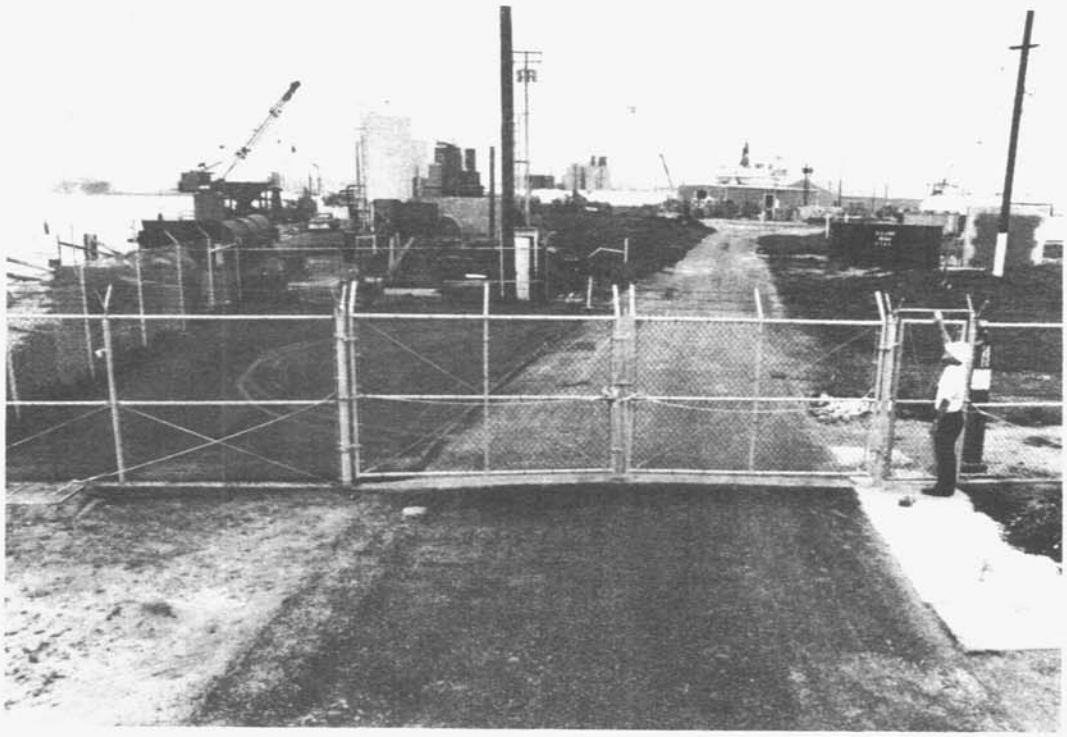
WATER OPERATION AND MAINTENANCE

BULLETIN NO. 108

JUNE 1979



IN THIS ISSUE

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning laborsaving devices and less costly equipment and procedures will result in improved efficiency and reduced costs of the systems for those operators adapting these ideas to their needs.

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

Any information contained in this bulletin regarding commercial products may not be used for advertisement or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

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Division of Operation
and Maintenance Technical Services
Engineering and Research Center
Denver, Colorado 80225

U.S. Navy installation. To increase resistance to forcible entry of chain-link gates, the U.S. Navy developed a reinforcement system of chains and wire ropes. The energy from the forcible entry attempt is transferred from the center of the gate through wire rope to the side gate posts and deadman concrete anchors.

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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

A reinforcement system developed by the Navy against forcible entry by ramming chain-link gates is described starting on page 1.

Inflation hurts! Now is the time to look for ways to reduce pumping costs. On page 7 are suggested checkpoints for potential savings.

Precautions for handling and disposing of askarel are described in the article on page 9.

The seriousness of making routine internal inspection of wire ropes a part of your maintenance inspection program is pointed out in the article on page 12.

A hydraulic seat mounted on your mower will make mowing steep side slopes easier and keep you from getting strained muscles. See page 14.

Check the article on page 15 for possible fire hazards due to use of aluminum wiring and aluminum terminal connections.

How often have you heard the saying, "Lightning never strikes twice in the same place?" The article on page 17 describes preventive measures against lightning damage.

REINFORCEMENT SYSTEM FOR CHAIN-LINK GATES[1]

A system for substantially increasing the resistance to forcible entry of typical chain-link gates at Naval stations has been developed. Chain-link gates can be broken through fairly easily by ramming the gate with an automobile, truck, etc. The locking mechanism and the hinges on the gate are the weakest components of the common chain-link gate. With the CEL (Civil Engineering Laboratory) system, these areas are reinforced by chain and wire rope. The energy from the forcible entry attempt is transferred from the center of the gate (the locking mechanism area) through the wire rope to the side gate posts and deadman concrete anchors. Since the wire ropes are interwoven, one has effectively produced a single wire rope barrier across the opening. As can be seen in cover photo, the system is simple and unobstrusive, and can be effective without hampering the normal operation of the gate.

This system can be easily fabricated from the following items: 12.7-mm (1/2-in) diameter wire rope, 12.7-mm (1/2-in) diameter chain, 6.4-mm (1/4-in) thick steel plate, 50-mm (2-in) diameter pipe, swaged-on clamps, concrete, eye bolts, and various nuts and bolts.

The eye bolts are set in a 0.6- by 0.6- by 0.6-m (2- by 2- by 2-ft) concrete pad (fig. 1). The 12.7-mm (1/2-in) diameter wire rope is strung from the eye bolts to the gate posts where another section of wire rope is interwoven with it (fig. 2). This second wire rope is strung across the inside face of the gate and is fastened to the vertical/horizontal pipe member (fig. 3).

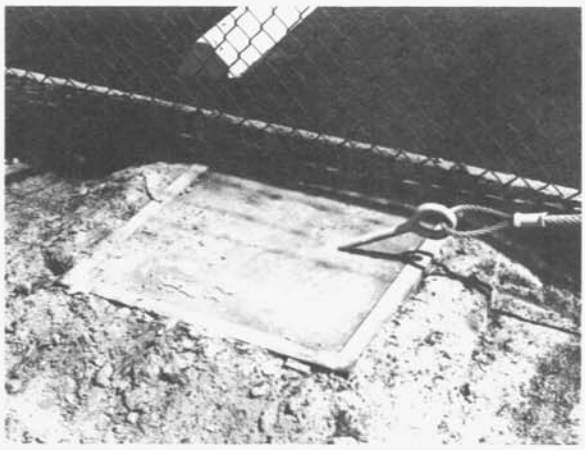

Figure 1.–Eye bolts set in concrete pads.

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[1] Reprinted by special permission of Head, Technical Documents Center, Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California.

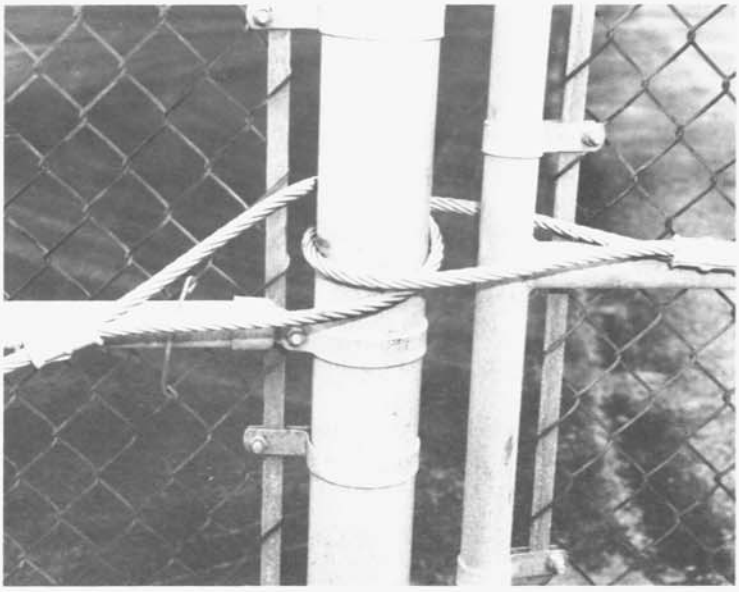


Figure 2.–Wire rope strung from eye bolts to gate posts.

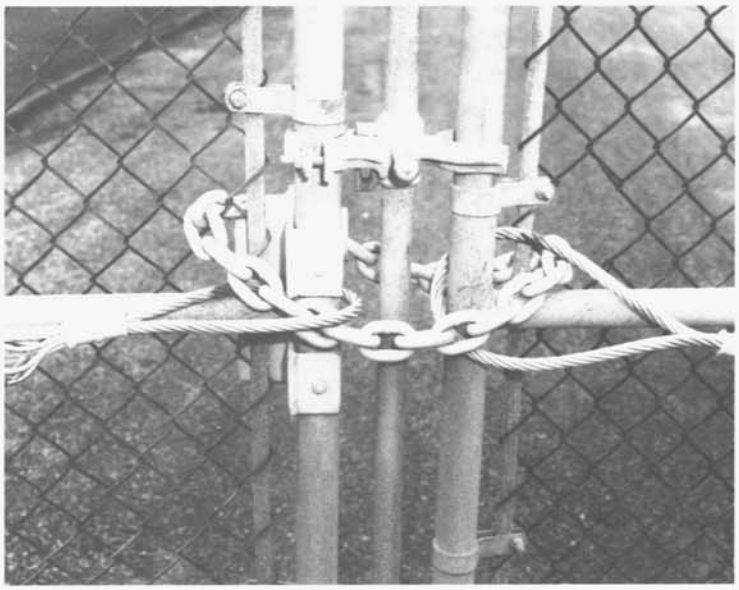


Figure 3.–Wire rope strung across inside face of gate and fastened to pipe member.

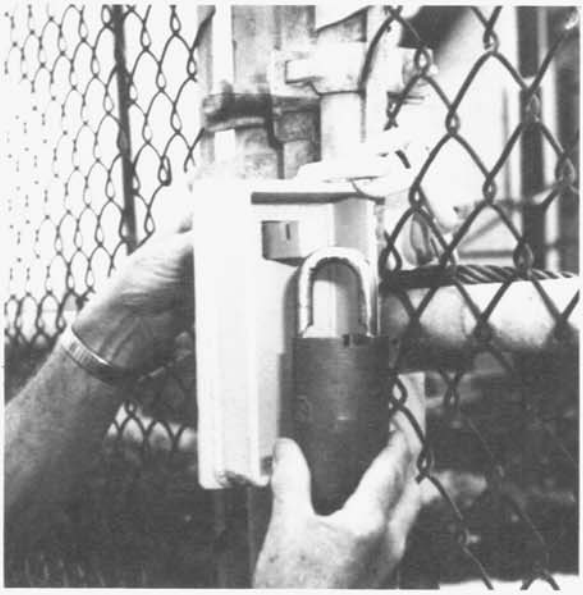
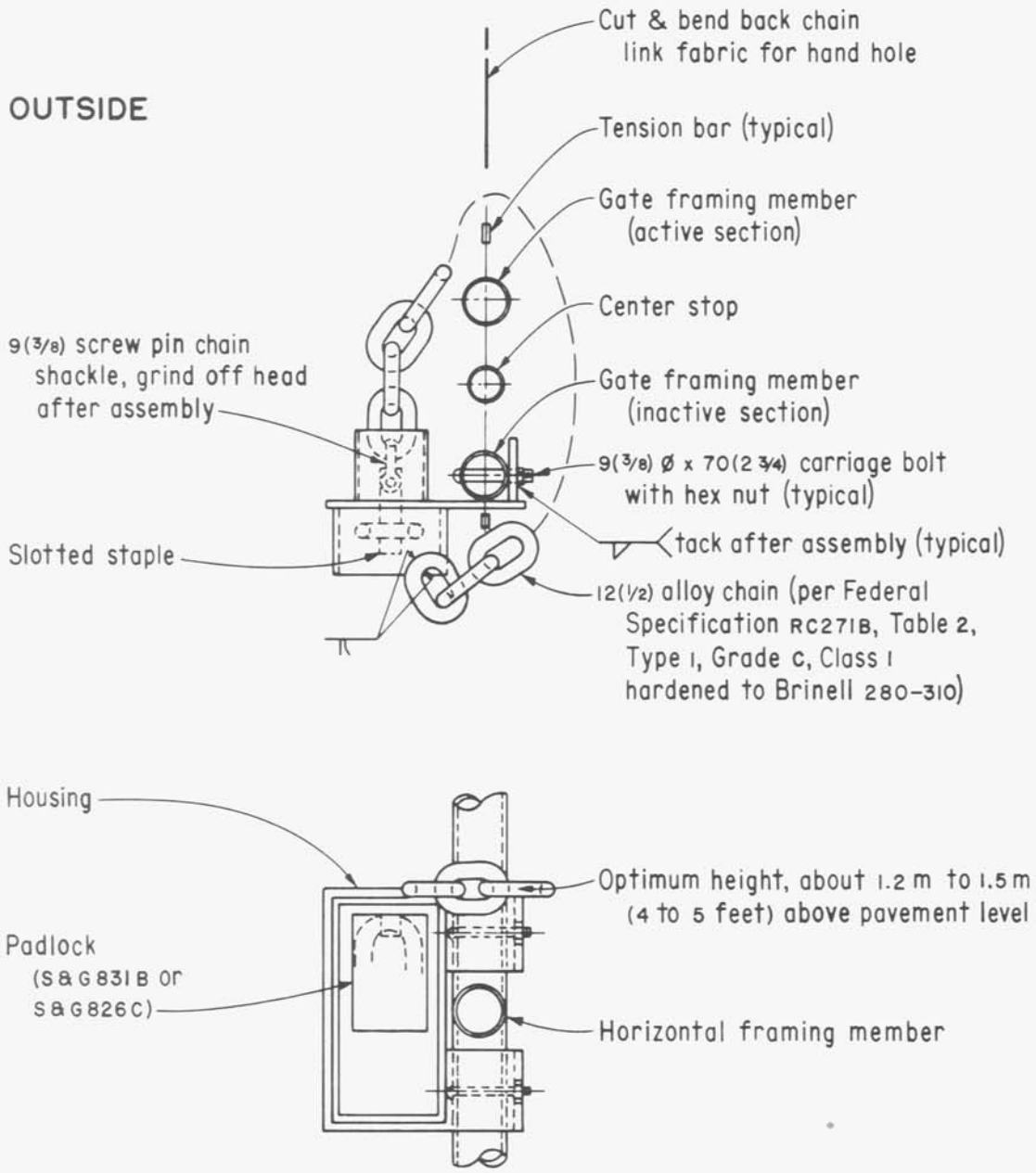


Figure 4.–Camaloy chain and high-security padlock.

Figure 5.–Slotted-staple hasp box assembly.

The crucial component of the system is the chain used to fasten the gates together. This chain must be Federal Specification RC271B, table 2, type 1, grade C, class 1 welded steel alloy chain hardened to Brinell hardness 280 to 310 to be effective. CEL found CAMALOY Chain, Part No. 040-0812 to be satisfactory. It retails at $11.81 per meter ($3.60 per foot). This is the only chain that has been found to be resistant to cutting by bolt cutters. This chain is passed through the wire-rope loops and then fastened together using a high-security padlock and a specially designed slotted-staple hasp box assembly (figs. 4 and 5). Figures 6, 7, and 8 give detailed information on how to fabricate the slotted-staple hasp box assembly and install it on the gate.

For further information, please contact Ken Gray, Code L61 (Physical Security Laboratory) telephone (805) 982-5927.



NOTES

Housing may be located above or below horizontal framing member when existing locking device on gate is in the way.

Dimensions are in millimeters (inches).

Figure 6.–Locking assembly for double-swing gate.

NOTES

Material: 6 (1/4) plate steel (unless noted)
Sand blast & paint Navy gray
Dimensions are in millimeters (inches)
Dimension A: 14 (9/16) when using Style A slotted staple
18 (3/4) when using Style B slotted staple
17 (11/16) when using Style C slotted staple

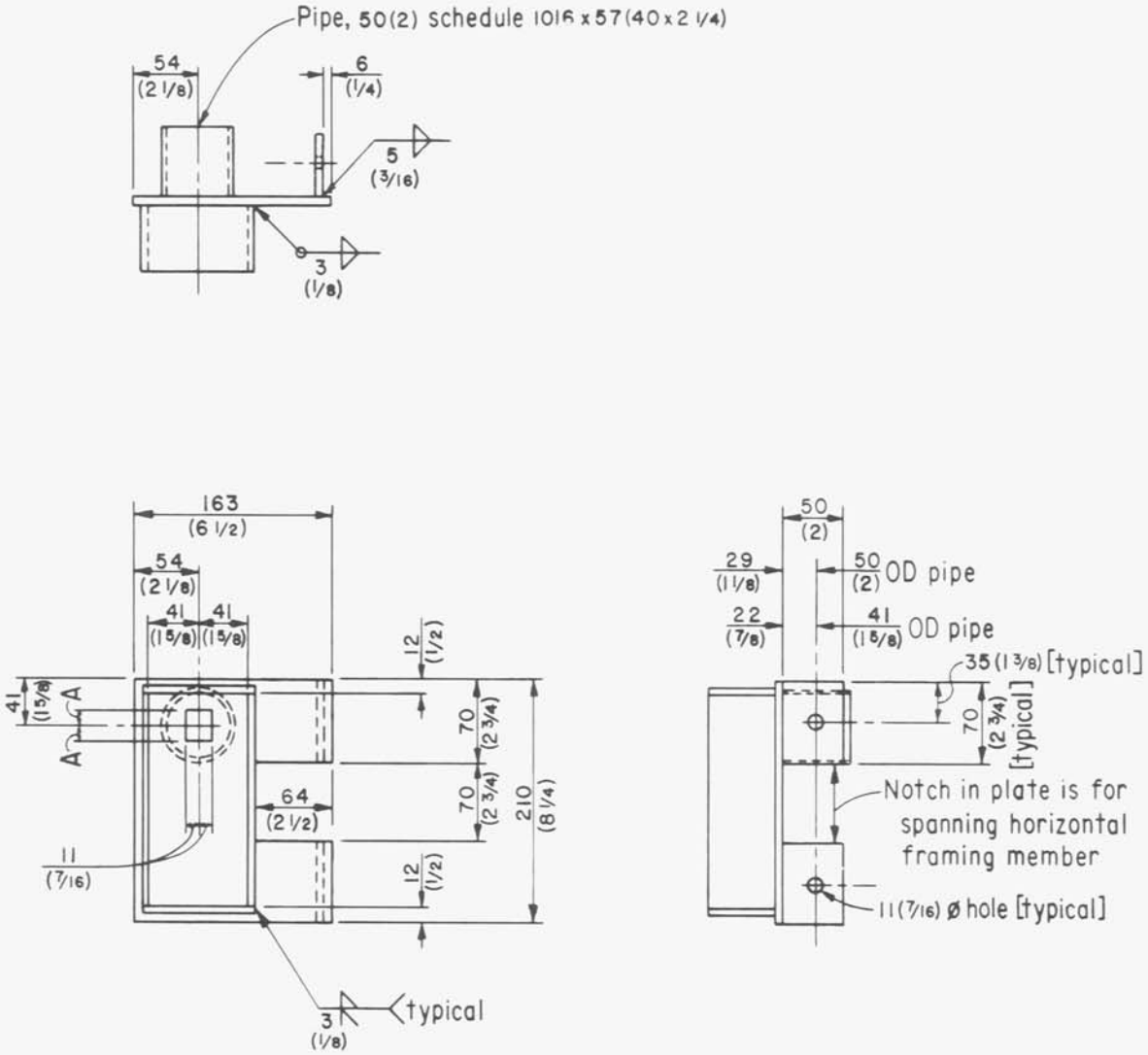


Figure 7.–Hasp/box assembly for double-swing gate.

NOTES

Variations required to accommodate locks with different throat heights

Style A – to be used with padlocks SAG 831B or SAG 826C
[19 (3/4) throat height opening]

Style B – to be used with padlock SAG 826C
[29 (1 1/8) throat height opening]

Style C – to be used with padlock SAG 826C
[25 (1) throat height opening]

Dimensions are in millimeters (inches)

Material: Steel

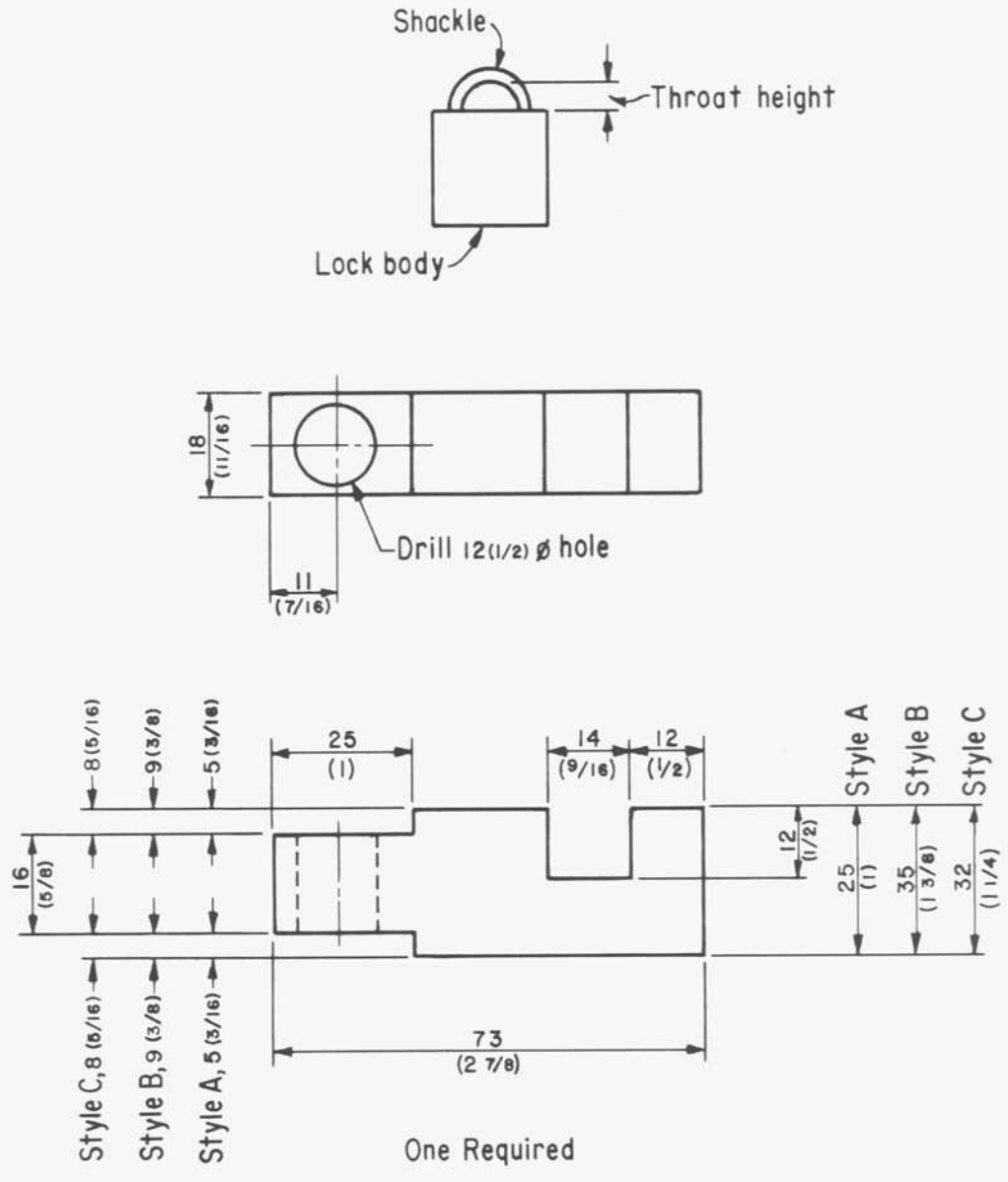


Figure 8.–Slotted staple for chain-locking system.

LOOK FOR WAYS TO REDUCE PUMPING COSTS[2]

As recently as 1972, the cost of irrigation pumping with natural gas from a deep well in Colorado was about $17 per hectare ($7 per acre) for gravity irrigation and about $25 per hectare ($10 per acre) for center pivot sprinkling corn. Cheap fuel was being used to produce cheap food.

The days of cheap energy are gone. Costs of most fuels for pumping and electricity have tripled or more since the Arab oil embargo. Inflation and the oil situation are expected to keep annual pumping cost increasing at the 10 to 12 percent level. For this year, we are looking at deep well pumping costs on corn of $54 to $86 per hectare ($22 to $35 per acre).

What can you, as the owner or tenant who pays the pumping bill, do about reducing this cost? There are two places to check out in your irrigation operation. First, make sure your motor and pump are working together to give you the most water and pressure for your money. Next, analyze your irrigation methods to see that you are getting the most out of the water. Let's review some of the checkpoints for potential saving:

Pump impeller adjustment.—Impeller adjustment can often increase pumping plant efficiency by 10 to 20 percent. The kilowatt (horsepower) load is usually affected little, but adjustment may help by being able to pump 1233 cubic meters (an acre-foot) of water in less time and with more pressure. Do not adjust impellers yourself unless you know the specifications. Pump repairmen claim that more pumps are damaged by maladjustment than by normal wear.

Engine maintenance.—Routine engine maintenance is tied closely to recordkeeping. Keep a record of pumping hours or days so that maintenance is done ahead of trouble and excess fuel consumption. If you wait until the engine is misfiring, you have waited far too long to change plugs, etc.

Replacing pumps.—Pump replacement is often necessary when the pump is badly worn. Rather than replace it with the same pump model, have the dealer check your water gallonage and pressure needs against pump curves to see whether or not the old pump was the best pump for the job. It is not unusual to find that a different pump impeller will do the job better and with less power demand.

Changing power units.—There are a few cases where extra horsepower was hooked to a pump "just to be safe" or because some future expansion or sprinkling was anticipated. In the case of internal combustion engines, many are too small or are run too fast. The gearhead may be misfit. In either case, it may pay now to make a change. Compare the annual investment costs against expected power savings.

Reducing pressure requirements.—High pumping cost is incentive to keep irrigation system pressure requirements as low as possible. This explains the current interest in center pivot spray nozzle and low pressure sprinkler systems. There can be some negative effects of very low operating pressures

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[2] Reprinted with special permission of the Editor, from a recent issue of the Colorado Rancher and Farmer.

on water application uniformity and runoff. These effects should be carefully evaluated before any changes in pressure are made to save on pumping costs.

Adding tailwater system.–Tailwater systems can definitely save money in the deep well areas. It takes about one-eighth the amount of horsepower to pump tailwater as it does to pump the well. Not only that, the tailwater system will allow more uniform irrigation since you need not worry about runoff.

Sign up in a power cutoff program.–Some of the electric power supplies have set up programs that offer a price break to irrigators that will shut down their motors on supplier demand. This can relieve the very high peak loads on transmission systems that usually take place for a couple of hours per day in hot weather. The supplier, in effect, can then pass on the reduced peak load charge to the power user who shuts down. Make sure you have an adequate water supply and a schedule that will allow you to shut down a small percentage of the normal operating time. Closer soil moisture monitoring may be required.

Less tillage.–Make better use of precipitation and irrigation water by maintaining a protective mulch at the soil surface to reduce evaporation. A normal water savings of 50 to 100 mm (2 to 4 in) is possible by till-planting corn rather than using conventional tillage.

Whatever you do (or don't do), it may be wise to sort out your old power bills and dig out the actual power or fuel used per well. Compare your own wells. Talk with your power advisers, and they will help you compare your use with other anonymous users in the area. If your bills are low, you probably know why. If your bills are high, it is time to find out and do something about it.

You may need a pumping plant test or an irrigation system check before making any change. One thing for sure–growling at the power supplier's clerk next August won't reduce the pumping bill. Reviewing your overall irrigation power setup now may help prevent that growl. For assistance, check with irrigation and pump consultants, extension service, and SCS personnel.

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DISPOSAL OF USED ASKAREL[3]

Askarel is the term used to describe a broad class of nonflammable synthetic chlorinated hydrocarbon insulating liquids used in electrical equipment. Askarel is composed of polychlorinated biphenyls (PCBs). Monsanto Industrial Chemical Company was the only U.S. corporation making askarel. Mansanto mixes Aroclor (a Monsanto tradewark), a polychlorinated biphenyl, with chlorobenzenes to produce different blends for electrical manufacturers.

Some common electrical manufacturer tradenames for askarel blends are:

Aroclor
Asbestol
Askarel
Chlorextol
Diaclor
Dykanol
Elemex
Hyvol
Inerteen
No-Flamol
Pyranol
Saf-T-Kuhl
Clophen
DK
Fenclor
Kennechlor
Phenoclor
Pyralene
Santotherm

On newer askarel filled transformers and capacitor cans, these tradenames will be marked on the nameplate.

Some general characteristics of askarel are:

1. Heavier than water
2. Higher dielectric strength than mineral oil
3. Nonflammable
4. Nonexplosive
5. Not susceptible to deterioration by oxidation
6. Lower coefficient of expansion than mineral oil
7. Will dissolve some insulating materials and paints
8. At ordinary operating temperatures, the viscosity of askarel is approximately the same as that of insulating oil

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[3] Reprinted from Power Maintenance Instruction No. 22, Bureau of Reclamation, and includes data from Substation Maintenance Standards by the Bonneville Power Administration.

9. As is the case with insulating oils, the dielectric strength of askarels is reduced by the presence of moisture

Askarel has been made and handled for over 40 years, and the potential health hazard from PCBs was not recognized until recently. The Department of Health, Education, and Welfare has identified PCBs as "cancer suspect agents" based on animal experimentation although there has been no documented human exposure toxic effects. The recommended threshold limit value (TLV) of 1.0 μg/cuMi for airborne concentrations is designed to protect the health and provide for the safety of employees up to a 10-hour workday, 40-hour workweek, over a normal working lifetime. Additionally, as with many organic chemical solvents, skin irritations may occur as a result of prolonged exposure, and the following precautions are to be followed when handling askarel:

1. Skin contact is to be avoided–utilize neoprene gloves, sleeve guards, aprons, neoprene boots, eye goggles, or face shield.

2. Heating of askarel is prohibited unless the system is entirely enclosed and vapor contact is controlled so there is no exposure to workmen.

First aid:

1. Skin contact.–Wash area contacted with soap and water as soon as possible.

2. Eye contact.–Flush eye with water for 15 minutes and consult a physician. Note: Take askarel label or product information along to the physician.

3. Respiratory contact.–Remove to a fresh air supply and notify a physician.

4. Clothing contact.–Remove and wash, dry clean, or discard.

Environmental Pollution

During the past 40 years of use, PCBs have been widely dispersed throughout the environment. PCBs are only compounded and do not occur in nature. It should be noted that askarel is a relatively small source of environmental contaminant from PCBs. Waste from the packaging industry has a much greater potential for environmental hazard.

In the past several years, evidence has accumulated that PCBs can have adverse ecological and toxicological effects. PCBs, like arsenic and mercury, are subject to bioaccumulation which is the process by which living organisms concentrate an element or compound to levels that are harmful to living organisms. Because of their adverse physiological effects to living organisms and because of their tendency toward bioaccumulation, PCBs have been declared a hazardous waste.

Regulations prescribing the disposal, storage, and marking requirements for polychlorinated biphenyls (PCBs) were published in the Federal Register, February 17, 1978. The regulations apply to all persons who manufacture, process, distribute in commerce, use, or dispose of PCBs including local, State, and Federal Government.

No significant release of askarel to the environment can be accepted. Present acceptable disposal methods of askarel are with high temperature incinerators or burial in a landfill dump approved for environmental hazardous materials.

To date, the following facilities have been approved by the EPA to dispose of PCB waste consisting of capacitors, properly drained transformers, contaminated soil, dirt, rags, asphalt, properly drained containers, and other debris:

1. Waste Management of Alabama, Inc.
   P. O. Box 1200
   Livingston, Alabama 35470

2. Chem-Nuclear Systems, Inc.
   P. O. Box 1269
   Portland, Oregon 97205

3. Wes-Con, Inc.
   P. O. Box 564
   Twin Falls, Idaho 83301

4. Newco Chemical Waste Systems, Inc.
   4626 Royal Avenue
   Niagara Falls, New York 14303

At present no facilities are approved for the disposal of liquid askarel. Therefore, liquid askarel must be properly stored according to the regulations published in the Federal Register, February 17, 1978, until such time as facilities are approved for the disposal of liquid askarel.

An updated list of approved facilities is published in the Federal Register approximately every month. For further information on the EPA approval of these disposal facilities, please get in touch with the appropriate EPA regional office.

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CRANE INSPECTIONS
INTERNAL CORROSION OF STANDING WIRE ROPE LINES*

A recent contractor accident resulting in failure of the pendant lines of a dragline has pointed out a potentially serious problem that may exist throughout the Bureau.

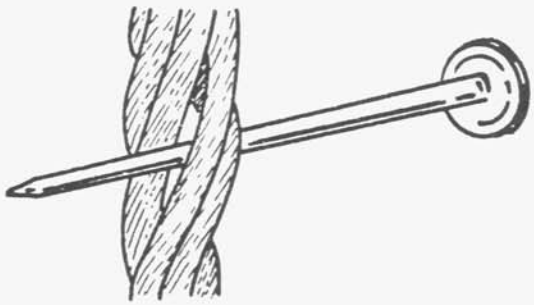
Both boom pendant lines broke under normal operating conditions allowing the boom to fail. Inspection concluded that the lines failed due to severe internal corrosion that was not evident on the surface. In fact, a visual inspection of the surface of the wire rope would have indicated they were in good condition and probably would have passed our crane testing and inspection requirements.

This condition could easily exist on other machines throughout the Bureau that are subject only to visual inspection of the outside surfaces of the rope. Standing lines, such as boom pendant lines, are the most likely to have internal corrosion since they are typically in service much longer than running lines.

Fortunately no injuries occurred as a result of this incident, and we have the opportunity to take positive steps to prevent a reoccurrence. A boom failure is potentially one of the most serious accidents we can encounter.

If not routinely scheduled, an inspection program of Bureau and contractor operated cranes and draglines should be initiated to insure that wire rope boom pendant lines or other standing lines are internally inspected. This inspection should insure proper lubrication and detect signs of corrosion and valley breaks in the cable. Internal inspection of wire ropes should be accomplished as soon as possible and incorporated into crane inspection and maintenance programs.

Following is an illustration of one method of opening up a rope for internal inspection:



To open a rope, insert marlin spike beneath two strands and rotate to lift strands and provide view of interior.

Noticeable rusting, corrosion or pitting of the wires is cause for replacement of the rope. In standing ropes, more than two broken wires in one lay in sections beyond end connections, or more than

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* Reprinted from Reclamation Safety News, Second Quarter 1978.

one broken wire at the end connection requires the rope to be taken out of service. A wire rope that has grease or dirt packed into the grooves between the strands prevents lubricants from penetrating into the inner core of the rope. Rope in this condition that has been in service for some time will likely show evidence of internal corrosion.

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HYDRAULIC SEAT FOR SLOPE MOWERS[5]
by Mark Solo

Mowing on a side slope can be exhausting and sometimes hazardous task. It is a tedious experience for an operator and can result in strained back muscles.

In June 1978, I attended the demonstration of a hydraulic seat that allows the operator to automatically level himself and, at the same time, offers him firm support. The prototype seat was being tested by a mowing contractor cutting grass on the sides of a hugh fly ash retention pond of a local utility. The slopes were about as high and as steep as I have ever seen anyone mow.

The hydraulic seat, manufactured by Citrite Corporation, Livonia, Michigan, was mounted on a Kut Kwick mower which can do steep slope work effectively due to its low center of gravity and hydraulic drive dual wheels. The operator told me that by sitting comfortably, instead of falling off the seat, he was able to concentrate on the mowing job rather than just hanging on. The operator estimated that the extra comfort would result in approximately a 30-percent increase in mowing production.

Figure 9.–A study in contrasts. Operator at right sits comfortably erect and can concentrate on job, while his co-workers perch in awkward positions.

The seat can be locked in any position or allowed to move with the operator. It has two cylinders with a 30-degree oscillation each way. Unequal weight distribution creates flow in the system. By keeping his back straight, the operator shifts more weight to the high side of the seat allowing it to come down and the low side to come up. Flow control can be preset to respond to the operator's preference, or the seat can be locked in any position by closing the valve.

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[5] Reprinted by special permission of the Editor, Public Works, from the February 1979 issue. The author is Director, Department of Public Works, Trenton, Michigan.

CHECK OLD ALUMINUM WIRING FOR FIRE HAZARD[6]

There have been growing numbers of reports from across the country of dangerous overheating and fires originating in connections of electrical wiring to conventional wall receptacles and snap switches. Such incidents can occur when either aluminum or copper wire is used, but reports indicate that incidents are greater with certain combinations of aluminum wire, electrical devices, and workmanship.

If your property was built after 1965, or has had additional wiring since that time, you may want to check to make sure there are no fire hazards due to electrical wiring. Potential hazards relating both to installation and materials based on aluminum devices have been discovered. Loose connections cause tiny high resistance glowing spots that can heat an entire connection hot enough to ignite paper touched to that connection. These loose connections are a real potential fire hazard.

Although good workmanship is a must for any wiring, other factors give it added importance with aluminum terminal connections. First aluminum oxide is one 10-millionth of an inch thick and as brittle as glass, proper tightening of the terminal screw breaks the oxide away, creating metal-to-metal contact that prevents oxide from reforming. A poorly tightened screw leaves the oxide in place, adding resistance and inviting terminal overheating.

Another metallurgical factor compounding the overheating problems is the substitution of plated steel terminal screws for brass in many devices. Since steel is 10 times poorer than brass as an electrical conductor, but only half as good as a heat conductor, electrical resistance at terminals increases and heat dissipation decreases.

Possibly contributing to the steel-screw problems is "path resistance" at the terminal. Tests indicate that resistance between the wire and the plate on the outlet or switch is three to five times greater than between wire and screw head. As a result, the screw may carry about three-fourths of the current. With a steel screw, this sends most of the current through a screw with 10 times the resistance of the wire.

Aluminum's expansion rate is over twice that of steel, which may add to the problem at the terminal. Clamped in a steel terminal or under an overheating steel terminal screw, aluminum expands and crushes itself against the steel. With a sufficient rise in temperature, the wire may even extrude itself out of the joint. When the parts cool, the aluminum contracts and the connection is loose.

One other metallurgical oddity involving aluminum wiring is "cold flow," also called "creep." It's the tendency of relatively soft metals like aluminum to flow gradually away from a stressed area, such as under a terminal screw, reducing contact pressure between the parts.

Alloying has now made aluminum wire more ductile and has also given it a creep strength (resistance to cold flow) comparable to copper. New receptacles and switches marked CO/ALR (for copper aluminum revised) look like their older counterparts, but their terminal systems differ greatly. Terminal screws are now brass with expansion rates much closer to aluminum than those of steel.

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[6] Reprinted by special permission of the Editor from a recent issue of the Washington Farmer-Stockman.

If your house is wired with aluminum (not likely if built before 1965) and you wonder if the job was done right, here are some trouble signs:

1. Warm faceplates on switches and receptacles.

2. Strange or distinctive odors in the receptacle or switch vicinity.

3. Persistent but intermittent flickering of lights that can't be traced to appliances or other external causes.

4. Unusual static on radio or television.

* * * * *

LIGHTNING FIRES[7]

Are you aware of the dangerous phenomena connected with lightning? It is estimated that lightning strikes somewhere on earth approximately 6,000 times every minute. And the old wives tale that lightning never strikes twice in the same place is not true. In the United States, about 18,000 houses are destroyed or damaged every year, causing millions of dollars worth of fire and property damage.

Lightning is electricity with extremely high voltage (pressure) and amperage (rate of electrical flow). In a powerful lightning bolt, there is unleashed enough power to heave a large ocean liner 1.8 m (6 ft) into the air.

Lightning can be best understood by comparing it to everyday electrical power. Ordinary house current has from 110 to 240 V and about 100 A. Such current can be lethal and, if shorted, can start fires. Powerful as it is, though, house voltage would have to be increased a thousandfold for the current to jump 0.3 m (1 ft) through the air. Lightning's 10 million to 100 million V, on the other hand, is so great that a bolt containing 1,000 to 300,000 or more amperes of current may leap a mile or more through the air.

Most lightning fires are caused by direct strikes to the roof, chimney, dormer, or other high part of a house or other building. Antennas are often struck, with bolts then jumping to plumbing or wiring.

Buildings can be protected against lightning damage through three methods: the installation of a lightning rod system; the installation of secondary service lightning arresters to the electrical power wiring and distribution circuits; the installation of antenna lightning discharge units.

Lightning rods (air terminals) are the familiar pointed rod structures seen projecting from the roofs and other high points of buildings. These rods are connected by heavy cables (conductors) to grounding equipment. Should lightning discharge collect in the atmosphere near a building so protected, the lightning rod system serves as a path by which the lightning may travel into the ground.

The discharge of a lightning bolt in the vicinity of powerlines usually induces a momentary high-voltage surge in the nearby wiring. A dependable secondary lightning arrester device, connected between the incoming electrical power wiring and distribution circuits and grounding equipment will safely divert the surge into the earth.

To protect television, radio, and CB receivers connected to outdoor antennas from damage by induced surges, a dependable lightning discharge unit should be connected between the outdoor antenna system and an earth ground.

Be sure that the lightning rod system installed at your house bears the Master Label of Underwriters Laboratories, Inc., and that lightning arresters and antenna discharge units carry the UL Listing Mark.

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[7] Reprinted from the January 1978 issue of National Safety News.

CORRECTION

Please make following correction to your copy of Bulletin No. 107:

Page 2, first paragraph, first line:

Change "minimum" to "maximum"

GPO 851 - 964