeration can be obtained. Although it is still customary to provide pumps to return 15 to 20% sludge by volume, as found in the aeration tanks, this method is not based on actual operating conditions. The pump capacities should be made large enough to keep sludge levels at operating heights in the clarifiers covering all variations likely to occur in the percentage of water content of the sludge.

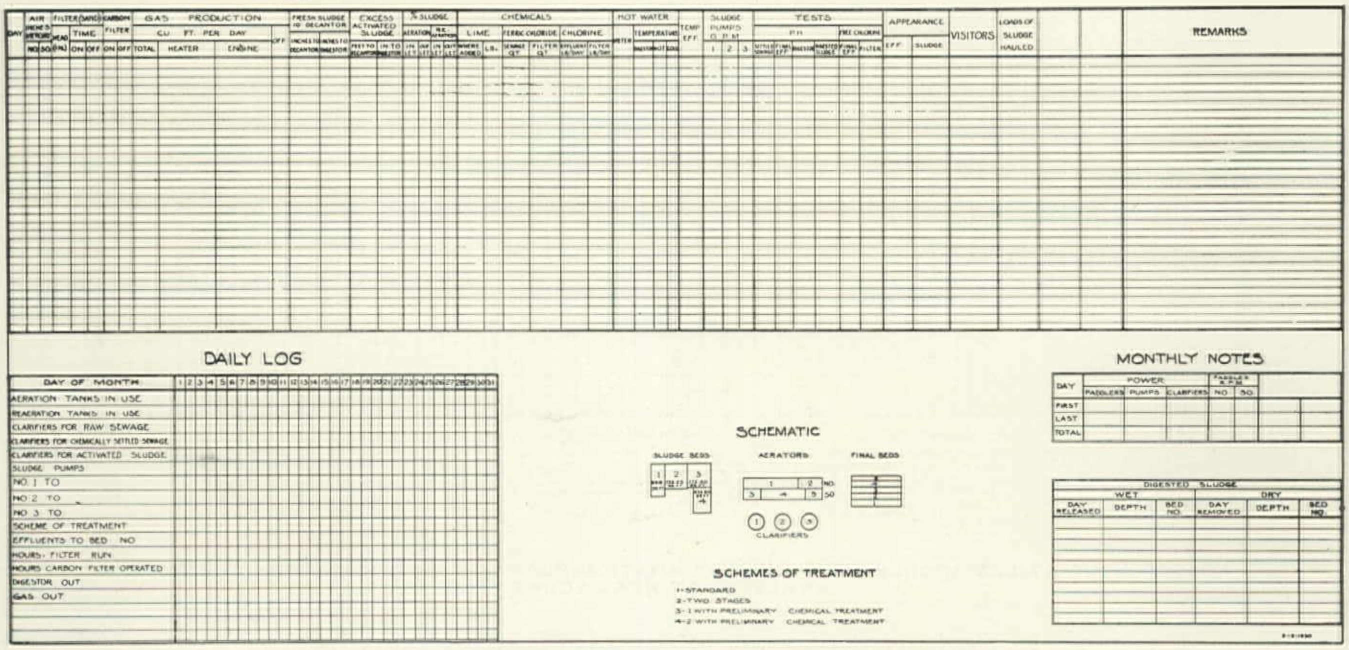
Two clarifiers, one 20 ft. and one 22 ft. diam., give rates of sedimentation from 550 to 1060 gal. per square foot per day, depending on the amount of sludge carried. The use of two clarifiers in series for standard treatment may sound radical to most engineers, but the performance of removing one-half of the suspended solids and oxygen demand value with no sacrifice of nitrates or dissolved oxygen speaks for itself. The second clarifier acts as a chlorination detention basin and also as a safety valve intercepting any sludge which, on account of a disturbed condition in the previous clarifier, might otherwise escape.

Special experiments in final sedimentation include upward filtration through sludge, preferably in a semi-bulked state, and perfection of inlet and outlet details. The filling up of the channels of the scraper arms in clarifier No. 3 to shed depositing sludge entirely overcomes the periodic rising which gives a bad impression and is noted in all clarifiers.

Chlorine from Wallace & Tiernan chlorinators applied at a rate of 20 lb. per million gallons carries through the clarifier, giving 0.2 p.p.m. at the outlet. This chlorine prevents algae growths in troughs and channels and disposal beds. Where formerly without chlorination, algae troubles were caused by discharging the final effluent into sand beds for a week, continuous runs with chlorination have been extended to 90 days.

During August, the final effluent from the clarifiers contained 2 p.p.m. of suspended solids, 7.5 p.p.m. oxygen demand, and a turbidity of 6 p.p.m. At times, the last clarifier was so clear that the brass squeegee plates in the center cone at the bottom of the clarifier could be seen from the top of the tank.

Filtration of Final Effluent—One-third of the activated sludge effluent is carried on to further treatment of coagulation with ferric chloride, mixture with returned ferric chloride sludge, superchlorination, sedimentation, filtration through sand, and dechlorination with activated carbon.



OPERATION RECORD FOR HEADWORKS OF SEWAGE RECLAMATION PLANT

The design of the coagulation and sand filtration works departs radically from standard design and is based on original experiments conducted by Carl Wilson at San Pedro.

Ferric chloride is added by a machine invented by Wilson. This device can be regulated to feed any desired dose proportional to the flow. Sludge returned from the first-third of the settling tank is mixed at the same point where the new ferric chloride is added. A heavy floc forms at once and the mixture is violently agitated. As mixing becomes gentler toward the end of the mixing period, a large floc forms which immediately deposits in the settling tank. The settling tank is designed for one-hour detention and filter runs are normal, indicating the vast superiority of ferric chloride as a coagulant over alum.

The sand filter can be operated at rates of 2 to 5 gal. per square foot per minute. The sand has an effective size of 0.9 mm., the sand depth is 12 in., and the gravel depth is 18 in. Water is admitted to the surface of the sand through nozzles in a surface manifold which keeps the surface sand in agitation. The filter is backwashed, first by admitting water through the surface grid used for the influent and, after the surface is violently washed, the usual backwash from the underdrains at a rate of 24 to 36 in. vertical rise per minute is applied. Wash water troughs are set 10 in. above the sand level. All wash water is returned to the aeration tanks and its sludge eventually reaches the digester. In this manner, no solids pass through the entire process and the total removal is practically 100%.

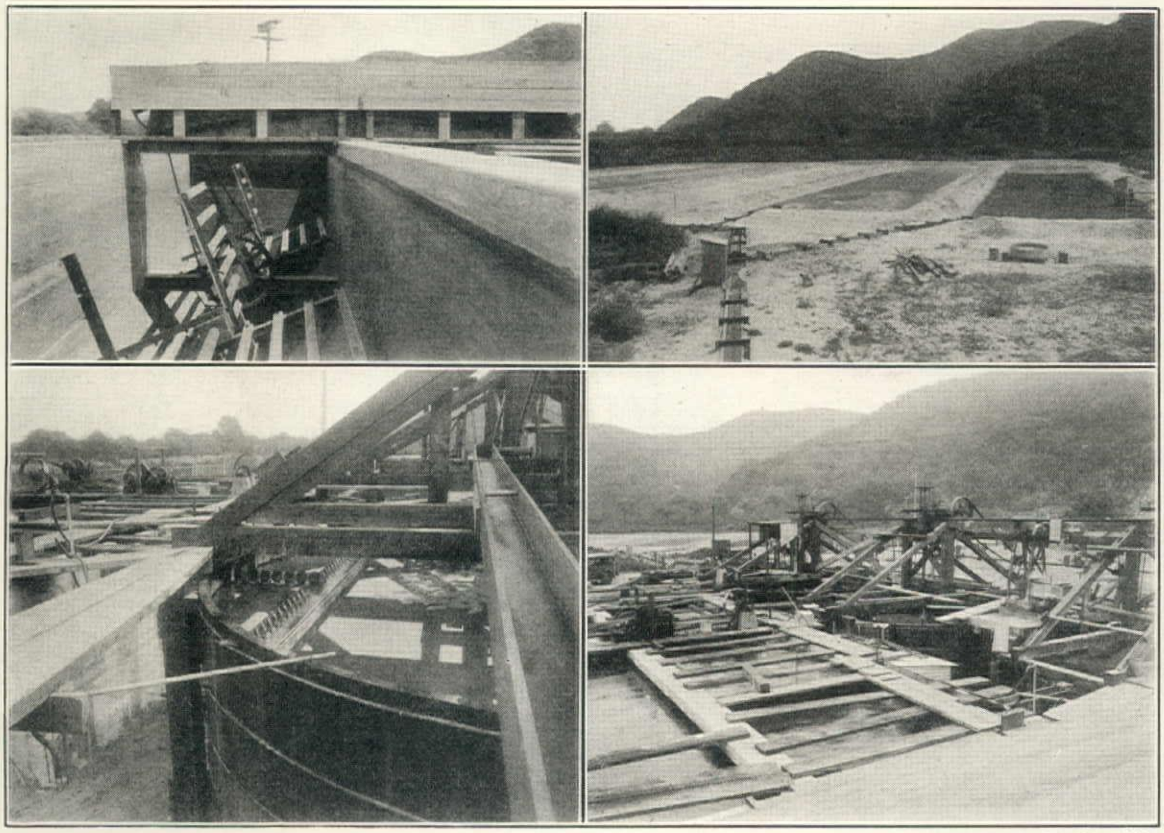
Chlorine applied at the mixing tank amounting to 25 lb. per million gallons oxidizes any essential oils, tastes, and organic matter, and carries through the sand filter with a residual chlorine value of 0.4 to 0.8 p.p.m. The total contact period in the clarifier and settling tank gives a contact period of three hours with free chlorine during the entire period, never falling below 0.2 p.p.m.

The carbon filter is constructed with the same area as the sand filter and is provided with an upward flow through a 24-in. depth. The carbon filter is ventilated and equipped to be rejuvenated by steam.

In addition to the customary experiments with amounts of coagulant, details of mixing, sedimentation, backwash rates and length of filter runs, particular attention is being given to a study of activated carbon filtration. In the first place, the experiments include several types of activated carbon, although to date only hydro-darco has been used. The maintaining of the surface portions of the activated carbon sterile is a problem. The length of filter runs and the proper method of rejuvenation must be carefully determined. So far, the carbon filter has operated 8 hours daily since May 12 this year, with complete removal of chlorine applied.

The final effluent is sparkling, clear, tasteless, odorless, and free of suspended solids, color and turbidity. It has an oxygen demand value of but a trace and an oxygen consumed value of 2.5 p.p.m.

Spreading Grounds—Five spreading beds giving a theoretical filtration rate of 200,000 gal. per acre per day were constructed by removing the top 15 in. of soil as found at the treatment plant site. The top soil is a fine sandy silt, underlain by coarser sand which merges into sand and gravel deposits of considerable depth. The ground water stands 15 to 35 ft. from the surface, depending upon the season.



(Upper Left) Imhoff Paddles in Aeration Tank, Filtros Plates Installed in 5-in. Channel at Left of Horizontal Shaft. (Upper Right) Final Sand Beds. Float Recorder on Right for First Bed, Evaporating Pan at Right, Parshall Flume in Foreground, Test Wells on Alternate Dikes. (Lower Left) Cipolletti Weir Outlet System for First Clarifier; Speed Reducer on Aeration Tanks. (Lower Right) Aeration Tanks and Final Clarifiers, W&T Chlorinators on Top Center Clarifier, Dorr Sludge Pump at Left, Automatic Sampler in Trough to Right of Hydrant

The beds have been carefully leveled and the wetted area determined. Each bed is equipped with a gauge. One bed is equipped with a recording gauge and is used for long periods of dosing; its rate of effective filtration, including time out, is 1,000,000 gal. per acre per day. Evaporation is determined by a standard type of evaporation pan.

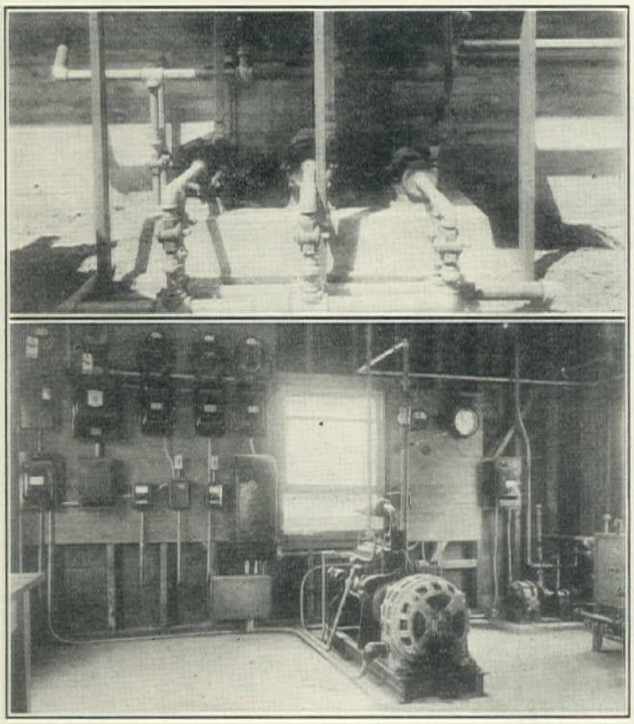
Fourteen 2-in. test wells have been sunk in and around these beds for the purpose of measuring water levels and collection of samples to determine underground chemical transformation as the effluent moves away, and to study nitrogen changes and travel of underground pollution.

The effect of the effluent spread on these sand beds will be carefully studied with reference to infiltration galleries 1½ miles below.

Sludge Disposal—Disposal of sludge has been for many years the bane of sewage disposal, and its mastery now makes for the success of reclamation. This has been accomplished at our plant by improving the separate sludge digestion process and experimenting with the treatment of overflow liquor and filtration of digested sludge.

The sludge works consist of a decanter tank, 10 ft. diam., a covered and heated digestion tank 20 ft. diam. and 16 ft. deep, gas collection, gas utilization through a heater and in a gas-driven electric generator, overflow arrangements, sludge filters, and drying beds.

The sludge process as now developed is odorless because all gases are collected and either burned or put



(Upper) Battery of Sludge Pumps, Showing Suction and Discharge Manifolds. (Lower) Electric Panel and Meters for All Uses. Gas-Electric Generator in Center, Hot Water System on Right, Digester Temperature Recorder in Upper Right

to beneficial use. The reduction of the sludge to a desirable fertilizer is inoffensive, economical, and utilitarian. The success already obtained by this experimental plant along this line has been largely secured through attention to details.

In the first place, only thick and properly conditioned sludge is pumped to the digester. The excess activated sludge is dewatered in the decanter tank to less than 20% of its original volume; experiments may reduce this still further. The concentrated activated sludge is then mixed with fresh sludge. When necessary, lime is also added to the decanter to correct the pH value in the digester. By circulating the combined mixture of activated sludge, fresh sludge, and lime from the decanter through the pump and back into the decanter, the activated sludge when put into the digester will not float and will readily yield to digestion. This process produces a minimum of overflow liquor, saves heat in the digester, and enables the pH of the digester to be easily controlled.

The overflow liquor is still further reduced by drawing off ripe sludge as new sludge is pumped into the digester. The remaining overflow liquor is not returned to the sedimentation tanks, but is placed on sand beds. Experiments are being made on the separate conditioning of overflow liquor for filtration and the conditioning of digested sludge for mechanical filtration to do away with all sand beds. The cake is in suitable form to be hauled away for use as a fertilizer.

It is proposed to conduct experiments with yeasts and enzymes in the digestion tank to accelerate digestion and gas production. A Ford gas engine connected to a motor used as a generator has been installed and the amount of power which can be generated from the sludge gas is being determined. It is already apparent that in a large plant receiving normal sewage, enough power may be developed to meet all its needs. In the experimental plant, the cooling water is used to heat the digester, there being probably three times as much heat from this source as is needed by the digester.

Experiments are also being conducted on the value of the sludge for the fertilization of various plants and trees.

Cost Data—A complete record of operation costs is maintained. Designs have also been made for activated sludge plants of complete design for the following sizes: 1 m.g.d., 10 m.g.d., and 25 m.g.d. The installation cost covering excavation, concrete, equipment, installation of equipment, and miscellaneous items has been determined and studied. This cost varies from $135,000 per m.g. for the small plant to $56,000 per m.g. capacity for the large plant. The operation costs are properly exterpolated to the larger plants, and with the size of every piece of machinery and motor known. The power and depreciation costs have been accurately determined. For a 25-m.g.d. plant of the activated sludge process without filtration, the operation cost figures $15 per m.g. including: labor—$3.66, power—$1.65, chemicals—$2.50, depreciation—$3.21, research—$1.00, maintenance—$0.50, and contingency—$2.04 (15.8%).

Separate cost figures will be worked out for each new successful scheme of treatment, so that the true value of all improvements can be determined. It is not so much what antiquated plants in the east and here cost, but what a new plant designed on our present knowledge can be constructed for under local conditions. It appears that further revisions will be sharply downward.

These data do not include any return from the sale or use of water or the sale of sludge for fertilizer.

What the Plant Is Accomplishing—Although the major work along research lines has yet to be concluded, nevertheless the plant has already dispelled certain previously mooted points and demonstrated that reclamation is really within reach.

It has shown that sewage can be completely treated without nuisance, offense, or production of any odors.

It has shown that industrial sewage, including cannery, film and soap wastes, by adjustment of pH, increasing air, and increasing the reaeration period, does not upset an activated sludge plant.

It has been shown that the costs of activated sludge plants built under local conditions are not as high as necessary at eastern plants, and that the gross cost of operation by attention to details of operation, selection of equipment, and intelligent supervision, need not exceed $15 per m.g.

It has been shown that complete treatment producing drinking water which is devoid of suspended solids, oxygen demand, odor, taste, color, or smell, and which meets the Treasury Department standards, costs less than untreated water brought in from outside sources.

It has been shown that all visitors are favorably impressed and that no one who has been tolerant enough to investigate has any psychological or sociological objections to the final effluent, formerly discharged to the ocean, being placed into gravels above infiltration galleries.

It has been shown that by designing, building and placing into operation a complete plant within four months time, and further by developing activated sludge in seven days and sufficient gas in ten days to operate the digester, that a large plant using no other types of machinery than installed at this plant could in case of emergency be constructed even in less time.

Electrolytic Corrosion of Underground Pipes

By H. A. Knudsen*

Mechanical and Electrical Engineer, East Bay Municipal Utility District, Oakland, California

Electrolytic corrosion of underground pipes and other metallic structures is familiar, and its results well known to operators of water, gas, oil, and other underground distribution systems.

Two Sources of Current—The term electrolysis includes the entire process of accelerated corrosion of metallic structures caused by electric current. The electric current may be from either of two sources. First, that external to the metals as from the negative feeder or rails of an electric railway; and second, that due to galvanic currents originating on the metal itself without any external agency to cause the current to flow. In either case, the underground metal pipes and cable sheaths, as well as the rail in contact with the surface of the earth, are the electrodes, and the moisture of the soil with its dissolved acids, salts, and alkalies, is the electrolyte.

Wherever the current flows away from the pipes, sheaths, or rails, they serve as anodes and the metal is corroded; wherever it enters the pipes, sheaths, or rails, they serve as cathodes, and metal, gas, or alkalies, according to the nature of the soil, will be liberated.

Protection Against Stray Currents—In the effort to reduce or eliminate damage to subterranean metallic networks resulting from stray currents from electric railway and galvanic currents, many methods have been devised and proposed by organizations and individuals interested in the subject. Notwithstanding the extent of the damage done and the cost of repairing and replacing corroded pipes and other structures, there has been, as yet, no method devised whereby electrolysis can be eliminated.

The problem of protecting reticulations of subsurface metallic structures in metropolitan areas is by no means a simple one, in that it involves more than one network of pipes and a system of underground cables, all overlaid with one or more networks of electric railways. In addition, many classes of soil are usually encountered, which further complicates the problem. In such a system many conditions must be dealt with, several of which are variable, changing with the expansion of the various utilities and municipalities involved, with age of the structures and with the seasons of each year.

Stray Currents from Electric Railways—The majority of pipe and cable failures from electrolysis are caused by currents straying from electric railway tracks into the earth. These currents find their way to water and gas pipes, telephone and power cables, and other underground structures. Wherever the currents leave the underground metallic structures through the earth, corrosion results and, eventually, leaks or failures follow.

Stray currents do not always take a simple path from rail to pipe, or other structures and thence along the pipe to the point of drainage. In seeking the path of least resistance these currents frequently take round-about paths, passing from one pipe system to another, and produce electrolytic corrosion at every point of passing from metallic structures to earth. Thus, not only are the structures of all interests operating underground reticulations subject to injury, but the entire public being served by means of these structures has a vital interest, as the enormous cost of replacement is passed on to the consumer through rates or taxes.

Cooperation Needed—Unless the municipalities and utilities involved cooperate harmoniously with a view to finding a solution that will be mutually beneficial, and parties responsible for electrolytic troubles assume the full share of their responsibility, the problem facing each of them separately is hopeless from the outset. The close physical proximity of the various structures in the streets belonging to the various interests makes them all parties to a defense against a common enemy.

Except in the cases where electric railways have a direct interest in underground distribution systems, the operators of these systems are forced to shoulder the entire burden of the expense of repairing and repla-

*Member, American Institute of Electrical Engineers.

ing their pipes and cables, and combating the stray-current evil. As long as stray currents are permitted to discharge into the earth, owners of the underground systems will have to suffer the consequences. Any of the measures which may be applied under these circumstances are merely palliatives and do not eliminate the cause of trouble.

Operators of subterranean piping and cable networks are faced with the necessity for permitting stray currents to flow on their structures, and of attempting to limit and control that flow within safe limits and direct it to drainage points where it can be removed by means of metal conductors.

Three Protective Methods—Resistance joints in pipe-lines have been advocated and used as a means of limiting the magnitude of stray electric currents. The results obtained have been somewhat disappointing, particularly where pipes or cables in which no means for current limitation is provided, are installed parallel, and in the immediate vicinity. These parallel structures pick up the stray currents and carry them to points where the potential difference is such as to cause a transfer of current to the protected pipe.

Insulated covering and coating for pipes and cables is another means which is being used. Like resistance joints, these too have their limitations. With the exception of concrete, which is expensive, none of the coatings being used can be regarded as permanent. The failure usually takes place at bubbles or small imperfections which are almost inevitable, or at bruises to the coating caused by handling. It cannot be disputed that coatings do increase the life of the structures, even though they do not eliminate the evil effects of stray currents.

One other method for the mitigation of electrolysis is being used with success on isolated pipe-lines. This is the electrolytic or cathodic method. By installing a cathodic unit at points where electrolysis damage is chronic and applying sufficient current by means of this equipment to neutralize the current producing corrosion, it is expected to eliminate damage at that location. In large networks, this is liable to produce other complications equal to—if not worse than—the trouble which it is sought to eliminate. While this method does well in case of galvanic currents, its application to stray currents will be expensive because of the larger currents involved.

It is evident that mitigative methods applied to underground structures are temporary and local in their results and that their use leads one to travel around in a circle, always ending at the point of departure.

Draining the System—Once stray currents have found their way onto the system, they must be removed with the least damage to the structures. The points at which the currents finally leave the pipes and cables are near the power substations which feed the railway system.

By draining the pipe through the use of electrical conductors between it and the cables and the negative bus of the substation, damage can be eliminated at that point. But, when drains are installed the resistance of the return path of the current is decreased, with the result that the amount of stray current is increased. Thus, while relieving the situation at one point, it is aggravated at other points, all of which are unknown until they manifest themselves through leaks or breakdowns which disrupt the service and are a source of great expense. In many instances, drainage and resistance joints operate at cross purposes, drainage producing a condition which resistance joints tend to eliminate.

Improve the Electric Railways—Stray currents can be limited by measures which are applicable to electric railways. The most obvious of these measures is the improvement of the rail circuit, such as the use of heavier rail sections, a better bond between rail sections, and supplementing the rail circuit by negative feeders. All of these measures tend to decrease the resistance of the return path of the currents to the source of power, consequently nearly all of the current will return by that route. Without such a low resistance return path, the currents trespass and destroy property of others.

The length of the rail circuits can, to the advantage of the railway system as well as others, be materially reduced by the installation of more power-supplying substations. These stations will of necessity be smaller than ones now in use, but the improvement to rail service will offset the slight additional cost. Recent improvements in substation control equipment have made possible the use of automatic stations.

More attention can be given to roadbeds to increase their insulating qualities in order to confine railway currents to their proper channels.

The results to be obtained by shortening and improving the rail circuit are by no means one-sided. In addition to reducing stray currents and the consequent damage therefrom, the power losses resulting from the high resistance of the return circuit will be materially reduced, with consequent reduction of power costs. Also, the better voltage conditions obtainable along the railways will make possible a faster car schedule.

Until operators of street railways recognize their responsibility with regard to stray current damage and take steps to confine the current to their own structures, operators of underground structures will be forced to expend large sums of money annually to keep their equipment in proper condition.

COMPETITION FOR TANK DESIGN

The Chicago Bridge & Iron Works is sponsoring a world-wide competition for improved design in elevated steel tanks. For the best eight renderings, $4000 in prizes is offered, divided as follows: first prize—$2000, second prize—$1000, third prize—$500, and five honorable mention prizes of $100 each.

Entries in the competition will consist of two drawings of a typical elevated steel tank with a nominal capacity of 200,000 gal. Entries will be received anonymously, displayed impartially, and judged by a 3-man jury of award. Albert M. Saxe, 430 n. Michigan ave., Chicago, has been appointed professional advisor for the competition and will handle all communications regarding it, receiving applications for entry until December 1, 1930. The contest, which closes March 1, 1930, is open to architects, engineers, and draftsmen.

Design and Operation of Swimming Pools

Necessity for More Frequent and Rigid Inspection and Extreme Care in Operation and Maintenance

By A. C. Beyer*
District Manager, Wallace & Tiernan Co., Inc., San Francisco

Editor's Note—A. C. Beyer was born in St. Paul, Minnesota, June 20, 1901, and graduated in sanitary engineering from the University of California in 1925. During college vacations Beyer was on surveying parties for the California Division of Highways and the Southern Pacific Co. From graduation until August, 1926, he was assistant city engineer of San Rafael, California, on design, construction, and maintenance of streets and other municipal improvements. From August, 1926, to January, 1929, he was a sales engineer for the Pelton Water Wheel Co., of San Francisco, handling all types of hydraulic machinery. Since January, 1929, he has been sanitary engineer and district manager in the San Francisco office of Wallace & Tiernan Co., Inc., handling chlorine control apparatus.

It is the intention of this article, in reviewing swimming pool design and operation, to emphasize the fact that it is worthy of more engineering attention that it has been receiving in many cases. Swimming pools are just as much a problem, particularly in the case of public pools, as are water treatment plants, to which they are similar in many details. It is certain that many relatively ineffective and uneconomical layouts would have been avoided and errors in operation corrected, if this was realized and qualified engineers consulted.

State and Municipal Regulation — California can point with pride to the fact that practically the first official action in the regulation of swimming pools in this country was taken in the passage of a regulation by the State Board of Health nearly twenty years ago. Soon after, a number of the larger cities in the country, including Detroit and Cincinnati, undertook inspection and regulation of public pools. At the present time, over thirty states have carefully drawn rules and regulations regarding swimming pools. Most of these are concerned both with design and operation. The list of cities in which swimming pools are subject to regulation by inspectors is quite extensive, but the number in which this inspection and regulation is really effective is, unfortunately, not so large.

Fill-and-Draw Type — The first swimming pools constructed were of the fill-and-draw type. In this type of pool the water would be changed whenever the operator thought advisable, or, in many cases, was forced to do so. Thorough, continuous treatment of the water in a fill-and-draw pool is not easy and is therefore usually neglected. Although such pools are certainly not to be encouraged, it must be recognized that they will continue to exist in certain cases and most regulations state that the pool must be emptied, cleaned, and refilled when the total number of bathers using the pool since the last emptying equals 20 persons for each 1000 gal. of pool capacity.

The only case in which a pool of the fill-and-draw type is really looked upon with favor by authorities is when an amount of fresh water is added equivalent to at least 400 gal. per bather. It is, of course, excellent when fresh water is added continuously to the pool in sufficient quantities, especially when such water is properly treated to give a residual of the disinfecting agent continuously in the pool, such as by chlorinating the incoming water. This type of operation would be equivalent to the modern pool with a recirculating system.

Recirculating System—It was the problem then of securing relatively large quantities of fresh, disinfected, clear water which led to the modern recirculating system. As a secondary factor in favor of such a system, it was soon obvious that the recirculation of swimming pool water would make possible important savings in heating costs where it was necessary to raise the temperature of the pool water.

Boy Scout Pool and Pueblo, Phoenix, Arizona

To make recirculation a success, the first designers followed closely the practice in water treatment. This was natural, as the recirculating system was actually to be a water purification plant.

The recirculating system for a swimming pool consists of the outlets which take the water normally from the deep end of the pool to the recirculating pump or pumps, followed by filters, a heater if used, and sterilization equipment; the water being then returned normally to the shallow end of the pool. The recirculating equipment—or purification plant as it may be regarded—should as a rule have sufficient capacity to handle an amount of water equivalent to the capacity of the pool in an eight-hour period. In certain cases, a smaller capacity is justified and in a few cases a larger capacity, depending principally upon the expected bathing load.

Centrifugal pumps are normally used for recirculating. In the case of large pools, several pumping

*Junior, American Society of Civil Engineers.

units are often installed, either to allow variations in the recirculating rates or as duplicates.

In most cases, a vacuum cleaner is considered a part of the recirculating equipment. This consists of a suitable suction head, with provision for attaching to the recirculating pump section, used for cleaning the bottom of the pool. Suitable strainers are invariably installed on the suction lines.

Types of Filters—All types of sand filters have been used in swimming pool repurification systems; slow sand filters, rapid gravity filters, and those of the pressure type. However, it was only in the case of some of the earlier pools that slow sand filters were used, since the amount of space required and labor in cleaning was relatively large.

L. S. Rosener Pool, Atherton, California

Pressure Filters—It has been estimated that about 80% of the pool filter equipment is of the pressure type, and on account of the economy in space this type of filter is usually preferred unless the water is very hard and causes incrustation of the sand grains. When the latter is the case, most designers prefer the open construction of the gravity filter, using it especially for large outdoor pools.

The design of the rapid sand filters for swimming pools follows closely water purification practice. A maximum rate of filtration of 3 g.p.m. per sq.ft. of surface area is recommended, and it is essential that proper pressure or loss-of-head gauges be provided. Rate controllers are to be preferred for larger pools.

In the case of pressure filters, the design of the valve nest, piping, etc., has been fairly well standardized, and although there is a considerable variation in details, and particularly in the type of under drainage system, it is fairly safe to say that any of the larger pressure filter manufacturers can be relied upon to furnish satisfactory units. In the case of small filters, an 'alum pot' is normally used for the coagulant, but in the larger pools the more accurate solution and orifice boxes are recommended.

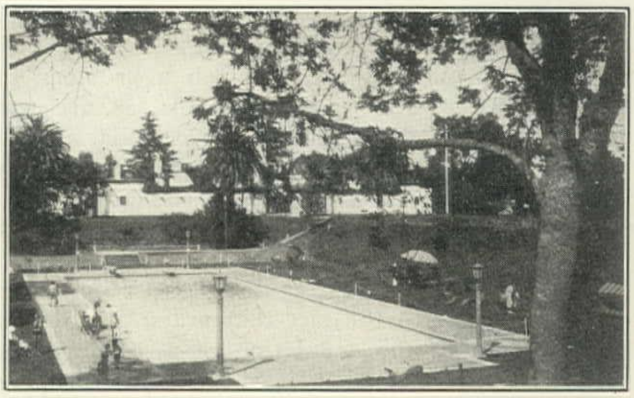
In a small pool, single filter units are often used. In such cases a separate pump, to give a sufficient volume of water for back washing at the proper rate, must be installed, except where city water under sufficient pressure is available.

The installation of multiple filter units has several advantages. In the first place, it is then possible to use the recirculating pump for back washing one filter unit at a time. Likewise, with the smaller filter units a more even distribution of filtration is secured. Then, too, it is possible in an emergency to put one unit out of service for repair or overhaul, and still get sufficiently satisfactory results for a short period.

Heating—It is desirable to heat swimming pool water in most cases; it is essential to do so for indoor pools in the northern section of this country. A temperature of from 2 to 5 degrees lower than the temperature of the air is usually considered desirable. The type of heating unit depends on whether steam or hot water is to be used. Automatic control of the temperature is desirable. Blowing steam directly into the pool is poor practice.

Disinfection—It is recognized that the proper type of disinfection is the most important step in producing swimming pool water which is safe for bathing at all times. Three types of disinfection have been tried: ozone, ultra-violet ray, and chlorine.

It is recognized that ultra-violet ray will satisfactorily disinfect clear water. However, there has been no satisfactory evidence produced to show that there is any residual sterilizing effect; in other words, in the case of swimming pool water it is essential that there be some disinfectant in the water in the pool itself to act on any infectious material given off by bathers, and the ultra-violet ray does not furnish this residual action. Therefore, in a considerable number of instances where ultra-violet ray treatment has been used, it has been found advisable to replace or supplement that treatment by chlorine. Ozone sterilization has limitations similar to ultra-violet ray.



Castlewood Country Club Pool, Near Pleasanton, California

The use of chlorine in some form is recognized to be the most satisfactory and effective method of pool disinfection. In the majority of pools in this country, with recirculating equipment, chlorine is introduced by means of solution-feed chlorinators in which the chlorine is accurately measured and applied into the recirculating system as a water solution. The dependability, low operating cost, and simplicity of modern chlorine control equipment has made this method of sterilization meet with the approval of designers, operators, and health authorities. Intermittent application of hypochlorites to swimming pool water, as formerly practiced, is no longer tolerated, as consistently good results are impossible.

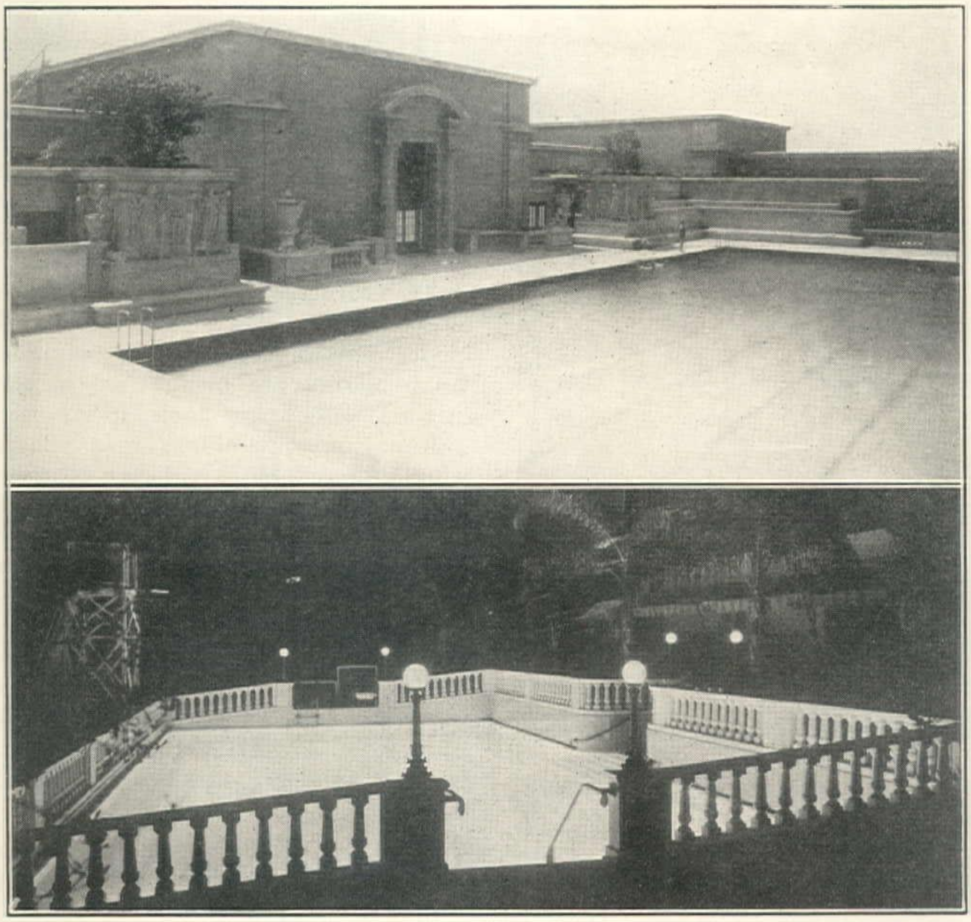
Residual Chlorine—The amount of chlorine added to the water is sufficient to maintain a residual in the pool between 0.2 p.p.m. and 0.5 p.p.m. This residual is easily determined by means of the orthotolidin test. The effectiveness of the treatment is witnessed to by the fact that health authorities accept a test for the proper chlorine residual in the swimming pool water as evidence that it is free from bacteria.

However, it is good practice to have the bacterial tests of the swimming pool water made at regular intervals, and this is the practice in all cities where effective regulation of pools is carried out.

Pool Design—The structural design of a swimming pool normally offers no unusual problems to an engineer. In this connection particularly, I would refer to the 1926 report of the Joint Committee on Bathing Places of the American Public Health Association. In this report was given fairly complete recommendations covering the construction details and proportioning of the pool of the usual rectangular form, in which the water is introduced at the shallow end and taken out at the deep end.

In the case of many of the larger pools various engineers have shown considerable ingenuity in shape, arrangement, and division of the pool or pools to suit special conditions. In our own locality the three men's pools constructed at Stanford University (described in **Western Construction News,** Vol. IV, No. 20, October 25th, 1929, issue) illustrate some of the possibilities. Another instance is the design for the municipal pool planned for the city of Modesto by Frank S. Rossi, city engineer; which pool has the novel shape of two semicircles connected by a rectangular section, and has a number of advantages. While the rectangular pool of conventional design is quite satisfactory in most instances, it is certain that there is opportunity for variation and improvement in a great many special cases.

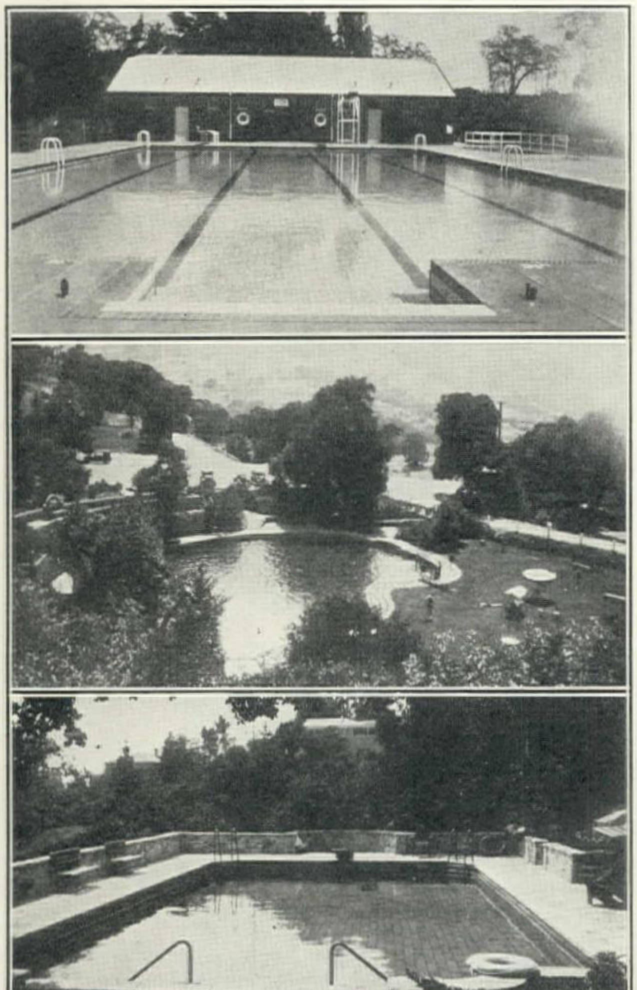
In the design of the recirculating piping and valve arrangement, considerable flexibility in operation can be obtained with little, if any, additional cost. A recent illustration of this point came to my attention in the design prepared by L. S. Rosener, consulting engineer of San Francisco, for his private pool at Atherton, California. The piping arrangement for the pool is such that the flow of recirculation can be changed, so that in cases where he wishes to heat the deep end of the pool rapidly, or increase the recirculation at that point for various other reasons, that can be accomplished by merely opening one valve and closing another. Various other ingenious arrangements on this and other pools designed by engineers could be mentioned, all of which appear simple enough when seen, but which are in most cases omitted or not taken advantage of when pools are merely built by laymen or mechanics without engineering assistance.



(UPPER) HEARST MEMORIAL POOL, UNIVERSITY OF CALIFORNIA. (LOWER) BEVERLY HILLS RANCH POOL OF E. L. DOHENY, SR., AT NIGHT

There is no question but that a tile finish for a pool makes the most satisfactory and best looking job. However, it is often the desire to effect some economy in using a cement finish. In the latter case, much dissatisfaction has resulted due to the improper use and application of various paints and coloring compounds. A little engineering advice and supervision in such cases would be a real saving and would result in better looking pools. (See Bulletin on Swimming Pools published by the Portland Cement Association).

Pool Operation—In swimming pool operation, it is as a rule not necessary to use as many different types of chemical treatment as in drinking water purification. In addition to alum for coagulation, soda ash is quite often employed to maintain a slight alkalinity



(Upper) Emporium Country Club Pool, Marin County, California. (Center) Orinda Country Club Pool, Contra Costa County, California. (Lower) Fair Estate Pool, Piedmont, California

in the water. A pH of between 7.2 and 7.8 is the optimum. Acid water of itself is irritating to the sensitive membranes and accentuates any irritating effect of other chemicals. In water of the alkalinity mentioned, it is impossible to have any irritating effects from the use of chlorine with the residuals recommended for sterilization.

As probably the most effective algicide, copper sulphate finds a use in swimming pools. Recently, however, it has been recognized that if the chlorine residual in the swimming pool is maintained at the point recommended for effective bacterial disinfection, then the growth of algae will be inhibited. This has resulted in a much wider use of chlorinators, both on private and public swimming pools, since the attractiveness of clear water without the disagreeable features of copper sulphate is much to be desired.

Recent Developments — Under-water lighting in pools, both indoor and outdoor, has made night bathing both safe and pleasurable. Most of the installations that I have seen of under-water lighting equipment indicate that it has been put in by rule of thumb methods. A little thought in type of lights and the arrangement is certainly justified. I believe that in the future the only type of lights that will be installed will be those which are removable and readily accessible without emptying the pool.

Foot Infections—Recently, the problem of eliminating the various types of foot infections has deservedly received considerable attention. Ringworm (athlete's foot) and plantar warts are the most common types of infection. This should be borne in mind by the designer in eliminating all types of floor covering or mattings which tend to stay continually moist, and in providing good drainage of floors and walkways. In operation, the washing down of floors with strong solutions of hypochlorite is very effective. In many cases, the solution from a chlorinator, properly diluted, can be conveniently used.

Ammonia-Chlorine and Chloramine—Again following progress in the field of water purification, ammonia-chlorine treatment is being widely looked to. As a matter of fact, in England there has been for several years a rather widespread use of the ammonia-chlorine or chloramine treatment in the case of swimming pools. In this country on a number of large pools ammoniators are being used in addition to chlorinators. In smaller pools, it has been found that the use of ammonia-alum for a coagulant, instead of aluminum sulphate, will give nearly equal results. It is my opinion that the principal advantage of ammonia-chlorine treatment is that a much higher chlorine residual in the pool can be maintained without any possible danger of complaints from bathers. It has been definitely shown that swimming pool water with a residual as high as 1 p.p.m. can be used by bathers without the slightest discomfort, even though they have previous knowledge of the chlorine content of the water. The ammonia-chlorine or chloramine treatment results in some economy in chlorine and also, some authorities claim, a much higher germicidal value.

In the past, the B. coli index and total bacteria count have been used as the criteria of swimming pool pollution. Recent studies have indicated that a more accurate index would be that of B. streptococci or staphylococci. Some excellent work in this regard has been done by the Detroit Department of Health.

The work already done in connection with swimming pools, particularly that of the sanitary engineering profession, as indicated above, has resulted in safe swimming pool water—most operators are dissatisfied if the water does not test better than drinking water —and in satisfactory conditions of operation. However, there is need for continued attention to swimming pools by the engineering profession to the end that the best available knowledge is taken advantage of and further improvements be developed.

Editor's Note—California Filter Co. installations were made for the Castlewood, Emporium, and Orinda country clubs and the Fair Estate, and International Filter Co. installations for the Huntington Hotel (front cover), Boy Scout Pool at Phoenix, and E. L. Doheny, Sr. W & T chlorinators were used at all of these pools.

Chloramine, Its Preparation, Properties, and Uses

By W. HIRSCHKIND
Chief Chemist, Great Western Electro-Chemical Co., Pittsburg, California

Chloramine, or rather chloramines, have been known for many years. The compounds were first discovered by Raschig[1] in 1907, while Rideal[2] in 1910, and Race[3] in 1915 pointed out their excellent bactericidal properties which exceeded several fold those of chlorine alone. It was not until the advent of the cheap synthetic ammonia, which had so marked an influence on many industries, when the work of Raschig, Race, and Rideal was reopened, and today chloramines may be classed as very important compounds in the sanitary field.

The compounds we are dealing with are 'Monochloramine' (NH_2Cl), 'Dichloramine' ($NHCl_2$, and sometimes, although largely as an undesirable by-product, the much older 'Nitrogen Trichloride' (NCl_3).

Chemistry of Chloramine Compounds—Raschig was the first to discover the formation of monochloramine by reaction with equimolar proportions of ammonia and hypochlorite in dilute solutions, according to the equation:

$$NaOCl + NH_3 = NH_2Cl + NaOH \qquad (a)$$

The solution so obtained decomposes easily, however, under the influence of the free caustic soda, as follows:

$$3\,NH_2Cl + 3\,NaOH = NH_3 + N_2 + 3\,NaCl + 3\,H_2O$$

Chloramine may further be produced by the reaction of chlorine with ammonia in dilute solutions, as follows:

$$Cl_2 + 2\,NH_3 = NH_2Cl + HCl \qquad (b)$$

The hydrochloric acid formed will immediately react with an additional mol of ammonia, forming ammonium chloride:

$$HCl + NH_3 = NH_4Cl$$

so that the ultimate reaction proceeds as follows:

$$Cl_2 + 3\,NH_3 = NH_2Cl + NH_4Cl$$

involving a molar ratio of ammonia to chlorine of 1:3, instead of 1:1 in equation (a). Besides the disadvantage of the larger ammonia consumption, chloramine prepared by this method cannot be stable because of numerous side reactions taking place under these conditions which lead partly to decomposition under evolution of nitrogen, partly to formation of nitrogen trichloride, etc.

The decomposition of chloramines may occur in the following steps:

$3\,NH_2Cl = NH_4Cl + 2\,HCl + N_2$	(1) Very slow
$NH_2Cl + 2\,HCl = NH_4Cl + Cl_2$	(2) Rapid
$NH_4Cl + 3\,Cl_2 = NCl_3 + 4\,HCl$	(3) Rapid (Bray & Dowell)[4]
$NH_4Cl + NCl_3 = N_2 + 4\,HCl$	(4) Slow (Bray & Dowell)[4]

Reaction (1) is apparently a very slow reaction under faintly alkaline condition. Reactions (2) and (3) are known to be rapid, and represent a large conversion of NH_2Cl into non-bactericidal ammonium chloride. If acid conditions are avoided, the chloramine decomposition is, therefore, slow.

Under acid conditions, the chloramine decomposes rapidly according to reactions (2) and (3). The solution retains some bactericidal value, however, because the nitrogen trichloride which forms decomposes more slowly according to reaction (4), unless organic matter is present, in which case the available chlorine is rapidly used up in oxidizing the organic matter.

Under strongly alkaline conditions, decomposition by reaction (1) is greatly accelerated. The alkali may be either caustic or a large excess of free ammonia. This has already been mentioned in the case of Raschig's reaction under (a).

With a smaller excess of free ammonia, hydrazine is formed, especially if reducing substances (formaldehyde, sugars, etc.) are present.

$$NH_2Cl + NH_3 = N_2H_5Cl \qquad (5)$$

It is evident from the aforementioned that the hydrogen-ion concentration plays an important role in stabilizing chloramine solutions.

Chapin[5] has shown that the nature of the product obtained through chlorination of an excess of ammonium ions is known to depend upon the pH of the solution, acidity leading towards nitrogen trichloride, and alkalinity towards monochloramine. In solutions with pH above 8.5, nothing but monochloramine was found; below pH 4.4, nitrogen trichloride is largely produced; while between pH 4.4 and 8.5, both mono and dichloramines exist.

The most advantageous method of preparing chloramine appears to be by the reaction of ammonia on an aqueous solution of free hypochlorous acid.[6]

$$HOCl + NH_3 = NH_2Cl + H_2O \qquad (c)$$

By this method, a neutral solution is obtained free from any of the aforementioned causes of self-decomposition.

Hypochlorous acid may be made by passing chlorine into a sodium bicarbonate solution, in the absence of direct daylight, until a precipitate of barium carbonate no longer forms when a portion of the solution is tested with barium chloride.

An alternate method is to pass chlorine into a suspension of finely divided calcium carbonate in water. The excess calcium carbonate should be filtered out. The same result may be obtained by passing chlorine water through a limestone tower which method is particularly adaptable to large-scale operations.

Where it is not convenient to use chlorine gas,

[1]Raschig: Monochloramine. Chem. Ztg., Vol. 31, p. 926, 1907; Berichte Vol. 40, p. 4586, 1907.

[2]Race: The Chlorination of Water (1917).

[3]Rideal: J. of Royal Sanitary Institute, Vol. 31, p. 33, 1910.

[4]Bray & Dowell: Experiments with Nitrogen Trichloride and The Reactions Between Chlorine and Ammonia. Jour. Am. Chem. Soc. 39,896 (1917).

[5]Chapin: Dichloramine. Jour. Am. Chem. Soc. 51, 2112 (1929).

[6]Olszewski: The Monochloramine Process for the Disinfection of Swimming-Pool Water. Chem. Ztg. 52, 141 (1928).

hypochlorous acid may be made from liquid-bleach solution (sodium hypochlorite, calcium hypochlorite) by adding a weak acid such as boric or carbonic acid. A large excess of the weak acid should be avoided.

Pure hypochlorous acid, free from dissolved salts, can be prepared by distilling any of the above solutions under reduced pressure and collecting the distillate. Regardless of the method of preparation, the hypochlorous acid solution should be kept in a dark bottle, as the acid decomposes rapidly in the light.

The chloramine solution is best prepared by adding dilute aqueous ammonia to a hypochlorous acid solution prepared by one of the above methods. The strength of the hypochlorous acid solution should first be determined by titration in the usual manner, or by diluting a portion of the solution and comparing with the orthotolidine standards. To convert the hypochlorous acid into chloramine, add the following quantities of ammonia:

Available chlorine in hypochlorous acid solution. (p.p.m.)	Volume of 1% ammonia* solution to each liter of hypochlorous acid solution. (c.c.)
100	3.0
200	6.0
300	9.0
400	12.0
500	15.0

The ammonia excess should be still greater if the solution contains other free acid—for example, where the hypochlorous acid is prepared by adding excess boric acid to bleach solution as described previously.

The hypochlorous acid solution used in making chloramine should not contain much more than 1000 p.p.m. of available chlorine, as the stability of chloramine solutions decreases rapidly above this concentration.

Properties of Chloramines—Pure chloramine can be obtained by distilling it from its aqueous solution in vacuo at low temperature as an unstable pale yellow oil floating on the surface of the water in the receiver. It decomposes rapidly at ordinary temperatures. At minus 60° C. it forms a colorless crystalline substance which on warming up decomposes with explosive violence. Dilute solutions of chloramine are, of course, perfectly harmless, and concentration can be effected up to 10% without explosive decompositions.

Water is a better solvent for monochloramine (NH_2Cl) than most organic solvents. This is accounted for by the polar character of the material. The distribution ratio of NH_2Cl between ether and water is approximately 1 to 1, and between chloroform and water, 0.25 to 1. NH_2Cl is practically insoluble in carbon tetrachloride, and $NHCl_2$ is only slightly soluble in this solvent, while NCl_3 is fairly soluble in the same solvent. This gives a means of separating NCl_3 from the other two compounds. The following is a list of some approximate distribution ratios for NH_2Cl and $NHCl_2$:

NH_2Cl	Chloroform/water	0.25
NH_2Cl	Carbon Tet./water	Very small
NH_2Cl	Ether/water	1.0 (Approx.)
$NHCl_2$	Chloroform/water	1.88
$NHCl_2$	Carbon Tet./water	0.85
$NHCl_2$	Ether/water	47.3

*The amounts of ammonia given in the table are 20% greater than the theoretical requirement for NH_2Cl, as the presence of excess hypochlorous acid or chlorine decreases the stability of the chloramine solution.

For analytical purposes, it is also of interest to note that NH_2Cl, $NHCl_2$, and NCl_3 all liberate iodine quantitatively from an acidified potassium iodide solution.

Chloramine is more soluble and less volatile than chlorine, also less irritating and nontoxic to humans. It has a bactericidal action of three to four times that of chlorine and a very much lower oxidation potential.

Application of Chloramines—The application of chloramines is based on its three outstanding properties: (1) high bactericidal effect; (2) non-toxicity to humans; and (3) low oxidation potential.

The low oxidation potential causes chloramines to persist for a longer time than chlorine alone and makes its application possible in cases where chlorine alone would be immediately used up by oxidation, as for instance in industrial slimes. Large dosages which are sometimes resorted to, to take care of heavy bacterial loads or killing of algae, and which may leave disagreeable odors and tastes by use of chlorine alone, can be carried out with perfect impunity by means of chloramines. Chloramines can be used in the food and packing industry where the use of chlorine might be detrimental.

For most commercial uses, it may be found advantageous to prepare the chloramine first and add it as such to the point of application, because in this case the most economical method of preparation can be used, involving an ammonia-chlorine ratio of approximately 1:4 by weight. In case of water supplies, etc., having a slightly alkaline reaction and containing considerable quantities of calcium and magnesium bicarbonate, chlorine and ammonia may be added direct in the above ratio.

For the prevention of tastes and odors in waters containing phenolic bodies, preammoniation followed by chlorination is probably the most efficient method, although it may involve a greater ammonia expenditure than in the afore-mentioned ratio of 1:4. The reason for this is that preammoniation will insure the formation of chloramine compounds in subsequent chlorination, rather than chlorophenols which are responsible for the tastes and odors.

There are two chloramine compounds on the market, in which the available chlorine is stabilized by combination with an organic radical. These compounds are chloramine 'T' and halazone, of the following compositions:

$$C_6H_4CH_3SO_2NNaCl \cdot 3H_2O$$
Chloramine 'T'

$$C_6H_4Cl_2SO_2N \cdot COOH$$
Halazone

The experience with these compounds has been however, that owing to their great stability, the bactericidal effect is a very slow one and cannot be compared with that of chloramines made from ammonia and chlorine compounds. The possibility exists that stable chloramines in solid form can be produced with bactericidal effects, comparable to monochloramine, but so far they have not been perfected.

STANDARD METHODS FOR EXAMINATION OF SEWAGE AND SEWAGE SLUDGE

A valuable symposium on this subject has been reprinted from Vol. II, No. 3 (p. 347 to 386) of the July, 1930, issue of the national 'Sewage Works Journal'.

Zeolite as a Factor in Municipal Water Softening

By R. B. Thieme
Pacific Coast Manager, International Filter Co., Los Angeles

It is not a debatable question that hard water is needless expense to any community, forced by circumstance to use it. This condition need not be endured, as practical and economical water softening methods are available. The experience of those cities and towns which soften their water supplies quickly demonstrates the benefits derived therefrom in satisfaction and economies effected.

Industrial establishments operating boiler plants, raw-water ice plants, laundries, and textile industries, have long since learned that any hardness in the water is both objectionable and expensive. Prior to the development of the household water softener, those living in hard-water communities endured the discomforts and were content with the small measure of relief afforded by rain water from cisterns.

Three Methods of Softening — The method of softening determines the reagents used. The sort of reagents constitutes by far the largest single item of expense in connection with water softening. But three methods of softening need be considered, namely: (1) Chemical softening in which lime is added to precipitate the carbonate hardness, and soda ash to remove the non-carbonate hardness; (2) zeolite softening, wherein common salt is the reagent indirectly employed to eliminate both forms of hardness; and (3) combination treatment, in which lime reduces the carbonate hardness to the lowest practical degree, followed by zeolite which eliminates all remaining hardness.

The most economical softening method involves consideration of many factors. The selection of the method can be competitive, based on the operating costs. There are several classes of water conditions, but to bring out the effect of competitive selection, Table 1 is sufficient.

TABLE 1

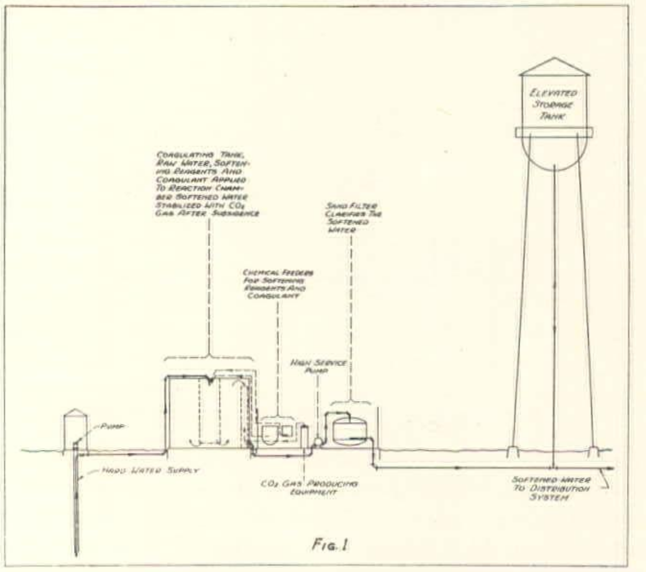
Classification of Supply Water

Class A. Clean, clear, iron-free hard waters.
1. Hardness, temporary, (calcium).
2. Hardness, temporary, (calcium and magnesium).
3. Hardness, both temporary and permanent.

Class B. All waters requiring clarification and/or iron removal.
1. Hardness, temporary, (calcium).
2. Hardness, temporary, (calcium and magnesium).
3. Hardness, both temporary and permanent.

The comparison in Table 1 leads directly to the question of selecting a lime-soda-ash plant, a straight zeolite plant, or a combination lime-zeolite plant. The first two may be selected for class 'A' waters in divisions 1 and 2, depending upon competitive reagent costs, size of requirements, etc. Class 'A' waters of the third division, as a rule, will require the combination plant for greatest economy. All waters of class 'B' will require either the lime-filtration type of softening plant or the lime-filtration-zeolite combination plant, the latter being especially economical in division 3.

Comparative Costs — The average amount of hydrated lime required per million gallon grains (one million gallons of water containing one grain of hardness per gallon) to eliminate those forms of hardness with which lime reacts is 165 lb., while the average amounts of soda ash or salt that must be used are 150 and 500 lb., respectively. An average cost of these chemicals per ton is: lime—$16.50, soda ash—$38.00, and salt—$8.50; giving a softening cost per million



Suitable Water Softening Plant for Community of Less than 7000 Inhabitants

gallon grains as follows: lime—$1.36, soda ash—$2.85, and salt—$2.13.

As zeolite treatment removes both carbonate and non-carbonate hardness, this method is cheaper than lime and soda ash softening in all cases where the non-carbonate hardness is high. Zeolite may be substituted advantageously for soda ash for the removal of non-carbonate hardness following lime treatment. Also, lime is cheaper than salt in removing carbonate hardness. These facts must always be considered in selecting the preferable method of softening for any water, although the cost of chemicals is not the only factor. The chemical composition of the water after softening must be given proper weight in the selection.

For a typical example, consider a plant of 10 m.g.d. capacity. In this example the water delivered to the mains can be 3 grains in hardness (51 p.p.m.), the water to be softened being of class 'A', division 3, with the analysis given in Table 2.

In Table 2, the cost of salt is adjusted to that of 10 m.g.d. of 51 p.p.m. hardness. In practice, the zeolite plant would not be 10 m.g.d. capacity, but would be 366/417 (or 417-51) of this capacity. This is a plant of about 8.75 m.g.d. output of so-called zero hardness water, and 1.25 m.g.d. of water of 417 p.p.m. hardness would be mixed through a suitable bypass.

Leading now to the combination plant, Table 3 shows the cost for complete lime pretreatment. It also shows the result of lime treatment and the amount of remaining hardness to be removed by the zeolite part of the plant.

Table 4 is a summary of the cost figures shown in Tables 2 and 3.

Pressure vs. Gravity Softeners—Before considering the economies of recently developed construction and operating methods, it is well to refer briefly to prac-

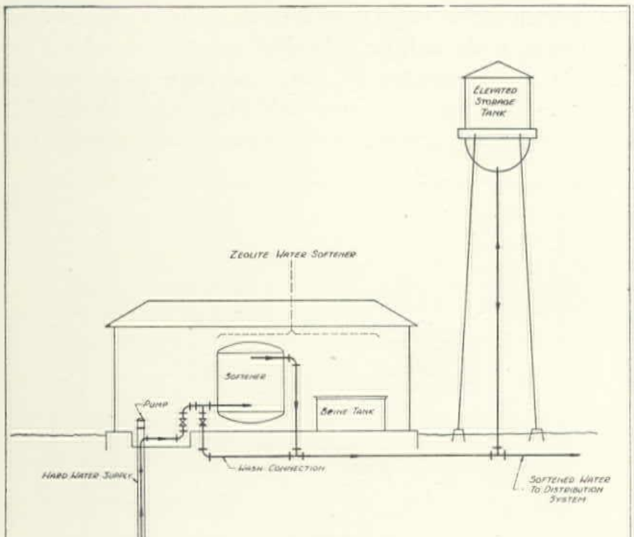


Fig. 2.

Pressure-Type Zeolite Water-Softening Tank

tices that have been followed in the past. Formerly, zeolite units were operated as pressure units, and as such they have met the demands made on them in the industrial field. There the quantities of water to be

TABLE 2

Reagent Costs for Softening 10 m.g.d. to 51 p.p.m.

Characteristic (p.p.m.)	Equivalent Hardness, as $CaCO_3$, (p.p.m.)	Cost per 10 m.g. Softened (Dollars): Lime	Soda Ash	Salt*	Salt Adjusted to 51 p.p.m., Effluent
$CaCO_3$—254		68.80			$\frac{366}{417} \times 450.00 = 395.00$
$CaSO_4$—86			95.00		
$MgSO_4$—119	417	25.80	150.00		
		94.60	245.00		
			339.60	450.00	395.00

*Cost based upon effluent of 10 p.p.m. or less.

TABLE 3

Result and Cost of Lime-Zeolite Softening Applied to the Same Water Shown in Table 2

Before Treatment: Characteristic (p.p.m.)	Equivalent $CaCO_3$ (p.p.m.)	Lime Cost per 10 m.g. (dollars)	After Treatment: Characteristic (p.p.m.)	Equivalent $CaCO_3$ (p.p.m.)
$CaCO_3$—254		68.80	$CaCO_3$—51	
$CaSO_4$—86			$CaSO_4$—86	
$MgSO_4$—119		25.80	$CaSO_4$—135	
	417	94.60		214

Salt cost per 10 m.g. (214 to 0 p.p.m.)	$205.00
Salt cost per 10 m.g. (214 to 51 p.p.m.)	$156.00
Cost of preceding lime treatment, per 10 m.g.	94.60
Total per 10 m.g. of 51 p.p.m. by lime-zeolite	$250.60

softened are comparatively small and the possibilities for conserving head are apparent.

The pressure zeolite softener is subject to physical and mechanical limitations in connection with multi-

TABLE 4

Reagent Costs

	Cost of 51 p.p.m. Effluent Per 10 m.g.	Per year
(a) By lime-soda ash method	$339.60	$124,000
(b) By straight zeolite method	395.00	144,175
(c) By lime-zeolite combination	250.60	91,500
Saving per year (a) over (b)		$20,175
Saving per year (c) over (a)		32,500
Saving per year (c) over (b)		52,675

unit operation in softening large quantities of water. First, the steel pressure vessel is restricted in size to transportation facilities. Even in horizontal form, the cross-sectional area perpendicular to the longitudinal center-line that can be used for a zeolite bed is comparatively small. It is impossible to have deep beds in such tanks, a condition that is desirable where extremely hard waters are to be handled. Each tank must have a complete set of operating valves; frequent regeneration is necessary, with the attendant operation of many valves. Loss of operating time is high, and low salt consumption impossible.

A somewhat parallel condition has always existed in the operation of pressure filters. To overcome this, the reinforced concrete gravity filter was developed. For the same reason, a more modern and efficient type of softening plant has been successfully developed, in

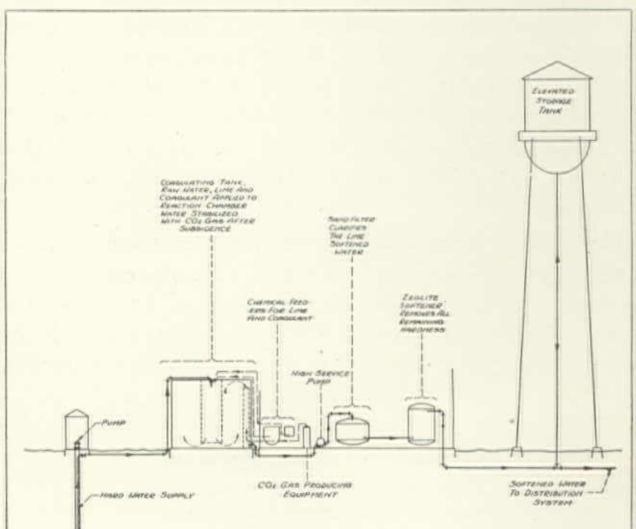


Fig. 3

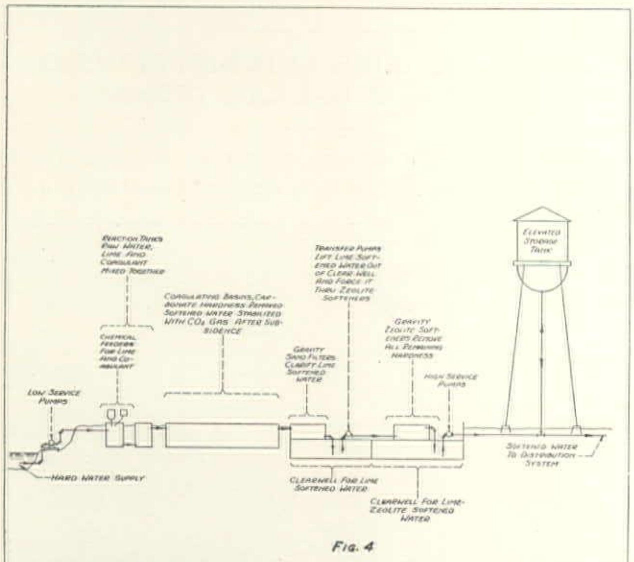
Lime-Zeolite Water-Softening Plant. Sand and Zeolite in Pressure Shells

which reinforced concrete gravity type basins are employed. Such construction allows increased operating areas and makes possible the use of much deeper beds. The increased volume of zeolite under each operative unit lengthens the time between regenerations. More effective distribution of both water and brine is secured through the underdrains of a rectangular bed than is possible through those of circular tanks. Also, an economy in salt consumption has been secured that has been impossible in the operation of pressure softeners. These improvements have, of course, made the overall operating efficiency of the concrete gravity zeolite plant much higher than the efficiency of a pressure plant of the same capacity.

Types of Installations — The first cost of a water softening plant depends upon the apparatus that must be provided for the kind of treatment selected and the conditions under which it must be installed. Softening with lime, or lime and soda ash, requires chemical feeders, reaction and coagulation tanks, recarbonating equipment, and sand filters. Fig. 1 is a diagrammatic sketch and flow diagram of the type of installation suitable, and generally most economical, to serve any community up to six or seven thousand inhabitants.

Fig. 2 is a flow diagram through a pressure-type zeolite softening plant. The equipment shown is suitable for handling a clean, clear raw-water supply that does not need filtering. In operating, raw water is pumped through the softener directly into the distribution system and, when the capacity of the zeolite has been utilized, the raw-water pump is stopped and a solution of common salt brine is applied to restore the softening properties of the zeolite.

A comparison between Fig. 1 and 2 discloses certain



Lime-Soda Water-Softening Plant, Reinforced Concrete Throughout

essential differences in construction and operating methods that affect costs. Two pumps are required for operating the chemical softener shown in Fig. 1, while one is required for the zeolite softener shown in Fig. 2. However, if the suction lift at the raw-water pumps is the same, the actual amount of power consumed in delivering treated water at the outlet of the filter or softener is about the same.

Fig. 3 is a flow diagram of a lime-zeolite softening plant in which pressure shells are used as containers for filter sand and zeolite, and a steel or wooden tank may be used for coagulation and sedimentation. Here as in Fig. 1, the hard water is pumped to the top of the coagulating tank, where sufficient lime is added to remove practically all of the carbonate hardness. After settling, sufficient CO_2 gas is added to stabilize the water and prevent after-precipitation. The high-pressure pump then forces water through the filter to clarify it, through the zeolite bed where all remaining hardness is removed, and finally into the distribution system.

Fig. 1, 2, and 3 are types of plant construction that are suitable for the smaller cities and towns. Different construction materials than those indicated are more economical for plants softening a million gallons or more daily. In these cases, reinforced concrete supplants wood or steel in tank and reservoir construction. Gravity filters and zeolite beds are used because large volumes of sand and zeolite can be most economically handled in this way, while coagulating basins are built practically at ground level to save money in construction and operation.

Fig. 4 is a flow diagram which shows how the various steps in treatment are carried out in a lime-soda plant of sufficient size to warrant reinforced concrete construction throughout. From the source of supply, the hard water is pumped to the reaction tanks where lime is used to remove all carbonate hardness. It next flows

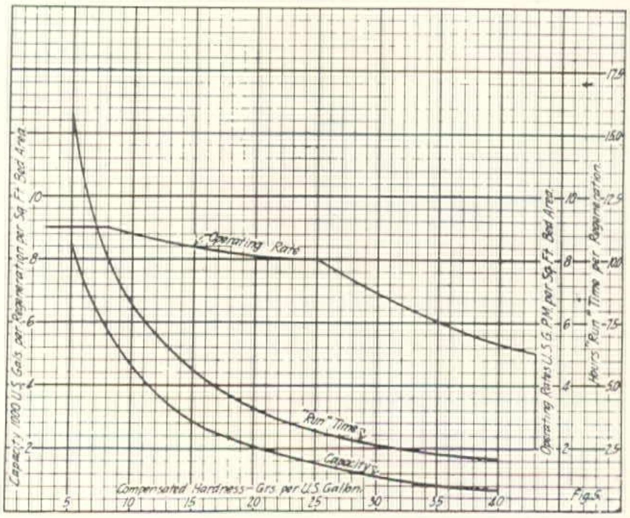


Fig. 5. Performance of Crystalite Zeolite Bed

from the tanks under the head established there, through the coagulating basins, the filters, and into the clear well for lime-softened water underneath the filters, being stabilized with CO_2 gas en route at the point indicated. This first clear well must be large enough to hold sufficient water for operating whatever number of zeolite beds are required, together with sufficient quantity for backwashing the filters and washing and brining zeolite beds, plus a reasonable margin to supply demands when one or more filters may be out of service for repairs.

Transfer pumps pick up the lime-treated water and force it through the zeolite beds and thence to the second compartment of the clear well where the zeolite-softened water is stored. High-service pumps, of course, supply the distribution system. Low-head pumps handle the transfer service mentioned—not over 25 or 30-ft. head, including suction lift, has to be overcome in the transfer from one clear well to the other, during which zeolite softening takes place.

A tabulation of conservatively estimated plant costs in connection with this layout is enlightening. Using the same data as in Tables 3 and 4 and a plant as described in Fig. 4, based on an output of 10 m.g.d. of softened water, costs are shown in Table 5.

Table 6 shows that the difference in operating costs justifies greater investment when this is required for the more expensive combination plant. The difference is increased with the bypassing of more pretreated or more hard water into the mains to increase the effluent hardness to 4, 5 or 6 gr. per gal.

Approximate figures are often asked for zeolite plants. Such figures are perfectly natural and come from the fact that any engineer familiar with filtration practices has in mind approximate costs of filter plants of definite capacities. There is no parallel between filtration and zeolite softening by which to gauge the cost of the latter. Too many variables enter into computations to make possible a cost estimate without a thorough analysis of conditions.

TABLE 5

Estimated Cost of the Three Types of Softening Plants for 10 m.g.d. of 51 p.p.m. Effluent

(Analysis same as Table 2)

(a) Lime-soda-ash plant (10 m.g.d.—417 to 51 p.p.m.)	$250,000
(b) Straight zeolite plant (8.75 m.g.d.—417 to 0 p.p.m.)	
Bypassing (1.25 m.g.d.—417 p.p.m.)	
Output (10 m.g.d.—51 p.p.m)	236,000
(c) Lime-zeolite plant	
Lime treatment (10 m.g.d.—417 to 214 p.p.m.)	$250,000
Zeolite treatment (7.6 m.g.d.—214 to 0 p.p.m.)	125,000
Bypassing (2.4 m.g.d.—214 p.p.m.)	
Output (10 m.g.d.—51 p.p.m.)	375,000

TABLE 6

Summary of Tables 4 and 5

	Estimated Added Investment	Reagent Saving Yearly	Saving in Per Cent of Added Investment
Lime-zeolite vs. lime-soda	$125,000	$32,500	26
Lime-zeolite vs. zeolite	139,000	52,675	38

Cost and Performance, Crystalite Zeolite — Fig. 5 shows that for International 'Crystalite' zeolite, under various operating conditions, the unit capacity, operating rate, and salt consumption vary with the hardness of the water to be treated, the capacity and rate decreasing as hardness increases.

Fig. 5 shows the performance of a Crystalite bed 5 ft. deep and 1.0 sq.ft. in operating area. With applied waters, the hardness of which is 25 gr. per gal. or less, operating rates in excess of 8 g.p.m. per sq.ft. can be realized and maintained to the limit of total capacity of the volume of Crystalite under operation. The reason for this is the up-flow operation which eliminates friction loss from packing of grains in down-flow operation.

Conclusion—There is much to be said in favor of softening municipal water supplies with zeolite. If hard-water supply conditions are such that this treatment is applicable, its possibilities should be thoroughly investigated. Salt now-a-days is cheap, the softening plant is economical in space requirements, the mechanical equipment is easily cared for, and operation can be largely a matter of routine.

CALIFORNIA SEWERAGE STATISTICS

C. G. Gillespie, chief of the State Bureau of Sanitary Engineering, reports the following California Sewerage statistics as of January 1, 1930: number of sewered places and population in same—278 and 4,374,000; population having access to sewers—4,065,000; population connected to sewers—3,387,000; disposal systems used jointly by more than one community—13; number of communities and population jointly served—62 and 2,438,000; number of sanitation districts and population served by same—5 and 269,000; total population connected to sanitation districts—143,000; number of sanitary districts and population served by same—34 and 56,600; number and population served by private systems—7 and 18,700.

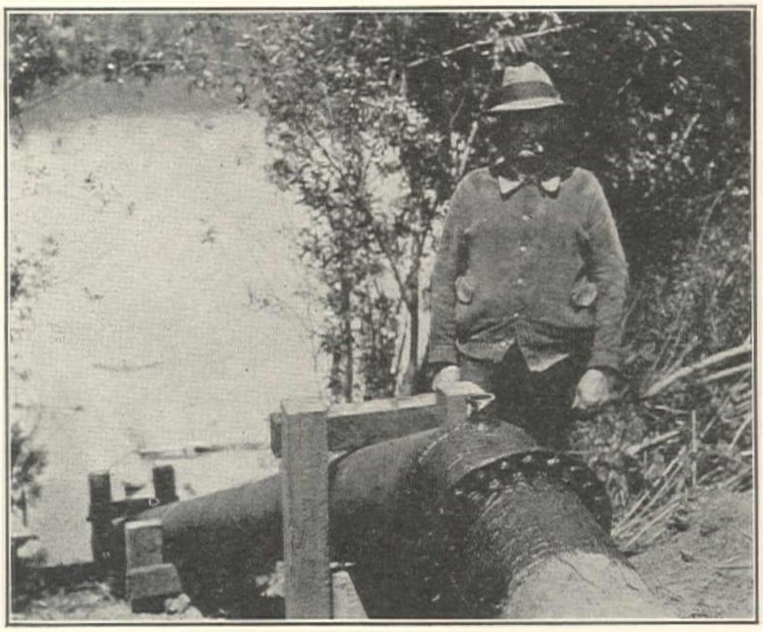
PINE CANYON DAM FOR PASADENA WATER DEPARTMENT

Edward Hyatt, state engineer of California, and George W. Hawley, deputy in charge of dams, have appointed the following consulting board of engineers to report on the application of the city of Pasadena to construct a concrete dam on the San Gabriel river in Pine canyon for the water supply of Pasadena: Charles P. Berkey, professor of geology, Columbia University, New York City; George D. Louderback, professor of geology, University of California, Berkeley; Ira A. Williams, consulting geologist, Portland, Oregon; J. L. Savage, chief designing engineer, U. S. Bureau of Reclamation, Denver, Colorado; George A. Elliott, consulting engineer, San Francisco; and M. C. Hinderlider, state engineer of Colorado, Denver.

CAST-IRON FEEDER AND DISTRIBUTION MAINS FOR DALLAS, TEXAS

A shift in the population center of Dallas, Texas, and the development of that city necessitated a revision of the water distribution system under a $4,000,000 program. This change was made along the Ulrickson plan, adopted in 1928, which provides for a new filter plant and pumping station and an entirely new system of trunk line mains (see article in March 25th, 1930, issue, p. 164). A contract for the feeder and distribution mains, including 19 miles of 36 and 30-in. cast-iron pipe and two miles of 28, 18, and 16-in. pipe, was awarded January 7, 1929, to the U. S. Pipe & Foundry Co. for $1,265,295.

Northwest Crane Laying 36-in. U. S. deLavaud Pipe at Dallas; Leadite Joints Used; Austin Ditcher in Background



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IMPORTANT PROPOSED WATER SUPPLY PROJECTS

San Francisco, California—Emergency pipe-line to connect with East Bay Municipal Utility District System, to be steel pipe, 12 miles long, from San Lorenzo to near Newark, Alameda county, bids open October 29	$ 1,000,000
Santa Cruz, California—8800 lin.ft. 20-in. cast-iron pipe-line, bids to be called for soon	35,000
Oxnard, California—Installation of water meters	30,000
Stratford, California—Steel casing, valves, pumping plant, and 30,000-gal. steel tank, bids open October 28	28,000
Torrance, California—Wells, reservoir, water treatment plant, water mains, and 250,000-gal. steel tank, bonds voted	400,000
San Jose, California—Earth-fill dam at Alum Rock park	50,000
Santa Ana, California—Pumping plant, steel tank and water mains in Westminster district for county, bids soon	32,000
Santa Barbara, California—Gibraltar dam, rock-fill type; also reservoir, pipe-line, and tunnel repairs	2,480,000
Long Beach, California—Reservoir, 54,000,000-gal. capacity, on Reservoir hill	400,000
Phoenix, Arizona—Pipe-lines, reservoir, wells, etc., for city, bids soon	2,364,000
El Cajon, California—Southern California Water Supply Co.	1,500,000
Los Angeles, California—City water works improvements (present system)	39,000,000
Eugene, Oregon—Water works improvements	250,000
Longview, Washington—Water works improvements	200,000
Olympia, Washington—Water works improvements	250,000
Hoquiam, Washington—Water works improvements	100,000
Walnut Creek, California—Distributing system, $60,000, and pipe-line to be built by California Water Service Co.	250,000
San Francisco, California—Hetch-Hetchy pipe-line	12,000,000
Pasadena, California—Dam and conduit	10,000,000
Baker, Oregon—Water system, city	500,000
Santa Ana, California—Dam for Serrano Water Co. and J. T. Carpenter Water Co.	750,000
San Jose, California—Santa Clara County Water Conservation Dist.	5,000,000
Los Angeles, California—Colorado river aqueduct	225,000,000
San Diego, California—City, enlarge Chollas heights reservoir	500,000
Tacoma, Washington—City, pipe-lines and wells	550,000
Los Angeles, California—Dam and pipe-line at Catalina for Santa Catalina Island Co.	1,400,000
Whittier, California—Pipe-lines, reservoirs, and pumps	310,000
Sacramento, California—City, enlarging filtration plant	450,000
Bellingham, Washington—Water mains and tunnel, city	750,000

Antioch, California—Furnish and install 1100 ft. of 10-in. cast-iron pipe, one valve, and four hydrants, bids open November 10.

PERSONAL MENTION

L. H. Nishkian, structural engineer of San Francisco, has developed jointly with D. B. Steinman of New York City a graphic method for the design of a continuous beam and frame.

D. G. McCulley, associate engineer for the Bureau of Reclamation, has been transferred from the Owyhee project to Hoover dam. His work at Owyhee has been taken over by Foster Towle.

Harry N. Jenks, of Berkeley, California, has resumed his practice as consulting sanitary engineer. During the past year Jenks was associated with the engineering office of Clyde C. Kennedy at San Francisco.

H. W. Bashore, construction engineer on the Vale project, Bureau of Reclamation, has been detailed to make a study of the proposed Columbia Basin project and has established headquarters at Spokane, Washington.

A. J. Dix, formerly testing officer for the engineering department at the University of Adelaide, Australia, has come to the United States to secure engineering employment, his temporary headquarters being at Berkeley, California.

Raymond E. Davis, professor of civil engineering and in charge of the materials testing laboratory at the University of California, Berkeley, was recently appointed an additional member of the consulting board for the Hoover dam.

S. E. Fitz-Simon, engineer for the reclamation service of the Argentine Republic, has been inspecting several projects of the Bureau of Reclamation, flood control and irrigation districts, and storage works for domestic water supply in the far west.

Dexter Kimball, dean of engineering at Cornell University and a lecturer in the business college at Stanford University, was a guest of the San Francisco section, American Society of Civil Engineers, at the regular bi-monthly meeting on October 21.

John J. Cone, president of R. W. Hunt Co., engineers, has retired, C. B. Nolte being advanced from vice-president and general manager to president and general manager with headquarters at the Chicago general office. J. C. Ogden, eastern manager, has been made vice-president with headquarters in New York.

Rhea Luper, state engineer of Oregon since 1923, has resigned following criticism of the business affairs of his office. C. E. Strickland, deputy state engineer, has been placed in temporary charge of the department pending the appointment of Luper's successor.

Ross G. Henniger, associate editor for several years of Electrical West, has left San Francisco for New York to become associate editor of the Journal of the American Institute of Electrical Engineers. Henniger took an active part in the San Francisco Electrical Development League.

George M. Bacon, state engineer of Utah, and W. D. Beers, engineer member of the Utah Colorado River Commission, were selected by Governor George H. Dern to represent the state of Utah at the meeting of the Colorado River Planning Commission in Denver on August 25.

Ralph Lowry, construction engineer for the Bureau of Reclamation on the Cle Elum dam of the Yakima project, Washington, has been transferred to Las Vegas, Nevada, where he will be principal assistant to Walker R. Young on the Hoover dam. Lowry was construction engineer on the Gibson dam, Sun River project, Montana.

Joe D. Wood, Idaho commissioner of public works, has resigned effective December 1 to enter the transportation field in a private enterprise; his successor has not been named. Wood joined the Idaho Bureau of Highways in 1914 as locating engineer and served as southwest district engineer from 1919 to 1926, at which time he succeeded W. J. Hall as commissioner of public works.

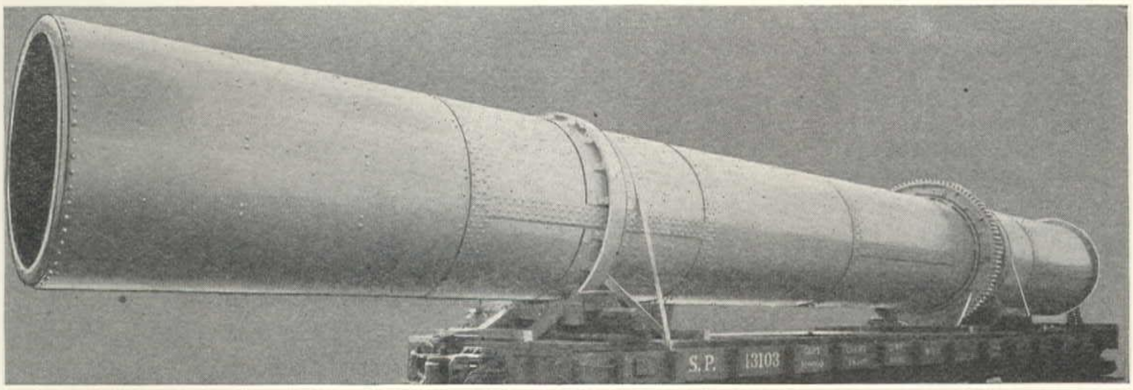
Charles T. Leeds, of Quinton, Code & Hill-Leeds & Barnard, consulting engineers, Los Angeles, has been employed by Los Angeles county to make a survey of tide, wind, and sand movements at the mouth of Alamitos bay. Col. Leeds was formerly district engineer, U. S. Engineers Office, on rivers and harbors in Southern California and chief construction engineer on the Los Angeles breakwater.

OBITUARY

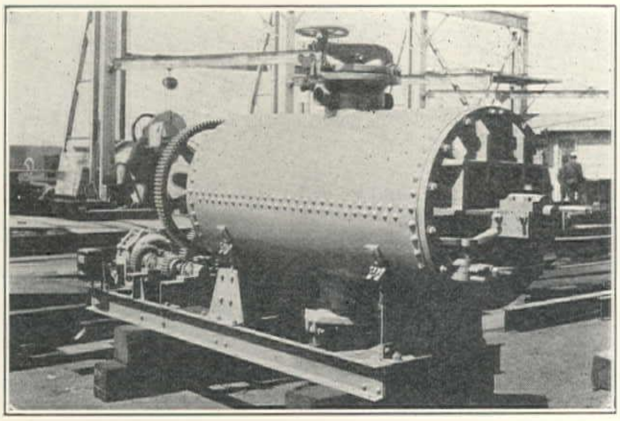
W. McCurdy, 69, for 25 years a civil engineer for the Southern Pacific Co., died at his home in Palo Alto on September 19. He is survived by his widow and one son.

Edgar B. Hagan, 22, employed as a civil engineer for the Clemmons Logging Co. near Melbourne, Washington, was instantly killed on August 29, when he stumbled and fell directly under a falling tree. Hagan graduated from the University of Idaho in 1928. He was prominent in student activities, serving one year as editor of 'The Idaho Engineer' and one term as president of the Idaho Student Chapter, American Society of Civil Engineers. He is survived by his parents and two brothers; burial was in Moscow, Idaho.

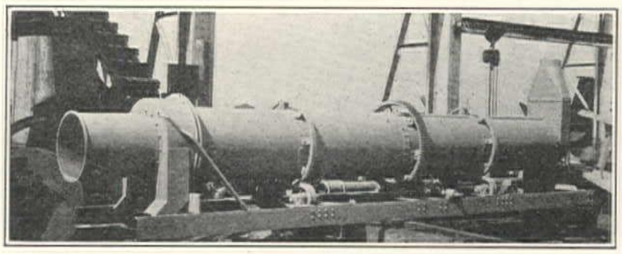
STANDARD DRYERS



STANDARD Parallel Current Dryer. Built for Philip R. Parks Kelp Drying Plant, San Pedro, Calif.



STANDARD Steam Jacketed Dryer. Celite Products Corp., Lompoc, Calif.



STANDARD Direct Heat Counter Current Dryer. Built for Standard Sanitary Mfg. Co.

STANDARD Rotary Dryer 8 ft. diameter by 150 ft. long.

STANDARD BOILER & STEEL WORKS

5001 Boyle Avenue **DElaware 1138** **Los Angeles, Calif.**

Cable Address, STANSTEEL - Bentley and Western Union Codes

New Equipment and Trade Notes

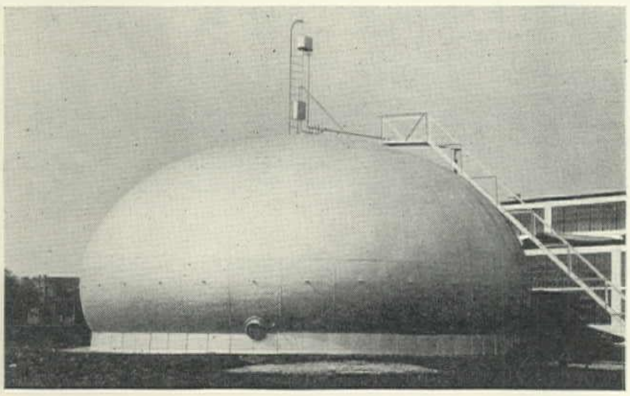
ACIPCO CELEBRATES SILVER ANNIVERSARY

October marks the twenty-fifth anniversary of the American Cast Iron Pipe Co. of Birmingham, Alabama. The company took off its first cast during May, 1906, and made the first shipment of pipe during that same month. In 24 years, Acipco has increased its annual production from 20,000 to 180,000 tons; annual sales now exceed $7,000,000 and the annual payroll is more than $2,000,000. Acipco has the largest cast-iron pipe plant and yard in America operating as a unit (200 acres), and maintains ten branch sales offices. The company operates under the John J. Eagan cooperative plan, which contains many desirable employee benefits.

Great strides have been made in American pipe foundry practice during the last quarter-century, including: continuous operation, manufacture of pressure pipe in 16-ft. lengths, cement lining of cast-iron pipe, and the Mono-cast centrifugal process of pipe manufacture—in all of which it is said that Acipco pioneered.

HORTONSPHEROID FOR PRESSURE STORAGE

The Chicago Bridge & Iron Works has released a bulletin describing a new type of oil storage tank to withstand internal pressure and known as the Hortonspheroid. This tank is spheroidal in shape, with flattened bottom, and is designed to economically use all of the metal in its construction. Natural



The Hortonspheroid for Pressure Storage

gasoline and other volatile liquids may be stored in this tank without evaporation, even though the liquid boils at normal temperature. Commercial installations are following the success of an experimental Hortonspheroid completed in 1928. Standard capacities are 2500 to 20,000 bbl. at 15-lb. pressure, with 10-lb. pressures also obtainable in the 10,000 and 20,000-bbls. sizes.

YEOMANS ELECTRICALLY-DRIVEN CAISSON PUMPS

Yeomans Bros. Co., Chicago, has released leaflet CP-350 describing its line of electrically-driven caisson pumps of the following sizes and capacities:

Capacity (g.p.m.)	Head (ft.)	Motor Hp. (1750-r.p.m.)	Weight (lb.)
75-175	40-60	5	625
75-175	60-80	7½	725
50-200	80-110	10	750

The pump is securely mounted in a forged steel yoke consisting of a lifting ring and two 10½-lb. side channels. It is direct-connected to a vertical motor—either A. C. or D. C.—through a flexible coupling. A grease-lubricated babbitt bearing is mounted on the pump casing and a grease-lubricated ball thrust bearing on the yoke attached to the upper side of the casing. Yeomans caisson pumps will handle dirty waters containing sand, silt, or mineral or acid solutions; they can be lowered into the caisson by cable from a crane or derrick.

WALLACE & TIERNAN AMMONIATOR

Increasing use of the clorine-ammonia process for the prevention of phenol and certain organic tastes and odors in water supplies is being given extensive investigation today. Recognizing the need for accurate and dependable control apparatus, Wallace & Tiernan have developed the MDPA and MDWA ammoniators which embody all the experience gained in 17 years' association with gas control.

The apparatus follows closely the design of W&T direct-feed chlorinators, certain modifications and changes being necessary to adapt it to feeding ammonia gas. The MDPA is a self-contained unit and can be installed anywhere; the MDWA is made in two forms—one for mounting on the wall at a place convenient to the point of application and the other adaptable for mounting on the standard W&T type MDP or MSP chlorinators. The ammoniator apparatus is guaranteed to accuracy of 4%.

PACIFIC STATES CAST IRON PIPE CO.

The Pacific States Cast Iron Pipe Co., Provo, Utah, announces the location of its Denver office in the Continental Oil bdg. at 18th and Glenarm st. Open house at the new office was celebrated October 3 and 4, with informal discussions of water works problems, exhibits of the company's products, and refreshments. Dana E. Kepner is manager of the Denver office.

There is now available at Denver for prompt l.c.l. delivery in Wyoming, Colorado, and New Mexico a large stock of McWane-Pacific class 150, horizontally-sand-cast, bell and spigot cast-iron pipe and fittings in 2 to 8-in. sizes, open bell and precaulked.

BYRON JACKSON DEEPWELL TURBINE PUMPS

The Byron Jackson Co., Berkeley, California, is said to have pioneered in 1901 the first deepwell turbine pump. Byron Jackson standard centrifugal pumps are built with one or more stages. Each size of pump case can be equipped with four or more enclosed interchangeable impeller types to cover the maximum range in head and capacity. The pump column comes in 12-ft. lengths and serves as the discharge line, also housing the line shaft and shaft bearings in an inner tube which excludes water and sand and affords positive lubrication. For electric drive, the standard pump heads are fitted with built-in motors; a belt drive can be substituted. One thrust bearing carries the weight of the rotor of the motor and the rotating elements of the pump.

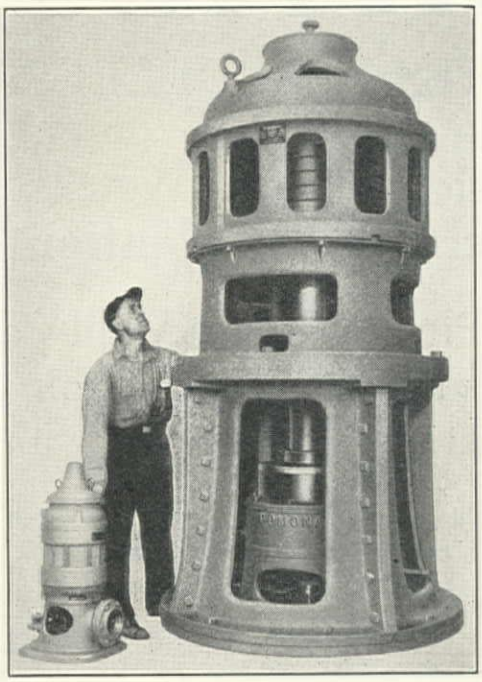
GOW HEADS WARREN BROS. CO.

Charles R. Gow, formerly chairman of the board of directors of Warren Bros. Co., became president of that organization March 1, succeeding John Dearborn, who resigned because of ill health. Dearborn retained his chairmanship of the finance committee and became chairman of the board of directors.

The A. M. Byers Co., Pittsburgh, Pa., announces the appointment of M. J. Czarniecki to the newly-created position of manager of tubular sales. This appointment is in line with an expansion program intended to broaden the market for wrought iron in forms other than pipe. Czarniecki joined the Byers sales organization in 1913, served as district manager at Chicago and New York, and in 1925 was made assistant general manager of sales.

POMONA TURBINE PUMP WITH 850-FT. LIFT

The Pomona Pump Co. of Pomona, California, recently constructed for the Cia Industrial El Potesi, at Zacatecas, Mexico, a turbine pump to lift water from 850 ft. underground. The shipment required two railway freight cars and weighed 48,000 lb. without the motor. The illustration shows the driving head and vertical motor used in this installation. The problem of proper lubrication and prevention of whipping in a drive shaft of such length was solved by using a water-lubricated, resilient type bearing. The shaft floats within a film of water and all vibrations are completely cushioned. The braking effect of an oil-filled tube—a more common method of lubrication—would have meant a great loss of power in this pump.



Driving Head and Westinghouse Motor for Pomona Deep Well Turbine Pump, 850-ft. Lift

Twenty-five individual pump stages on bowls were used. Twelve of these were installed 400 ft. underground and the others at the 833-ft. level. Only one shaft is used, the separate sets of stages driving from the same motor mounted at the surface. A regulating device below the top group compensates for increase in shaft length as the hydraulic load increases. The impellers have no lower shroud and are adjustable from the surface to compensate for eventual wear. The total weight of all moving parts is transmitted to a roller-bearing in the pump head, the bearing running in oil.

'SIKA' LIQUID WATERPROOFING COMPOUND

The American Sika Corp., 56 w. 45th st., New York City, is introducing 'Sika', a quick-setting liquid waterproofing compound which has been used for many years throughout the British Empire and all European countries. It is claimed that Sika will cause cement, cement mortar, or cement concrete to set in any given time from a few seconds upwards, or to set under still or agitated water within a few seconds; that it will cause a neat cement test piece to have a tensile strength rising to 100 lb. per sq.in. at the age of one hour; that it will cause a cement rendering to adhere to and set on a surface over or through which water is running, and without having to remove the water pressure. It is further claimed that Sika will cause a cement or cement mortar to set in, remain in, and completely seal a hole, leak, or joint in a structure through which water is pouring under pressure, and without having to remove the pressure.

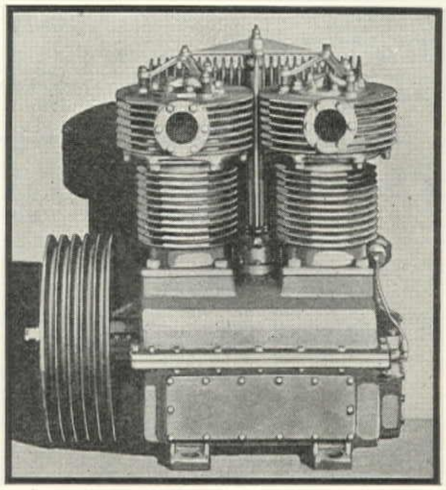
Waterproofing carried out with Sika ten years ago is said to be still perfect. Sika is reported to have waterproofed under pressures due to heads exceeding 500 ft. without removing the preessure. Sika can be used to effectively prevent frost bite when incorporated in concrete. One gallon of Sika waterproofs one cubic yard of concrete.

For waterproofing new concrete or cement plastering as the work proceeds, normal setting Sika No. 1 is added to the mixing water as an ingredient to the concrete or cement plastering in the proportions of 1:12 or 15 by volume. For waterproofing existing work where no water pressure is present or where such pressure can be relieved during operations, normal setting Sika No. 1 is added to the mixing water in the same proportion as for the case above. Waterproofing existing work where the water pressure cannot be removed during operations resolves itself into three classes, as follows: (1) water pouring through in jets or large quantities; (2) water percolating through or running over surface; and (3) damp spots as a result of porosity of the cement. Class 1 waterproofing is handled by sealing with cement activated by Sika quick-setting No. 2 and then covering with a cement mortar activated by Sika No. 1. For class 2 jobs, a cement and sand mortar activated by quick-setting Sika 4A is plastered on and afterwards covered with a cement mortar activated by No. 1. In the last case, the surface is rendered with a cement mortar activated with No. 1. Six grades are available for various waterproofing problems, each grade being colored for easy identification.

Before ordering Sika, the manufacturer suggests that customers give the fullest possible details of the case they have in hand and, where necessary, ask for special instructions in the use of the compound.

DAVEY AIR-COOLED COMPRESSORS

The Davey Compressor Co., Kent, Ohio, has developed a 142-c.f.m. air-cooled compressor which passes heat off instantly into the air through the medium of special aluminum alloy compressor heads and manifolds, cast with deep fins to give greater radiating area. With normal temperature in Davey compressors 150 deg. lower than that required to burn and carbonize oil, the units are free from carbon formation. Easy portability is another feature of these compressors. They are furnished for mounting on Caterpillar or McCormick-Deering tractors, using a power take-off from the tractor drive shaft, or are mounted on trailers or skids, in which case they are powered by Hercules motors through two sets of multiple V-type belts.



Davey 142-c.f.m. Air-Cooled Compressor

SPEEDER EXPANDS SALES ORGANIZATION

The Speeder Machinery Corp., Cedar Rapids, Iowa, manufacturer of Speeder gasoline, electric, and diesel-powered shovels, cranes, and draglines, recently added two district sales engineers to its organization in the western states. These men are B. C. Larrabee, with headquarters at Seattle, and R. C. Higley, with headquarters at Dallas. R. F. Sanchez has been named export manager with offices at New York City.

UNIT BID SUMMARY

Note: These unit bids are extracts from our Daily Construction News Service

WATER SUPPLY SYSTEM

SEATTLE, WASH.—CITY—STEEL PIPE LINE

Bids received as follows by City for constructing Cedar River Pipe Line No. 1 replacement and west Seattle Pipe Line:

USING LOCK-BAR STEEL PIPE (Three lowest bidders)

(1) Queen City Constr. Co., 603 18th St., Seattle (awarded contract) $1,207,116
(2) Western Pipe & Steel Co. $1,260,182
(3) Puget Sound Bridge & Dredge Co. 1,318,518

	(1)	(2)	(3)
120,000 cu.yd. excavation for pipe line trench (earth)	.60	.60	.82
7,600 cu.yd. excavation for pipe line trench (rock)	1.00	2.50	2.25
19 acres clearing and grubbing	200.00	125.00	160.00
15,000 cu.yd. borrowed earth	.45	.40	.50
24,388 lin.ft. removing woodstave pipe	.50	.50	.45
6,400 lin.ft. removing steel pipe	1.00	1.00	.70
900 cu.yd. gravel filling	1.75	2.50	2.10
41,000 lb. closing in pieces	.16	.10	.10
1,130 lin.ft. 30-in. dia. 5/16-in. plate lock bar steel pipe	9.95	10.47	11.00
215 lin.ft. 36-in. dia. 5/16-in. plate lock bar steel pipe	38.50	37.61	42.00
18,499 lin.ft. 48-in. dia. 5/16-in. plate lock bar steel pipe	12.10	12.17	12.47
680 lin.ft. 48-in. dia. 3/8-in. plate lock bar steel pipe	14.65	15.30	15.90
6,040 lin.ft. 48-in. dia. 7/16-in. plate lock bar steel pipe	15.00	15.88	16.65
250 lin.ft. 48-in. dia. 1/2-in. plate trip. riv. butt steel pipe	32.15	41.25	35.00
26,600 lin.ft. 66-in. dia. 5/16-in. plate lock bar steel pipe	15.80	16.00	16.60
980 lin.ft. 66-in. dia. 3/8-in. plate lock bar steel pipe	18.55	19.37	20.05
885 lin.ft. 66-in. dia. 7/16-in. plate lock bar steel pipe	20.10	21.63	22.70
615 lin.ft. 66-in. dia. 1/2-in. plate trip. riv. butt steel pipe	27.85	29.85	30.65
4,770 lin.ft. 66-in. dia. 9/16-in. plate trip. riv. butt steel pipe	30.00	33.42	34.67
19 air valve units	350.00	375.00	360.00
16 concrete chambers for air valves	175.00	180.00	170.00
2 large brick valve chambers	165.00	300.00	240.00
2 brick chambers for manholes	90.00	150.00	140.00
2,000 lin.ft. 6-in. 'A' cast iron blow off pipe	.90	1.50	1.39
320 lin.ft. 6-in. steel ventilating pipe	3.00	3.00	2.00
1 12-in. standpipe complete	900.00	850.00	850.00
15 6-in. blow offs	80.00	145.00	120.00
15 cast-iron valve boxes for blow offs	17.50	53.00	48.00
500 cu.yd. concrete blocking	16.00	25.00	23.00
200 M. ft. B.M. timber in temp. bridges and crossings	35.00	45.00	47.00
1 000 cu.yd. concrete in railroad and highway crossings	25.00	25.00	20.00
175,000 lb. reinforcing steel	.06	.05	.06
8,000 lb. special castings, iron	.20	.19	.17
8,000 lb. special castings, steel	.30	.27	.32
444 cu.yd. excavation in Duwamish River Crossing	10.00	5.00	10.00
215 cu.yd. concrete in Duwamish River Crossing	18.00	16.00	15.00
Lump sum, temporary trestle in Duwamish River Crossing	1000.00	1600.00	1900.00
3 ea. 36-in. flanged gate valves, with by-pass	1400.00	1685.00	1600.00
3 ea. 36-in. flanged check valves	1550.00	2050.00	1900.00
3 electrically operated floor stands (36-in. gate valves)	1300.00	1398.00	1400.00
2 ea. 30-in. double flanged gate valves with by-pass	770.00	960.00	920.00
540 lin.ft. tunneling	13.00	22.00	16.00
540 lin.ft. tunnel lining	18.00	15.00	29.00
2 ea. concrete entrance chambers	190.00	250.00	200.00
1 ea. valve house	7300.00	4500.00	5200.00
1 ea. 8-in. flanged check valve	55.00	83.00	65.00
60 lin.ft. 8-in. galvanized steel pipe in valve house	4.50	9.00	7.50
840 lin.ft. piling	1.00	2.00	1.50

USING RIVETED STEEL PIPE (Three lowest bidders)

(1) Geo. Nelson, 231 Summit Ave., North, Seattle, Wash. (low) $1,313,527
(2) Queen City Const. Co., Seattle $1,348,582
(3) Western Pipe & Steel Co., S. F. 1,396,725

	(1)	(2)	(3)
120,000 cu.yd. excavation for pipe line trench (earth)	.20	.60	.60
7,600 cu.yd. excavation for pipe line trench (rock)	2.00	1.00	2.50
19 acres clearing and grubbing	200.00	200.00	125.00
15,000 cu.yd. borrowed earth	.60	.45	.40
24,388 lin.ft. removing woodstave pipe	.50	.50	.50
6,400 lin.ft. removing steel pipe	1.00	1.00	1.00
900 cu.yd. gravel filling	5.00	1.75	2.50
41,000 lb. closing in pieces	.15	.16	.10
1,130 lin.ft. 30-in. dia. 5/16-in. plate riveted steel pipe	8.20	10.15	10.70
215 lin.ft. 36-in. dia. 5/16-in. plate riveted steel pipe	9.65	39.10	38.30
17,669 lin.ft. 49½-in. dia. 5/16-in. plate riveted steel pipe	13.25	13.40	13.55
780 lin.ft. 49½-in. dia. 3/8-in. plate riveted steel pipe	15.85	15.25	15.88
480 lin.ft. 49½-in. dia. 7/16-in. plate riveted steel pipe	18.60	17.35	18.10
620 lin.ft. 49½-in. dia. 1/2-in. plate dbl. riveted steel pipe	21.05	18.95	19.74

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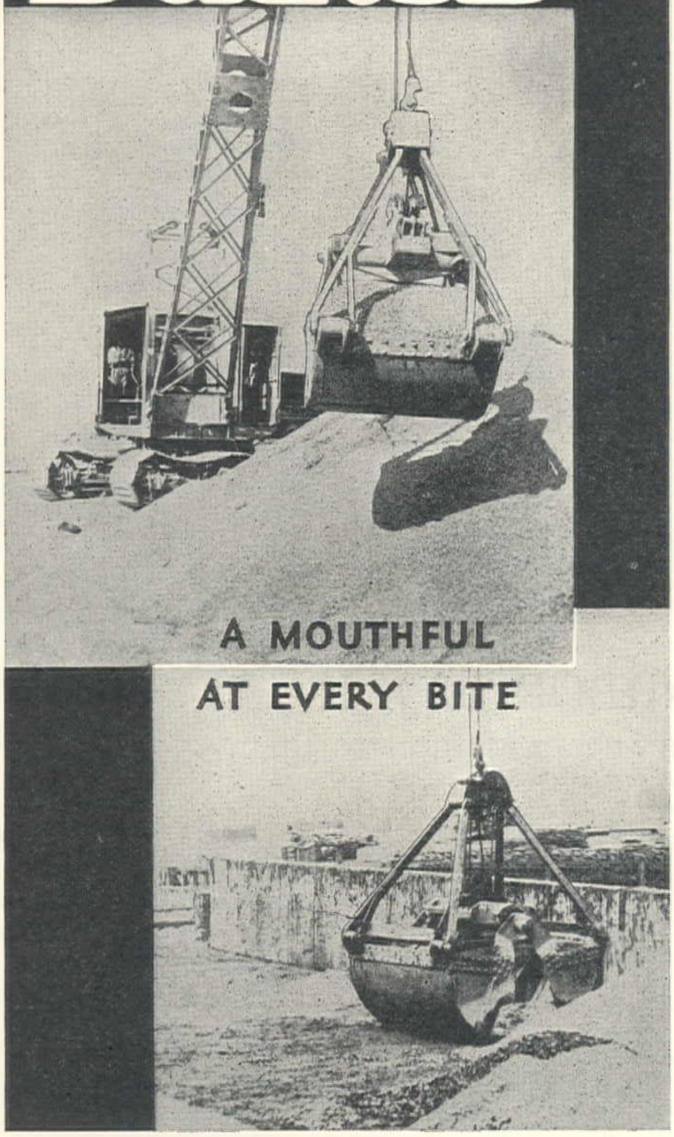
Owen Buckets



AND MORE BITES PER DAY

Here's a combination that gets the job done with no time lost. Add to that the labor-saving ability to clean-up as it goes along, and you have the real reasons why Owen Type "S" Rehandling Buckets provide a bigger day's work than any other bucket of the same weight and capacity.

THE OWEN BUCKET CO.
6018 Breakwater Ave., Cleveland, Ohio

OWEN BUCKET CO. .... Oakland, Calif.
BROWN-BEVIS CO. .... Los Angeles, Calif.
CLYDE EQUIPMENT CO. .... Portland, Ore.
H. J. ARMSTRONG .... Seattle, Wash.

Pipe that meets a definite quality standard

THE purchaser of Bethlehem Steel Pipe is assured of a product that conforms in every respect to a definite and long-established standard of quality—the standard to which this Company has been working throughout more than half a century devoted to the manufacture of steel and steel products.

From the mining of the ore, through the finishing operations, the manufacture of Bethlehem Steel Pipe is controlled by one organization. Each step in the conversion of the steel into pipe is carried out under the supervision of thoroughly experienced men. The tests and inspections are most critical, so as to make certain that each length of pipe shipped conforms in every way to the Bethlehem standard of quality.

Bethlehem Steel Pipe is quality pipe. Pipe that meets every requirement and passes every test.

PACIFIC COAST STEEL CORPORATION
Subsidiary of
BETHLEHEM STEEL CORPORATION
General Offices: Matson Building, San Francisco
Seattle: 28th Avenue S. W. and W. Andover Street
Portland: American Bank Building
Los Angeles: Pacific Finance Building
Honolulu: Schuman Building
Export Distributor: Bethlehem Steel Export Corporation, 25 Broadway, New York City

PACIFIC COAST STEEL CORPORATION

SEATTLE, WASH.—CITY—STEEL PIPE LINE (Continued)

5,670 lin.ft. 49½-in. dia. ½-in. plate trip. riv. butt. steel pipe	23.15	21.55	22.27
250 lin.ft. 48-in. dia. ½-in. plate trip. riv. butt steel pipe	22.55	32.15	41.25
24,400 lin.ft. 68½-in. dia. 5/16-in. plate riveted steel pipe	18.15	17.55	17.82
1,540 lin.ft. 68½-in. dia. ⅜-in. plate riveted steel pipe	21.70	20.20	21.00
1,190 lin.ft. 68½-in. dia. 7/16-in. plate riveted steel pipe	25.35	22.80	23.81
1,020 lin.ft. 68½-in. dia. ½-in. plate dbl. riveted steel pipe	28.55	25.55	26.89
930 lin.ft. 66-in. dia. ½-in. plate trip. riv. butt steel pipe	27.40	27.85	29.85
4,770 lin.ft. 66-in. dia. 9/16-in. plate trip. riv. butt steel pipe	30.70	32.00	33.42
19 air valve units	300.00	350.00	375.00
16 ea. concrete chambers for air valves	120.00	175.00	180.00
2 large brick valve chambers	200.00	165.00	300.00
2 ea. brick chambers for manholes	100.00	90.00	150.00
2,000 lin.ft. 6-in. 'A' cast iron blow off pipe	1.00	.90	1.50
320 lin.ft. 6-in. steel ventilating pipe	3.00	3.00	3.00
1 ea. 12-in. standpipe, complete	1000.00	900.00	850.00
15 ea. 6-in. blow offs	300.00	80.00	145.00
15 ea. cast iron valve boxes for blow offs	25.00	17.50	53.00
500 cu.yd. concrete blocking	12.00	16.00	25.00
200 M. ft. B.M. timber in temp. bridges in crossings	30.00	35.00	45.00
1,000 cu.yd. concrete in railroad and highway crossings	16.00	25.00	25.00
175,000 lb. reinforcing steel	.05	.06	.05
8,000 lb. special castings, iron	.12	.20	.19
8,000 lb. special castings, steel	.16	.30	.27
444 cu.yd. excavation in Duwamish River Crossing	7.50	10.00	5.00
215 cu.yd. concrete in Duwamish River Crossing	20.00	18.00	16.00
Lump sum, temporary trestle in Duwamish River Crossing	2000.00	1000.00	1600.00
3 ea. 36-in. flanged gate valves with by-pass	1400.00	1400.00	1685.00
3 ea. 36-in. flanged check valves	1800.00	1550.00	2050.00
3 electrically operated floor stands (36-in. gate valves)	1500.00	1300.00	1398.00
2 ea. 30-in. double flanged gate valves with by-pass	900.00	770.00	960.00
540 lin.ft. tunneling	15.00	13.00	22.00
540 lin.ft. tunnel lining	16.00	18.00	15.00
2 ea. concrete entrance chambers	200.00	190.00	250.00
1 ea. valve house	4500.00	7300.00	4500.00
1 ea. 8-in. flanged check valve	125.00	55.00	83.00
60 lin.ft. galvanized steel pipe in valve house	5.00	4.50	9.00
840 lin.ft. piling	1.00	1.00	2.00

RIVER AND HARBOR WORK

PORTLAND, ORE.—GOV'T—REPAIRS AND EXTENSION TO JETTY—TILLAMOOK BAY, OREGON

Hauser Construction Co., Multnomah Hotel, Portland, Ore., who bid $429,890, low bid to U. S. Engineer's Office, Custom House, Portland, Ore., for repairing and extending jetty at Entrance to Tillamook Bay, Oregon. Bids from:

(1) Hauser Const. Co., Portland $429,890
(2) Kern & Kibbe, Portland, Ore. 469,420
(3) A. Guthrie & Co., Inc., Portland 475,402
(4) The Gilpin Const. Co., Portland $537,975
(5) Thomas E. Young & Co., Portland 517,555
(6) C. R. Johnson, Portland 532,025

	(1)	(2)	(3)	(4)	(5)	(6)
220,000 tons of stone	1.49	1.85	1.73	1.80	1.82	1.95
67,000 lin.ft. piling	.70	.375	.60	1.10	.62	.90
755 M ft. b.m. lumber	50.00	35.00	46.00	55.00	74.00	35.00
21,000 lb. drift bolts	.07	.04	.06	.05	.07	.05
160 tons steel relay rails	42.00	36.00	43.00	55.00	54.00	40.00
450 pairs angle bars	2.00	1.10	2.25	2.00	3.30	2.00
12,000 lb. railroad spikes	.10	.0425	.05	.05	.10	.05
6,000 lb. wire and ship spikes	.10	.06	.07	.07	.10	.10
16,000 lin.ft. wire strap. cable, second-hand	.10	.04	.10	.60	.09	.07
18,000 lb. bolts	.10	.055	.10	.06	.12	.11
5 sets frogs and switches	$150	95.00	$300	$300	$150	90.00
800 pile points	3.00	1.00	6.00	3.50	2.75	4.00

BRIDGES AND CULVERTS

TUCSON, ARIZ.—CITY—REINFORCED CONCRETE BOX CULVERT

J. J. Garfield Building Co., Tucson, Arizona, who bid $71,398, low bid to City for reinforced concrete culvert covering the Arroyo to be 8 by 10 ft., and 2010 ft. long. Bids on:

(1) 3,395 cu.yd. Class 'A' concrete
(2) 538 cu.yd. Class 'B' concrete
(3) 451,589 lb. reinforcing steel
(4) 5 manhole rings and covers
(5) 1,520 lb. steel cover plates
(6) 32 lin.ft. 10-in. Class 'A' cast-iron pipe
(7) 7,132 cu.yd. excavation, unclassified
(8) 1,000 cu.yd. borrow for backfill

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	TOTALS
J. J. Garfield Co., Tucson	11.90	11.00	.04	25.00	.0525	3.69	.86	.56	$71,398
R. E. McKee, L. A.	11.35	9.75	.05	24.00	.06	6.00	.70	.50	72,253
Anderson Bros. Const. Co.	13.25	7.80	.041	26.00	.06	4.00	.75	.40	73,793
W. Peper, Phoenix, Ariz.	12.85	12.00	.04	25.00	.10	5.00	.75	.40	74,331
Miracle Const. Co.	12.00	10.00	.045	18.00	.12	2.50	1.00	.65	74,575
Lee Moor Const. Co.	13.30	13.30	.04	14.00	.04	1.50	.72	.10	75,786
H. F. Brown, Tucson, Ariz.	14.20	9.53	.041	24.00	.055	3.00	.7475	.49	77,872
Rex B. Mesney	13.50	8.45	.045	36.50	.05	5.70	.92	.70	78,402
V. R. Dennis Const. Co.	16.00	12.00	.06	25.00	.05	2.00	.75	.30	89,269
M. M. Sundt, Tucson, Ariz.	14.76	14.01	.0585	30.00	.09	5.00	.65	.27	89,418

STREET AND ROAD WORK

PORTLAND, ORE.—GOV'T—GRADING—SIUSLAW NATIONAL FOREST, LANE COUNTY, OREGON

Award of contract recommended to Kern & Kibbe, 290 E. Salmon St., Portland, $440,929 for 4.935 miles grading Sections 5D, 5E and 5F, Roosevelt Coast Highway, Siuslaw National Forest, LANE COUNTY, OREGON, for Bureau of Public Roads. Bids from:

(1) Kern & Kibbe, Portland $440,929
(2) J. C. McGuire, Butte, Montana 472,332
(3) General Const. Co., Seattle 475,735
(4) Morrison-Knudsen Co., Boise 478,287
(5) C. R. Johnson, Portland, Ore. 478,682
(6) Allen & Govan, Olympia, Wash. 487,957
(7) A. C. Goerig, Seattle, Wash. $494,881
(8) A. C. Greenwood, Portland, Ore. 495,297
(9) Myers & Goulter, Seattle 497,215
(10) Earl L. McNutt, Eugene, Ore. 520,477
(11) Hauser Const. Co., Portland 570,618
(12) Guy F. Atkinson, Portland 579,347

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
63 acres clearing	$200	$225	$150	$200	$135	$300	$480	$200	$180	$350	$225	$200
37 acres grubbing	$275	$300	$250	$150	$135	$260	$160	$300	$170	$170	$225	$250
633,000 cu.yd. roadway excavation	.44	.48	.46	.45	.53	.49	.47	.495	.51	.50	.65	.56
2,230 cu.yd. exca. struct.	1.25	1.00	1.50	1.50	1.00	1.00	2.00	1.50	1.40	1.00	2.00	1.50
4,000 cu.yd. borrow exca.	.42	.49	.40	.40	.50	.40	.50	.75	.45	.50	.65	.56
4.935 mi. finish road	$600	$200	$800	$200	$250	$500	$1,000	$500	$300	$500	$150	$200
50 ea. trees or snags	50.00	10.00	5.00	15.00	5.00	9.00	5.00	20.00	10.00	10.00	5.00	20.00
197,000 half-mi.yd. haul	.10	.10	.05	.14	.11	.10	.09	.12	.09	.11	.10	.15
680 lin.ft. tunnel excav.	66.50	75.00	95.00	90.00	67.50	80.00	90.00	65.00	92.00	70.00	$100	$120
220 M ft. b.m. untr. timber	55.00	70.00	$100	90.00	50.00	65.00	70.00	85.00	70.00	$100	80.00	75.00
2,000 sq.ft. crib face	1.10	1.00	1.25	1.50	.25	1.00	.60	1.50	1.20	2.50	.50	2.00
500 cu.yd. 'A' conc. culvert	29.00	28.00	30.00	30.00	26.00	25.00	30.00	30.00	22.00	45.00		30.00
480 cu.yd. 'D' conc. pav. and curbs	20.00	25.00	22.00	28.00	21.00	13.50	25.00	28.00	18.00	30.00	30.00	30.00
50 cu.yd. 'E' conc., tunnel	35.00	22.00	30.00	32.00	22.00	25.00	25.00	30.00	30.00	50.00	30.00	50.00
65,000 lb. reinf. steel	.07	.065	.06	.07	.065	.07	.10	.08	.07	.08	.10	.08
2,010 ft. 18-in. rein. conc. pipe	3.40	2.50	3.75	4.00	2.65	3.00	3.10	3.50	3.10	3.50	2.50	3.00
80 lin.ft. 24-in. rein. conc. pipe	4.85	4.00	6.00	5.75	3.65	4.50	4.00	5.00	4.40	5.00	3.50	5.00
700 ft. 2-in galv. wr. iron pipe	.30	.40	.40	.50	.25	.50	.25	.40	.25	.70	.15	.50
200 cu.yd. handld. riprap	3.00	2.00	5.00	2.50	2.00	4.00	2.00	4.00	4.00	5.00	4.00	4.00
600 cu.yd. handld. rk. emb.	1.25	2.00	2.50	2.00	1.25	2.00	3.00	3.00	4.00	5.00	3.00	2.00
500 ft. 6-in. tile underdrain	.36	.50	.60	1.00	.40	1.00	.30	1.00	.30	1.00	.50	.60
3,000 ft. wood guard rail	.80	.90	.90	.80	.80	1.00	.80	1.00	1.00	1.00	1.00	1.25
Maintenance of detours	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
720 ft. 18-in. ex. str. reinf. conc. pipe	4.30	3.25	4.50	5.00	3.65	4.00	4.00	4.50	4.00	5.00	3.00	4.00
160 ft. 24-in. ex. str. reinf. conc. pipe	5.25	5.00	6.50	6.00	4.00	5.00	5.00	6.00	5.00	6.00	4.00	6.00
6 acres sand slope protec.	$300	$300	$900	$250	$100	$500	$200	$400	$1,000	$500	$100	$1,000

PHOENIX, ARIZ.—GRADING & STEEL BRIDGE—STATE FLAGSTAFF-FREDONIA HIGHWAY

Contract awarded to Veater & Davis, 204 Cotton Exchange Bdg., El Paso, Texas, who bid $448,103 for grading and surfacing of 40 miles of Flagstaff-Fredonia Highway, from Cameron Bridge North, and constructing steel bridge, work for Arizona State Highway Commission. Bids received from the following concerns:

(1) Veater & Davis, El Paso, Texas $448,103
(2) Merritt-Chapman-Scott Corp. 479,586
(3) Hodgman & MacVicar, Pasadena 507,189
(4) Skeels & Graham Co., Tucson 524,578
(5) Everly-Allison & Armstrong 532,340
(6) T. J. Tobin Const. Co., New Mexico 534,231
(7) Morrison-Knudsen Co., Boise 552,297
(8) George W. Orr, El Paso, Texas $564,024
(9) Utah Const. Co., Ogden, Utah 584,271
(10) Schmidt & Hitchcock, Arizona 592,416
(11) Miracle Const. Co., Phoenix 629,360
(12) Gist & Bell, Arcadia, Calif. 647,189
(13) V. R. Dennis Const. Co., San Diego 657,209
(14) Jasper-Stacy Co., San Francisco 718,766

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
84 squares clearing and grubbing	7.50	10.00	10.00	5.00	6.00	5.00	10.00	1.50	10.00	5.20	12.50	10.00	15.00	15.00
132,425 cu.yd. roadway excavation	.50	.76	.50	.69	.55	.725	.50	.75	.58	.87	.78	.70	.85	.70
33,693 cu.yd. drainage excavation	.35	.30	.40	.25	.65	.30	.40	.54	.35	1.25	.93	.60	1.25	.60
1,500 cu.yd. slides and overbr.	.375	.57	.375	.5175	.4125	.54375	.375	.5625	.435	.6525	.585	.525	.6375	.525
4,182 cu.yd. struct. excavation	1.50	1.00	1.00	1.00	1.50	1.25	1.50	1.50	1.00	1.10	1.38	1.50	1.50	2.50
310,485 cu.yd. borrow excavation	.25	.21	.25	.275	.32	.23	.23	.37	.35	.37	.375	.38	.35	.38
2,035 sta.yd. overhaul	.05	.08	.05	.10	.03	.05	.05	.05	.05	.07	.03	.05	.10	.05
2,000 cu.yd. clear and stripp. surf. pits	.27	.30	.20	.50	.25	.25	.30	.30	.25	.65	.50	.40	.25	.60
15,070 cu.yd. subgrade stabilizer	.75	.70	.75	.80	.60	1.00	1.20	.90	.95	.78	1.20	1.00	1.10	1.60
32,135 cu.yd. mi. subgr. stabilizer, haul	.18	.20	.20	.18	.15	.25	.20	.20	.21	.165	.25	.25	.20	.40
429 cu.yd. Class 'A' concrete	26.00	24.00	28.00	27.50	30.00	34.00	37.50	25.00	32.00	25.00	26.60	34.00	35.00	39.25
40,060 lb. reinforcing steel	.055	.06	.055	.055	.055	.06	.06	.06	.0625	.052	.054	.06	.06	.07
2,156 cu.yd. cement rubble masonry	9.00	13.50	17.00	15.00	13.00	15.00	18.00	15.50	19.00	15.00	18.60	21.00	14.00	22.20
2,408 cu.yd. plain riprap	3.00	4.00	2.50	4.50	4.00	4.50	3.50	4.50	2.00	3.25	5.00	3.00	7.50	5.00
8,410 lin.ft. cable guard fence	.80	1.10	.75	1.00	1.10	1.00	1.20	.90	1.00	.90	1.00	1.00	1.20	1.20
2,556 lin.ft. 24-in. corr. pipe	3.25	1.90	3.50	3.00	2.75	2.55	2.50	2.28	3.00	2.75	2.80	3.00	2.75	4.00
2,788 lin.ft. 30-in. corr. pipe	3.75	2.35	4.25	3.75	3.50	3.00	3.00	2.85	3.50	3.50	3.55	3.70	5.50	5.20
4,806 lin.ft. 36-in. corr. pipe	5.25	3.75	6.00	5.75	5.25	4.75	5.00	4.70	5.35	5.25	5.80	5.30	8.00	7.50
34 lin.ft. 42-in. corr. pipe	6.00	5.25	7.00	7.00	6.50	6.36	6.00	5.55	7.20	7.35	7.95	8.00	11.00	10.00
98 lin.ft. 48-in. corr. pipe	8.00	6.25	9.00	10.25	9.00	8.36	8.00	7.95	9.00	11.00	11.50	9.00	14.00	12.00
BRIDGES														
7,441 cu.yd. excavation	1.75	1.00	1.00	1.00	1.50	1.25	1.00	1.75	1.50	1.10	1.50	2.00	2.00	3.00
2,407 cu.yd. 'A' concrete	26.00	24.00	28.00	27.50	30.00	34.00	37.50	25.00	32.00	25.00	26.60	34.00	35.00	39.25
241,125 lb. reinforcing steel	.055	.06	.055	.055	.055	.06	.06	.06	.0625	.052	.054	.06	.06	.06
604,657 lb. structural steel	.0575	.065	.06	.06	.0525	.059	.07	.055	.0725	.055	.062	.07	.06	.066
5,128 cu.yd. cement rubble masonry	10.00	13.50	17.00	15.25	16.00	15.00	19.00	15.50	19.00	15.00	18.75	21.00	14.00	22.50
225 cu.yd. plain riprap	3.00	4.00	2.50	4.50	4.00	4.50	3.50	4.50	2.00	3.25	5.00	3.00	7.50	5.00

DENVER, COLO.—GOVT.—ARAPHOE FOREST, COLORADO—GRADING

Award of contract recommended to E. H. Honnen, Box 391, Colorado Springs, Colo., who bid $117,702 to U. S. Bureau of Public Roads, Denver, Colorado, for 4.4 miles grading Berthoud Pass Project, located in Arapahoe Forest, Grand County, Colorado. Bids received on:

(1) 18 acres clearing
(2) 14 acres grubbing
(3) 154,000 cu.yd. roadway excav.
(4) 1,450 cu.yd. struct. excav.
(5) 44,000 sta.yd. overhaul
(6) 102 cu.yd. 'A' concrete
(7) 550 cu.yd. cement rub. masonry
(8) 2,014 ft. 24-in. corr. pipe culv.
(9) 6,357 hand-laid rock embank.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	TOTALS
E. H. Honnen, Colorado Springs	$100	$100	.55	1.00	.03	26.00	17.00	2.25	1.00	$117,702
Hinman Bros. Const. Co., Denver	190	150	.63	1.50	.03	26.00	15.00	2.60	1.35	136,094
Cook & Benson, Ottawa, Kansas	150	100	.65	1.50	.04	27.00	14.00	2.50	1.50	137,134
Utah Const. Co., Ogden, Utah	200	100	.60	1.75	.03	30.00	19.00	2.50	2.50	140,208
L. T. Lawler, Butte, Montana	150	75	.84	2.00	.03	30.00	15.00	2.40	1.35	166,862
Engineers estimate	150	50	.60	1.50	.03	28.00	14.00	2.25	1.25	126,149

SAN FRANCISCO, CALIF.—GOVT.—GRADING AND TUNNEL CONSTRUCTION—YOSEMITE VALLEY

Award recommended to A. C. Goerig, 413 Fairview Ave. North, Seattle, $627,224 for grading Sect. A5, Rt. 2, Wawona Route, and Sect. B2, Rt. 1, South Road, Yosemite Park, for Bureau of Public Roads. Bids received from:

(1) A. C. Goerig $627,224
(2) Utah Const. Co. and Morrison-Knudsen 654,145
(3) J. G. Donovan and Martter & Bock 672,158
(4) C. R. Johnson 691,216
(5) T. E. Connolly 699,949
(6) H. W. Rohl 720,833
(7) O. A. Lindberg 738,584
(8) W. S. Mead 751,528
(9) A. Guthrie & Co. $760,659
(10) Youdall Construction Co. 768,444
(11) W. A. Bechtel 771,610
(12) MacDonald & Kahn 774,440
(13) Geo. Pollock 814,533
(14) Western Construction Co. 838,209
(15) Engrs. Estimate 710,788

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
20 acres clearing	$200	$200	$500	$100	$300	$200	$500	$150	$180	$275	$325	$400	$300	$250	$350
96,500 cu.yd. unclass. excavation	1.00	1.10	1.27	1.40	1.43	1.20	1.00	1.05	1.40	1.24	1.35	1.50	1.40	1.18	.95
1,500 cu.yd. excav. structures	2.00	3.00	2.50	3.00	2.50	2.00	2.50	2.00	2.00	2.00	4.50	2.50	2.00	3.00	2.00
13,500 cu.yd. borrow, unclassified	.75	.50	.25	.40	.35	.30	.25	.55	.40	.45	.50	.40	.50	.30	.50
121,500 sta.yd. overhaul	.02	.03	.04	.03	.02	.02	.02	.02	.05	.03	.05	.05	.01	.02	.04
3.697 mi. finish earth graded road	$1,000	$600	$300	$400	$200	$400	$1,000	$350	$400	$400	$300	$300	$500	$200	$300
166 cu.yd. Class 'A' concrete	30.00	32.00	45.00	35.00	32.00	30.00	30.00	32.00	35.00	36.00	40.00	35.00	30.00	45.00	32.00
15,600 lb. reinforcing steel	.10	.10	.08	.08	.07	.07	.08	.07	.08	.07	.065	.07	.06	.07	.07
3,150 cu.yd. cement rubble masonry	20.00	13.00	18.00	15.50	12.00	12.00	15.00	13.00	15.00	14.00	17.00	14.00	12.00	18.00	15.00
760 ft. 18-in. corr. metal pipe	2.25	2.50	2.37	2.45	2.10	2.25	2.00	2.30	1.90	1.75	3.00	2.30	2.00	2.70	2.00
954 ft. 24-in. 14 ga. corr. metal pipe	3.00	3.25	3.51	2.95	2.70	3.00	3.00	3.25	2.90	2.50	4.00	3.25	3.00	3.60	2.75
340 ft. 24-in. 12 ga. corr. metal pipe	3.75	4.00	4.69	3.90	3.00	3.50	3.75	4.30	3.30	3.00	4.50	3.25	4.00	4.40	3.50
88 ft. 30-in. 14 ga. corr. metal pipe	3.50	6.00	4.36	5.00	4.00	3.50	4.00	4.00	4.00	3.00	5.00	4.00	4.50	5.75	3.50
3,026 cu.yd. handlaid rock embankment	2.00	2.00	2.25	1.50	2.00	3.00	2.50	3.60	3.00	4.50	3.50	4.00	2.00	2.50	4.00
38,700 cu.yd.mi. haul, tun. and gal. exca. mat.	.25	.30	.25	.20	.20	.25	.30	.20	.25	.25	.50	.25	.25	.35	.25
34,600 cu.yd.mi. haul, borrow	.25	.30	.15	.18	.18	.30	.30	.34	.25	.30	.40	.30	.25	.35	.25
4,230 lin.ft. tunnel excavation	80.00	94.00	80.00	90.00	96.40	95.00	$110	$103	99.00	$105	90.00	98.00	$111	$113	$100
20 lin.ft. gallery excav. 10 ft. x 10 ft.	20.00	28.00	28.00	35.00	34.00	30.00	22.00	42.00	40.00	40.00	40.00	37.50	40.00	28.00	20.00
500 lin.ft. gallery excav. 14 ft. x 14 ft.	30.00	38.00	45.00	40.00	37.00	50.00	43.50	46.00	55.00	60.00	60.00	60.00	42.50	55.00	35.00
530 lin.ft. gallery excav. 7 ft. x 6 ft.	20.00	15.00	11.00	12.00	22.00	15.00	10.00	27.00	18.00	20.00	20.00	20.00	27.50	20.00	9.00
500 lin.ft. concrete tunnel lining	50.00	14.00	$100	65.00	48.00	$120	50.00	$110	70.00	75.00	$110	78.00	$110	$120	80.00
600 cu.yd. gunite lining	30.00	20.00	25.00	30.00	20.00	26.00	20.00	33.00	45.00	27.00	40.00	35.00	42.00	50.00	35.00
500 lin.ft. enlarge 14x14 ft. gallery		72.00	40.00	60.00	70.00	60.00	66.50	47.50	55.00	60.00	62.50	75.00	90.00	55.00	65.00

Total bids do not include supplemental item.

HELENA, MONTANA—STATE—GRADING—JEFFERSON COUNTY

Contract awarded to Sam Orino, Spokane, Washington who bid $177,206 to State Highway Commission, Helena, Montana, for 8.7 miles grading Butte-Boulder Road, Section C, in JEFFERSON COUNTY. Bids received on:

(1) 93,542 cu.yd. rock excav.
(2) 180,725 cu.yd. special excav.
(3) 239,940 sta.yd. overhaul
(4) 1,560 ft. 24-in. reinf. conc. culv.
(5) 624 ft. 30-in. reinf. conc. culv.
6) 488 ft. 36-in. reinf. conc. culv.
(7) 2,160 cu.yd. riprap
(8) 6,850 cu.yd. earth cushion
(9) 11,440 ft. wire guard rail
(10) Clearing and grubbing
(11) 112 cu.yd. 'D' concrete
(12) 342 cu.yd. 'A' concrete
(13) 46,450 lb. rein. steel
(14) 681 cu.yd. str. excav.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	TOTALS
Sam Orino	.80	.27	.01	3.25	4.50	6.00	1.25	.30	.65	$ 6,000	$30	$28	.07	3.00	$177,206
Jas. Crick, Spokane	.41	.41	.02	4.50	6.50	9.00	.70	.60	.30	10,000	30	30	.10	5.00	179,268
L. T. Lawler, Butte	.79	.29	.015	3.15	4.40	6.50	.90	.40	.75	5,500	26	24	.06	3.50	179,749
Stanley Bros.	.90	.30	.02	3.45	4.40	6.50	1.50	.40	.60	2,000	22	22	.08	2.00	188,317
M. J. Kuney, Spokane	.45	.45	.04	4.00	6.00	8.00	.45	.45	.70	10,000	27	27	.08	2.00	191,075
C. & F. Teaming & Const. Co., Butte, Mont.	.75	.45	.005	2.46	4.15	5.45	1.00	.25	.50	4.500	25	25	.065	2.10	192.060
Clifton, Applegate & Toole	.90	.35	.02	4.00	5.50	8.00	2.00	.40	.60	12.000	28	28	.065	5.00	216.096
Engineers estimate	1.00	.24	.04	3.50	5.00	6.50	2.00	.40	$1	5,500	28	26	.07	4.00	204.724

CARSON CITY, NEVADA—STATE—LANDER COUNTY—GRADING AND SURFACING

Contract awarded to Utah Construction Co., Phelan Bdg., San Francisco, and Ogden, Utah, who bid $147,975 for 11.7 miles grading and surfacing in LANDER COUNTY from town of Austin east, work for the Nevada State Highway Commission. Bids received from:

(1) Utah Construction Co. $147,975
(2) J. N. Tedford, Fallon, Nev. 159,368
(3) Dodge Bros., Inc., Fallon, Nev. 163,746
(4) Isbell Const. Co., Carson City 167,248
(5) S. H. Newell & Co., Portland, Ore. 169,904
(6) Nevada Rock & Sand Co., Reno, Nev. $172,953
(7) Morrison-Knudsen Co., Boise, Ida. 183,539
(8) Gibbons & Reed, Salt Lake City 201,095
(9) Engineer's estimate 199,877

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
235,100 cu.yd. roadway excav.	.46	.54	.51	.57	.56	.58	.59	.65	.65
174,713 sta.yd. overhaul	.04	.03	.02	.005	.03	.03	.02	.03	.04
11.70 mi. preparing subgrade and shoulders	$150	$100	$100	$50	$300	$100	$160	$500	$100
6,800 cu.yd. selected borrow	.50	.35	.75	.60	.60	.44	.70	.78	.75
22,900 cu.yd. selected material surface	.76	.70	1.00	.75	.80	.70	1.00	.78	1.00
600 cu.yd. selected material in stockpiles	.70	.70	1.00	.75	.80	.70	.95	.78	1.00
24 lin.ft. remove 12-in. corr. pipe	.80	.40	.50	1.00	.50	.60	.55	1.25	.75
25 cu.yd. Class 'A' concrete	42.00	35.00	50.00	35.00	40.00	45.00	37.00	40.00	40.00
12 ft. install 15-in. corr. pipe	.65	.50	.75	.50	.20	.50	.65	.90	.75
2,900 ft. install 18-in. corr. pipe	.70	.50	.75	.50	.30	.60	.65	1.15	.75
452 ft. install 24-in. corr. pipe	.80	.50	1.00	.75	.40	.65	.75	1.60	.75
272 ft. install 36-in. corr. pipe	1.00	.50	1.00	1.00	.60	.75	.95	2.50	.75
79 cu.yd. cement rubble masonry	18.00	10.00	15.00	15.00	10.00	15.00	15.00	25.00	15.00
2.512 ft. timber guard rail	.85	.80	1.10	1.00	.60	1.00	1.15	.90	1.00
267 monuments	4.00	2.50	4.00	4.00	3.00	5.00	5.00	6.50	4.00
11 demolish headwalls	8.00	5.00	5.00	5.00	5.00	10.00	5.00	7.50	5.00
3 furnish and install posts for markers	8.00	5.00	5.00	10.00	10.00	1.00	4.00	6.00	5.00
7.940 ft. fencing	.14	.08	.12	.21	.10	.25	.22	.17	.13
1.610 ft. remove and reconstruct fence	.06	.04	.05	.10	.10	.08	.25	.08	.08
Lump sum demolish buildings	$100	$200	$250	$350	$200	$50	$135	$100	$500

CONSTRUCTION NEWS SUMMARY

NOTE: For additional information regarding projects in this summary refer to Daily Construction News Service, date appearing at end of each item.

LARGE WESTERN PROJECTS

(See Construction News, this issue, for details.)

WORK CONTEMPLATED

Piers, wharves, seawall, railroad and dredging for Board of State Harbor Commissioners, San Francisco, $10,000,000.

Bascule bridge over Coos Bay for Oregon State Highway Commission, $250,000.

BIDS BEING RECEIVED

Earth dam for Brown County Water District No. 1, Brownwood, Texas. Bids to November 6.

Municipal auditorium for City of Pasadena, Calif. $1,050,000. Bids to November 24.

Steel pipe-line from San Lorenzo to Newark, Alameda County, for City and County of San Francisco. $1,000,000.

BIDS RECEIVED

Buildings for Engineering Group at University of California, Berkeley, Calif., Barrett & Hilp, San Francisco, $499,275 low.

Jetty extension at Tillamook Bay, Oregon, for U. S. Engineer's Office, Portland. Hauser Const. Co., Portland, $429,890 low.

CONTRACTS AWARDED

Transmission lines and furnishing power for Hoover Dam, Boulder Canyon Project, for U. S. Bureau of Reclamation, to Southern Sierras Power Co., Riverside, Calif. $1,730,000.

Grading 40 miles of Flagstaff-Fredonia Highway for State of Arizona, to Veater & Davis, El Paso, Tex., $448,103.

Grading 5 miles Siuslaw National Forest, Lane County, Oregon, for Bureau of Public Roads, to Kern & Kibbe, Portland, $440,929.

Steel pipe-line, Cedar River and West Seattle, for City of Seattle, Wash., to Queen City Const. Co., Seattle, $1,207,116.

STREET and ROAD WORK

WORK CONTEMPLATED

ALAMEDA, CALIF.—Plans by City Engineer, for improving Third St., involving 28,000 sq.ft. oil macadam paving, corr. culverts, etc. 10-7

MENLO PARK, CALIF.—Plans by City Engr., Bert J. Mehl, and will be presented to City Council Nov. 1, for paving with 1½-in. emulsified asphalt on 4-in. waterbound rock macadam base, various streets. $70,000. 1911 Act. 10-9

MONTEREY, CALIF.—Plans by Engineers, Olmsted & Gillelen, Hollingsworth Bdg., L. A., for improving Garvey Ave. for City, involving concrete paving, corr. and reinf. concrete pipe. Bids after Oct. 27. $250,000. 10-11

OAKLAND, CALIF.—Plans by W. N. Frickstad for improving Hampton Road, Liggett Drive, Estates Drive, Sims Drive, and Pershing Drive, involving 105,693 sq.ft. 6-in. concrete paving, 9874 cu.yd. excavation, reinf. conc. pipe conduit, corr. and concrete culverts, etc. Bids after Oct. 30. 10-3

PALO ALTO, CALIF.—Plans by City Engineer, J. F. Byxbee, Jr., for paving various City streets to cost $95,000. 10-16

SAN ANSELMO, CALIF.—Plans by City Engineer, Geo. W. Manley, protests Oct. 22, for improving Berlin Ave., Rose Lane, Karl Ave., etc., grading, concrete paving, corr. culverts, etc. 10-13

SAN FRANCISCO, CALIF.—Plans by City Engrs. Office for improving Monterey St. from Union to Greenwich St., etc., involving 1285 cu.yd. concrete, 115,000 lb. reinf. steel, concrete and macadam paving, fencing, vitr. and cast-iron pipe, lighting system, etc. 10-11

SEBASTOPOL, CALIF.—Plans by City Engineer, protests Nov. 3, for improving Burnett St., paving with 5-in. concrete. 10-13

WILLOW GLEN, CALIF.—Plans by H. N. Bishop, Engr., Bank of Italy Bdg., San Jose, bids after Nov. 10 by City, for improving Willow St., Kotenberg and Blewett Aves., involving 274,460 sq.ft. grading, 119,000 sq.ft. 5½-in. and 115,486 sq.ft. 4½-in. asphalt paving, concrete pipe sewers, curbs, gutters, sidewalks, corr. culverts, etc. $93,000. 10-3

BIDS BEING RECEIVED

PHOENIX, ARIZ.—Bids to 2 p.m., November 7, by Arizona State Highway Commission, for bridges and oil processing Phoenix-Yuma Road, 15 miles from Piedra east, involving 560 cu.yd. concrete, 40,000 lb. reinf. steel, 310,000 gallons oil, and 22,000 cu.yd. mineral aggregate. 10-20

BELL, CALIF.—Bids to 8:30 p.m., November 17, by the City Council, Bell, for improving Mayflower Avenue. Work involves 47,990 sq.ft. sidewalk, 12,049 ft. curb, 181,430 sq.ft. oiled macad. and disin. granite subbase, 297,673 sq.ft. grading, 4436 ft. 8-in. and 4416 ft. 6-in. vit. sewers, 18 manholes. 10-10

INGLEWOOD, CALIF.—Bids to 8 p.m., November 3, by City Clerk, for improving Van Ness avenue involving 122,600 sq.ft. 4-in. asphalt base with 2-in. Durite surface. 10-18

LOS ANGELES, CALIF.—Bids to 2 p.m., October 29, by the Division of Highways, office of the District Engineer, District VII, Room 1111, Associated Realty Bldg., Los Angeles, for furnishing and applying heavy fuel oil to roadbed between La Canada and 2½ miles northerly in LOS ANGELES COUNTY, a distance of 2.4 mi. 10-17

OAKLAND, CALIF.—Bids to 10 .30 a.m., November 5, by County Clerk for 2 miles Hayward-Redwood Canyon Road, near west side of San Leandro reservoir, involving 80,000 cu.yd. grading, corr. pipe, etc. 10-14

REDWOOD CITY, CALIF.—Bids to 10 a.m., November 3, by County for improving Hillside Blvd. involving 3750 tons asphalt. 10-15

SACRAMENTO, CALIF.—Bids to 2 p.m., Nov. 5, by California Division of Highways for 0.2 mile near Wasco, KERN COUNTY, involving 18,950 cu.yd. roadway excavation, 610 cu.yd. concrete paving, reinf. conc. pipe, etc. 10-8

SAN FRANCISCO, CALIF.—Bids to 2 p.m., March 10, 1931, by U. S. Bureau of Public Roads, 807 Sheldon Bldg., 461 Market St., San Francisco, for surfacing Section E and applying bituminous surface treatment on Sections A, B, C, D, and E, Route No. 1, Loop Route, Lassen Volcanic National Park, California, a distance of 7.71 miles to be surfaced and 29.77 miles to have bituminous surface treatment.

Time of performance and approximate quantities will be given in a later invitation for bids, which will be advertised approximately February 17, 1931. As project will soon be covered with snow, contractors are requested to go over work not later than November 1, and may inspect work by getting in touch with J. A. Killalee, Junior Highway Engineer, Viola, Calif. 10-18

SAN FRANCISCO, CALIF.—Bids to 2 p.m., March 3, 1931, by U. S. Bureau of Public Roads, 807 Sheldon Bldg., 461 Market St., San Francisco, for surfacing and applying bituminous surface treatment on Project 4, Bright Angel Springs, North Entrance, on the North Rim of the Grand Canyon National Park, Arizona, a distance of 9.97 miles.

Quantities will be published in later call for bids about February 10, 1931. As project will soon be covered with snow, contractors are requested to go over work not later than November 1. Prospective bids may inspect work by getting in touch with R. Thirion, at Kaibab Forest, or V. T. Ranch, Arizona. 10-18

SAN FRANCISCO, CALIF.—Bids to 2 p.m., March 3, 1931, by the Bureau of Public Roads, 807 Sheldon Bldg., 461 Market St., San Francisco, Calif., for grading a portion of the Houserock Canyon National Forest Highway, from Station 0-00 to Station 440-53 of Route No. 28, Arizona, a distance of 8.4 miles.

Work involves the following approximate quantities:

110,000 cu.yd. unclassified excavation;
306 cu.yd. cement rubble masonry;
2,800 lin.ft. corr. metal pipe;
13 M.B.M. bridge timber, untreated.

Time of performance will be given in later invitation for bids which will be advertised on approximately February 10, 1931. As the country adjacent to the proposed construction will soon be covered with snow, contractors who desire to furnish a bid this winter are urged to go over the work not later than November 1, 1930. Prospective bidders may inspect the line as staked and review the rough draft of the plans by getting in touch with W. J. Nelson, Jacobs Lake, Arizona. 10-18

SAN FRANCISCO, CALIF.—Bids to 2:30 p.m., October 29, by Board of Public Works, City Hall, S. F.: (1) 44th Ave. from Moraga to Noriega Sts., paving with 6-in. conc. base and 2-in. asphalt surface, vitr. sewers, $1600; (2) Alameda St. from Potrero Ave. to York St. by grading, $7200; (3) Crossing of Kirkwood Ave. and Mendell St., paving with 6-in. concrete base and 2-in. asphalt surface, and vitr. culverts, $2000; (4) Crossing of Delano Ave. and Mt. Vernon Ave., 6-in. concrete base with 2-in. asphalt surface, vitr. sewers, $1600; (5) Cayuga Ave. from Oneida Ave. to Seneca Ave., 6-in. concrete base with 2-in. asphalt surface, vitr. sewers, etc., $26,000; (6) 26th Ave. from Ortega to Pacheco Sts., etc., 6-in. concrete base with 1½-in. asphalt surface, $6000. 10-14

SANTA BARBARA, CALIF.—Bids to 10 a.m., Nov. 3, by County for grading and oil macadam highway, 2630 lin.ft., on Patterson Ave. 10-13

DENVER, COLO.—Bids to 2 p.m., October 31, by Bureau of Public Roads, for 13 miles Hondo-Mescalero Highway, Lincoln Forest, NEW MEXICO, involving 136,800 cu.yd. excavation, 21,800 cu.yd. gravel or rock surfacing, concrete structures, corr. pipe, etc.

DENVER, COLO.—Bids to 10 a.m., October 31, by Colorado State Highway Commission, for (1) 18 miles oil processing from Stratton to Burlington, work involving 48,200 cu.yd. excavation, 63,000 tons gravel or rock surfacing, 438,000 gallons asphaltic road oil, 218,800 sq.yd. oil processing, concrete structures, corr. pipe, etc.; and (2) 9.8 miles EAGLE COUNTY from Wolcott to Avon, involving 197,000 cu.yd. roadway excavation, 33,300 tons gravel or rock surfacing, etc.

BOISE, IDAHO—Bids to 2 p.m., October 28, by Commissioner of Public Works, for 7.4 miles surfacing from Mt. Home to Tollgate, ELMORE COUNTY, involving 5600 cu.yd. rock surfacing.

BOISE, IDA.—Bids to 2 p.m., October 28, by State for: (1) 8 miles from Chester to Ashton, FREMONT COUNTY, involving 66,000 cu.yd. earth excavation, 9700 cu.yd. rock excavation, 19,900 cu.yd. gravel surfacing, etc.; and (2) 8.7 miles from Donnelly south, VAL-

LEY COUNTY, involving 58,500 cu.yd. excavation, 23,400 cu.yd. rock surfacing, etc.

PORTLAND, ORE.—Bids to 10 a.m., October 30, by Oregon State Highway Comm., for: COOS COUNTY—Surfacing 13.6 miles of the Lakeside-North Bend Section of the Roosevelt Coast Highway, involving: 52,000 cu.yd. crushed gravel. DESCHUTES and CROOK COUNTIES—3.11 miles of highway roadbed on the Middle Unit, Bear Creek-Millican Section of Prineville-Millican Highway, involving: 30,000 cu.yd. excavation. JACKSON COUNTY—9.65 miles regrading and 8.0 miles resurfacing Eagle Point-Trail Section of Crater Lake Highway, involving: 14,300 cu.yd. broken stone or crushed gravel in stock piles; 45,000 cu.yd. excavation. LANE COUNTY—(1) 8.3 miles of Lincoln County Line-China Creek Section of Roosevelt Coast Highway; work involves: NORTH UNIT, 194,000 cu.yd. excavation; SOUTH UNIT, 278,000 cu.yd. excavation; (2) 9.3 miles of Hendricks Bridge-Doyle Hill Section of McKenzie Highway, with broken stone and crushed gravel and furnishing broken stone in stock piles, involving: 26,800 cu.yd. broken stone; 18,500 cu.yd. crushed gravel. UMATILLA COUNTY—(1) 21,000 cu.yd. broken stone in stock piles on Pendleton-Emigrant Hill Section of Old Oregon Trail; (2) 22,700 cu.yd. broken stone in stock piles on Adams-Milton Section of Oregon-Washington Highway. WASCO and CLACKAMAS COUNTIES—14,000 cu.yd. broken stone in stock piles on the Mt. Hood-Bear Springs Section of Mt. Hood Highway.

OGDEN, UTAH—Bids to 10 a.m., November 3, by Bureau of Public Roads, for 8.3 miles Widtsee-Bryce Sect., Powell National Forest, GARFIELD COUNTY, Utah, involving 60,000 cu.yd. roadway excavation, etc.

SALT LAKE CITY, UTAH—Bids to 2 p.m., October 27, by State Road Commission of Utah, State Capitol, Salt Lake City, Utah, for grading 5.305 mi. between Thistle and Castella in UTAH COUNTY. Work involves: 171,000 cu.yd. unclass. excavation; 11,950 cu.yd. gravel surfacing. 10-16

OLYMPIA, WASH.—Bids to 10 a.m., Nov. 13, by Washington State Highway Department, for: BENTON and YAKIMA COUNTIES—7.5 miles Prosser to Grandview, involving: 95,700 cu.yd. excavation. PEND OREILLE COUNTY—1.5 miles McCloud Creek Revision, involving: 95,500 cu.yd. excavation. SKAMANIA COUNTY—0.9 mile Stevenson to Nelson Creek, involving: 72,470 cu.yd. excavation. GRANT COUNTY—2.1 miles of Grand Coulco Highway, Alkali Lake Vicinity, involving 56,000 cu.yd. excavation. 10-18

BIDS RECEIVED

PHOENIX, ARIZ.—Low bids as follows by City: (1) J. C. Steele Const. Co., Phoenix, $24,900 low for improving 11th St., etc., paving with concrete; and (2) Pacific Const. Co., Phoenix, Ariz., $14,800 low for improving Third St., paving with concrete, etc.

PHOENIX, ARIZ.—Ben Pearce Const. Co., Box 105, Station B, San Diego, $31,079 for surfacing 22 miles Holbrook-Lupton Highway for State. 10-10

SACRAMENTO, CALIF.—Chigris & Sutsos, 2211 18th St., S. F., $15,020 for grading and surfacing 0.4 of a mile at High Rock Hill, HUMBOLDT COUNTY, for State. 10-15

DENVER, COLO.—Cook & Ransom, Ottawa, Kansas, $63,088 low for 2 miles grading Six Mile Creek Project, Pike National Forest, JEFFERSON and DOUGLAS COUNTIES, Colorado, for Bureau of Public Roads

CONTRACTS AWARDED

PHOENIX, ARIZ.—To Pacific Const. Co., Phoenix, $7450 for improving McKinley St., etc., paving with concrete.

PHOENIX, ARIZ.—Awards as follows by State Highway Commission: (1) To Veater & Davis, Cotton Exchange Bldg., El Paso, Tex., $448,103 for grading and steel bridge on Flagstaff-Fredonia Highway north from Cameron Bridge, 40 miles; and (2) To Stanley Jaicks, Oak Park, Ill., $75,788 for grading 8.3 miles toward Tucson on Florence-Tucson Highway. (See Unit Bid Summary). 10-20

PHOENIX, ARIZ.—Awards as follows by City: (1) To J. C. Steel Const. Co., Phoenix, $25,000 for concrete paving 11th St., etc.; (2) To Phoenix-Tempe Stone Co., Phoenix, Ariz., $46,187 for paving 12th and 15th Aves.; and (3) To Pacific Const. Co., Phoenix, Ariz., $14,806 for paving Third St.

COMPTON, CALIF.—To M. A. & P. R. Hughes, 1020 Loma Vista St., Long Beach, $24,310 for improving Golden Ave., etc., concrete paving, vitr. and cast-iron sewers, and fire hydrants for City. 10-10

EUREKA, CALIF.—To W. C. Colley, 35 Northampton Road, Berkeley, $15,139 for grading 4½ miles of Hoopa Valley Road for County. 10-7

LONG BEACH, CALIF.—Awards as follows by City: (1) To D. P. Durham, 900 Raymond Ave., Long Beach, $24,700 for improving 67th Way, curbs, sidewalks, water mains, and sewers; and (2) To Sully-Miller Contr. Co., 1500 W. 7th St., Long Beach, $19,639 for improving Chestnut Ave. and 23rd St., curbs, gutters, sidewalks, asphalt paving, water and gas mains. 10-9

MARTINEZ, CALIF.—To Chas. Brown, 220 So. 10th St., Richmond, $7274 for paving with Durite surface on rock cushion streets in Dist. 3 for County. 10-6

OROVILLE, CALIF.—Awards as follows by County: (1) To Hemstreet & Bell, Marysville, who bid 47¢ per cu.yd., total $3681, for grading ½ mile of La Porte Road, near Bangor, involving 7813 cu.yd. roadway excavation; and (2) To Hemstreet & Bell, Marysville, who bid 43¢ per cu.yd., total $4503, for grading ½ mile of Oroville-Pentz-Magalia Highway from Lockermans Place to Parish Home Camp, involving 11,850 cu.yd. roadway excavation. 10-8

SACRAMENTO, CALIF.—Awards as follows by California Division of Highways: (1) To Cornwall Construction Co., 219 E. Main St., Santa Barbara, who bid $22,362 for 0.6 of a mile of grading and paving with concrete in SANTA BARBARA COUNTY, located about 1.2 miles north of Santa Maria; (2) To Martin Green, 288 17th St., San Bernardino, who bid $32,389 for 0.3 miles grading and paving with portland cement concrete at Malaga Street in SAN BERNARDINO COUNTY. 10-15

SACRAMENTO, CALIF.—Awards as follows by California Division of Highways: (1) To F. W. Teschke, 3172 Cahuenga Ave., Los Angeles, who bid $39,544 for grading and paving with concrete 1 mile at Castaic Creek, LOS ANGELES COUNTY; (2) To Basich Bros. Construction Co., 3788 South Vermont Street, Los Angeles, who bid $89,162 for grading and concrete paving 0.9 of a mile in SAN MATEO COUNTY, through the town of South San Francisco; (3) To Geo. E. McDaniels, Marysville, who bid $7843 for property fence on about 9 miles, between Bear Creek and 8 miles west of Williams, in COLUSA COUNTY; and (4) To Fredrickson & Watson, 354 Hobart Street, Oakland, and Fredrickson Bros., Stockton, $120,819 for 7.3 miles surfacing with bituminous treated crusher-run base in SAN MATEO COUNTY from Redwood City to San Mateo. (See Unit Bid Summary, Oct. 10th issue.) 10-9

SAN DIEGO, CALIF.—To Daley Corp., 4430 Boundary St., San Diego, $112,032 for grading East Torrey Pines Road for City. (See Unit Bid Summary, Oct. 10th issue.) 10-8

SAN FRANCISCO, CALIF.—To California Construction Co., Standard Oil Bdg., S. F., $103,844 for improving Section C, Sunset Blvd., from Noriega to Santiago Street, grading, paving with asphalt surface on concrete and waterbound macadam base, vitrified sewers, pipe conduit, etc. (See Unit Bid Summary, Oct. 10th issue.) 10-8

SAN JOSE, CALIF.—To Union Paving Co., Call Building, San Francisco, for the improvement of Monterey St., etc., in the City of Gilroy. Bids received as follows: (1) Paving roadway; (2) Per ton asphalt concrete base; and (3) Constructing bridge approaches:

	(1)	(2)	(3)
Union Paving Co.	$7920	$4.90	$1470
A. J. Raisch	8412	5.50	1808

10-7

SAN JOSE, CALIF.—To San Jose Paving Co., San Carlos and Dupont Sts., San Jose, $3731 to County for improving Glen Eyrie Road. 10-7

SANTA BARBARA, CALIF.—To W. H. West, 124 Depot Road, Santa Barbara, $22,579 for grading, corr. culverts, wire fencing, etc., on 1.3 miles of San Julian Road for County. 10-15

SEBASTOPOL, CALIF.—To S. M. McGaw, Box 387, San Rafael, $12,705 for concrete paving High St. and Maple Ave. for City. 10-9

STOCKTON, CALIF.—Awards as follows by County: (1) To Pereira & Reed, 545 Roosevelt Ave., Tracy, $14,167 for grading and surfacing Bacon Island Road; and (2) To Pereira & Reed, 545 Roosevelt Ave., Tracy, $25,320 for grading and surfacing J. R. Russell Road. 10-7

VENTURA, CALIF.—To P. Cristich, 1209 California Reserve Bdg., L. A., $30,249 for concrete paving and grading 1 mile of Ventura Ave. near Lefgren for County. 10-9

DENVER, COLO.—Award of contract recommended as follows by Bureau of Public Roads: (1) To E. H. Honnen, Box 391, Colorado Springs, $117,702 for grading 4.4 miles Berthoud Pass Project, Grand County, Colorado; and (2) To Western Bridge & Const. Co., Omaha, Nebr., $36,813 for grading and surfacing 5.6 miles of Deadwood-Custer Hot Springs Project, Pennington County, South Dakota. (See Unit Bid Summary.)

DENVER, COLO.—Awards as follows by State: (1) To Utah Const. Co., Ogden, Utah, $70,235 for grading and gravel surfacing 2 miles in MOFFAT COUNTY from Craig to Hamilton; and (2) To Pople Bros., Trinidad, Colo., $77,655 for oil processing 6 miles near Trinidad, LAS ANIMAS COUNTY.

BOISE, IDA.—Awards as follows by State: (1) To Triangle Const. Co., Spokane, Wash., $17,647 for surfacing from Bonners Ferry North, BOUNDARY COUNTY; (2) To W. M. Devlin, Mt. Home, Ida., $8775 for 3 miles gravel surface north of Grandview, JEROME COUNTY; (3) To Triangle Const. Co., Spokane, Wash., $20,230 for 8.4 miles rock surfacing from Greer north, LEWIS COUNTY; (4) To C. F. Dinsmore & Co., Ogden, Utah, $33,640 for roadway and concrete bridge west of McCall, VALLEY COUNTY; and (5) To J. J. Fuller, Vale, Ore., $12,630 for grading and gravel surfacing from Salmon City south, LEMHI COUNTY.

HELENA, MONT.—Awards as follows by State: (1) To Sam Orino, Spokane, Wash., $177,206 for 8.7 miles grading, Sect. C. Butte-Boulder Road, JEFFERSON COUNTY; (2) To Buck Helean, Missoula, Mont., $50,345 for grading and surfacing 5.7 miles Ravalli-St. Ignatius Highway, LAKE COUNTY; (3) To F. C. & D. Const. Co., Billings, Mont., $54,829 for 14 miles grading and surfacing Sect. E, Billings-Hardin Road, BIG HORN COUNTY; and (4) To Tomlinson-Arkwright Const. Co., Great Falls, Mont., for 19 miles grading Gildford-Chester Highway, LIBERTY AND HILL COUNTIES. (See Unit Bid Summary.)

CARSON CITY, NEV.—To Dodge Bros., Fallon, Nev., $43,842 for 7.6 miles grading and surfacing in ORMSBY AND LYON COUNTIES from Carson City to east of Mound House for State Highway Comm. 10-16

CARSON CITY, NEV.—To Utah Const. Co., Phelan Bdg., S. F., and Ogden, Utah, $147,975 for 11.7 miles grading and surfacing in LANDER COUNTY from Austin east for State. (See Unit Bid Summary.) 10-3

PORTLAND, ORE.—Award of contract recommended to Kern & Kibbe, 290 E. Salmon St., Portland, Ore., who bid $440,929 for grading 4.935 miles Section 5D, 5E, and 5F, Roosevelt Coast Highway, Siuslaw National Forest, LANE COUNTY, Oregon, for Bureau of Public Roads. (See Unit Bid Summary.) 10-20

OGDEN, UTAH—Award of contract recommended to C. & F. Teaming & Const. Co., Butte, Montana, $34,402 for 5.4 miles grading Salmon-Montana Line Highway, Salmon National Forest, LEMHI COUNTY, Idaho.

COLFAX, WASH.—To C. B. Quillen, Clarkston, Wash., $30,500 for grading and surfacing Highway 31 for County.

EPHRATA, WASH.—To Wm. Zeckier, Neppel, Wash., $11,450 for grading and surfacing Highway 3 for County.

OLYMPIA, WASH.—Awards as follows by State Highway Comm.: (1) To Rowland Const. Co., Seattle, $62,560 for 2.4 miles grading from Teanaway to Bristol, KITTITAS COUNTY; (2) To L. Romano Co., Seattle, $134,630 for grading Cascade Wagon Road; and (3) To Halloran Bros., Seattle, $75,300 for grading and surfacing near Twisp, OKANOGAN COUNTY.

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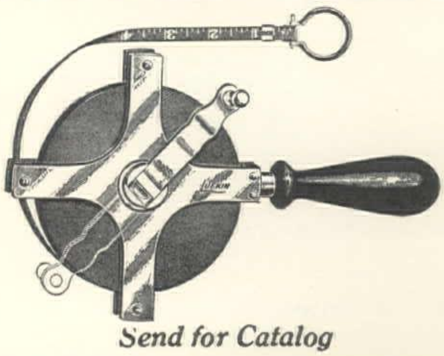

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OLYMPIA, WASH.—Awards as follows by State Highway Comm.: (1) Contract awarded to Norris Bros., Burlington, Wash., $11,986 for 1.5 miles widening concrete paving from Skagit County line to Dahlgrens Crossing, SNOHOMISH COUNTY; (2) Contract awarded to R. G. Stevenson, Seattle, who bid $31,646 (under Sec. 2, Schedule A) for paving with concrete a second 20-ft. strip on 1.8 miles of state road No. 1, Seattle south; (3) Contract awarded to Morrison-Knudsen Co., Boise, Idaho, who bid $145,268 for clearing, grading, and draining 2.1 miles of state road No. 3, Swauk creek east and west, in KITTITAS COUNTY; (4) Contract awarded to Gordon W. Marsh, Inc., Chehalis, $37,383 for clearing, grading, and draining 4.9 miles of state road No. 5, Divide to West Fork, in LEWIS COUNTY; (5) Contract awarded to John Ottesen Co., Inc., Seattle, who bid $84,971 for clearing, grading, and draining 5 miles of state road No. 21, Silverdale north, in KITSAP COUNTY; and (6) Contract awarded to Morrison-Knudsen Co., Boise, Idaho, who bid $45,853 for clearing, grading, and draining 1.1 miles of Asotin-Oregon state line road, Anatone south, in ASOTIN COUNTY. 10-10

SEATTLE, WASH.—To A. C. Goerig, Seattle, Wash., $35,510 for constructing fill on Fairview Ave. North for City.

BRIDGES and CULVERTS

WORK CONTEMPLATED

BERKELEY, CALIF.—Plans by City Engr., protests Oct. 21, for buttresses and walks on Euclid Ave., involving 40 cu.yd. concrete, 1800 lb. reinf. steel, and 40 cu.yd. excavation. 10-6

SAN DIEGO, CALIF.—Plans by Engrs., Tom J. Allen and R. R. Rowe, 309 G St., San Diego, protests Nov. 3 by City, for steel bridge on First St., involving 1473 cu.yd. concrete, 520 tons structural steel, lighting standards, paving, etc. $155,000. 10-11

SANTA ROSA, CALIF.—Plans by Consulting Engr., H. B. Hammill, 381 Bush Street, San Francisco, for steel bridge with reinforced concrete piers to be constructed across the mouth of the Russian River in Sonoma County for Joint Highway District No. 16, Santa Rosa. Bridge will be 900 ft. long with a 24-ft. roadway and is to consist of two steel truss spans, 145 ft. long each, and nine 60-ft. steel girder spans, I-beams, and reinforced concrete piers. $190,000. J. B. Piatt, Daugherty-Shea Building, Santa Rosa, is Engineer for Joint Highway District No. 16. 10-8

SALEM, ORE.—Plans prepared by State Bridge Engineer, C. B. McCullough, Oregon State Highway Comm., Salem, Oregon, and call for bids will be issued soon for a double leaf Bascule Highway Bridge, 140 ft. clear span with 1700 ft. of viaduct approach (roadway width 27 ft. plus two 3½-ft. sidewalks). Bridge is to be constructed over Coos Bay. Alternative bids will be taken on the viaduct approach (1) For reinf. concrete; and (2) For timber superstructure on concrete foundations. $250,000. 10-14

BIDS BEING RECEIVED

OAKLAND, CALIF.—Bids to 12 m., October 30, by City Clerk, for reinforced concrete retaining wall on Hopkins and High Sts. Cost $6000. 10-20

SACRAMENTO, CALIF.—Bids to 10 a.m., October 29, by County, for east fender for Walnut Grove Bridge. 10-17

SACRAMENTO, CALIF.—Bids to 2 p.m., November 12, by California Division of Highways, for constructing four timber bridges located from 17 to 21 miles west of Wasco, KERN COUNTY. Work involves: 150 M redwood, 250 cu.yd. concrete, etc. 10-15

SAN LUIS OBISPO, CALIF.—Bids to 2 p.m., October 28, by Division of Highways, District Engineer, for the repairing of a timber bridge across San Carpojo Creek about 11 miles north of San Simeon, by constructing a timber truss span 75 ft. 10 in. long, on concrete piers to replace some of the existing bents. 10-16

SANTA ANA, CALIF.—Bids to Oct. 28 by County for redwood or Douglas fir bridge over Coyote Creek on Buena Park-La Habra Road. $6000. 10-13

SANTA BARBARA, CALIF.—Bids to 10 a.m., November 10, by County for steel bridge with reinforced concrete deck, over San Jose Creek on Patterson Avenue. $6000. 10-8

YUBA CITY, CALIF.—Bids to 2 p.m., October 31, by Joint Highway District 12, Second and C Sts., Yuba City, for: (1) 120-ft. reinf. conc. trestle bridge near Robbins over canal of Reclamation District No. 1500; (2) 20-ft. reinf. conc. bridge, near Robbins, over canal of the Sutter Mutual Water Company. 10-18

BIDS RECEIVED

PHOENIX, ARIZ.—Hoggan & Farmer, Security Bldg., Phoenix, Ariz., who bid $29,788, low to Arizona State Highway Commission, for railroad overpass and approaches about 4 miles northwest of Tucson, on the Florence-Tucson Highway. 10-17

TUCSON, ARIZ.—J. J. Garfield Bldg. Co., Tucson, Ariz., $71,398 low for culvert covering the Arroyo for City. (See Unit Bid Summary.) 10-18

BERKELEY, CALIF.—J. H. Fitzmaurice, 354 Hobart St., Oakland, who bid $8870, low bid to the University of California for retaining wall at the Athletic Field. 10-17

EUREKA, CALIF.—Smith Bros. Co., Eureka, $4247, as follows, low bid to Dist. Engr., California Division of Highways, Eureka, for replacing timber lift span of bridge over Eureka Slough at Eureka, HUMBOLDT COUNTY. 10-18

SACRAMENTO, CALIF.—Geo. J. Ulrich Const. Co., P.O. Box 773, Modesto, $11,462 low bid to California Division of Highways for widening 5 concrete bridges in SOLANO COUNTY from Vacaville to Dixon. 10-15

SAN LUIS OBISPO, CALIF.—Wm. Lane, Paso Robles, $4998 low bid for timber bridge over Santa Maria River, SANTA BARBARA COUNTY, for California Division of Highways. 10-13

SPOKANE, WASH.—Chas. A. Power, Spokane, Wash., $33,100 low for reinf. concrete bridge over Spokane River at Howard St. for City.

CONTRACTS AWARDED

FRESNO, CALIF.—To M. Madsen, 247 Maple St., Fresno, who bid $2992 for constructing a timber and concrete bridge over irrigation canal at Centerville. 10-20

LOS ANGELES, CALIF.—To E. G. Perham, 1128 Stearns Drive, Los Angeles, who bid $25,000 to County for constructing two bridges in San Gabriel Canyon on Crystal Lake Road. 10-17

LOS ANGELES, CALIF.—To E. G. Perham, 1128 Stearns Drive, Los Angeles, who bid $16,700 to County for reinforced concrete bridge on Avalon Boulevard, across Nigger Slough. 10-8

MERCED, CALIF.—Awards as follows by County: (1) To C. B. Cameron & Sons, Merced, $1225 for timber bridge over Black Rascal Creek on Bartholomew Road; (2) To Linde & Allen, Merced, $2475 for concrete bridge over Mariposa Creek, Tuttle Road; (3) To E. K. Angle, Dos Palos, $3425 for concrete bridge over canal on Centralla Road; (4) To Roy Kruger, Gustine, $3834 for concrete bridge over canal on Warren and Ingamar Road; (5) To E. K. Angle, Dos Palos, $1750 for timber bridges on Dos Palos Road and on Lone Willow Road. 10-15

MODESTO, CALIF.—To Geo. J. Ulrich Const. Co., Box 773, Modesto, $4975 for reinf. conc. bridge 372 over Hood Creek for County. 10-16

RIVERSIDE, CALIF.—To E. G. Perham, 1128 Stearns Drive, Los Angeles, who bid $18,000 to County for steel bridge over Batiste Wash near Val Vista. 10-16

SACRAMENTO, CALIF.—To Carpenter Bros., 457 North Canyon Drive, Beverly Hills, California, $50,545 to the California Division of Highways for bridge across Alamitos Bay, near Long Beach, consisting of 15 19-ft. timber spans with concrete deck, and one 41-ft. 4-in. steel beam removable span. 10-9

SACRAMENTO, CALIF.—To C. J. Nystedt, Capitol National Bank Bdg., Sacramento, who bid $44,966 (using untreated timber construction) for the construction of a steel draw span and timber trestle bridge over Snodgrass Slough, work for the County. 10-14

SALINAS, CALIF.—To Ben C. Gerwick, 112 Market St., S. F., $31,219 for reinf. conc. bridge over Elkhorn Slough on Salinas-Watsonville Road near Moss Landing for County. 10-6

SAN RAFAEL, CALIF.—To A. T. Howe, 111 Stanford St., Santa Rosa, $3834 for two reinf. conc. bridges on Inverness-Point Reyes Road for County. 10-14

SANTA ANA, CALIF.—To Nead Construction Co., 809 Avalon Bldg., Wilmington, $8282 to county for wooden and steel truss bridge over Santiago Creek on the Santiago Boulevard. 10-16

SANTA CRUZ, CALIF.—To C. C. Gildersleeve, Felton, $11,413 for constructing Boulder Creek Bridge in Boulder Creek for County, reinf. concrete construction. 10-8

STOCKTON, CALIF.—To Geo. French, Jr., Box 675, Stockton, who bid $1935 for the construction of culverts on J. R. Russell Road, 6 miles southeast of Tracy. 10-7

SEWER CONSTRUCTION

WORK CONTEMPLATED

NEWPORT BEACH, CALIF.—Plans as follows for sewer improvements for City: (1) Plans by Consulting Engineers, Currie Engineering Co., Anderson Bdg., San Bernardino, San Bernardino County, for sewage disposal plant, consisting of trickling filters and Imhoff tanks, to have 2,000,000 gallons per day flow; and (2) Plans by City Engineer, R. L. Patterson, for 10,000 lin.ft. of 24-in. sewer main. Rights of way must be secured before bids for the above work can be called. $185,000. Work under 1911-1915 Acts. 10-14

REDWOOD CITY, CALIF.—Plans by County Surveyor, Geo. A. Kneese, bids after Oct. 20, for outfall sewer to serve San Bruno, Lomita Park, Capuchino and part of South San Francisco, involving 37,000 ft. 4-in. to 21-in. vitr. pipe, 8000 ft. 18-in. to 8-in. cast-iron pipe, 22,620 ft. timber trestle, valves, pumping plants, etc. 1925 Act. $120,000. 10-14

REDWOOD CITY, CALIF.—Plans by County Surveyor, Geo. A. Kneese, and will be presented to County November 3, for vitrified pipe sewer system at Colma to cost $130,000. Work under 1921 Act. 10-20

REDWOOD CITY, CALIF.—Plans by County Surveyor, Geo. A. Kneese, bids by County after November 3 for outfall in San Bruno, Lomita Park, Capuchino and South San Francisco, involving 37,000 ft. 4-in. to 21-in. vitrified, 8000 ft. 8-in. to 18-in. cast iron pipe, timber trestle, pumps, etc. 1925 Act. 10-6

BIDS BEING RECEIVED

SAN FRANCISCO, CALIF.—Bids to 2:30 p.m., Oct. 29, by Board of Public Works for 895 ft. 2-ft. 6-in. by 3-ft. 9-in. reinf. concrete sewer on Army St. from Pennsylvania Ave. to Mississippi St. 10-10

SAN FRANCISCO, CALIF.—Bids to 2:30 p.m., October 29, by Board of Public Works, City Hall, S. F., for vitrified pipe sewers on Sect. C of Alemany Blvd. $27,000. 10-16

BIDS RECEIVED

OAKLAND, CALIF.—W. J. Tobin, 527 Balfour Ave., Oakland, $23,448 for concrete and $24,311 for vitrified, low bid to City for sewer in Hopkins St., Midvale Ave., etc. 10-16

MT. VERNON, WASH.—Low bids as follows by City for sewer system: (1) T. Collucio, 1425 Hanford St., Seattle, $92,840 low for vitrified, and (2) S. Macri, 511 21st Ave. North, Seattle, $92,727 low for concrete.

CONTRACTS AWARDED

MADERA, CALIF.—To Thompson Bros., P.O. Box 1288, Fresno, $18,403 for vitr. sewers, pumps, and ejectors for City. A. M. Jensen, 68 Post St., S. F., is Engineer. 10-3

PASADENA, CALIF.—To F. L. Lee, 1215 E. Walnut St., Pasadena, who bid $17,381 as follows to City for sewer in Ave. 64:

Rein. conc. pumping plant	$7,550
Vitrified sanitary sewer	$8,250
950 ft. 4-in. cast-iron pipe	1.70 ft.

10-9

REDONDO BEACH, CALIF.—To Gogo & Rados, 914 Sunset Boulevard, Los Angeles, who bid $7500 to City for constructing centrifugally spun reinforced concrete and corrugated iron storm drain in Saphire St. 10-4

REDWOOD CITY, CALIF.—To Geo. C. DeGolyer, Federal Telegraph Building, Oakland, $3846 to the City for concrete storm sewers in El Camino Real. 10-7

WATSONVILLE, CALIF.—To Granite Const. Co., Watsonville, $958 for sewer on Monte Vista Ave. for City. 10-14

ALBUQUERQUE, N. M.—To F. D. Shufflebarger, Albuquerque, N. M., $130,000 for vitrified storm sewers for City.

WATER SUPPLY SYSTEMS

WORK CONTEMPLATED

OXNARD, CALIF.—The City of Oxnard, Ventura County, is considering the installation of water meters throughout the City, to cost $30,000. O. L. Isham is Superintendent of the Municipal Water Department, Oxnard. 10-10

BIDS BEING RECEIVED

ANAHEIM, CALIF.—Bids to 8 p.m, Nov. 5, by City, for 2625 ft. 4-in., 4575 ft. 6-in. and 160 ft. 6-in. cast iron pipe and 5000 lb. fittings. 10-20

BEVERLY HILLS, CALIF.—Bids to 8 p.m., Nov. 5, by City Clerk for (1) Booster pumps and hydro-pneumatic pressure tanks; and (2) 6320 ft. 2-in., 4-in., and 6-in. cast-iron mains on Larabee St., etc. 10-13

FORT MASON, CALIF.—Bids to 11 a.m., November 7, by the Constructing Quartermaster, Fort Mason, California, for installation of a water softener plant at Letterman General Hospital, San Francisco.

ITEM "A"—Furnish and deliver in place the entire zeolite, or equal, water softener apparatus consisting of two units and one brine tank complete with all piping, valves, meters, etc., between.

ITEM "B"—Furnish and install all piping above and underground to hot water storage tanks distributed in different localities throughout the Letterman General Hospital. 10-18

SAN FRANCISCO, CALIF.—Bids to 2:30 p.m., Oct. 29, by the Board of Public Works, City Hall, San Francisco, for construction of 12 miles of pipe line to connect with the system of the East Bay Municipal Utility District and to run from San Lorenzo to near Newark, Alameda County. Work involves: 35,000 ft. 46-in. riveted steel pipe OR 44-in. lock-bar steel pipe OR 44-in. welded steel pipe; 32,000 ft. 38-in. riveted steel pipe, OR 36-in. lock-bar steel pipe, OR 36-in. welded steel pipe; 18,000 cu.yd. excavation; 240 cu.yd. concrete; 30,000 lb. reinforcing steel. 10-17

STRATFORD, CALIF.—Bids to 7 p.m., October 28, by Stratford Public Utility District for water improvements, involving 12,000 4-in. welded casing, 1150 ft. 2-in. black screw pipe, gate valves, hydrants, one 30,000-gal. steel tank and tower, and pumping plant. $28,000. J. B. Benedict, Route 1, Box 225, Hanford, is Engr. 10-16

GRANTS PASS, ORE.—Bids to 5 p.m., October 28, by the City of Grants Pass, Oregon, for water system improvements as follows: SECTION 2, INSTALLATION OF DISTRIBUTION SYSTEM—Work involves: 10,000 cu.yd. excavation and backfill; laying 4500 lin.ft. 16-in. cast iron pipe; laying 10,000 lin.ft. 12-in. cast iron pipe; laying 1200 10-in. cast iron pipe; laying 13,000 lin.ft. 8-in. cast iron pipe; laying 24,000 lin.ft. 6-in. cast iron pipe; setting 110 gate vales; setting 93 hydrants; installing 70,000 lb. cast iron fittings. Material listed above has been previously purchased by the City of Grants Pass. SECTION 3, RESERVOIR LINING—Work involves: 600 cu.yd. concrete; 38,000 lb. reinforcing steel; two truss roofs, 66 ft. x 103 ft. Baar & Cunningham, Spalding Bldg., Portland, Ore,, are Engineers. 10-20

BROWNSVILLE, TEX.—Bids to 10 a.m., Oct. 31, by H. Van Horn, City Secretary, City Hall, Brownsville, Texas, for constructing new and complete water filtration plant of 4 m.g.d. capacity. 10-14

BROWNWOOD, TEX.—Bids to 2 p.m., November 6, by the Board of Directors of Brown County Water Improvement District No. 1, Brownwood, Texas, for the construction of an earthen reservoir dam and appurtenant works across Pecan Bayou, about 8 miles above the City of Brownwood, Brown County, Texas, including a spillway for reservoir. Work involves 730,000 cu.yd. dam embankment, 96,000 cu.yd. excavation for cut-off trench and for conduits, 15,000 cu.yd. riprap, 5000 cu.yd. gravel blanket, 5000 cu.yd. rock fill, 7500 cu.yd. concrete in conduits, gate wells, and gate house, 3600 cu.yd. concrete in spillway channel, 8000 sq.ft. steel sheet piling, 1,344,000 lb. reinforcing steel. 10-7

BIDS RECEIVED

FORT MASON, CALIF.—Bids as follows by Constructing Quartermaster, Fort Mason, San Francisco, for furnishing and erecting one 50,000-gallon steel tank and one 55-ft. steel tower at Fort Miley:

Chicago Bridge & Iron Works, Rialto Bdg., S. F. (low)	$5410
Pittsburgh-Des Moines Steel Company	6880

10-6

SACRAMENTO, CALIF.—Bids received as follows by City:
(A) Furnishing valves as follows:
(1) 125 gate valves, 4-in.;
(2) 50 gate valves, 6-in.

	(1)	(2)
Rensselaer Valve Co.	9.15	16.50
Walworth Calif. Co.	9.59	16.45
Schaw-Batcher Co.	9.59	16.45
Thomson-Diggs Co.	9.59	16.45
Crane Co., Sacramento	9.70	17.25
Water Works Supply Co.	10.25	18.00
Darling Valve Co.	10.50	18.50

(B) Furnishing 100 fire hydrants:

Rensselaer Valve Co.	40.00 ea.
Crane Company, Sacramento	41.50 ea.
Water Works Supply Co.	41.50 ea.
Darling Valve Co.	53.35 ea.

SPOKANE, WASH.—Bids as follows by City for 1,250,000 gallon steel or concrete tank:

STEEL TANK

Chicago Bridge & Iron Works, Rialto Bldg., San Francisco (low)	$70,800
Pittsburgh-Des Moines Steel Company	74,600
Seattle Boiler Works	79,500

CONCRETE TANK (2 lowest)

Morrison-Knudsen Co., Boise, Idaho (low)	$81,283
Alloway & George, Seattle	89,913

10-18

CONTRACTS AWARDED

DANVILLE, CALIF.—To Hutchinson Co., 1450 Harrison St., Oakland, for trenching of 14 miles for 12-in. and 12-in. cast iron pipe line for California Water Service Company, Federal Reserve Bank Bldg., San Francisco, line to run from Galindo pumping station to Danville, Contra Costa County.

Contract awarded to American Cast Iron Pipe Company, Balboa Bldg., San Francisco, for furnishing the above pipe. 10-17

OAKLAND, CALIF.—Awards as follows by East Bay Municipal Utility District: (1) To Pacific States Cast Iron Pipe Co., 111 Sutter St., San Francisco, who bid 35¢ per lin.ft., total bid of $5250, for furnishing 15,000 lin.ft. Class 150 cast-iron pipe, 4-in.; (2) Contract awarded as follows to the U. S. Pipe & Foundry Co., Monadnock Bdg., San Francisco: 25,000 lin.ft. 6-in. cast-iron pipe, Class 250, bid of 59¢ per ft., total $14,750; 17,000 ft. 8-in. cast-iron pipe, Class 250, bid of 89¢ per ft., total $15,130; 616 tons of 12-in. Class 'B' cast-iron pipe, bid of $3870 per ton, total of $23,839; 437 tons of 16-in. Class 'B' cast-iron pipe, bid of $39.70 per ton, total of $17,348. 10-4

RED BLUFF, CALIF.—To Pacific States Cast Iron Pipe Co., 111 Sutter St., S. F., who bid 48¢ per ft. to City for 1000 ft. 4-in. cast iron pipe. 10-15

GREAT FALLS, MONT.—To McGuire & Blakeslee, Great Falls, Mont., $35,000 for installing 20-in. main for City on First Ave., Pike Drive, etc.

SEATTLE, WASH.—To Queen City Construction Co., 603 18th St., Seattle, who bid $1,207,116, USING LOCK-BAR STEEL PIPE, for constructing Cedar River Pipe Line No. 1 replacement and west Seattle Pipe Line, for the City. (See Unit Bid Summary). 10-20

IRRIGATION and RECLAMATION

BIDS BEING RECEIVED

MERCED, CALIF.—Bids to Nov. 4 by Merced Irrigation District for 4000 bbl. of cement. 10-7

PARADISE, CALIF.—Bids to 11 a.m., Nov. 4, by Paradise Irrigation District, Butte County, for: 80 ft. 30-in. 10-gauge riveted steel slip-joint pipe, 40 bbl. Portland cement, 20 cu.yd. sand, 40 cu.yd. gravel, 230 ft. 4-in. standard screw-joint pipe, 1 30-in. L.P. heavy duty gate, Calco Model 108 or similar (pedestal lift and 50 ft. of lift rod), 5000 ft. b.m. dimension lumber; also hauling all material from Magalia station to job; damming water from tunnel, installing 30-in. pipe, welding 30-in. gate to pipe, filling tunnel with concrete over pipe, and balance with loose rock, constructing concrete bulkhead, intake and screen support, etc.; building operating trestle and installing pedestal lift. 10-10

PLACERVILLE, CALIF.—Bids to 2:30 p.m., Nov. 5, by El Dorado Irrigation District for clearing site of Webber Creek Reservoir. 10-13

CONTRACTS AWARDED

FAIR OAKS, CALIF.—To Sacramento Pipe Works, Sacramento, who bid $3.24 per lin.ft. installed for furnishing and installing 2000 lin.ft. of 30-in., 10-ga. steel pipe, work for the Fair Oaks Irrigation District. 10-14

MERCED, CALIF.—Awards as follows by Merced Irrigation District: (1) To Alldrin & Anderson, P.O. Box 222, Merced, who bid $37,470 for 34,000 lin.ft. of concrete lining, involving 524,000 sq.ft. 2-in. lining; and (2) Contract awarded to Osterberg Bros., Route D, Modesto, who bid as follows for three wells: Drilling—$1.50 ft. 16-in. and $1.75 ft. for 18-in. wells; and Casings—$3.05 ft. for 16-in. and $3.41 for 18-in. wells. 10-7

TERRA BELLA, CALIF.—To Universal Air Brush Co., 1536 W. Slauson, Los Angeles, who bid as follows to the Terra Bella Irrigation District for cleaning and covering with protective coating standpipe and pipe-line: Bid of .5683¢ per lin.ft. for covering with one primer and two coats of McEverlast approximately 20,000 lin.ft. of 26-in. to 30-in. riveted pipe; bid of $515 for cleaning and protective coating standpipe. 10-13

TURLOCK, CALIF.—Awards as follows by the Turlock Irrigation District, Turlock, for 900,000 sq.ft. concrete lining, concrete structures, etc.: (1) To Alldrin & Anderson, P.O. Box 222, Turlock, $3645 for Schedule 8; and (2) To Pacific Properties & Const. Co., 3747 Woodruff Ave., Oakland, $18,397 for Schedule 8. 10-8

REDMOND, ORE.—To Kern & Kibbe, 290 E. Salmon St., Portland, Oregon, who bid $29,778 for the construction of 1878 lin.ft. of 12-ft. creosoted wood-stave flume, work for the Central Oregon Irrigation District, Redmond, Oregon. 10-4

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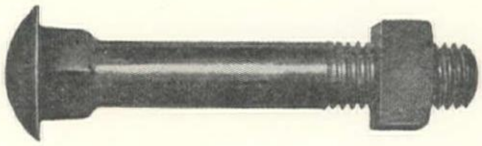

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RIVER and HARBOR WORK

WORK CONTEMPLATED

SACRAMENTO, CALIF.—Plans by U. S. Engineer's Office, California Fruit Bdg., Sacramento, bids soon for: (1) Levee at Moulton Landing, Colusa County, involving 114,000 cu.yd. embankment; and (2) Reinf. conc. weir at Moulton Landing, Colusa County, to be 500 ft. long. 10-11

SAN FRANCISCO, CALIF.—Bond election Nov. 4 by the State of California to vote on issuing $10,000,000 in bonds for the construction of improvements as follows to San Francisco Harbor. Work includes: 8 new piers on north side of Ferry Building, 1 large pier in China Basin, 2 bulkhead wharves in Central Basin, development work at Islais Creek, including wharves, extension of grain terminal, lengthening the seawall, dredging, etc., extension of the Belt Railroad. 10-11

BIDS BEING RECEIVED

RICHMOND, CALIF.—Bids to 3 p.m., November 13, by U. S. Engineer's Office, Custom House, San Francisco, for: (1) Dredging in Richmond Harbor, work involving 94,340 cu.yd. dredging; (2) Sand Fill in Richmond Harbor, work involving 195,000 cu.yd. fill. 10-18

SACRAMENTO, CALIF.—Bids to 3 p.m., Oct. 29, by U. S. Engineer's Office, California Fruit Bdg., Sacramento, for levee along Yolo By-Pass near Yolano Station, involving 247,000 cu.yd. embankment. 10-11

SAN FRANCISCO, CALIF.—Bids to 11 a.m., November 5, by the Public Works Officer, Twelfth Naval District, 100 Harrison Street, San Francisco, for repairs and replacements to Piers Nos. 1, 2, and 3 at the U. S. Naval Receiving Ship, San Francisco, Yerba Buena Island, California. 10-14

BIDS RECEIVED

FORT MASON, CALIF.—Healy-Tibbitts Const. Co., 64 Pine St., S. F., $1160 low bid for repairs to dock at Ft. Winfield Scott, for Constructing Quartermaster, Fort Mason. 10-15

FORT MASON, CALIF.—Healy-Tibbitts Const. Co., 64 Pine St., S. F., $1721 low for repairs of torpedo wharf at Ft. Winfield Scott, for Constructing Quartermaster, Ft. Mason. 10-3

PORTLAND, ORE.—Hauser Construction Co., Multnomah Hotel, Portland, who bid $429,890, low bid to U. S. Engineer's Office, Custom House, Portland, Ore., for constructing of jetty extension at entrance to Tillamook Bay, Oregon. (See Unit Bid Summary.) 10-17

CONTRACTS AWARDED

OAKLAND, CALIF.—To Healy-Tibbitts Const. Co., 64 Pine St., S. F., at $10,000 for creosoted pile repairs to dock of Albers Bros. Milling Co. at foot of 7th St., Oakland. 10-3

OAKLAND, CALIF.—To American Dredging Company, 255 California Street, San Francisco, who bid $13,982 to the Oakland Port Commission, Oakland, for dredging at Grove and Market Street Docks. 10-7

SAN DIEGO, CALIF.—To Robt. T. Dawson, 4333 Maryland Street, San Diego, who bid $19,469 to the Public Works Office, Headquarters, 11th Naval District, San Diego, for constructing quay wall for the Marine Railway, Naval Operating Base (Destroyer Base), San Diego, Calif. 10-9

SAN FRANCISCO, CALIF.—To Healy-Tibbitts Const. Co., 64 Pine St., S. F., $39,200 for two creo. timber wharves and 100 yacht berths at the Marina for Park Comm. 10-3

MACHINERY and SUPPLIES

BIDS BEING RECEIVED

PHOENIX, ARIZ.—Bids to Oct. 30 by the Arizona State Highway Commission, Phoenix, Arizona, for furnishing five four-wheel drive type trucks, five V-type snow plows, one large crawler-type tractor, one medium crawler-type tractor, and one rotary type snow plow. 10-13

LOS ANGELES, CALIF.—Bids to 2 p.m., October 27, by the County Clerk, for furnishing 62,500 lb. of square deformed reinforcing steel in stock lengths for use in Big Tujunga Dam No. 1. 10-17

SACRAMENTO, CALIF.—Bids to 10 a.m., November 17, by State Purchasing Agent, P.O. Box 621, Sacramento, for furnishing 15 more or less Heavy duty 8 ft. leaning wheel graders with scarifier attachments; 10 more or less Heavy duty 8 ft. leaning wheel graders; 5 more or less Medium weight 8 ft. leaning wheel graders; 5 more or less 7 ft. leaning wheel graders. 10-16

SAN FRANCISCO, CALIF.—Bids to 3 p.m., Oct. 27, by Clerk, Board of Supervisors, City Hall, S. F., for one concrete mixer. 10-14

TACOMA, WASH.—Bids to 2 p.m., October 27, by the Board of Contracts and Awards, City Hall, Tacoma, Wash., for locomotive crane and boiler room coal scales. 10-20

CONTRACTS AWARDED

EL CENTRO, CALIF.—To Pacific States Cast Iron Pipe Co., 417 So. Hill St., L. A., $4047 for 4000 ft. 6-in. and 3000 ft. 4-in. cast-iron pipe for City. 10-17

FULLERTON, CALIF.—Awards as follows by City: (1) To American Cast Iron Pipe Co., Los Angeles, $14,933 for furnishing and delivering cast iron pipe and fittings; (2) Contract awarded to Rensselaer Valve Co., Los Angeles, who bid $1600 for furnishing gate valves, valve boxes and check valve. 10-17

LIGHTING SYSTEMS

WORK CONTEMPLATED

VISALIA, CALIF.—Plans by City Engr., protests Oct. 20, for 51 2-light Union Metal Mfg. Co. electroliers on Locust St., Court St., etc. 10-3

CONTRACTS AWARDED

REDWOOD CITY, CALIF.—To City Improvement Company, 2055 Center Street, Berkeley, $7090 to City for the installation of 17 two-light electroliers on portions of Broadway and Brewster Avenue. 10-7

FLOOD CONTROL WORK

BIDS BEING RECEIVED

LOS ANGELES, CALIF.—Bids to 2 p.m., October 27, by County for 2500 ft. diamond drilling holes at site of San Gabriel Dam No. 1. 10-17

LOS ANGELES, CALIF.—Bids to 2 p.m., October 27, by County for exploration of tunnels for San Gabriel Dam No. 1. Work involves: 725 ft. driving 16 tunnels, without timbering; 75 ft. driving 16 tunnels where timbering is necessary. 10-17

POWER DEVELOPMENT

CONTRACTS AWARDED

DENVER, COLO.—To Westinghouse Electric & Manufacturing Co., who bid $45,700 to the Bureau of Reclamation for furnishing one 5000-kv-a., alternating current generator, three or four 1667-kv-a. 2300 to 19,100/33,000 Y-volt transformers, two gang-operated disconnecting switches, and one switchboard and auxiliary apparatus, for the Shoshone power plant, Shoshone project, Wyoming. 10-10

LAS VEGAS, NEVADA—Contract awarded by U. S. Reclamation Service, to Southern Sierras Power Company, Riverside, California, for transmission lines and furnishing power for Hoover Dam, Boulder Canyon Project. Estimate for five and one-half years, $1,730,000. 10-16

MUNICIPAL IMPROVEMENTS

CONTRACTS AWARDED

FLORENCE, ARIZ.—To Phoenix-Tempe Stone Co., Phoenix, Ariz., who bid $114,545 for improvements for City, paving with cement concrete, lighting system, and vitrified pipe sewers. 10-17

THE BUYERS' GUIDE

Refer to advertisements for addresses of companies listed. Advertisers index on page 90

Acetylene, Dissolved
Prest-O-Lite Co., Inc., The

Acetylene Generating Apparatus
Oxweld Acetylene Co.

Air Compressors
Bacon Co., Edward R.
Gardner-Denver Co.
Ingersoll-Rand Co.
Jenison Machinery Co.
Leitch & Co.
National Brake & Electric Co.
Rix Company, Inc., The
Schramm, Inc.
Sullivan Machinery Co.
West Coast Tractor Co.

Air Compressors—Engines
Atlas Imperial Diesel Engine Co.

Asphalt
Gilmore Oil Co.
Seaside Oil Co.
Shell Oil Co.
Standard Oil Co.
Union Oil Co.

Asphalt, Emulsified
American Bitumuls Co.
Shell Oil Co.

Asphalt Plants and Equipment
Bacon Co., Edward R.
Jenison Machinery Co.
Link-Belt Co.
Spears-Wells Mchy. Co., Inc.
Standard Boiler & Steel Works
Union Tank & Pipe Co.

Asphalt Paving
Warren Bros. Roads Co.

Back Fillers
Austin Machy. Corp.
Bucyrus-Erie Co.
Caterpillar Tractor Co.
Cleveland Tractor Co., The
Harnischfeger Sales Corp.
Jenison Machinery Co.
Link-Belt Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Spears-Wells Machy. Co., Inc.
Speeder Machinery Corp.
Thew Shovel Co., The
Universal Crane Co., The
West Coast Tractor Co.
W-K-M Company, Inc.
Worden Co., W. H.

Beams, Channels, and Angles
Pacific Coast Steel Corp.

Bins, Storage and Hopper
Bacon Co., Edward R.
Blaw-Knox Co.
Diamond Iron Works, Inc.
Heltzel Steel Form & Iron Co.,The
Jenison Machinery Co.
Link-Belt Co.

Blades—Fresno and Graders
Solano Iron Works

Blasting Supplies
Giant Powder Co., Cons., The
Hercules Powder Co.

Boilers
Montague Pipe & Steel Co.
Water Works Supply Co.

Bolts, Nuts and Rods
Claussen & Co., C. G.
Kortick Mfg. Co.

Bonds (Street) Bought
W. P. Bullock

Bonds, Surety
Aetna Casualty & Surety Co.
Associated Indemnity Corp.
Commerce Casualty Co.
Consolidated Indemnity & Insurance Co.
Detroit Fidelity & Surety Co.
Fidelity & Casualty Co. of N. Y., The
Fidelity & Deposit Co. of Maryland
Glens Falls Indemnity Co.
Great American Indemnity Co.
Indemnity Insurance Co. of North America
Maryland Casualty Co.

Bonds, Surety (Continued)
Massachusetts Bonding & Insurance Co.
New Amsterdam Casualty Co.
Rolph, James Jr., Landis & Ellis

Brick, Common
Gladding Bros. Mfg. Co.

Buckets, Elevator and Conveyor
Bacon Co., Edward R.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Lakewood Engr. Co.
Link-Belt Co.

Buckets, Dredging
Haiss Mfg. Co., Geo.
Harnischfeger Sales Corp.
Owen Bucket Co.

Buckets, Excavating
Bacon Co., Edward R.
Bucyrus-Erie Co.
Haiss Mfg. Co., Geo.
Harnischfeger Sales Corp.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Marion Steam Shovel Co.
Orton Crane & Shovel Co.
Owen Bucket Co.
Taylor & George
Williams Co., G. H.
Worden Co., W. H.

Buckets, Rehandling
Industrial Brownhoist Corp.
Jenison Machinery Co.
Lakewood Engr. Co.
Orton Crane & Shovel Co.
Owen Bucket Co.

Cableways
American Steel & Wire Co.
Bacon Co., Edward R.
Jenison Machinery Co.
Leschen & Sons Rope Co., A.
Worden Co., W. H.
Young Machy. Co., A. L.

Carbide
Union Carbide Sales Co., The

Cars, Industrial
Bacon Co., Edward R.
Jenison Machinery Co.
Lakewood Engr. Co.

Carts, Concrete
Bacon Co., Edward R.
Harron, Rickard & McCone Co.
Jenison Machinery Co.
Lakewood Engr. Co.
Ransome Concrete Machinery Co.

Castings, Iron and Steel
American Cast Iron Pipe Co.
Link-Belt Co.
U. S. Cast Iron Pipe & Fdy. Co.

Castings, Street and Sewer
U. S. Cast Iron Pipe & Fdy. Co.

Cement
Portland Cement Association

Chemicals
California Filter Co., Inc.
Great Western Electro-Chemical Co.
International Filter Co.

Chlorinators
California Filter Co., Inc.
International Filter Co.
Wallace & Tiernan
Water Works Supply Co.

Chlorine
Great Western Electro-Chemical Co.

Chutes, Concrete
Bacon Co., Edward R.
Haiss Mfg. Co., Geo.
Jenison Machinery Co.
Lakewood Engr. Co.
Ransome Concrete Machinery Co.

Clarifiers, Water
Dorr Co., The
International Filter Co.
Wallace & Tiernan Co.

Clay Products
Gladding, McBean & Co.
Pacific Clay Products Co.

Concrete Buckets
Jenison Machinery Co.
Young Machy. Co., A. L.

Concrete Curing
Concrete Curing Co.
Inertol Company, Inc.
McEverlast, Inc.

Concrete Forms
Bacon Co., Edw. R.
Blaw-Knox Co.

Concrete Roads
Portland Cement Association

Conveyors, Portable

Conveyors, Elevating and Conveying
Bacon Co., Edward R.
Bodinson Mfg. Co.
Jenison Machinery Co.
Link-Belt Co.

Cranes, Electric, Gasoline Locomotive
American Hoist & Derrick Co.
Austin Machy. Corp.
Bacon Co., Edward R.
Bucyrus-Erie Co.
Harnischfeger Sales Corp.
Harron, Rickard & McCone Co.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Link-Belt Co.
Marion Steam Shovel Co.
Northwest Engineering Co.
Ohio Power Shovel Co., The
Orton Crane & Shovel Co.
Speeder Machinery Corp.
Thew Shovel Co., The
Universal Crane Co., The
W-K-M Company, Inc.

Cranes, Tractor
Harnischfeger Sales Corp.
West Coast Tractor Co.

Cranes, Traveling
Harnischfeger Sales Corp.
Jenison Machinery Co.
Thew Shovel Co., The

Crushers
Austin Western Road Machy. Co., The
Bacon Co., Edward R.
Diamond Iron Works, Inc.
Jenison Machinery Co.
Smith Engineering Works
W-K-M Company, Inc.
Young Machy. Co., A. L.

Crushers—Engines
Atlas Imperial Diesel Engine Co.

Culverts, Concrete
Portland Cement Association

Culverts, Metal
California Corrugated Culvert Co.
U. S. Cast Iron Pipe & Fdy. Co
Western Pipe & Steel Co.

Culverts, Part Circle
California Corrugated Culvert Co.
Western Pipe & Steel Co.

Culverts, Vitrified
Gladding, McBean & Co.
Pacific Clay Products

Curing, Concrete
Concrete Curing Co.
Inertol Company, Inc.
McEverlast, Inc.

Cutting Apparatus
Jenison Machinery Co.
Diamond Iron Works, Inc.
Haiss Mfg. Co., Geo.
Oxweld Acetylene Co.
Victor Welding Equipment Co.

Cutting Edges
Solano Iron Works

Dams
Ambursen Dam Co., Inc.

Derricks
Bacon Co., Edward R.
Jenison Machinery Co.
Young Machy. Co., A. L.

Diesel Engines
Atlas Imperial Diesel Engine Co.

Ditch Machinery
Bacon Co., Edward R.
Bucyrus-Erie Co.
Cleveland Trencher Co.
Harnischfeger Sales Corp.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Link-Belt Co.
Marion Steam Shovel Co.
National Equipment Corp.
Northwest Engineering Co.
Ohio Power Shovel Co., The
Orton Crane & Shovel Co.
Thew Shovel Co., The

Draglines
Austin Machy. Corp.
Bacon Co., Edward R.
Bucyrus-Erie Co.
Harnischfeger Sales Corp.
Harron, Rickard & McCone Co.
Jenison Machinery Co.
Link-Belt Co.
Marion Steam Shovel Co.
National Equipment Corp.
Northwest Engineering Co.
Ohio Power Shovel Co.
Sauerman Bros., Inc.
Spears-Wells Machy. Co.
Speeder Machinery Corp.
Thew Shovel Co., The
Universal Crane Co., The
Worden Co., W. H.
Young Machy. Co., A. L.

Dragline—Diesel Engines
Atlas Imperial Diesel Engine Co.

Drain Tile
Gladding, McBean & Co.
Gladding Bros. Mfg. Co.
Pacific Clay Products

Drills, Rock
Bacon Co., Edward R.
Gardner-Denver Co.
Ingersoll-Rand Co.
Leitch & Company
Rix Company, Inc., The
Schramm, Inc.
Sullivan Machinery Co.

Dump Cars
Bacon Co., Edward R.
Jenison Machinery Co.

Dump Wagons
Le Tourneau Mfg. Co.
West Coast Tractor Co.

Engineers
Ambursen Dam Co., Inc.
Burns-McDonnell-Smith Engr. Co.
Hunt Co., R. W.
Porter, Geo. J.

Engines, Diesel, Gasoline and Steam
Atlas Imperial Diesel Engine Co.
Bacon Co., Edward R.
Continental Motors Corp.
Hercules Motors Corp.
Ingersoll-Rand Co.
International Harvester Co.
Jenison Machinery Co.
Le Roi Co.
Novo Engine Co.

Excavating Machinery
American Tractor Equipment Co.
Austin Western Road Machy. Co., The
Bacon Co., Edward R.
Bodinson Mfg. Co.
Bucyrus-Erie Co.
Caterpillar Tractor Co.
Cleveland Tractor Co., The
Excavating Equipment Dealers, Inc.
Haiss Mfg. Co., Geo.
Harnischfeger Sales Corp.
Harron, Rickard & McCone Co.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Link-Belt Co.
Marion Steam Shovel Co.

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OPPORTUNITY PAGE

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THE BUYERS' GUIDE—*Continued from Page 82*

Excavating Mchy. (Continued)
- National Equipment Corp.
- Northwest Engineering Co.
- Ohio Power Shovel Co.
- Orton Crane & Shovel Co.
- Owen Bucket Co.
- Sauerman Bros., Inc.
- Shaw Excavator & Tools Co.
- Speeder Machinery Corp., The
- Thew Shovel Co., The
- Universal Crane Co., The

Excavating Mchy.—Diesel Engines
- Atlas Imperial Diesel Engine Co.

Expansion Joints
- Industrial & Municipal Supply Co.
- U. S. Cast Iron Pipe & Fdy. Co.
- Water Works Supply Co.

Explosives
- Giant Powder Co., Cons., The
- Hercules Powder Co.

Equipment—Rental
- Atkinson Construction Co.
- Contractors Mchy. Exchange
- Tieslau Bros.

Filters, Water
- California Filter Co., Inc.
- International Filter Co.

Fire Hydrants
- Industrial & Municipal Supply Co.
- Rensselaer Valve Co.
- Water Works Supply Co.

Floating Roofs
- Chicago Bridge & Iron Works

Flood Lights
- Oxweld Acetylene Co.
- Taylor & George

Flooring, Industrial
- Paraffine Companies, Inc., The

Floors, Mastic
- Wailes Dove-Hermiston Corp.

Flumes, Concrete
- Portland Cement Association

Flumes, Metal
- California Corrugated Culvert Co.
- Montague Pipe & Steel Co.

Fluxes
- Victor Welding Equipment Co.

Forms, Steel
- Blaw-Knox Co.
- Jenison Machinery Co.
- Lakewood Engr. Co.

Form Ties
- J. M. Willard Co.

Freight, Water
- American-Hawaiian Steamship Co.

Gas Holders
- Chicago Bridge & Iron Works
- Western Pipe & Steel Co.

Gates, Cast-Iron
- California Corrugated Culvert Co.

Gates, Radial
- California Corrugated Culvert Co.

Gates, Sheet Metal
- California Corrugated Culvert Co.

Governors, Steam Engine
- Gardner-Denver Co.
- Young Machy. Co., A. L.

Governors, Turbine
- Pelton Water Wheel Co., The

Grader Blades
- Solano Iron Works

Gravel Plant Equipment
- Austin-Western Road Mchy. Co., The
- Bacon Co., Edward R.
- Bodinson Mfg. Co.
- Bucyrus-Erie Co.
- Diamond Iron Works, Inc.
- Harnischfeger Sales Corp.
- Jenison Machinery Co.
- Link-Belt Co.
- Smith Engineering Works
- Young Mach. Co., A. L.

Hammers, Steam Pile
- Bacon Co., Edward R.
- Harron, Rickard & McCone Co.
- Kratz & McClelland, Inc.
- Union Iron Works, Inc.

Hoists, Hand and Power
- Bacon Co., Edward R.
- Gardner-Denver Co.
- Harnischfeger Sales Corp.
- Harron, Rickard & McCone Co.

Hoists, Hand, Power (Cont.)
- Ingersoll-Rand Co.
- Jaeger Machine Works, The
- Jenison Machinery Co.
- Link-Belt Co.
- Novo Engine Co.
- Sullivan Machinery Co.
- West Coast Tractor Co.
- Worden Co., W. H.
- Young Machy. Co., A. L.

Hoppers, Steel
- Bacon Co., Edward R.
- Blaw-Knox Co.
- Haiss Mfg. Co., Geo.
- Jenison Machinery Co.
- Lakewood Engr. Co.
- Link-Belt Co.

Hose, Steam, Air and Water
- Gardner-Denver Co.
- Ingersoll-Rand Co.
- Leitch & Co.
- Rix Company, Inc., The

Hydro-Tite
- Industrial & Municipal Supply Co.

Insurance, Casualty
- Aetna Casualty & Surety Co.
- Associated Indemnity Corp.
- Commerce Casualty Co.
- Consolidated Indemnity & Insurance Co.
- Detroit Fidelity & Surety Co.
- Fidelity & Casualty Co. of N. Y., The
- Fidelity & Deposit Co. of Maryland
- Glens Falls Indemnity Co.
- Great American Indemnity Co.
- Indemnity Insurance Co. of North America
- Maryland Casualty Co.
- Massachusetts Bonding & Insurance Co.
- New Amsterdam Casualty Co.
- Rolph, James Jr., Landis & Ellis

Iron, Plates and Sheets
- American Rolling Mill Co., The

Jacks, Lifting
- Jenison Machinery Co.

Kettles, Tar and Asphalt
- Bacon Co., Edward R.
- Montague Pipe & Steel Co.
- Spears-Wells Machy. Co.
- Young Machy. Co., A. L.

Leadite
- Water Works Supply Co.

Loaders, Power, Truck and Wagon
- Haiss Mfg. Co., Geo.
- Industrial Brownhoist Corp.
- Jaeger Machine Works, The
- Jenison Machinery Co.
- Link-Belt Co.
- Spears-Wells Machy. Co.
- Young Machy. Co., A. L.

Locomotives, Electric, Gas and Steam
- Jenison Machinery Co.

Lumber
- McCormick Lumber Co.

Metal Lath
- Truscon Steel Company

Meters, Venturi
- International Filter Co.
- Water Works Supply Co.

Meters, Water
- Industrial & Municipal Supply Co.
- Neptune Meter Co.

Mixers, Chemical
- Dorr Co., The
- International Filter Co.

Mixers, Concrete
- Bacon Co., Edward R.
- Foote Company, Inc.
- Garfield & Co.
- Harron, Rickard & McCone Co.
- Jaeger Machine Works, The
- Jenison Machinery Co.
- Lakewood Engr. Co.
- National Equipment Corp.
- Ransome Concrete Machinery Co.
- Young Machy. Co., A. L.

Mixers, Plaster
- Bacon Co., Edw. R.
- Jaeger Machine Works, The
- Jenison Machinery Co.
- Young Machy. Co., A. L.

Motors, Gasoline
- Continental Motors Corp.
- Hercules Motors Corp.
- Jenison Machinery Co.
- Le Roi Co.

Oxy-Acetylene Apparatus
- Oxweld Acetylene Co.

Oxygen in Cylinders
- The Linde Air Products Co.

Paints, Acid Resisting
- Columbia Wood and Metal Preservative Co.
- Inertol Company, Inc.
- Paraffine Companies, Inc., The
- Wailes Dove-Hermiston Corp.

Paints, Metal Protective
- Columbia Wood and Metal Preservative Co.
- Inertol Company, Inc.
- McEverlast, Inc.
- Paraffine Companies, Inc., The
- Wailes Dove-Hermiston Corp.

Paints, Technical
- American Bitumuls Co.
- Columbia Wood and Metal Preservative Co.
- Inertol Company, Inc.
- Paraffine Companies, Inc., The
- Wailes Dove-Hermiston Corp.

Paints, Waterproofing
- Columbia Wood and Metal Preservative Co.
- Inertol Company, Inc.
- McEverlast, Inc.
- Paraffine Companies, Inc., The
- Wailes Dove-Hermiston Corp.

Pavers, Concrete
- Bacon Co., Edw. R.
- Foote Company, Inc.
- Harron, Rickard & McCone Co.
- Kratz & McClelland, Inc.
- National Equipment Corp.
- Ransome Concrete Machinery Co.

Paving Breakers
- Gardner-Denver Co.
- Ingersoll-Rand Co.
- Leitch & Co.
- Rix Company, Inc., The
- Schramm, Inc.
- Sullivan Machinery Co.

Paving, Contractor
- Warren Bros. Roads Co.

Paving Plants
- Bacon Co., Edward R.
- Jaeger Machine Works, The
- Jenison Machinery Co.
- Standard Boiler & Steel Works

Paving Tools
- Bacon Co., Edward R.
- Harron, Rickard & McCone Co.

Penstocks
- Chicago Bridge & Iron Works
- Lacy Manufacturing Co.
- Pittsburgh-Des Moines Steel Co.
- Water Works Supply Co.
- Western Pipe & Steel Co.

Pile Drivers
- Bacon Co., Edward R.
- Bucyrus-Erie Co.
- Harnischfeger Sales Corp.
- Harron, Rickard & McCone Co.
- Industrial Brownhoist Corp.
- Ingersoll-Rand Co.
- Jenison Machinery Co.
- Kratz & McClelland, Inc.
- Northwest Engineering Co.
- Orton Crane & Shovel Co.
- Thew Shovel Co., The
- Union Iron Works, Inc.

Piles, Concrete
- Raymond Concrete Pile Co.
- MacArthur Concrete Pile Corp.

Piling
- Pacific Coast Steel Corp.

Piling, Redwood
- Union Lumber Co.

Pipe, Bell and Spigot
- National Cast Iron Pipe Co.

Pipe, Cast-Iron
- American Cast Iron Pipe Co.
- Claussen & Co., C. G.
- Industrial & Municipal Supply Co.
- National Cast Iron Pipe Co.
- Pacific States Cast Iron Pipe Co.
- U. S. Cast Iron Pipe & Fdy. Co.
- Water Works Supply Co.

Pipe, Cement Lined
- American Cast Iron Pipe Co.
- National Cast Iron Pipe Co.
- U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Centrifugal
- National Cast Iron Pipe Co.

Pipe Clamps and Hangers
- Kortick Mfg. Co.

Pipe Coatings
- American Concrete Pipe Co.
- Inertol Company, Inc.
- McEverlast, Inc.
- Paraffine Companies, Inc., The
- Wailes Dove-Hermiston Corp.

Pipe, Concrete
- American Concrete Pipe Co.
- Lock Joint Pipe Co.
- Portland Cement Association

Pipe, Culvert
- California Corrugated Culvert Co.
- Gladding, McBean & Co.
- Pacific Clay Products
- Western Pipe & Steel Company

Pipe Fittings
- American Cast Iron Pipe Co.
- Claussen & Co., C. G.
- Industrial & Municipal Supply Co.
- National Cast Iron Pipe Co.
- Pacific Pipe Co.
- Pacific States Cast Iron Pipe Co.
- U. S. Cast Iron Pipe & Fdy. Co.
- Weissbaum & Co., G.

Pipe, Flanged
- National Cast Iron Pipe Co.

Pipe Line Machinery
- Bacon Co., Edward R.
- Harnischfeger Sales Corp.
- Jenison Machinery Co.
- W-K-M Company, Inc.

Pipe, Lock-Bar
- Western Pipe & Steel Co.

Pipe, Preservative
- Columbia Wood & Metal Preservative Co.

Pipe, Pressure Line
- Lacy Manufacturing Co.
- Lock Joint Pipe Co.
- Western Pipe & Steel Co.

Pipe, Riveted Steel
- Lacy Mfg. Co.
- Montague Pipe & Steel Co.
- Pittsburgh-Des Moines Steel Co.
- Western Pipe & Steel Co.

Pipe, Sewer
- Gladding, McBean & Co.
- Pacific Clay Products

Pipe, Standard
- Claussen & Co., C. G.
- Pacific Pipe Co.

Pipe, Vitrified
- Gladding Bros. Mfg. Co.
- Gladding, McBean & Co.
- Pacific Clay Products

Pipe, Welded Steel
- California Corrugated Culvert Co.
- Lacy Manufacturing Co.
- Montague Pipe & Steel Co.
- Steel Tank & Pipe Co.
- Union Tank & Pipe Co.
- Western Pipe & Steel Co.

Plows, Road
- Austin-Western Road Mchy. Co., The
- Bacon Co., Edward R.
- Jenison Machinery Co.
- Spears-Wells Machy. Co.

Pneumatic Tools
- Gardner-Denver Co
- Ingersoll-Rand Co.
- Leitch & Co.
- Schramm, Inc.

Poles, Redwood
- Union Lumber Co.

Powder
- Giant Powder Co., Cons., The
- Hercules Powder Co.

Power Units
- Bacon Co., Edw. R.
- Continental Motors Corp.
- Hercules Motors Corp.
- International Harvester Co.
- Jenison Machinery Co.
- Novo Engine Co.

Preservative, Wood, Metal, etc.
- Columbia Wood & Metal Preservative Co.
- Paraffine Companies, Inc., The

Pumps, Centrifugal
- Byron Jackson Pump Mfg. Co.
- Industrial & Municipal Supply Co.
- Ingersoll-Rand Co.
- Jaeger Machine Works, The
- Pelton Water Wheel Co., The
- Rix Company, Inc., The
- Washington Iron Works
- Woodin & Little

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OPPORTUNITY PAGE

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Pumps, Deep Well
Byron Jackson Pump Mfg. Co.
Industrial & Municipal Supply Co.
Jenison Machinery Co.
Pelton Water Wheel Co., The
Pomona Pump Co.
Woodin & Little

Pumps, Dredging and Sand
Jenison Machinery Co.

Pumps, Hydraulic
Jenison Machinery Co.

Pumps, Power
Gardner-Denver Co.
Jaeger Machine Works, The

Pumps, Road
Bacon Co., Edward R.
Jaeger Machine Works, The
Jenison Machinery Co.
Novo Engine Co.
Woodin & Little

Pumps, Sewage
Dorr Co., The
Fairbanks, Morse & Co.
Industrial & Municipal Supply Co.

Pumps, Sewage Ejector
Industrial & Municipal Supply Co.

Pumps, Sludge
Dorr Co., The

Pumps, Water Works
Fairbanks, Morse & Co.
Industrial & Municipal Supply Co.
Jenison Machinery Co.
Pelton Water Wheel Co., The
Pomona Pump Co.
Washington Iron Works

Rails
Claussen & Co., C. G.

Reinforcing Bars
Pacific Coast Steel Corp.
Soulé Steel Co.

Reinforcing Wire Fabric
Soulé Steel Co.

Reservoirs, Steel
Chicago Bridge & Iron Works
Western Pipe & Steel Co.

Riveting Machines
Ingersoll-Rand Co.
Rix Company, Inc., The

Road Finishers
Bacon Co., Edward R.
Blaw-Knox Co.
Jenison Machinery Co.
Lakewood Engr. Co.

Road Forms
Bacon Co., Edward R.
Blaw-Knox Co.
Heltzel Steel Form & Iron Co.
Jenison Machinery Co.
Lakewood Engr. Co.

Road Graders and Scrapers
American Tractor Equipment Co.
Austin Western Road Machy. Co., The
Bacon Co., Edward R.
Caterpillar Tractor Co.
Jenison Machinery Co.
Jumbo Scraper Co.
Shaw Excavator & Tools Co.
Spears-Wells Machinery Co.
Taylor & George
West Coast Tractor Co.
Worden Co., W. H.
Young Machinery Co., A. L.

Road Oil
Gilmore Oil Co.
Seaside Oil Co.
Shell Oil Co.
Standard Oil Co.
Union Oil Co.

Road Oil, Emulsified
American Bitumuls Co.
Shell Co.

Road Rollers
American Tractor Equipment Co.
Austin Western Road Machy. Co., The
Bacon Co., Edward R.
Huber Manufacturing Co.
Jenison Machinery Co.
Spears-Wells Machinery Co.
Taylor & George

Roofing
Paraffine Companies, Inc., The

Rules, Steel, Wood and Aluminum
Lufkin Rule Co., The

Saws, Portable
Ingersoll-Rand Co.
Jenison Machinery Co.
Young Machinery Co., A. L.

Scarifiers
American Tractor Equipment Co.
Austin-Western Road Mchy. Co., The
Bacon Co., Edward R.
Jenison Machinery Co.
Le Tourneau Mfg. Co.
Spears-Wells Machinery Co.
West Coast Tractor Co.
Worden Co., W. H.

Scrapers, Dragline, Fresno, Wheeled
American Tractor Equipment Co.
Austin-Western Road Mchy. Co., The
Bacon Co., Edward R.
Jenison Machinery Co.
Jumbo Scraper Co.
Sauerman Bros., Inc.
Shaw Excavator & Tools Co.
Solano Iron Works
West Coast Tractor Co.

Screens, Sand and Gravel
Bacon Co., Edward R.
Bodinson Manufacturing Co.
Diamond Iron Works, Inc.
Haiss Mfg. Co., Geo.
Jenison Machinery Co.
Link-Belt Co.
Smith Engineering Co.
Young Machinery Co., A. L.

Screens, Sewage
Dorr Co., The
Link-Belt Co.

Screens, Vibrating
Link-Belt Co.
Smith Engineering Works

Second-Hand Equipment
Atkinson Construction Co.
Contractors Mchy. Exchange
Excavating Equipment Dealers, Inc.
Tieslau Bros.

Sewage Disposal Apparatus
Dorr Co., The
Industrial & Municipal Supply Co.
International Filter Co.
Link-Belt Co.
Wallace & Tiernan
Water Works Supply Co.

Sewer Joint Compound
Ric-Wil Co., The

Sharpeners, Rock Drill Steel
Gardner-Denver Co.
Ingersoll-Rand Co.

Sheet Piling
Pacific Coast Steel Corp.

Shovels—Diesel Engines
Atlas Imperial Diesel Engine Co.

Shovels, Electric, Gasoline, Steam
American Hoist & Derrick Co.
Bacon Co., Edward R.
Bucyrus-Erie Co.
Excavating Equipment Dealers, Inc.
Harnischfeger Sales Corp.
Harron, Rickard & McCone Co.
Industrial Brownhoist Corp.
Jenison Machinery Co.
Link-Belt Co.
Marion Steam Shovel Co.
National Equipment Corp.
Northwest Engineering Co.
Ohio Power Shovel Co.
Orton Crane & Shovel Co.
Spears-Wells Machinery Co.
Speeder Machinery Corp., The
St. Louis Power Shovel Co.
Thew Shovel Co., The
Young Machy. Co., A. L.

Shovels, Hand
Jenison Machinery Co.
Worden Co., W. H.

Sluice Gates
California Corrugated Culvert Co.
Water Works Supply Co.

Spreaders, Gravel, Rock and Asphalt
Bacon Co., Edward R.
Jenison Machinery Co.

Standpipes
Chicago Bridge & Iron Works
Montague Pipe & Steel Co.
Pittsburgh-Des Moines Steel Co.
Western Pipe & Steel Co.

Steel, Drill
Gardner-Denver Co.
Ingersoll-Rand Co.
Leitch & Co.
Rix Company, Inc., The

Steel Plate Construction
Chicago Bridge & Iron Works
Lacy Manufacturing Co.
Montague Pipe & Steel Co.
Pittsburgh-Des Moines Steel Co.
Western Pipe & Steel Co.

Steel, Structural
Pacific Coast Steel Corp.
Western Iron Works
Western Pipe & Steel Co.

Street Sweepers, Sprinklers, Flushers
Austin Western Road Machy. Co., The
Jenison Machinery Co.

Steel Joists
Truscon Steel Co.

Steel Piling
Pacific Coast Steel Corp.

Steel Windows
Truscon Steel Co.

Subgraders
Bacon Co., Edward R.
Blaw-Knox Co.
Lakewood Engineering Co.

Swimming Pool Equipment
California Filter Co., Inc.
International Filter Co.

Tamping Rollers
American Tractor Equipment Co.

Tanks, Air Compressor
Ingersoll-Rand Co.
Lacy Manufacturing Co.
Rix Company, Inc., The
Western Pipe & Steel Co.

Tanks, Corrugated
California Corrugated Culvert Co.
Western Pipe & Steel Co.

Tanks, Elevated Steel
Chicago Bridge & Iron Works
Lacy Manufacturing Co.
Montague Pipe & Steel Co.
Pittsburgh-Des Moines Steel Co.
Western Pipe & Steel Co.

Tanks, Oil Storage
Chicago Bridge & Iron Works
Lacy Manufacturing Co.
Steel Tank & Pipe Co.
Western Pipe & Steel Co.

Tapes, Measuring, Steel and Fabric
Lufkin Rule Co., The

Testing Laboratories
Hunt Co., R. W.

Tie Plates
Pacific Coast Steel Corp.

Ties, Redwood
Union Lumber Co.

Timbers, Redwood
Union Lumber Co.

Torches, Welding and Cutting
Oxweld Acetylene Co.
Victor Welding Equipment Co.

Towers, Transmission
Pacific Coast Steel Corp.
Water Works Supply Co.

Tractors
Bacon Co., Edward R.
Caterpillar Tractor Co.
Cleveland Tractor Co.
International Harvester Co.
Linn Mfg. Corp., Division of La France-Republic Corp.
National Brake & Electric Co.
West Coast Tractor Co.
Worden Co., W. H.

Tractor Parts
Taylor & George

Trailers—Heavy Duty
Williams Co., G. H.

Tramways
American Steel & Wire Co.
Bacon Co., Edward R.
Leschen & Sons Rope Co., A.

Transmission Machinery, Power
Bodinson Mfg. Co.
Link-Belt Co.

Transportation, Water
American-Hawaiian Steamship Co.

Trench Excavators
Austin Mchy. Corp.
Bacon Co., Edw. R.
Cleveland Trencher Co., The
Harnischfeger Sales Corp.
Jenison Machinery Co.
Link-Belt Co.
Thew Shovel Co., The

Truck Cranes
Harnischfeger Sales Corp.
Jenison Machinery Co.
Universal Crane Co., The

Trucks
International Harvester Co.
La France Republic Corp.
Linn Mfg. Corp., Division of La France-Republic Corp.
Sterling Motor Truck Co.

Tunnel Shovels
Bucyrus-Erie Co.
Harnischfeger Sales Corp.
Jenison Machinery Co.
Marion Steam Shovel Co.
St. Louis Power Shovel Co.

Turbines, Hydraulic
Pelton Water Wheel Co., The
Water Works Supply Co.

Turntables
Bacon Co., Edward R.
Jenison Machinery Co.

Unloaders, Car and Wagon
Bacon Co., Edward R.
Jenison Machinery Co.
Link-Belt Co.

Valves
California Corrugated Culvert Co.
Claussen & Co., C. G.
Golden Anderson Valve Co.
Industrial & Municipal Supply Co.
Pacific Pipe Co.
Water Works Supply Co.

Valves, Gate
California Corrugated Culvert Co.
Claussen & Co., C. G.
Pelton Water Wheel Co., The
Water Works Supply Co.

Valves, Hydraulic
California Corrugated Culvert Co.
Pelton Water Wheel Co., The
Water Works Supply Co.

Washers, Sand and Gravel
Diamond Iron Works, Inc.
Jenison Machinery Co.
Smith Engineering Works

Waterproofing Compounds
Inertol Company, Inc.

Water Purification
California Filter Co., Inc.
Industrial & Municipal Supply Co.
International Filter Co.
Wallace & Tiernan
Water Works Supply Co.

Water Softeners
California Filter Co., Inc.
International Filter Co.

Water Supply Installations
California Filter Co., Inc.
Industrial & Municipal Supply Co.
International Filter Co.
Wallace & Tiernan
Water Works Supply Co.

Water Transportation
American-Hawaiian Steamship Co.

Water Wheels
Pelton Water Wheel Co., The
Water Works Supply Co.

Water-Works Supplies
American Cast Iron Pipe Co.
California Filter Co., Inc.
Industrial & Municipal Supply Co.
International Filter Co.
Wallace & Tiernan
Water Works Supply Co.

Welding Apparatus (see Torches)
Oxweld Acetylene Co.
Victor Welding Equipment Co.

Welding Equipment
Taylor & George
Victor Welding Equipment Co.

Welding Rods and Wire
Victor Welding Equipment Co.

Welding Supplies
Oxweld Acetylene Co.
Victor Welding Equipment Co.

Well Casing
Montague Pipe & Steel Co.

Wheelbarrows
Harron, Rickard & McCone Co.
Jenison Machinery Co.

Windows, Steel
Truscon Steel Company

Wire Rope
American Steel & Wire Co.
Edwards Co., E. H.
Jenison Machinery Co.
Leschen & Sons Rope Co., A.
Worden Co., W. H.

OPPORTUNITY PAGE

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OFFICIAL BIDS

U. S. DEPARTMENT OF AGRICULTURE

Bureau of Public Roads

Grading—Arizona

San Francisco, California, October 15, 1930

Sealed bids, in single copy only, subject to the conditions contained herein, will be received until 2:00 o'clock p.m. on the 3d day of March, 1931, and then publicly opened, for furnishing all labor and materials and performing all work for grading the portion from Station 0+00 to Station 440+53 of Route No. 28, Houserock Canyon National Forest Highway, Arizona.

The length of the project to be graded is 8.4 miles and the principal items of work are approximately as follows:

Excavation, unclassified, 110,000 cu.yd.
Cement rubble masonry, 306 cu.yd.
Corrugated metal pipe in place, 2800 lin.ft.
Bridge timber, untreated, in place, 13 M.B.M.

Time of performance will be given in later Invitation for Bids which will be advertised on approximately February 10, 1931. As the country adjacent to the proposed construction will soon be covered with snow, contractors who desire to furnish a bid this winter are urged to go over the work not later than November 1, 1930. Prospective bidders may inspect the line as staked and review the rough draft of the plans by getting in touch with W. J. Nelson, Jacobs Lake, Arizona.

Where copies of plans and specifications are requested, a deposit of $10.00 will be required to insure their return. If these are not returned within 15 days after opening of bids, the deposit will be forfeited to the Government. Checks should be certified and made payable to the Federal Reserve Bank of San Francisco.

Guarantee will be required with each bid as follows: In the amount of five (5) per cent of the bid.

Performance bond will be required as follows: In the amount of one hundred (100) per cent of the total contract price.

Liquidated damages for delay will be the amount stated in the Special Provisions for each calendar day of delay until the work is completed and accepted.

Partial payments will be made as the work progresses for work and material delivered if such work and material meet the approval of the contracting officer.

Article on patents will be made a part of the contract.

Bids must be submitted upon the Standard Government Form of Bid and the successful bidder will be required to execute the Standard Government Form of Contract for Construction.

The right is reserved, as the interest of the Government may require, to reject any and all bids, to waive any informality in bids received, and to accept or reject any items of any bid, unless such bid is qualified by specific limitation. It is expected that $200,000.00 will be made available for doing this work. Award of contract will not be made until and unless the necessary funds therefor have been appropriated by Congress or otherwise made available.

Envelopes containing bids must be sealed, marked, and addressed as follows:
Bid for Road Construction.
Project 28-B, Houserock Canyon National Forest Highway, Arizona. 807 Sheldon Bdg., 461 Market Street, San Francisco, California.

C. H. SWEETSER,
District Engineer, Bureau of Public Roads.

UNITED STATES DEPARTMENT OF THE INTERIOR

National Park Service

Surfacing and Bituminous Treatment—Arizona

San Francisco, California, October 15, 1930

Sealed bids, in single copy only subject to the conditions contained herein, will be received until 2:00 o'clock p.m. on the 3d day of March, 1931, and then publicly opened, for furnishing all labor and materials and performing all work for surfacing and applying bituminous surface treatment on Project 4 (Surfacing), Bright-Angel Springs-North Entrance, on the North Rim of the Grand Canyon National Park, Arizona.

The length of the project to be surfaced is 9.97 miles.

Time of performance and approximate quantities will be given in a later Invitation for Bids which will be advertised on approximately February 10, 1931. As the country adjacent to the proposed construction will soon be covered with snow, contractors who desire to furnish a bid this winter are requested to go over the work not later than November 1, 1930.

Prospective bidders may inspect the work and proposed quarry sites by getting in touch with R. Thirion, Associate Highway Engineer, either at Kaibab Forest or V. T. Ranch, Arizona.

Where copies of plans and specifications are requested, a deposit of $10.00 will be required to insure their return. If these are not returned within 15 days after opening of bids, the deposit will be forfeited to the Government. Checks should be certified and made payable to the Federal Reserve Bank of San Francisco.

Guarantee will be required with each bid as follows: In the amount of five (5) per cent of the bid.

Performance bond will be required as follows: In the amount of one hundred (100) per cent of the total contract price.

Liquidated damages for delay will be the amount stated in the Special Provisions for each calendar day of delay until the work is completed and accepted.

Partial payments will be made as the work progresses for work and material delivered if such work and material meet the approval of the contracting officer.

Article on patents will be made a part of the contract.

Bids must be submitted upon the Standard Government Form of Bid and the successful bidder will be required to execute the Standard Government Form of Contract for Construction.

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

It is expected that $90,000.00 will be made available for doing this work. Award of contract will not be made until and unless the necessary funds therefor have been appropriated by Congress or otherwise made available.

Envelopes containing bids must be sealed, marked, and addressed as follows:
Bid for Road Surfacing.
Project 4 (Surfacing), Bright Angel Springs-North Entrance, Grand Canyon National Park, 807 Sheldon Bdg., 461 Market Street, San Francisco, California.

C. H. SWEETSER,
District Engineer, Bureau of Public Roads.

UNITED STATES DEPARTMENT OF THE INTERIOR

National Park Service

Surfacing and Bituminous Treatment

San Francisco, California, October 15, 1930

Sealed bids, in single copy only subject to the conditions contained herein, will be received until 2:00 o'clock p.m. on the 10th day of March, 1931, and then publicly opened, for furnishing all labor and materials and performing all work for surfacing Section E and applying bituminous surface treatment on Sections A, B, C, D, and E, Route No. 1, Loop Route, Lassen Volcanic National Park, California.

The length of the project to be surfaced is 7.71 miles and the length of project on which bituminous surface treatment is to be applied is 29.77 miles.

Time of performance and approximate quantities will be given in a later invitation for bids which will be advertised on approximately February 17, 1931. As the country adjacent to the proposed work will soon be covered with snow, contractors who desire to furnish a bid this winter are requested to go over the work not later than November 1, 1930.

Prospective bidders may inspect the work and proposed quarry sites by getting in touch with J. A. Killalee, Junior Highway Engineer, Viola, California.

Where copies of plans and specifications are requested, a deposit of $10.00 will be required to insure their return. If these are not returned within 15 days after opening of bids, the deposit will be forfeited to the Government. Checks should be certified and made payable to the Federal Reserve Bank of San Francisco.

Guarantee will be required with each bid as follows: In the amount of five (5) per cent of the bid.

Performance bond will be required as follows: In the amount of one hundred (100) per cent of the total contract price.

Liquidated damages for delay will be the amount stated in the Special Provisions for each calendar day of delay until the work is completed and accepted.

Partial payments will be made as the work progresses for work and material delivered if such work and material meet the approval of the contracting officer.

Article on patents will be made a part of the contract.

Bids must be submitted upon the Standard Government Form of Bid and the successful bidder will be required to execute the Standard Government Form of Contract for Construction.

The right is reserved, as the interest of the Government may require, to reject any and all bids, to waive any informality in bids received, and to accept or reject any items of any bid, unless such bid is qualified by specific limitation. It is expected that $160,000 will be made available for doing this work. Award of contract will not be made until and unless the necessary funds therefor have been appropriated by Congress or otherwise made available.

Envelopes containing bids must be sealed, marked, and addressed as follows:
Bid for Road Surfacing.
Sections A, B, C, D, and E, Route No. 1, Loop Route, Lassen Volcanic National Park, 807 Sheldon Bdg., 461 Market Street, San Francisco, California.

C. H. SWEETSER,
District Engineer, Bureau of Public Roads.

SITUATIONS WANTED

SITUATION WANTED—A labor foreman, experienced, sewer construction, concrete, street, curb and gutter walks, pipe lines, general work. R. Smith, 404 Chestnut Street, Redwood City, Calif.

POSITION WANTED. I am a middle-aged man with 10 years' experience as superintendent and foreman on highway and bridge construction, familiar with asphalt, concrete or any other type; also grading. Best of references. 466 49th St., Milwaukee, Wis.

SITUATION WANTED—Estimator and licensed engineer, college graduate, 15 years' experience on building construction and engineering work, steady and reliable, go anywhere. E. A. Root, 4642 W. 18th St., Los Angeles.

SITUATION WANTED—Experienced Diesel engineer and operator wants a steady position. Has had four years' experience on Atlas Imperial Diesel engines. Box 510, Western Construction News.

OPPORTUNITY PAGE

CONTINUED

OFFICIAL BIDS

NOTICE TO CONTRACTORS

Bridge

Sealed proposals will be received at the office of the State Highway Engineer, Public Works Building, Sacramento, California, until 2 o'clock p.m. on November 12, 1930, at which time they will be publicly opened and read, for construction in accordance with the specifications therefor, to which special reference is made, of portions of State Highway, as follows:

Kern County, four timber bridges from seventeen to twenty-one miles west of Wasco (VI-Ker-33-C), one composed of twelve 19-foot spans, one composed of four 19-foot spans, and two composed of two 19-foot spans each, all on framed bents with concrete footings.

Proposal forms will be issued only to those Contractors who have furnished a verified statement of experience and financial condition in accordance with the provisions of Chapter 644, Statutes of 1929, and whose statements so furnished are satisfactory to the Department of Public Works. Bids will not be accepted from a Contractor to whom a proposal form has not been issued by the Department of Public Works.

Plans may be seen, and forms of proposal, bonds, contract and specifications may be obtained at the said office, and they may be seen at the offices of the District Engineers at Los Angeles and San Francisco, and at the office of the District Engineer of the district in which the work is situated. The District Engineers' offices are located at Eureka, Redding, Sacramento, San Francisco, San Luis Obispo, Fresno, Los Angeles, San Bernardino and Bishop.

A representative from the district office will be available to accompany prospective bidders for an inspection of the work herein contemplated, and Contractors are urged to investigate the location, character and quantity of work to be done, with a representative of the Division of Highways. It is requested that arrangements for joint field inspection be made as far in advance as possible. Detailed information concerning the proposed work may be obtained from the district office.

No bid will be received unless it is made on a blank form furnished by the State Highway Engineer. The special attention of prospective bidders is called to the "Proposal Requirements and Conditions" annexed to the blank form of proposal, for full directions as to bidding, etc.

The Department of Public Works reserves the right to reject any or all bids or to accept the bid deemed for the best interests of the State.

DEPARTMENT OF PUBLIC WORKS,
DIVISION OF HIGHWAYS.
C. H. PURCELL, State Highway Engineer.
Dated October 15, 1930.

NOTICE TO CONTRACTORS

Grading and Paving

Sealed proposals will be received at the office of the State Highway Engineer, Public Works Building, Sacramento, California, until 2 o'clock p.m. on November 5, 1930, at which time they will be publicly opened and read, for construction in accordance with the specifications therefor, to which special reference is made, of portions of State Highway, as follows:

Kern County, near Wasco (VI-Ker-33-D), about two-tenths (0.2) mile in length, to be graded and paved with Portland cement concrete.

Proposal forms will be issued only to those Contractors who have furnished a verified statement of experience and financial condition in accordance with the provisions of Chapter 644, Statutes of 1929, and whose statements so furnished are satisfactory to the Department of Public Works. Bids will not be accepted from a Contractor to whom a proposal form has not been issued by the Department of Public Works.

Plans may be seen, and forms of proposal, bonds, contract and specifications may be obtained at the said office, and they may be seen at the offices of the District Engineers at Los Angeles and San Francisco, and at the office of the District Engineer of the district in which the work is situated. The District Engineers' offices are located at Eureka, Redding, Sacramento, San Francisco, San Luis Obispo, Fresno, Los Angeles, San Bernardino and Bishop.

A representative from the district office will be available to accompany prospective bidders for an inspection of the work herein contemplated, and Contractors are urged to investigate the location, character and quantity of work to be done, with a representative of the Division of Highways. It is requested that arrangements for joint field inspection be made as far in advance as possible. Detailed information concerning the proposed work may be obtained from the district office.

No bid will be received unless it is made on a blank form furnished by the State Highway Engineer. The special attention of prospective bidders is called to the "Proposal Requirements and Conditions" annexed to the blank form of proposal, for full directions as to bidding, etc.

The Department of Public Works reserves the right to reject any or all bids or to accept the bid deemed for the best interests of the State.

DEPARTMENT OF PUBLIC WORKS,
DIVISION OF HIGHWAYS.
C. H. PURCELL, State Highway Engineer.
Dated October 8, 1930.

NOTICE TO CONTRACTORS

Bridges

Sealed proposals will be received at the office of the State Highway Engineer, Public Works Building, Sacramento, California, until 2 o'clock p.m. on October 29, 1930, at which time they will be publicly opened and read, for construction in accordance with the specifications therefor, to which special reference is made, of portions of State Highway, as follows:

San Mateo County, a reinforced concrete girder bridge across Redwood Slough near Redwood City (IV-S.M-68-C), consisting of three 35-foot spans and one 22-foot span on concrete pile bents.

Los Angeles County, a reinforced concrete girder bridge over the Atchison, Topeka & Santa Fe Railway at Manhattan Beach (VII-L.A-60-C), consisting of one 42-foot span, two 31-foot spans, one 30-foot 10-inch span and one 30-foot 2-inch span on concrete bents.

Proposal forms will be issued only to those Contractors who have furnished a verified statement of experience and financial condition in accordance with the provisions of Chapter 644, Statutes of 1929, and whose statements so furnished are satisfactory to the Department of Public Works. Bids will not be accepted from a Contractor to whom a proposal form has not been issued by the Department of Public Works.

Plans may be seen, and forms of proposal, bonds, contract and specifications may be obtained at the said office, and they may be seen at the offices of the District Engineers at Los Angeles and San Francisco, and at the office of the District Engineer of the district in which the work is situated. The District Engineers' offices are located at Eureka, Redding, Sacramento, San Francisco, San Luis Obispo, Fresno, Los Angeles, San Bernardino and Bishop.

A representative from the district office will be available to accompany prospective bidders for an inspection of the work herein contemplated, and Contractors are urged to investigate the location, character and quantity of work to be done, with a representative of the Division of Highways. It is requested that arrangements for joint field inspection be made as far in advance as possible. Detailed information concerning the proposed work may be obtained from the district office.

No bid will be received unless it is made on a blank form furnished by the State Highway Engineer. The special attention of prospective bidders is called to the "Proposal Requirements and Conditions" annexed to the blank form of proposal, for full directions as to bidding, etc.

The Department of Public Works reserves the right to reject any or all bids or to accept the bid deemed for the best interests of the State.

DEPARTMENT OF PUBLIC WORKS,
DIVISION OF HIGHWAYS.
C. H. PURCELL, State Highway Engineer.
Dated October 1, 1930.

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

Pumping Plant Equipment

Washington, D. C., September 15, 1930.

Sealed bids (Specifications No. 514) will be received at the office of the Bureau of Reclamation, Denver, Colorado, until 3:00 o'clock p.m., October 31, 1930, and will at that hour be opened, for furnishing one pump having a capacity of 180 second-feet when operating under a total effective head of 31 feet; one 800-horsepower, 2200-volt, 3-phase, 60-cycle, synchronous motor, and auxiliary and control apparatus, as listed in the schedule, for pumping Station No. 1, Minidoka Project, Idaho. All apparatus will be installed by the Government. For particulars, address the Bureau of Reclamation, Burley, Idaho; Denver, Colorado; or Washington, D. C.

P. W. DENT,
Acting Commissioner.

HELP WANTED

As listed by the Engineering Societies' Employment Service, 57 Post Street, San Francisco. Applicants will please apply direct to them.

HELP WANTED—By reliable manufacturer of construction equipment, competent factory sales representative for West Coast. State qualifications and full experience in first letter. Box 425, Western Construction News.

WANTED—First-class mechanic having wide experience on gas shovels, trucks, compressors, pumps, and electrical equipment. To take complete charge; salary open; long road job in the mountains, A-1 camp conditions. References required. Write full details of experience in first letter. Box 400, W.C.N.

MECHANICAL ENGINEER with considerable experience in the design and manufacture of pressure pumps, to design same for 600 pounds working pressure. Good opportunity for an experienced designer. Apply by letter. Location, Northern California. R-3358-S.

STRUCTURAL DRAFTSMAN, about 30 years old, technical graduate, with experience covering design and layout of steel, concrete and timber structures. Salary depends upon ability. Location, San Francisco. R-3353-S.

VALUATION ENGINEER, preferably technical graduate, not over 35 years, for special work requiring several years' experience in plant operation or commercial department of telephone company. Salary $2700 per year. Apply by letter. Headquarters, San Francisco. R-3322-S.

JUNIOR SALES ENGINEER, 25-26 years old, with sales ability and initiative for permanent opportunity with salary. The line sells to industries and utilities. Apply by letter with photo. Location, San Francisco. R-3338-S.

DESIGNING ENGINEER, civil, capable of designing, surveying and planning hydro-electric developments, including dams, etc. Chief emphasis on design. Apply only by letter. Location, Europe. W-1413.

CIVIL ENGINEER, graduate with experience in the design and construction of sewers and water works, to purchase an interest in an engineering business. Some experience in electrical engineering desirable. Apply only by letter. Location, Kansas City. W-499-C-S.

SALES ENGINEER for the sale of creosoted wood products. This experience desirable but not essential. Apply by letter. Headquarters. South. Travelling. X-7633-C-S.

ENGINEER, young, either employed now or recently employed on design of hydraulic equipment, particularly centrifugal pumps. Apply by letter giving all details of experience, salary, etc. Location, Middle West. K-297-W-1288-C-S.

PROFESSIONAL DIRECTORY

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