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Bureau of Reclamation

OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES

RELEASE NO. 28

April, May and June 1959

CONTENTS

All-American Canal Trashrack at Imperial Dam is protected cathodically by anodes shown attached to downstream side of structure. Photo No. 212-A-9673.

OPERATION AND MAINTENANCE

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INTRODUCTION

We are indebted to Mr. G. E. Tank, General Manager, Imperial Irrigation District, Imperial, California, and to two of his operations men, L. R. McGlocklin, Superintendent, River Division, and C. H. Youngstrom, Senior Electrical Engineer, who have prepared the excellent article included in this issue of the bulletin describing the use of cathodic protection of submerged metalwork on the All-American Canal System, Boulder Canyon Project, California. The protection of submerged metalwork is of major concern on all projects, but more particularly in the corrosive water used in the irrigation of the Imperial and Coachella Valleys of Southern California, and other areas in the Southwest.

This bulletin, published quarterly, is circulated for the benefit of irrigation project operation and maintenance people. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. Reference to a trade name does not constitute the endorsement of a particular product, and omission of any commercially available item does not imply discrimination against any manufacturer. It is hoped that the labor-saving devices or less costly equipment developed by the resourceful water users will be a step toward commercial development of equipment for use on irrigation projects in a continued effort to reduce costs and increase operating efficiency.

To assure proper recognition to those individuals whose suggestions are published in this and subsequent bulletins, the suggestion number as well as the person's name is being given. All Bureau offices are reminded to notify their Suggestions Awards Committee when a suggestion is adopted.

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Division of Irrigation Operations
Commissioner's Office
Denver, Colorado

CATHODIC PROTECTION OF SUBMERGED METALWORK
on the
All-American Canal System
Boulder Canyon Project

The protection of submerged metalwork against electrolytic deterioration, or corrosion, is considered a major maintenance and economic problem by the Imperial Irrigation District in its role of diverting and delivering Colorado River water via Imperial Dam and the All-American Canal, of the Boulder Canyon Project, for over half-a-million acres of the Imperial and Coachella Valleys of Southern California.

Basically, the problem of corrosion or oxidation on a metal surface submerged in water is an electro-chemical reaction in which the flow of an electrical current from the metal to the water permits the pitting and rusting of underwater steel. This phenomena can be reduced or eliminated by stopping the flow of current.

Coating of the metal surface to insulate it from the water continues to be the most widely accepted method of accomplishing the needed protection. The problems and costs involved in selecting correct coatings, scheduling work, preparing surface and applying coatings are well known to men charged with the responsibility of protecting irrigation works.

Initial Installations

It was the inquisitiveness inherent in good maintenance men that caused the Bureau of Reclamation to initiate in 1950, and the Imperial Irrigation District to improve, a system of preservation known as cathodic protection for submerged metalwork of the trashrack, headgates and desilting basin clarifiers for the All-American Canal at Imperial Dam. Cathodic protection is used generally at all checks, drops and turnouts on the All-American Canal.

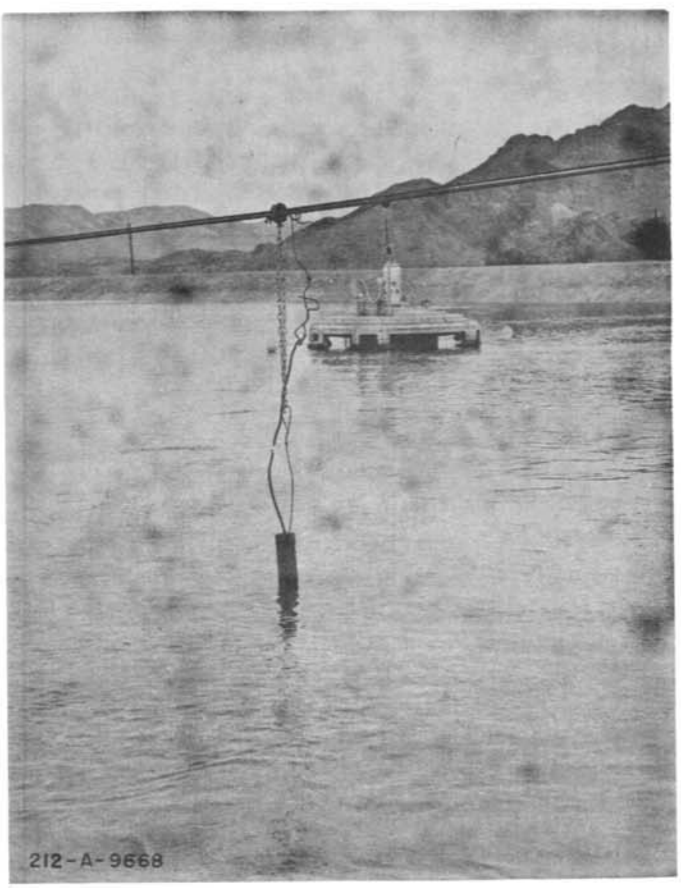
Corrosion and cathodic protection involve the electrochemical principles of a primary battery, of which the common dry cell is an example. In the cell, a direct current flows from the anode, which corrodes, through the electrolyte to the cathode, which does not corrode. By making the metal to be protected the cathode, of an electrolytic or galvanic cell using an external anode, natural corrosion currents are neutralized, and corrosion does not take place. This can be accomplished by impressing a direct current between the external anode and the metal to be protected with a rectifier or other direct-current source. Cathodic protection can also be done by making the metal to be protected the cathode of a primary battery by choosing the proper material for the external anode. Such anodes are called galvanic or sacrificial anodes. When a submerged steel surface is receiving cathodic protection, a protective film of hydrogen, calcium carbonate, and other chemical forms on the surface of the metal, and this film is being constantly renewed by keeping the metal surface charged cathodically. An analysis of water being used for irrigation in the system shows 163 parts per million of calcium carbonate, with a pH ranging from 7.2 to 8.4.

Installations With and Without a Power Source

Direct current power for cathodic protection is supplied by a rectifier, where alternating current is readily available. Where electric power is not convenient to the structure, galvanic or sacrificial anodes can be used. Magnesium or zinc are two types of anodes commonly used without an external source of power. The magnesium or zinc anode and the submerged steel surface to be protected constitute a galvanic cell. Since the magnesium or zinc has a higher solution potential than the submerged steel surface, a driving force of approximately one volt is obtained from this combination and the necessary cathodic protection current flows through the circuit. As this current flows, the anode gradually dissolves at a rate proportional to the amount of current. A resistor is used when required to regulate the current.

Cathodic Protection Supplements Surface Coatings

In most cases it is desirable to use cathodic protection supplemental to regular surface coatings both to increase the time between recoatings and to minimize the cost of cathodic protection. As a coating begins to fail, the area requiring protection increases. Experience has shown, however, that a current of approximately one milliampere per square foot of submerged area to be protected is adequate. Experience also has shown that for best results, the object being protected must be grounded; i.e., connected to the negative pole of the rectifier.

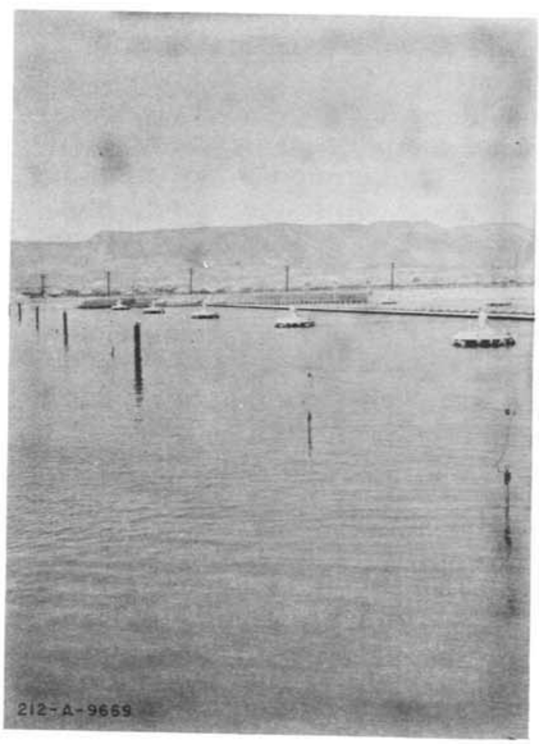


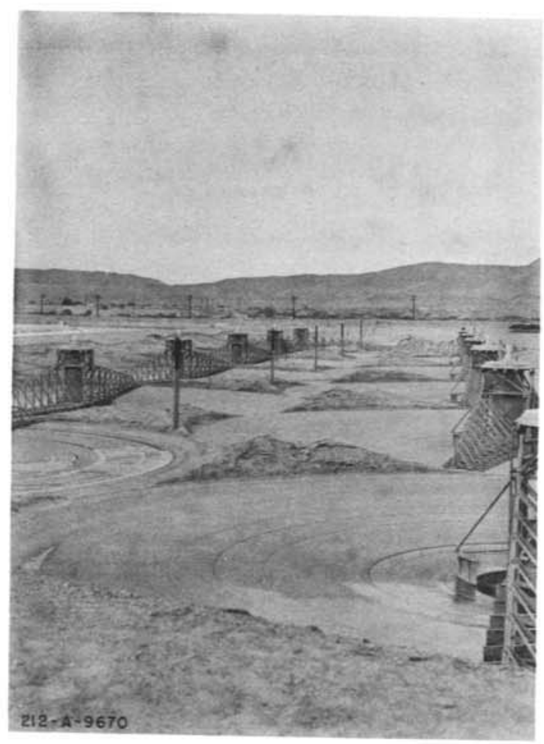
Type of Anodes

The Bureau of Reclamation experimented with scrap iron anodes which were satisfactory except for their rapid and irregular dissipation requiring frequent replacement and allowing chunks of metal to fall into the desilting basins plugging the underflow valves. At the time the Imperial Irrigation District assumed responsibility for care, operation and maintenance of the All-American trashrack, headworks and desilting basins in 1952, the Bureau was experimenting with graphite anodes, such as that shown at left. These anodes are available commercially, and in 1953 were costing about $16.00 for a 3-inch diameter by 60-inch long anode, weighing 28 or 29 pounds. The graphite anodes were a definite improvement over the scrap iron anodes, and the District converted to graphite as rapidly as possible at Imperial Dam.

Location of Anodes

Experience has shown that to protect a given structure or group of structures; e.g., one side of a desilting basin having 12 clarifiers and considerable underground conduit and piping, that it was more efficient to use additional anodes spacing them opposite the clarifiers rather than equidistant from each other. Using 12 equally spaced anodes in one half of a desilting basin, and an impressed current of 29 amperes, or 2.42 amperes per anode, certain anodes were weighed periodically, for one twelve-month period. The rate of dissipation was 6.15 pounds per year for a total of 73.8 pounds for the half-basin. During another twelve-month period using 20 anodes, including 13 suspended opposite the clarifiers and 7 anodes buried in the sand floor, and an impressed current of 26 amperes, 0.30 amperes per anode, the rate of dissipation for a twelve-month period dropped to 2.73 pounds per anode for a total of 54.6 pounds. Thus a 26 percent reduction in rate of anode dissipation was effected while providing more efficient protection to approximately 35,000 square feet of submerged and buried metal surface in this half-basin. Suspension of the anodes in South half-basin No. 3





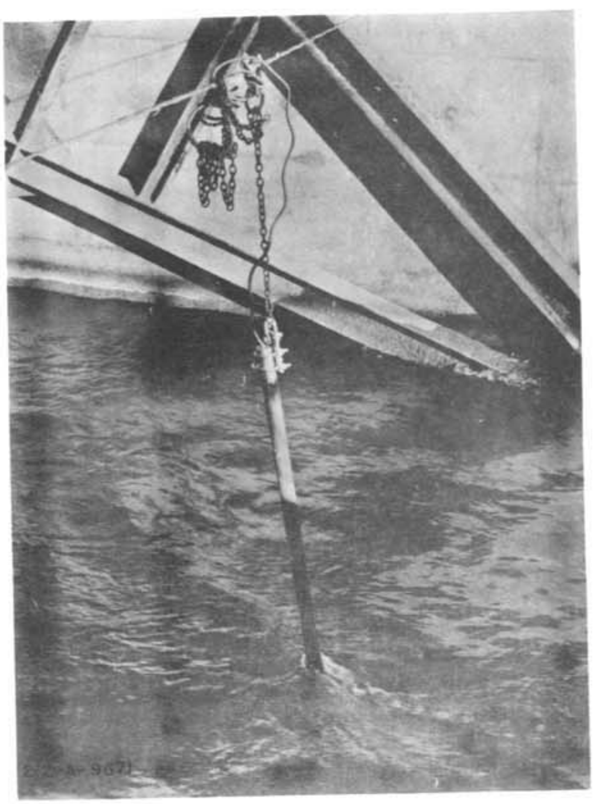
of the All-American Desilting Basin is shown in the left photograph above. The rotary scrapers in South half-basin No. 2 in the right photograph.

Experience at Desilting Works

The coating on the desilting basin clarifiers is a coal-tar enamel. The machines were exposed to the weather for about three years before the Bureau of Reclamation began experimentation with cathodic protection. At the time the Imperial Irrigation District assumed responsibility for operation and maintenance of the facility, the coal-tar coating was in fair condition, with fair bond to the steel. Extensive cracks were noted, but no excessive corrosion.

Numerous failures had occurred in the underground sludge lines, water lines, and metal conduits of the desilting basins. After the protective system was expanded to include anodes buried in the basin floors, there have been no additional failures in the underground piping for the past two years.

The graphite anode dissipates evenly, tapering to a point at its lower extremity; however, its useful life terminates at about 8 or 9 pounds when it becomes quite thin and fragile. Thus, the graphite anode has an effective weight of 20 pounds, and if efficiently employed should last from three to seven years.



In 1955, a high-silicon, cast-iron, anode was marketed. These were tried experimentally and found to have a very low rate of dissipation. One of the anodes of this type is shown with an adjustable chain suspension in the photograph at left. These anodes are 2 inches in diameter, 60 inches long, and weigh about 48 pounds. Their cost is about $19.00 per anode. For comparison with the graphite anode mentioned above; while the graphite anode was dissipating at the rate of 2.73 pounds per year, an experimental high-silicon, cast-iron, anode in the same half-basin, lost only 0.75 pound. Because of their greater mechanical strength and promised longer life, the District is changing to high-silicon, cast-iron anodes as replacement becomes necessary.

The desilting works for the All-American Canal are composed of three large basins, each being divided in half by an influent channel. The 72 clarifiers have a total submerged steel surface area estimated at nearly 200,000 square feet, yet the cost of maintaining the desilting basin cathodic protection system for the year 1958 was less than $2,000. The estimated cost of sandblasting and coating this complicated machinery would be approximately $300,000, making evident economy effected by cathodic protection.

Evaluation of Protection Provided

The Bureau of Reclamation employed the use of coupons, or test plates of clean steel, strategically located on the structures and available for ready observation of effectiveness of the cathodic protection system. The District has also cleaned test areas to bare metal, on the individual structures, for observation. It became evident, however, in order to design or improve a cathodic protection system to assure adequate corrosion control that more refined methods of evaluating the system should be employed.

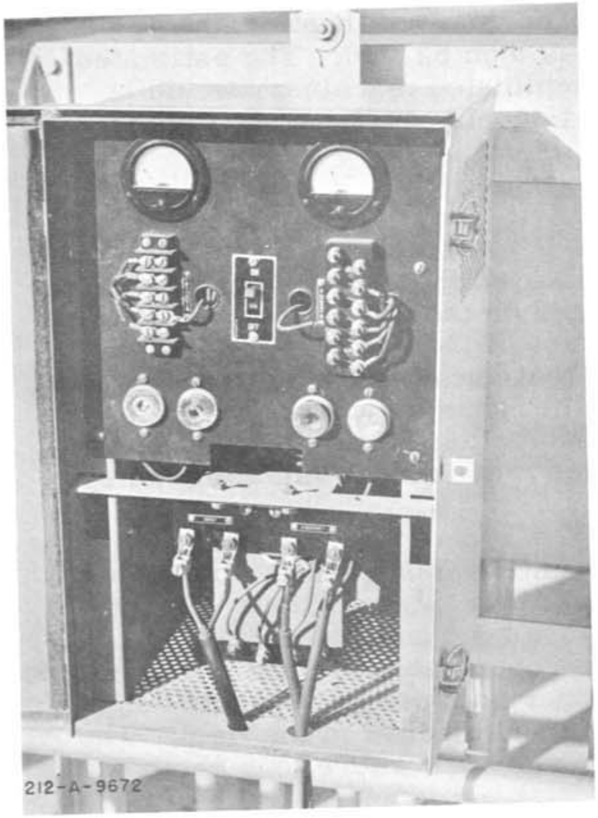
Data obtained from the American Gas Association, the National Association of Corrosion Engineers, and other organizations, clearly indicated the need of instruments to assure adequate protection. A "Rhodes" Potentiometer Voltmeter, one copper sulphate and one lead chloride half-cell were purchased. The copper sulphate half-cell is the most convenient since it can be prepared and cleaned in the field. The lead chloride cell with a jellied solution was used where long periods of immersion were required.

The method of determining whether a structure is receiving adequate protection is to attach the half-cell to a pole, and with leads connected to the instrument, hold the cell 3 to 6 inches from the metal surface about a foot below the water line. The rectified current is then adjusted until the voltage of the copper sulphate half-cell is 0.85-volts positive to the steel surface. (A 0.70-voltage between the copper sulphate half-cell and steel is considered as a minimum to assure protection.)

The lead chloride half-cell was useful where it was necessary to leave the cell submerged for a long period. A 0.2-volt difference of the lead chloride half-cell to the steel surface was found to assure protection.

Typical Installations

Many cathodic protection installations employ the dry disc or plate type rectifier which converts the usual alternating current commercial power to direct current. The rectifier unit usually contains a transformer to reduce the input voltage to 20 volts or less, tap-changing links or rheostats to adjust the voltage, and fuses or circuit breakers to protect the equipment from overload. A voltmeter and an ammeter are usually provided in order to assure proper operation. A rectifier unit of a cathodic protection system at a check on the All-American Canal is shown in the photograph at the top of the following page.



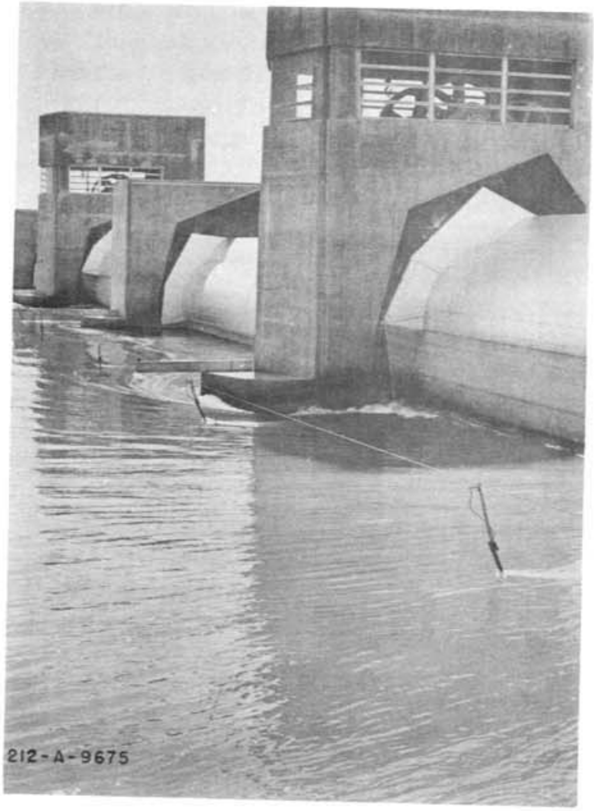
In the installation of a protective system for a structure, the main criterion is the placing of the anodes to give an even distribution of current, as evidenced by half-cell voltages; however, existing conditions for a given structure, such as velocity of water flow, access for maintenance, and structural design will require compromises.

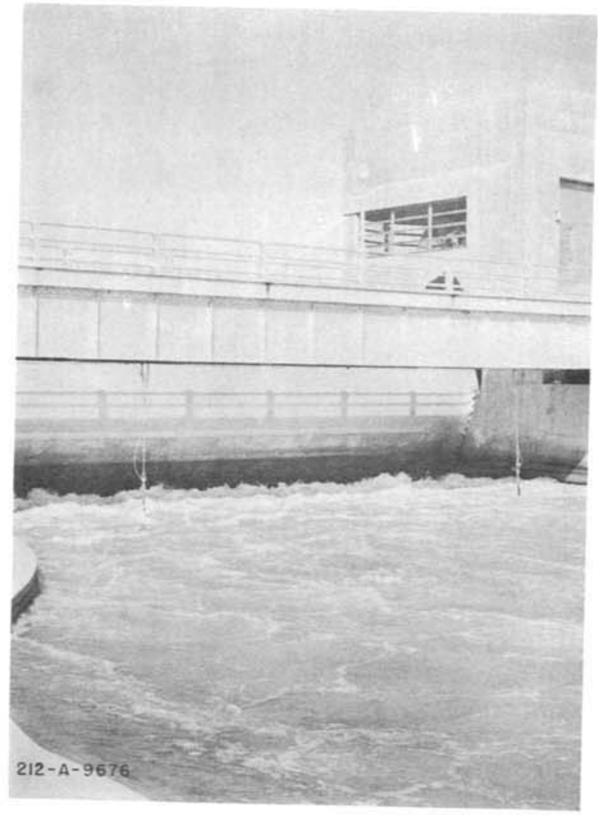
The trashrack for the All-American Canal headworks at Imperial Dam, as shown on the cover of this issue of the bulletin, is an example of a compromise. Here anodes should be placed both in front of and in the rear of the structure. The operation involved in cleaning the trashrack prohibits the use of anodes in front of the rack; therefore, a compromise was made by placing anodes only in the rear of the rack, as shown in the lower photograph, with enough current applied to obtain a fair protection of the front.

The original coal-tar enamel coating on the trashrack and screens is still in fair condition, although the rack has been in service since its completion in 1938.

The protective system for the All-American Canal headgates, as shown on the following page is a typical installation for large gates. Two anodes are suspended upstream and downstream from each of the four 75-foot wide gates. The 3/8-inch messenger cable supporting the anodes also serves as the conductor for the rectified current.

The Bureau has installed only upstream anodes prior to the District's assumption of responsibility in 1952. The original red

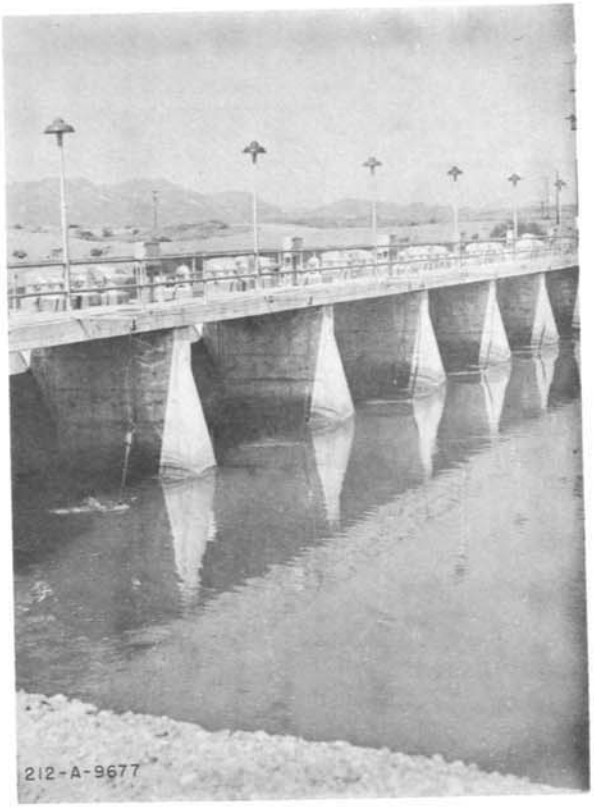




lead primer and aluminum coating was in fair condition on the front of the gates, but the ends and downstream portions were seriously corroded. This was especially true of areas near the water surface subjected to water spray from turbulence. The District sandblasted the submerged portions and corroded areas of each gate and applied an acid-cured zinc, in inorganic vehicle, coating. The above water portion of the gates was wire brushed and spotted with vinyl resin primer followed by vinyl resin aluminum paint.

The use of cathodic protection for the upstream side of the numerous radial gates on the All-American Canal is usually simplified because the water surface elevations at the gates are constant and approach velocities are usually low. A typical installation at a check is shown in the photograph on the following page in which the anodes are centered in the middle of the gate bay and suspended a few feet upstream from the deck of the structure.

The downstream side of the radial gates is more of a problem. The portion of the gate submerged by backwater is protected by the normal installation except that the anodes may have to be placed far enough downstream to avoid excessively turbulent water. Such an installation is shown in the photograph on page 4. To balance the current between the front and rear of the gates, it is necessary to use resistance in the leads to the anode lines.



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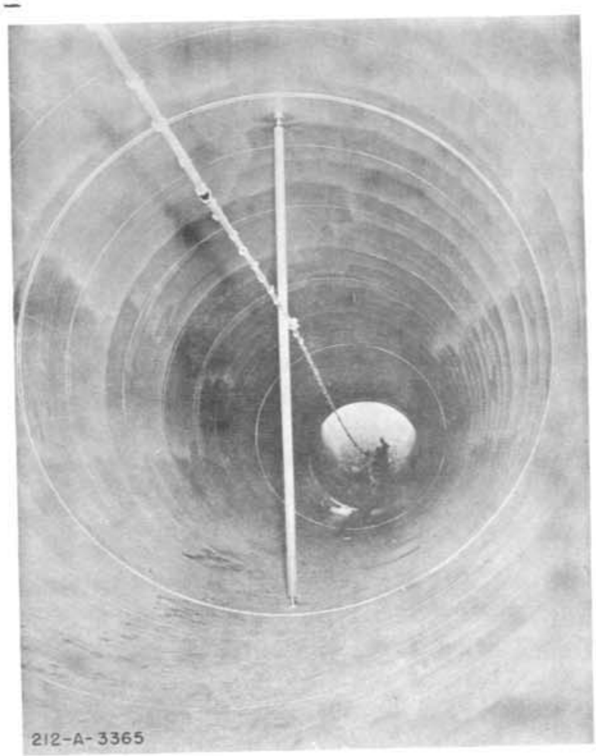

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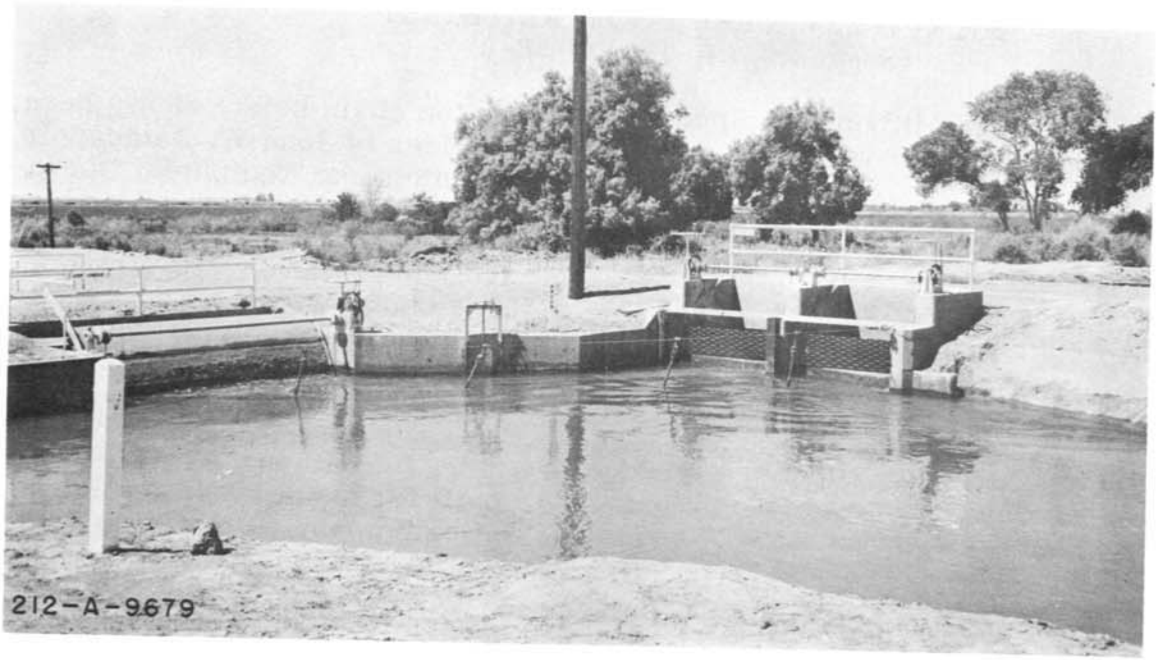
The portion of the gate above normal water surface is subject to spray due to turbulent water and leakage. The only protection against corrosion in this area is the proper application of paint.

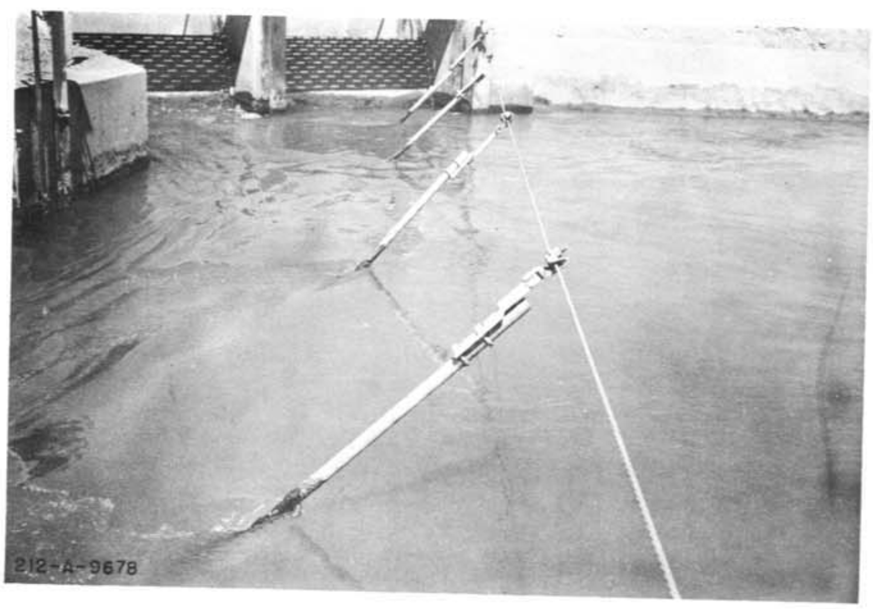
Application of cathodic protection to the New River Siphon was complicated by the large size of the structure. This siphon consists of two steel barrels, one of which is shown in the lower photograph. Each barrel is 15'-6" in diameter with an overall length of 476 feet and the water velocity is about 7 fps. Two types of anodes are used. The anode in the west barrel, the one shown in the photograph, is of magnesium and depends on galvanic action between the magnesium of the anode and the iron of the barrel for cathodic protection. The second, or east, barrel has a steel rod anode and cathodic protection is provided by a rectifier.

Both anodes extend throughout the length of the barrel and are suspended in the center on a steel messenger cable covered by a plastic tube. Regulation of cathodic protection current in the magnesium anode installation is provided by an external resistor. District experience shows that the protection afforded the siphon barrels by either the impressed current system with iron anode or the galvanic system with magnesium anode is equal and sufficient. The fouling of anode supports by floating trash has not been serious.

Smaller structures on the All-American Canal system are also being protected by cathodic methods. An example of some of the smaller installations is the check and turnout illustrated in the photographs on the following page.

A general view of the check





and turnout arrangement of the anodes is shown in the upper photograph. The anodes of this protective system are magnesium.

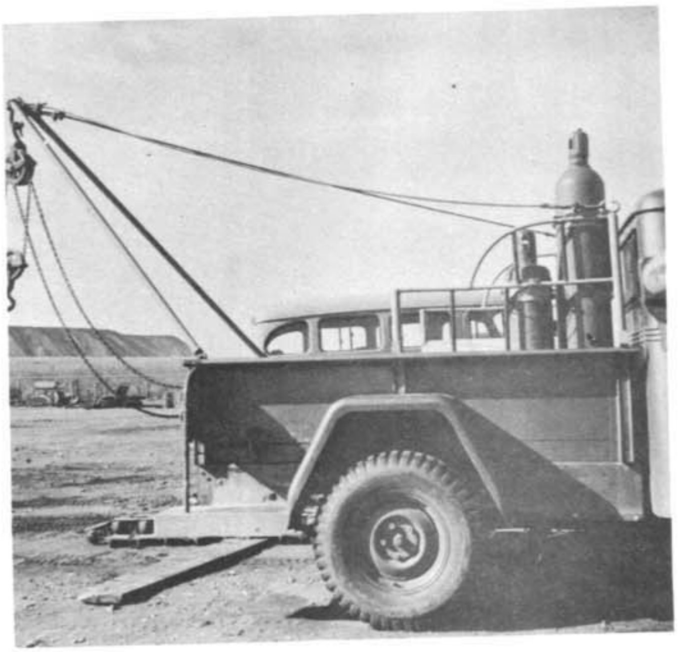
The method used in suspending the anodes and more detail of the suspension device and attachment of the anodes to the messenger cable are shown in the photograph at left.

Judging from the number of inquiries relative to cathodic protection received in Denver, this interesting presentation by L. R. McGlocklin and C. H. Youngstrom, Superintendent of the River Division and Senior Electrical Engineer, respectively, of the Imperial Irrigation District of the use being made of cathodic protection will be followed closely by many.

* * * * *

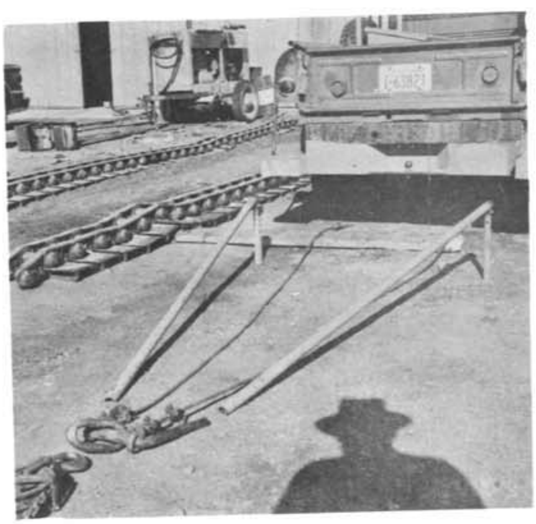
PICKUP MOUNTED BOOM AND HOIST
(Suggestion R-5-APO-58-8)

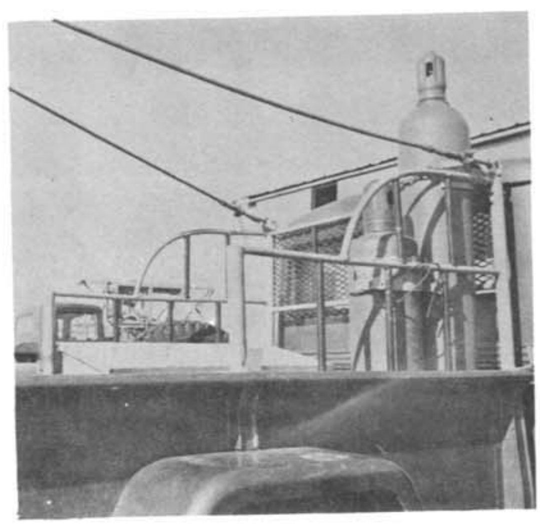
The small boom equipped with a 3/4-ton chain hoist, shown here, mounted on the rear of a pickup truck, was an idea of John W. James, Jr., Maintenance Equipment Operator, of the San Marcial Field Branch of the Middle Rio Grande Project, New Mexico. The boom has been very efficient in handling parts assemblies that weigh in excess of 1,200 pounds.



Although designed and built for handling large pieces of equipment, it has been most useful in loading and unloading with fewer men, heavy items of steel, lumber, chemicals, etc.

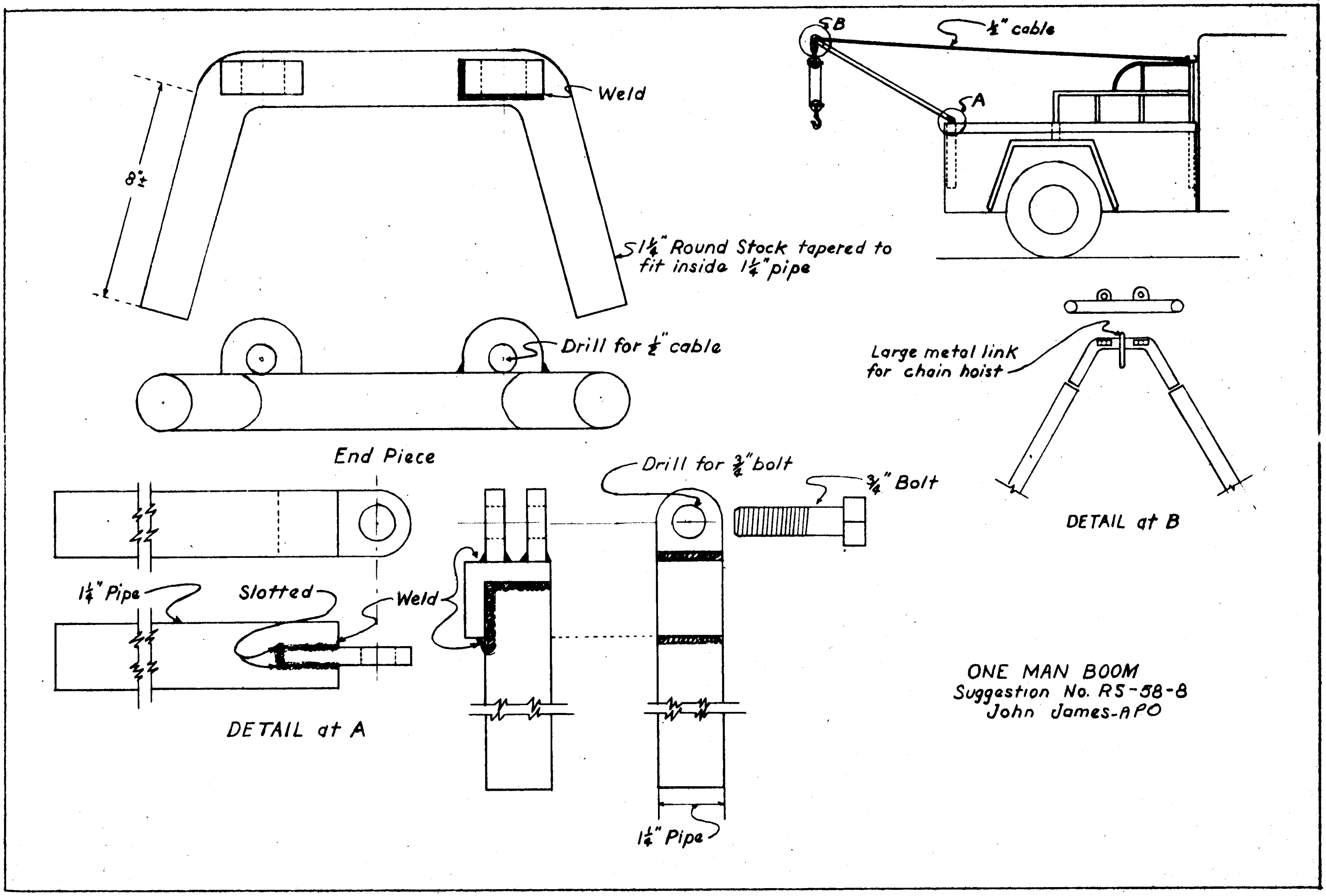
The boom was constructed of $1\frac{1}{4}$-inch pipe and $1\frac{1}{4}$-inch steel stock tapered to fit into the pipe. The boom is held in position for operation by one-half inch cable attached to





a pipe standard fitted into the stake welds in the sides of the bed. The boom can be quickly assembled and dismantled at the site of the work and can be fastened to the sides of the truck bed for transportation from one job to another. Details of construction are shown in the drawing on the facing page.

* * * * *


B
½" cable
A
Weld
8'±
1¼" Round Stock tapered to fit inside 1¼" pipe
Drill for ½" cable
Large metal link for chain hoist
End Piece
Drill for ¾" bolt
¾" Bolt
DETAIL at B
1¼" Pipe
Slotted
Weld
DETAIL at A
ONE MAN BOOM
Suggestion No. RS-58-8
John James-APO
1¼" Pipe

SAFETY CONFERENCE HIGHLIGHTS
Region 1

On January 12 and 13, 1959, the Region 1 Safety Conference was held in Boise, Idaho. Some 40 individuals participated in the conference--safety engineers from all over the region, design and construction engineers, Bureau attorneys, Bureau O&M people, and quite a number of irrigation operators from water user operated projects. A number of very excellent presentations were made and excerpts from some of these will be of interest to operation and maintenance personnel.

Mr. W. Burpee, Field Solicitor, commented regarding the handling of water:

> ". . . it is quite like handling dynamite--you are not dealing with an ordinary substance. Anyone who takes water out of its natural environment must recognize that he is dealing with a dangerous substance. Certain decisions have been given that he is responsible only if he is negligent. . . The amount of care you take to be sure that you are not incurring a liability, should be done by any means to insure that you are handling the water safely."

Regional Engineer Don Walter in discussing the prevention of accidents, stated:

> "Cooperation in the prevention of accidents is both a moral and personal obligation of each employee. I like to consider that each employee is a safety inspector, always exercising reasonable precaution, promptly reporting unsafe working conditions and observing applicable safety measures and procedures."

In view of the high frequency rate of accidents among Bureau O&M people (their record is the poorest in the Bureau), the explanation of why this might be true by the region's Chief of Irrigation Operation, Mr. Ted Nelson, will be of interest. Mr. Nelson remarked that:

> "Records reveal that 32 percent of all accidents take place on the farm . . . Irrigation O&M work in many ways is similar to farm work . . . many of the (O&M) workers come from the local farms.
>
> "There are many other reasons why it is difficult for O&M employees to work safely. One is that he has

to be a jack-of-all trades. Let us follow the working foreman of a small repair crew through the process of installing a small concrete structure in a lateral. First he has to load his truck so that he can have tools, equipment and material. Sometimes (he must drive) through difficult highway traffic to the job and it is not unusual that behind the truck he is trailing a concrete mixer. When he gets to the work site, the truck has to be unloaded so he can haul water and aggregate. Forms have to be built and the mixer set up. As work progresses, concrete is placed, forms are removed, the structure backfilled, props replaced and metalwork secured to the concrete and painted. In the process this small crew has in addition to using numerous hand tools, used the truck they rode to work in, a dragline or 'cat' to excavate and backfill the structure, the concrete mixer, water pump and possibly an air compressor. Following the completion of the job this same crew may be called upon to assist in the repair of a leak or break in a lateral, burn weeds, 'puddle-in' a washed out structure, and perform many other duties."

The truth of Mr. Nelson's remarks will be easily recognized by operation and maintenance organizations; that the great variety of duties irrigation O&M personnel are called upon to perform exposes them to a great variety of hazards. This means a much greater effort must be exerted in the safety training of O&M crews than would be necessary with a crew following a more or less set routine from day to day, if we are to better our safety record.

Mr. E. E. Ennis, Safety Engineer of the Columbia Basin Project spoke on the safety of the public on an irrigation project:

". . . getting influential people--and others--to go along with you (on matters of community safety) isn't a matter of occasionally walking in on some of them and giving them a sales pitch. You have to be an active participant in various community organizations and activities, the majority of which are not primarily interested in or connected with safety. By so doing you can make your contacts--your friendships--upon which to build your campaign of safety."

By assisting in the organization of the County Farm Safety Council, Mr. Ennis has been invited to provide speakers on safety for their meetings and through this organization's connections with the county agent, that official has been able to secure radio and TV time for the dispensing of safety information to the general public. Mr.

Ennis also stated:

> ". . . Unless we have the good will of the majority of the people in our communities, we are going to have a tough time selling safety.
>
> "Our field irrigation personnel have been very helpful in not only promoting safety, but in creating good will. We have tried to get the youngsters to swim elsewhere, other than our canals, especially if their chosen swimming hole happens to be near a drop or the head of a siphon. We haven't tried that by a 'get tough' policy. Rather, our ditchriders and others get out of their cars and explain to the kids why they shouldn't be swimming or fishing where they are. This seems to be paying off. When we find the occasional exception, we try to see his parents--tell them the dangers--the whys-- and usually we get cooperation.
>
> "Don't be afraid to toot your horn a little. Radio --the press--TV--(the people responsible for these publicity mediums) are always willing to give safety coverage. Of course they want something that catches the eye--that appeals to the public. For instance, . . . a husky young farmer fell into a check drop and really got churned up in the stilling pool. Just about didn't get out. Made a good story; first, he was a husky man; second, he was an experienced irrigator; third, he was a responsible member of the community. . ; and, fourth, he readily admitted that he nearly drowned. The angle we played up was this-- if this type of man can accidentally fall into a lateral--nearly drowns--then what would happen if a youngster fell in."

Harold T. Nelson, Regional Director, Region 1, in welcoming those in attendance at the conference called attention to the fact that it was the first such conference held in Region 1. He also stressed that the conference was to provide an interchange of ideas from the field men present and that from this should come a coordinated plan for dealing with the variety of problems encountered.

All agreed that the conference was productive and thought provoking, that we must think "safety," preach "safety," practice "safety," and as Mr. Nelson stated in summing up the accomplishments of the conference:

> "A well developed and coordinated (safety) program will save us money . . ."

* * * * *

TIPS ON BATTERY CARE

Robert H. Hawkins, Manager, Central Division, Service Department, Caterpillar Tractor Company, in writing the "Master Mechanic" section of the December 1958 issue of Western Construction states that machine owners have come to expect convenience and dependability when starting diesel engines in all weather, regardless of temperature extremes. Some machines come equipped with gasoline starting engines, while others depend on cranking the diesel with electric starting motors. Even gasoline starting engines often have their own direct electric starting systems. In fact, most electric starting systems are dependent on one source of power--the storage battery.

A storage battery has a limited capacity (the quantity of electricity which can be taken from it in a given period of time) just as a water storage tank can maintain a flow of so many gallons per minute for only a certain number of minutes. The capacity of a battery (sometimes called its electrical size) is usually listed in "ampere-hours." This term is used to specify the amount of current a battery will deliver continuously for a definite number of hours or minutes. Capacity depends on how well the battery is constructed, its age, the size of the plates, and how many plates are assembled in each cell.

Why do storage batteries run down? Frequently the problem is the same as with any storage system: If more is taken out than is put back in, the reservoir for storage ultimately becomes empty. Added electrical load, such as lights, heaters, two-way radios, sometimes impose more drain on the system than can be replaced by the generator. There are other reasons. The first is age. After many hours use, the storage capacity is reduced. A second reason may be internal faults which continually drain off the electrical supply. Finally, improper maintenance and operation make a battery "age" quickly.

Any battery requires some attention for continued satisfactory service. Here are a few necessary rules for its care:

Periodic Check of Electrolyte or Water Level

A most important step in extending battery life is a periodic check of the electrolyte or water level. Nearly all storage batteries have a reserve space for water in the top above the plates, and most battery manufacturers recommend that water be added until it is 3/8-inch above the plates. Be careful not to overfill the battery because this allows the electrolyte to splash out and corrode all metal it contacts. Continued overfilling will result in so much loss of acid that the electrolyte may no longer be strong enough for the battery to deliver the required energy to crank the engine. If the battery requires water more often than once every two weeks, the charging rate is too high.

Keep Battery Clean

Wash the battery occasionally with a "baking soda" solution (one pound of soda to one gallon of water) to neutralize the acid which is present on the case, and then rinse it with a stream of cold water. Cleanliness also includes the terminals. Wire brush them until corrosion is removed and then coat them with petroleum jelly.

Keep Battery Charged

Maintain the battery in a normal state of charge--the specific gravity should be above 1.225--by keeping the generator output and voltage regulator in proper adjustment.

Never let a battery remain in a discharged condition for an extended period of time. The discharge action of a battery sulphates the plates, but this can be driven off if the battery is charged soon after discharge. However, if the battery is allowed to remain too long in a discharged condition, the sulphate becomes hard and is very difficult, if not impossible, to drive off the plates during charging.

Batteries have much longer service life if they are kept at or very near full charge at all times. In normal operation of equipment, some discharging and charging of the battery takes place continuously, but the battery is not discharged to a great extent at any time. However, cycling a battery (regularly discharging it almost completely and then recharging it) will seriously affect its service life.

Prevent Freezing

In cold weather, never add water at the end of a day's run. Instead, add water in the morning just before starting or right after starting. In this manner, the water will be thoroughly mixed with the acid by the end of the day's run and freezing of the electrolyte will be prevented.

Allow Rest

Never use the electric starter more than 30 seconds at a time and then allow approximately 2 minutes between cranking cycles. The brief "rest period" allows the battery plates to cool and allows the battery to recuperate sufficiently to again deliver a surge of power.

After emergency use or accidental energy loss, such as leaving the lights on overnight, it might be necessary to "quick charge" the battery. No particular fault can be found with "quick charging" or "hot charging" methods providing the manufacturers instructions are closely followed.

Storage Procedures

Storage batteries which are not in use will lose their strength gradually (the rate of discharge depends upon the temperature) when left on the shelf or stored in machines for an extended period of time. The higher the temperatures, the greater the loss of energy. To keep them up to strength and ready to use, recharge any batteries in storage when their specific gravity drops to 1.240. A fully charged battery will show a hydrometer reading of 1.270-1.280.

* * * * *

EXPANDED METAL COVERS AND WALKWAYS

The use of expanded metal for the protection of operating personnel and the general public has been illustrated in the bulletin before, but the more general use of the material for safety has added advantages.

The pleasing appearance as well as the safety provided is well illustrated in the photograph of the protective cover on the distribution box in the suburban areas of the Salt River Project, Arizona.

The operating walkway on the structures shown below, provided by the Salt River Valley Water Users' Association, are also pleasing in appearance as well as functional, and well suited to the populated Phoenix Area.

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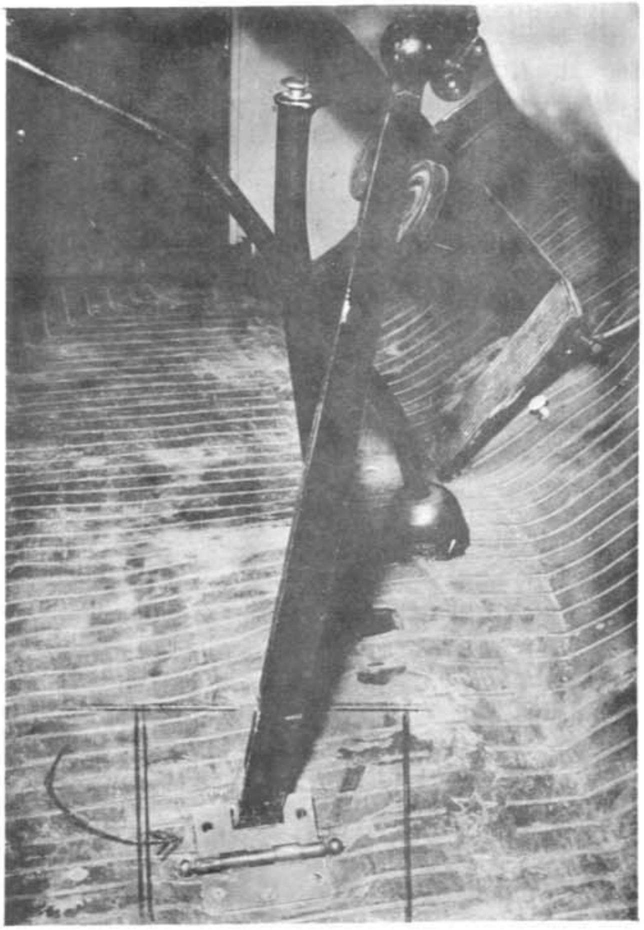
SAFETY LATCH FOR POWER TAKE-OFF LEVER
(Suggestion R2-58-99)



When the power take-off lever on a $1\frac{1}{2}$-ton truck was accidentally tripped, damaging the winch, Mr. Jacob Gobel, headquartered at Oak View, California, on the Ventura Project in Region 2, suggested the simple device shown in the photograph at left, to prevent a similar accident in the future.

The very ordinary hinge, slotted to closely fit the power take-off lever at floor level, can be quickly fastened in place.

Apparently the Ventura Project experience is only one of several similar accidents. Others also were interested in the idea. Not only did the suggestion bring an award from the Bureau of Reclamation, Suggestion Awards Program, but one of the McGraw-Hill Publications sent Mr. Gobel a check for a photograph and a description of the device.

* * * * *

AUTOMATIC DISPENSERS OF GYPSUM AND CHEMICALS

Continued irrigation of agricultural land with water having a low soluble salt content tends to leach out electrolytes necessary for desirable soil tilth and causes the soil to "puddle." Puddled soils tend to pack readily, become relatively impervious to water, and are not well aerated. In such a condition, water, air and root penetration into the soil is diminished and most crops will not do well. The condition can be prevented or improved by the addition of certain electrolytes to the soil.

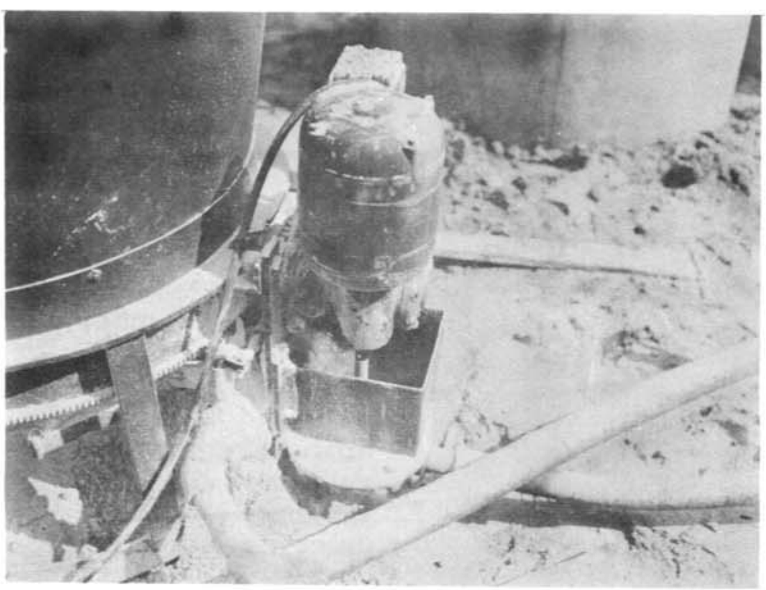
Gypsum has proved to be the most practical soil conditioner for agricultural use and may be applied in irrigation water or broadcast over an area and disked into the soil. Most growers in the Southern San Joaquin Valley of California prefer to apply gypsum with their irrigation water; using one of several devices available on the market for metering dry, water-soluble, chemicals into open ditch or pipe line systems. The use of these devices has been described in an article prepared for the bulletin by Glenn J. Berry, Irrigation Agriculturist, closely associated with the work on the Central Valley Project, California, and following the subject for the U. S. Bureau of Reclamation's Region 2, Sacramento, California.

Each of the devices illustrated requires a small amount of water circulating through the unit. Dry gypsum is metered from a hopper into this stream which is returned to the main irrigation flow. Water for operation of the devices can be obtained by plumbing into a pipe line system or by pumping from an open ditch.

The Deco Model

In the Delano and Bakersfield areas, where electricity is usually available nearby, the Deco auger type dispenser is widely used. A typical installation is shown in the upper photograph at left.

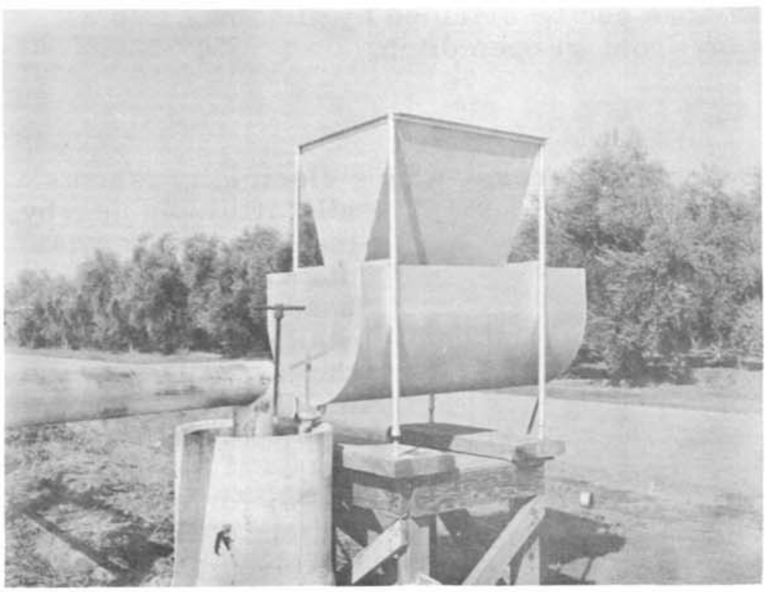
A circular plate, forming the bottom of the hopper, is revolved slowly bringing the gypsum into contact with an auger which feeds the dry material into a mixing basin where it is mixed with water and pumped back into the irrigation flow.

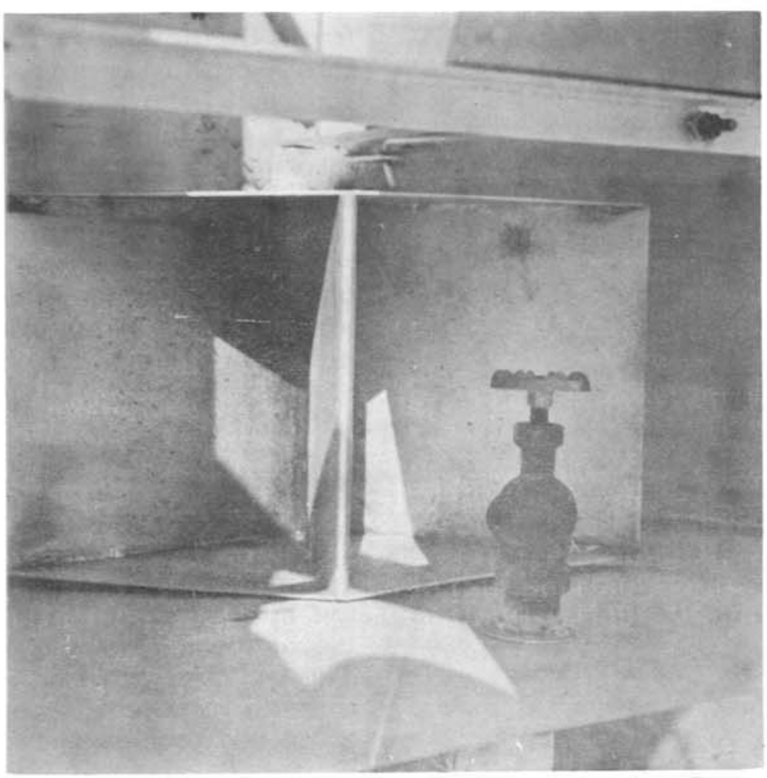


The lower photograph shows the mixing basin below the motor and the location of the notched revolving bottom plate. The auger extending into the hopper is partially enclosed and rate of delivery can be controlled by regulating the size of the opening of the auger box. The gypsum can be mixed at rates of from 25 to 800 pounds per hour. The hopper has a capacity of 1,000 pounds. The commercially available machine sells for approximately $500.

Water Powered Exeter Model

Growers in the Exeter Irrigation District, who wish to build their own dispenser, can obtain particulars for the device shown on this page from the Exeter Irrigation District, Exeter, California.





The homemade device as shown has a capacity for holding 700 pounds of gypsum, and the machine uses water bypassed through the unit to operate a simple mechanism to meter gypsum from the hopper.

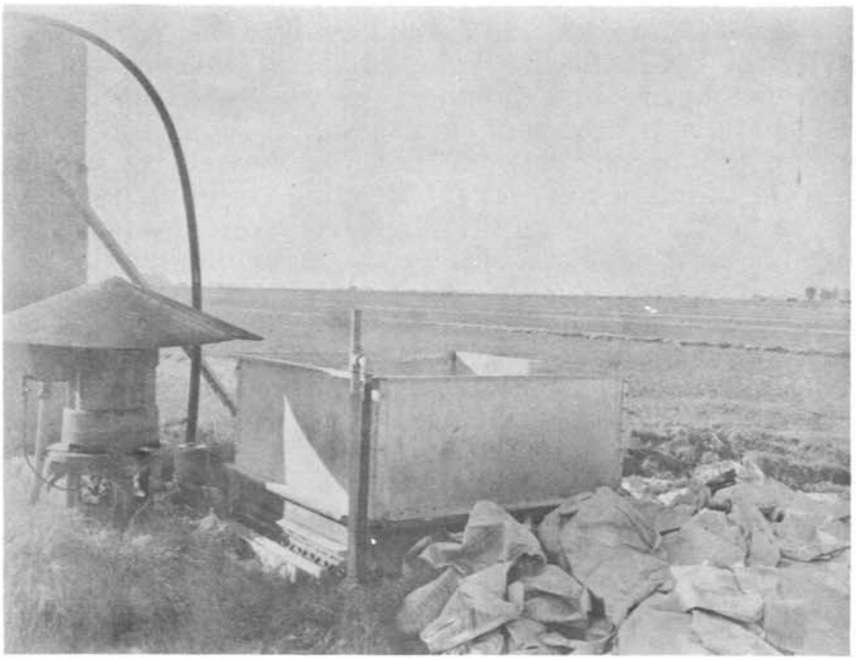
Water entering the unit alternately fills two bucket like containers mounted on a shaft; turning the shaft back and forth to move a metering bar at the bottom opening of the hopper from one side to the other. The lower photograph at left, shows the arrangement of the two buckets which power the shaft and the water inlet located above the buckets. The hopper which contains the dry gypsum is located in the upper left corner.

When the device is installed in a pipe line system as shown in the upper photograph, no other source of power is required. The rate of delivery of the chemical can be regulated by adjusting the amount of water entering the unit.

A similar commercial dispenser is also distributed in the area.

Jaeco Hydrator

The Jaeco Hydrator has no moving parts. Jets of water from nozzles on the manifold are directed into the hopper hydraulically eroding the dry gypsum, which is returned with the water to the irrigation stream. In the installation of this type of device as shown at the left, a sump pump is necessary to pump the treated water into the standpipe. When installed in a manner similar to that shown for the Exeter model, no power source is required.



The unit will operate with as little as one and one-half pounds of water pressure. Delivery rates of from 50 to 500 pounds of gypsum per hour can be obtained by changing the size of the nozzle orifices. The hydrator is available in 1-, 2-, and 3-ton capacities at a cost of about $140, $160, and $180, respectively.

While the above machines vary somewhat in ability to handle damp or lumpy gypsum, all work most satisfactorily with a finely processed material. Gypsum of a fineness that 85 percent will pass through a 100 mesh screen is widely used.

Since gypsum readily absorbs moisture from the atmosphere, and tends to cake, the hoppers should be fitted with a tight top cover. Fair weather application is generally a rule followed by the irrigators.

The above devices can be used to apply fertilizer or other water soluble chemicals. With minor modifications they can be utilized to continuously introduce copper sulfate into open ditch systems for control of submerged aquatic weeds. Additional information regarding the dispensers may be obtained by writing the Fresno Operations Field Branch, U. S. Bureau of Reclamation, Fresno, California.

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OUTBOARD GEAR GREASE AS PUMP LUBRICANT

The Fort Sumner Irrigation District, which operates the Fort Sumner Project in New Mexico, reports that some of their problems in the operation of a hydraulic turbine-driven pumping plant have been alleviated by the use of outboard gear grease. The grease is being used to lubricate bearings which operate under water and, according to the water users, has improved bearing life and thus, the service of the facility.

The Fort Sumner Project was completed early in 1951 and the pumping plant with other projects works was turned over to the Fort Sumner Irrigation District for operation and maintenance. The irrigation water supplied this project direct from a diversion on the Pecos River carries considerable silt and sand. Some of this material found its way into the pump bearings causing undue wear and also caused the turbine wicket gates control mechanism to freeze. Bearing troubles developed in the pump almost immediately after the plant had been placed in service and continued for several seasons. Extensive overhaul was required at the end of each irrigation season and the plant had to be shut down for repairs during one or two irrigation seasons. The trouble appeared to be primarily one of the water carrying granular material into the bearings, but inadequate lubrication also was a contributing factor in the difficulties encountered.

The equipment, as shown in the drawing on page 24, was originally installed with all bearings lubricated by drip cups using a light oil. Consideration was first given to a more positive method of lubrication with the light oil, hence, an electrically operated force-feed oiler was installed. The change improved pump service, but did not solve the bearing problem. Accordingly, during an overhaul of the pump following the 1955 irrigation season, the pump was modified by the Fort Sumner Irrigation District and use of outboard gear grease, as a lubricant, was initiated.

During modification, the pump shafts were built-up and then machined to fit the bearings and two new lubrication lines were added. One line provided for the lubrication of the main bearing flange bushing at the bottom of the main turbine bearing which was not previously lubricated, and where excessive wear on the turbine shaft had occurred. The second lubrication line extended to the gate ring which adjusts the turbine wicket gates. Here, a channel was cut around the ring to receive the grease and provide for lubrication of the ring which has always frozen during the latter part of the season making gate adjustments impossible.

The equipment is lubricated regularly twice a day at twelve hour intervals. A small quantity of the outboard gear grease works out the ends of the bearings and forms a small ridge of grease which withstands the erosion of the flowing water. With the bearings sealed, sand and silt is prevented from entering. The gate adjustment mechanism has also remained free, since lubrication was supplied to the gate ring.

The plant has now operated three seasons and is beginning the fourth without excessive bearing wear. The equipment has been inspected at the end of each irrigation season and only minor adjustments have been necessary. If further details are desired on the modification and use of the outboard gear grease, write the Regional Director, U. S. Bureau of Reclamation, Amarillo, Texas.

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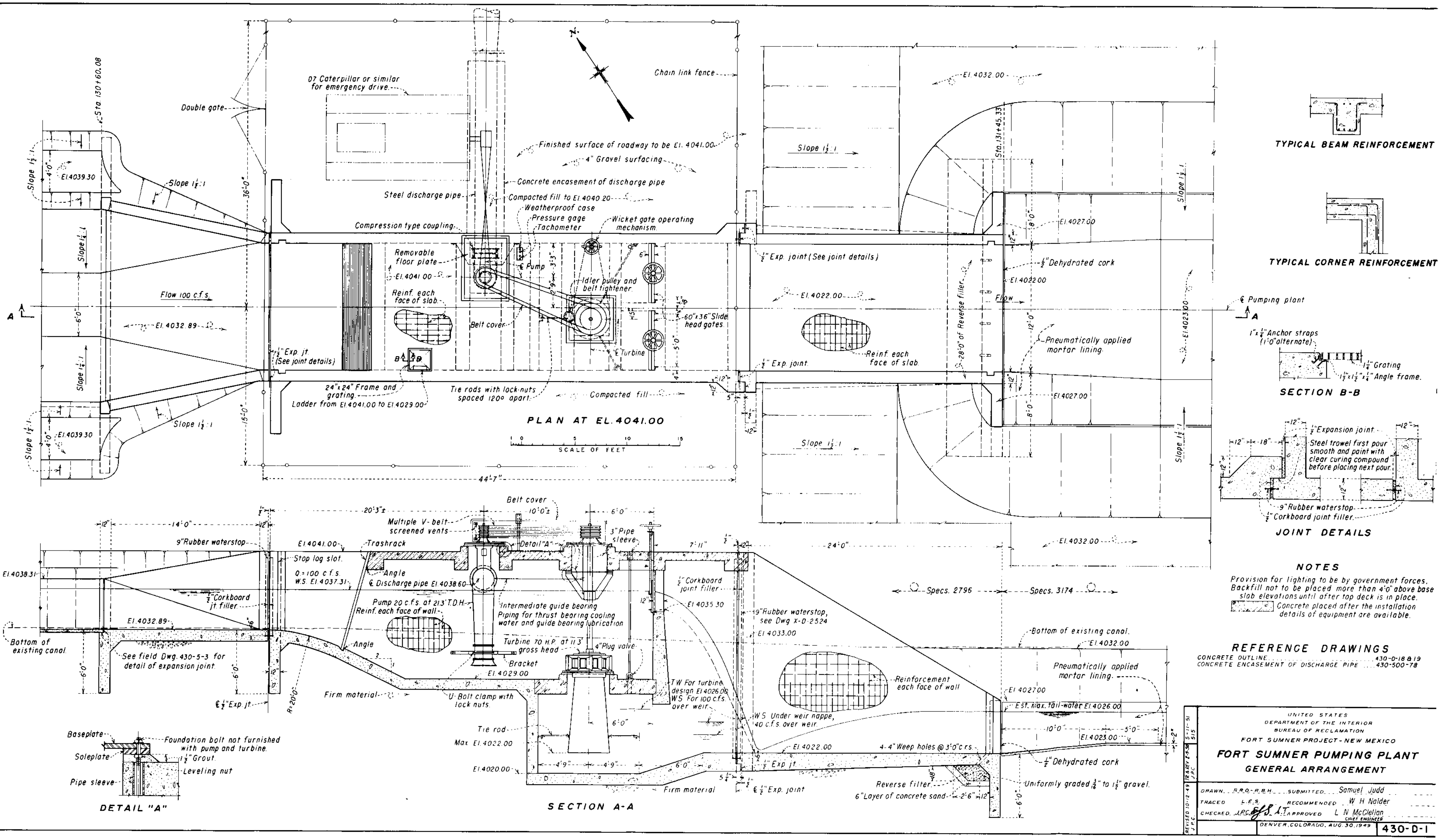
PLASTIC PROTECTORS FOR TABLES AND CHARTS
(Suggestion R2-58-188)

Especially helpful to ditchriders, hydrographers, and others, who must frequently refer to rating tables, charts, and other documents in the field, are plastic protectors for these documents. Mr. Jesse F. Esque, Fresno Operations Field Branch, Central Valley Project, California, reminds us that the protectors are available in clear plastic, visible from both sides, and obtainable from the General Services Administration as follows:

Catalog No. 7530-286-1407 . . . 11" x 8½" (punched for 3-ring binder) $0.06 ea.

Catalog No. 7530-286-1410 . . . 8" x 10½", $0.08 ea.

* * * * *


PLAN AT EL. 4041.00
SCALE OF FEET
SECTION A-A
SECTION B-B
DETAIL "A"
JOINT DETAILS
TYPICAL BEAM REINFORCEMENT
TYPICAL CORNER REINFORCEMENT
Chain link fence
D7 Caterpillar or similar for emergency drive
Double gate
Finished surface of roadway to be El. 4041.00
4" Gravel surfacing
Concrete encasement of discharge pipe
Steel discharge pipe
Compacted fill to El. 4040.20
Weatherproof case
Pressure gage
Tachometer
Wicket gate operating mechanism
Compression type coupling
Removable floor plate
Idler pulley and belt tightener
60"x36" Slide head gates
Belt cover
Turbine
Pump
Flow 100 c.f.s.
24"x24" Frame and grating
Ladder from El. 4041.00 to El. 4029.00
Tie rods with lock-nuts spaced 120° apart
Compacted fill
Pneumatically applied mortar lining
½" Dehydrated cork
28'-0" of Reverse filter
Reinf. each face of slab
Multiple V-belt
screened vents
Trashrack
Stop log slot
Q = 100 c.f.s. W.S. El. 4037.31
Discharge pipe El. 4038.60
Pump 20 c.f.s. at 21.3' T.D.H.
Intermediate guide bearing
Piping for thrust bearing cooling water and guide bearing lubrication
Turbine 70 H.P. at 11.3' gross head
4" Plug valve
3" Pipe sleeve
U-Bolt clamp with lock nuts
Firm material
9" Rubber waterstop
½" Corkboard joint filler
Bottom of existing canal
See field Dwg. 430-5-3 for detail of expansion joint
Reinforcement each face of wall
T.W. For turbine design El. 4026.00
W.S. For 100 c.f.s. over weir
W.S. Under weir nappe, 40 c.f.s. over weir
Est. max. tail-water El. 4026.00
4-4" Weep holes @ 3'-0" c.rs.
Reverse filter
6" Layer of concrete sand
Uniformly graded 3/16" to 1½" gravel
Specs. 2796
Specs. 3174
Baseplate
Soleplate
Pipe sleeve
Foundation bolt not furnished with pump and turbine.
1½" Grout
Leveling nut
1"x¼" Anchor straps (1'-0" alternate)
1½" Grating
1½"x1½"x¼" Angle frame
½" Expansion joint
Steel trowel first pour smooth and paint with clear curing compound before placing next pour.
NOTES
Provision for lighting to be by government forces.
Backfill not to be placed more than 4'-0" above base slab elevations until after top deck is in place.
Concrete placed after the installation details of equipment are available.
REFERENCE DRAWINGS
CONCRETE OUTLINE 430-D-18 & 19
CONCRETE ENCASEMENT OF DISCHARGE PIPE 430-500-78
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
FORT SUMNER PROJECT - NEW MEXICO
FORT SUMNER PUMPING PLANT
GENERAL ARRANGEMENT
DRAWN R.R.O.-R.B.H. SUBMITTED Samuel Judd
TRACED L.E.S. RECOMMENDED W. H. Nalder
APPROVED L. N. McClellan
CHIEF ENGINEER
DENVER, COLORADO, AUG. 30, 1949
430-D-1
RECORD DRAWING GPO 832033