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United States
Department of the Interior, Bureau of Reclamation

IRRIGATION OPERATION AND MAINTENANCE

BULLETIN NO. 62

October, November, December 1967



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The Irrigation Operation and Maintenance Bulletin is published quarterly, for the benefit of irrigation project people. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning labor saving devices and less costly equipment and procedures, developed by resourceful project people, 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.

* * * * *

Division of Irrigation Operations
Office of Chief Engineer
Denver, Colorado



COVER PHOTOGRAPH:
Anti-roll bars and seat belts shown in this picture were fabricated and installed by Bureau field personnel on this front-end loader and backhoe at our Folsom Field Division, Folsom, California. PX-D-58448NA

IRRIGATION OPERATIONS AND MAINTENANCE
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INTRODUCTION

The protective anti-roll bars, described in the first article beginning on page 1, are constructed to give maximum protection to the operator. The article also points out the hazards of tractor operation and gives some rules to follow for tractor safety.

An article on page 8, entitled "Synthetic Resin Primer for Coal-Tar Enamel," calls attention to a research report on the superior qualities of synthetic primers for coal-tar enamels. Also on this page are six suggestions for solving everyday problems.

Starting on page 9, an article about protective masks and respirators, points out that it is important to know the advantages and limitations of the various types of devices before using them.

Here on page 13 is a suggestion by Mr. D. L. Johnson, of the Grand Teton National Park Service, for lubricating automotive door latches.

No one wants to ruin a perfectly good pump. However, it can be done as this article starting on page 14 indicates.

On page 15, there is a very interesting short article entitled, "Miscellaneous Tips for Repairing Cranes."

Two suggestions on the operation and servicing of a ring-follower gate and a hollow-jet valve at Granby Dam, can be found on page 16. These suggestions may have application elsewhere.

A gage for estimating the widths of cracks in concrete shown on page 18, may prove to be a useful tool in many instances for measuring random cracks in concrete and other material.

When natural conditions are inadequate to remove water surplus to crop needs, a drainage system must be built. The Operation and Maintenance standards for the constructed system is discussed in an article beginning on page 20.

TRACTOR OPERATION AND ANTI-ROLL BARS

More than 1,000 persons are killed each year in tractor accidents, of which more than 500 are caused by tractors overturning.^{1/} These accidents have occurred on private property, farms, estates and public property, including roadsides and parks. Incorrect use of the vehicle and lack of "Anti-roll bars or seat belts," directly attributed to most of the fatal accidents. Tractor accidents are especially serious in that the operator is usually working alone and in many instances in isolated areas.

The seriousness of this problem and the toll from overturned farm tractors previously emphasized in Bulletin No. 43, issued in March 1963, "Anti-roll Bars on tractors save lives." The continuing toll has resulted in the Bureau of Reclamation, through the Office of Chief Engineer, recently requesting all Regional Directors to initiate appropriate steps to provide for the installation of anti-roll bars on all farm-type tractors in their regions.

Misuse of the features that make the tractor such a useful and versatile piece of equipment can result in accidents, producing injuries or death. A review of factors contributing to these accidents is the purpose of this article.

Hazards.

Several conditions contribute to the accidents with tractors. Power applied to the rear wheels which tends to lift the front end may, under the following conditions tip the tractor over backwards:

- a. Driving over soft ground causes the drive wheels to slip or become lodged. If the wheels are slipping and the operator blocks or chains the wheels to prevent them from slipping, and then shifts to low gear, applies full power and engages the clutch too quickly, the tractor may tip over backwards.
- b. Going up an incline, such as climbing out of a ditch. If the clutch is engaged too quickly, while applying full power, the tractor may become overbalanced and tip over backwards.
- c. Pulling a load, attached to the axle or to the drawbar, that has been raised too high, or has too short a hitch. The moments of force which cause a tractor to tip over backward are a product of the load and the height of the hitch from the ground. With the hitch the proper length, if the tractor starts to tip over backwards the hitch will lower rapidly, reducing this force. If the hitch is

^{1/}National Safety Council Data Sheet No. 587.

raised, the force is increased, making the tendency to tip over backwards greater. If the hitch is shortened on the load attached to the axle, the force may not reduce rapidly enough as the front wheels rise, resulting in the possibility of tipping over backwards.

When on level ground, poor soil conditions, holes, ruts, rocks, and other obstacles result in less stability and possible loss of control of the tractor. On slopes, in ditch sections, and on irregular surfaces tractor control becomes more critical.

The possibility of overturning, especially when operating on slopes, or on unstable or uneven ground, is increased by:

- a. Short turns.
- b. Traveling too fast for conditions.
- c. Lack of familiarity with area of operation.
- d. Hidden obstacles.
- e. Poor operator judgment.
- f. High hitch points.
- g. Lack of operator training. Machinery does exactly what the operator directs it to do through its controls. Thus, the operator must understand the tractor controls and how they direct the tractor. The operator must also know how environmental factors affect him and his tractor.
- h. Lack of familiarity with a particular type or size of tractor.
- i. Lack of retraining at appropriate intervals.
- j. Operator impairment (vision, cold, distraction, etc.)



Figure-1

Protective Device.

The protective tractor anti-roll bar, is now being used by many governmental units, as well as private groups and individuals. It guards against personal injury in tractor rollover or rear tipover accidents. A typical anti-roll bar device is shown in Figure-1.

The anti-roll bar is essentially a frame installed on a tractor to prevent the machine from turning past 90 degrees in case of an upset. The bar (frame) is sometimes made from steel

tubing. Angle iron and I-beam materials also can be used, Figure-2, and Figure-3.

The use of a seat belt, in addition to the anti-roll bar, provides the added protection of keeping the operator in his seat, within the confines of the anti-roll bar, in the event the tractor tips over. In addition, it provides a more stable seat for the operator on rough terrain.

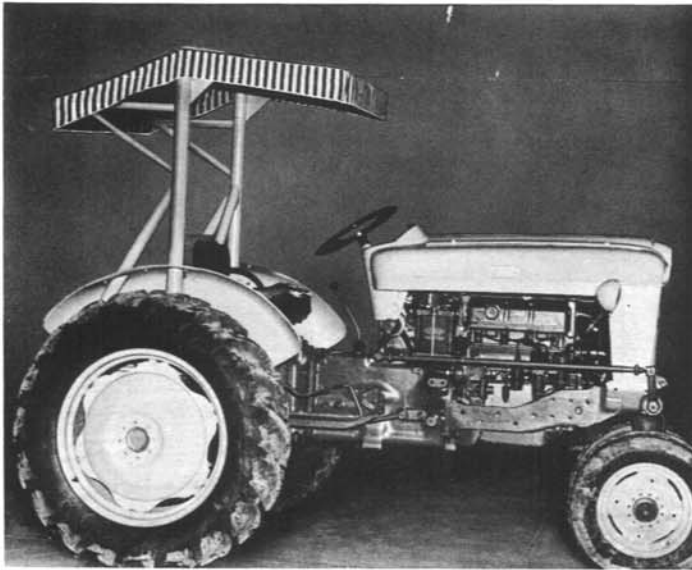


Figure-2



Figure-3

One state highway department reported eight rollovers of tractors during 1963. In six of these cases the tractors were equipped with anti-roll bars and seat belts. These rollovers were limited to 90 degrees. None of the six operators were injured, nor were the tractors damaged. In the other two rollovers, both operators were killed. Their tractors were not equipped with anti-roll bars or seat belts.

The design of the anti-roll bar should:

- a. Limit side roll or rear tipover to 90 degrees.
- b. Extend sufficiently to the rear to prevent the operator from coming in contact with towed or mounted attachments, in the event of a rear tipover.
- c. Permit optimum visibility.
- d. Not interfere with operator's movements in controlling the equipment.
- e. Permit easy attachment and removal when maintenance repairs are to be performed.
- f. Be simple and inexpensive to construct. (Costs reported vary from \$35 to \$250.)
- g. Permit operator's easy escape if tractor turns over.

- h. Not limit usefulness of equipment.
- i. Be of sufficient strength to prevent the tractor from crushing the operator in the event of a rollover or a backward tipover.

Drawing No. 1, page 7, shows 2-1/2-inch steel tubing and 1/4-inch plates welded to a pipe frame and bolted to an axle housing, this affords maximum protection for the operator and tractor. Note the frame on the backside slopes to the rear give added tip-over protection.

Drawing No. 2, shows the construction for the canopy that is shown in Figure-2, on page 3.

Since there are many different models, types, and sizes of tractors, and types of towed equipment, the anti-roll bar should be designed by the agency or department responsible for equipment maintenance and operation. The ingenuity of the mechanic can help to produce the particular design best suited to the equipment involved. Figure-4 below, is one typical design presently in use, and shows a Bulldozer outfitted with a heavy-duty protective canopy. Another design is shown in Figure-5, page 5. This shows the four-sided protection a tubular safety frame can give when extended over edge of the tires, since large tires may increase the roll in some cases.

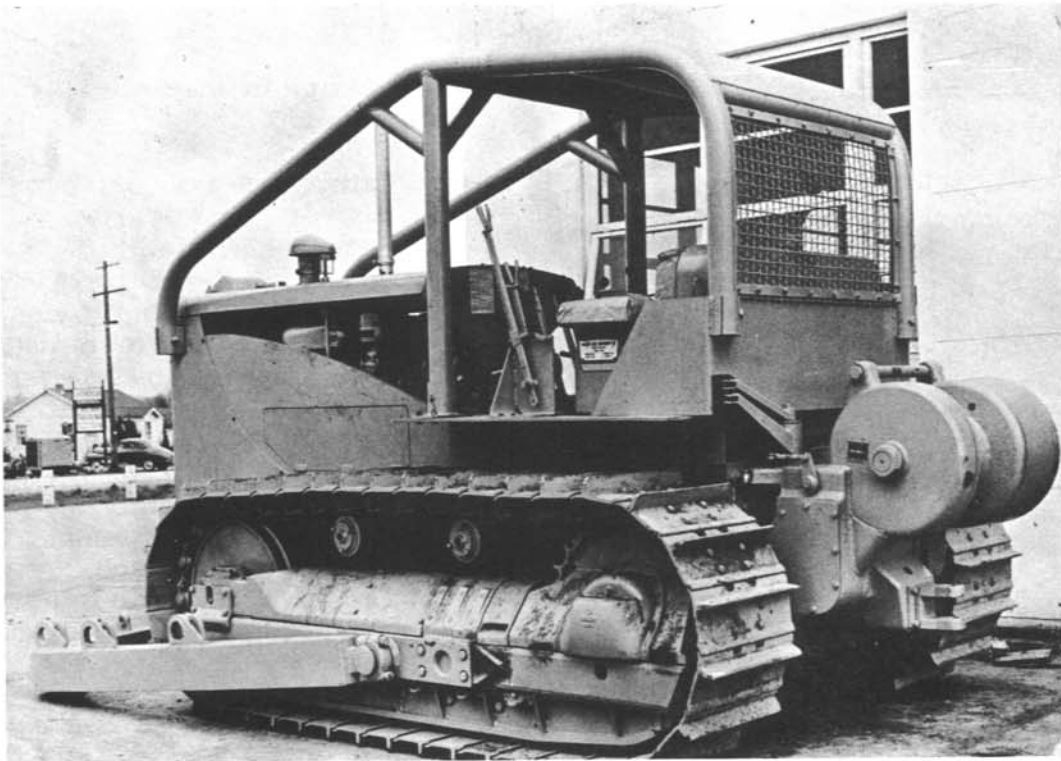


Figure-4



Figure-5

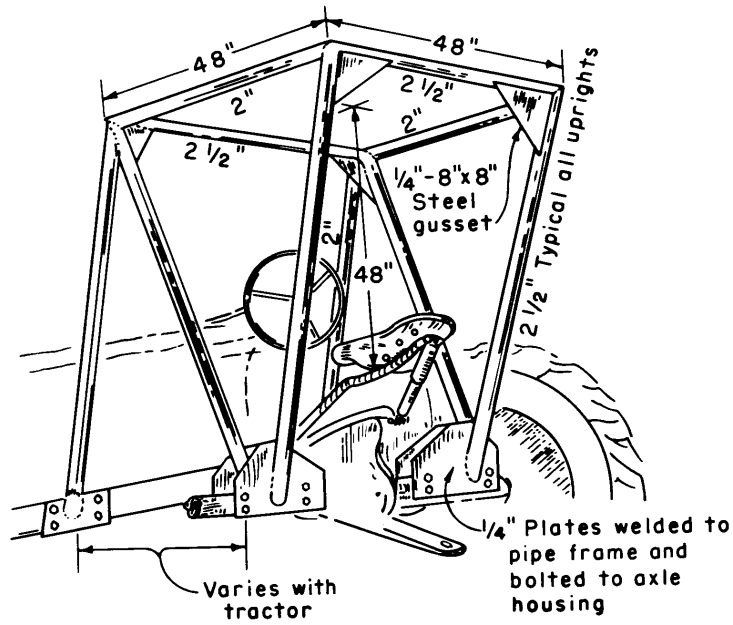
A seat belt prevents the operator from falling under the tractor in an upset or during rough operations, when operating a tractor with an anti-roll bar installed. It will also provide the operator with a more stable seat when operating over rough terrain.

Operating Safety Precautions

The anti-roll bar and seat belt are devices to protect the operator when an accident occurs. These, however, are not a substitute for preventing an accident. It is therefore helpful to observe the following "Rules for Tractor Safety":

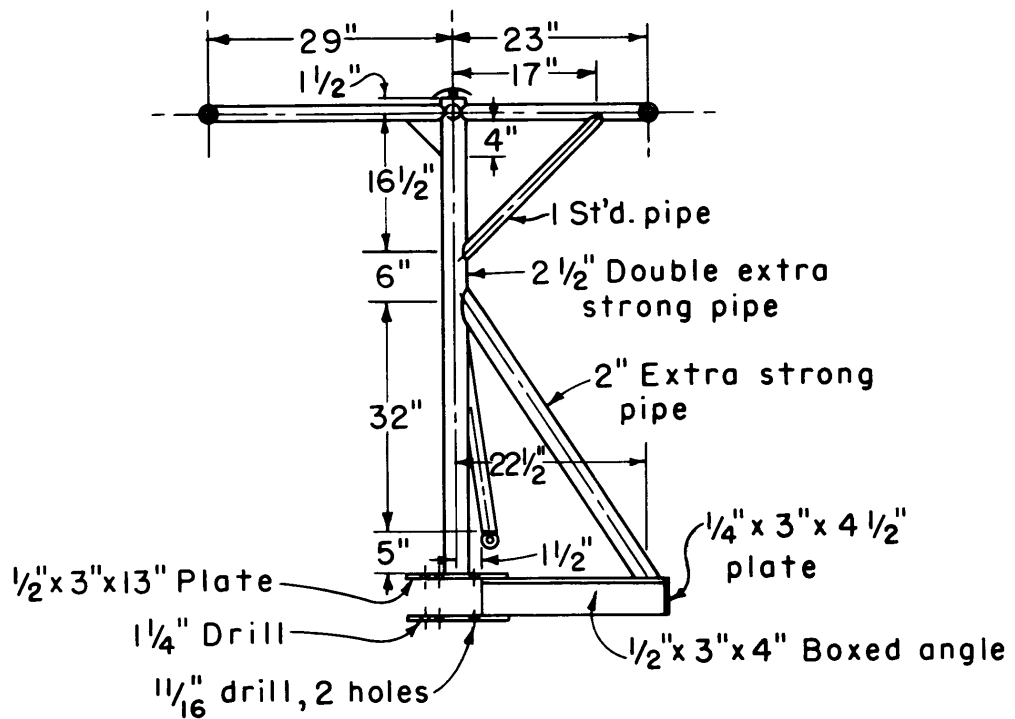
- a. Slow down when making sharp turns. Most tractors will overturn sideways whenever a short turn is made at high speed.
- b. Add front-end weights when operating on hilly ground and proceed with caution. Use lower gears when going downhill.
- c. When pulling a load, hitch only to the draw bar. Keep the draw bar hitch at least 13 inches, but less than 17 inches, off the ground. The higher a load is hitched, the easier it is for the tractor to overturn backwards.
- d. Front-end loaders or fork lifts raised high make a tractor top-heavy. When moving a front load, keep it low and the rear wheels as level as possible.

- e. Avoid holes and obstacles such as a stone or stump.
- f. Slow down when vision is limited or when operating on rough ground.
- g. When stuck, try to back out. Gunning the engine or fastening a post to the rear wheels greatly increases the chances of tipping over backward. Get help to be pulled out, if you can't back out.
- h. When on highways, abide by the accepted rules for auto drivers. Use proper hand signals, avoid travel during heavy traffic periods, and check brakes for equal application when locked together for highway use.
- i. When driving on highways use the lighting and markings required by your state vehicle code. Consider using a slow-moving vehicle emblem mounted on the back of your vehicle.
- j. Do not mow grass with a tractor on slopes greater than 3 to 1 slope.
- k. When using a sickle-bar mower, never cut with sickle-bar blades downhill, but always on the up-side of the slope, so that the pull of gravity will not cause the tractor to turn over.
- l. Shut off the engine before dismounting from the tractor.
- m. Shut off the engine before making adjustments to either the tractor or towed equipment.
- n. Do not allow riders on tractor, on the draw bar, or on towed equipment, unless a seat is provided for them.
- o. Fenders are guards for your protection, keep them in place at all times.
- p. Plan the job well ahead of time and watch for hazards, including those overhead.
- q. Leave tractor on incline only after the engine has been turned off, gear shift placed in park position, and wheels braked and blocked.
- r. Keep power takeoff shield in place.
- s. Dismount or mount a tractor only when it is stopped. Keep steps and platform clean.



Drawing No. 1

NOTE: All welded construction



SIDE VIEW

Drawing No. 2

METHODS OF ATTACHING ANTI-ROLL BARS

SYNTHETIC RESIN PRIMER FOR COAL-TAR ENAMEL

A water resources technical publication Research Report No. 8 released by the Chemical Engineering Branch, Division of Research, Office of Chief Engineer, describes laboratory research and field experience which was initially directed toward evaluating the bonding qualities of coal-tar primer. This work, which also included synthetic resin primed coatings, concludes that synthetic resin primers were remarkably superior as effective and foolproof bonding agents for coal-tar enamel.

This publication is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or the Chief Engineer, Bureau of Reclamation, Attention 841, Denver Federal Center, Denver, Colorado 80225. Price 25 cents a copy.

SIX STEPS TO BETTER PROBLEM SOLVING

When you have a seemingly insoluble problem, try finding the answer creatively--through brainstorming. To do this, you must get rid of mental blocks that stifle creative thinking and concentrate on the cause, rather than the effects, of the problem. Here is the way to do it:

1. State the problem. Why is it a problem? How is it a problem? To whom is it a problem?
2. Define the problem. Write down all factors pertaining to the problem. From these, select a handle--the real crux.
3. Brainstorm. Seek as many ideas as your imagination can produce. With a little practice, says one supervisor, you will be able to think up and write down as many as ten ideas per minute.
4. Evaluate your ideas. Establish a yardstick to measure your ideas, depending on the time and the situation.
5. Let your ideas incubate. This can take from several minutes to several months. During this time write down any unrelated ideas you may think of--perhaps you can use them on another problem.
6. Plan the action. How do you get the message to the boss? Be prepared with several solutions--and enough material to back up your position if he questions it.

Plant Administration & Engineering

HOW TO SELECT AND USE RESPIRATORS^{1/}

In many industrial situations a gas mask or respirator can save a man's life. But you can't select them on a hit-or-miss basis because what is right for one hazard may be completely wrong for another. If you work in areas requiring these protective devices, you should know the advantages and limitations of gas masks, chemical cartridge respirators, filter respirators and self-rescue respirators.

Air-purifying respirators remove gases and particles from air you breathe. They are divided into three general classes:

- (a) Chemical filters.
- (b) Mechanical filters.
- (c) Combinations of the two.

A mechanical single filter respirator is shown in use in the photograph below.



Chemical Filter Respirators

Chemical filter respirators include gas masks, chemical cartridge respirators (nonemergency gas respirators) and self-rescue respirators. They remove toxic gases and vapors from inhaled air and channel exhaled breath to the surrounding atmosphere.

^{1/}Reprinted by permission of the editor from an article appearing in *Safety Maintenance* (Vol. 133, No. 3) 1967, as condensed in *Supervisory Management*, May 1967.

Gas Mask Respirators

Gas masks consist of a canister containing the appropriate granular fill, a full facepiece and a body harness to hold the canister securely in place. Inhaled air is drawn through the canister and enters the facepiece without accumulating moisture on the eyepieces. A check valve keeps exhaled breath from entering the canister and forces it out through an exhalation valve. The facepiece is held securely to the wearer's face by an elastic head harness.

Gas masks are designed to provide respiratory protection against a specific gas, such as chlorine; a class of gases or vapors, such as organic vapors; a combination of two or more classes of gases or vapors, such as acid gases and organic vapors; or all gases and vapors.

Canisters are generally manufactured in the regular or industrial size, and the large or super size. The large canister provides longer service than the regular size does, and in most cases a canister designed for a single gas or a single class of gases and vapors will provide better--and longer--protection than a canister designed for protection against a variety of gases and vapors.

Here are some precautions to take when you use gas masks:

1. Make sure the atmosphere contains at least 16 per cent of oxygen and no more than 2 per cent of most toxic gases (3 per cent of ammonia).
2. Select the appropriate canister for the contaminant involved. A canister that protects against carbon monoxide or another odorless gas should have an indicator to show when to replace it.
3. Check to see that the gas mask is in good operating condition.
4. Adjust the canister harness on the body to allow some slack in the breathing tube connected to the facepiece.
5. Adjust the facepiece to a gastight fit on the face. There are two tests for a good fit: (a) Close off the exhalation valve and exhale gently into the facepiece. If a slight positive pressure builds up on the facepiece without outward leakage, it is adjusted properly. (b) Close off the breathing tube, inhale so the facepiece starts to collapse and hold the breath for about ten seconds. If the facepiece stays partially collapsed and there is no inward leakage, it is adjusted properly.
6. Test the complete gas mask for gastightness by closing off the air intake at the bottom of the canister, either with the palm of the hand or with the bottom canister seal, and inhale as outlined in 5 above.

7. Enter the contaminated area cautiously at all times. If you smell the contaminant, return to fresh air immediately and look for a leak.
8. Attach a fresh canister to the mask before entering a contaminated area, especially an extremely hazardous atmosphere or one containing gas that has little odor.
9. Do not remove the facepiece or attach a fresh canister until you're certain you're in clean air.
10. After leaving the contaminated area, replace the bottom seal on the canister to prevent the contents from deteriorating. This is particularly important with a carbon monoxide gas mask canister. If you don't know how long the canister has been used, install a new canister.

Chemical Cartridge Respirators

These respirators, (nonemergency gas respirators) consist of a half-mask facepiece with elastic headbands, check valves that force air out through an exhalation valve and one or two cartridges filled with granules that absorb gases or vapors. The cartridges, which can be easily removed and replaced, are usually designed to protect against single gases or vapors, or against single classes of these.

The chemical cartridge respirator is limited to use in low concentrations of certain gases and vapors (e. g. , a maximum of 0.1 per cent) where there is no immediate danger to life and where the atmosphere is not deficient in oxygen. It should not be used for protection against odorless gases or vapors; those that are highly toxic in low concentration, such as phosgene and arsine; or those that greatly irritate the eyes.

Make sure the right chemical cartridge is used for the intended purpose; for instance, an organic vapor cartridge will not afford respiratory protection against ammonia. Knitted cotton covers for the face-contacting surface of the facepiece should not be used because they are not gas-tight. When using such respirators, take these precautions:

1. See that the respirator is in good operating condition, with gaskets in place and the right chemical cartridges securely mounted.
2. Adjust it for a gas-tight fit on the face. You can test for this by using the same methods used with gas masks. If you choose the inhalation method, close off inlets in the facepiece with cardboard discs or stoppers usually furnished by the manufacturer.

3. Enter the contaminated area cautiously; if you notice any leakage of the contaminant, replace the cartridges.

Self-rescue Respirators

The self-rescue respirators are designed to provide the greatest possible respiratory protection in an emergency. This device consists basically of a small filter element, a mouthpiece, a nose clip and a means of carrying it conveniently or storing it near the work location. Most filter elements are similar to chemical cartridges made for protection against specific gases or vapors, but particulate filters are also available.

Use a self-rescue respirator only as an emergency device in escaping to a safe atmosphere or to the appropriate protective equipment.

Mechanical Filter Respirators

Mechanical filter respirators keep dust, fume or mist out of inhaled air by means of a filter, usually a fibrous pad. The facepiece may be a full or a half mask with elastic headbands and one or two filters for inhaled air. Most of them contain check valves that force exhaled breath out through an exhalation valve.

These respirators protect against a specific dust, fume or mist; a single class, such as toxic dust; or a combination of several classes. They do not protect against gases and vapors or against an atmosphere deficient in oxygen.

Some filters are re-usable, some not. Re-usable filters must be cleaned mechanically according to the manufacturer's instructions. Never wash or treat them with solvents.

If the filter must be changed several times an hour, select a longer lasting protective device. Do not use mechanical filter respirators where heavy concentrations of particulate matter build up or abrasive particles rebound rapidly. For such conditions use an abrasive blasting respirator.

Be sure to check these respirators for good operating condition and secure fit of appropriate filters. Check too for facepiece fit, following the same procedure given for gas masks. Always replace filters when they become too clogged for easy breathing. Where the atmosphere contains irritating matter such as lime, or where excessive perspiration may occur, you can use a knitted cotton cloth furnished by the manufacturer to prevent contact between your face and the rubber part of the facepiece. Never use these, though, on fume respirators.

To check the effectiveness of a mechanical filter respirator, look in a mirror when you remove the facepiece, and see if there are any dust streaks where your face was covered by the facepiece.

Combination Respirators

Combination chemical and mechanical filter respirators remove toxic gases and vapors, as well as particulate matter, from inspired air. Several forms are available, and their limitations are generally those that apply individually to chemical filter respirators and mechanical filter respirators.

* * * * *

LUBRICATING AUTOMOTIVE DOOR LATCHES

(Reprinted by permission of GRIST, January/February, 1967 issue, a publication by the National Conference on State Parks, Washington, D.C.)

Door latch assemblies of new cars and trucks usually are lubricated with a spray-on or brush-on light grease. After about 5000 miles this light grease channels away from the friction points and wear begins. The latch may fail to operate properly, causing a safety hazard. External lubrication does not properly reach the inaccessible portions of the assembly. Removing the door panel was the only way of getting to the parts needing lubrication--that is until Donald L. Johnson, Automotive mechanic at Grand Teton National Park made the following suggestion.

By removing the upper latch retaining screw, and using a squirt-type oil can, he lubricates the inner assembly through the opening. This not only saves the time of removal and replacement of the door panel, but a lubricated lock is less likely to become a safety hazard.

Mr. Johnson also suggests that this door latch lubrication become a part of routine vehicle maintenance with a check scheduled for every 2000 or 4000 miles.

* * * * *

He who every morning plans the transactions of the day and follows out that plan, carries a thread that will guide him through the maze of the most busy life. But where no plan is laid, where the disposal of time is surrendered merely to the chance of incidence, chaos will soon reign.

Victor Hugo

NINE WAYS TO RUIN A PERFECTLY GOOD PUMP^{1/}

The general parts and service manager working for a leading manufacturer in the United States, recently wrote an article titled "How to Ruin a Construction Business Without Even Trying." It included a list of "the most effective ways to shorten pump life," a digest of which follows:

1. The Oil Economy Method. This method creates havoc with engine bearings, pistons, and valves and is sure to stop the pump. You simply decide to become exceptionally thrifty, even stingy, to the point of being known as "cheap." Don't change the oil. Or you can get all the discarded oil from your own as well as other people's trucks and cars and use it in your pump.
2. Breaking Pump Tank. This is simple--just leave liquids in the pump during freezing weather.
3. Eliminate Strainers. Here's a sure-fire method of pump destruction: remove the strainer, bury the hose deeply in the mud--and watch the fun. Your pump will pick up anything!
4. Cavitation. Another method of destroying a pump is to run it with a smaller suction hose than that specified by the manufacturer. This starves the pump of liquid and creates a condition that will ruin the impeller and diffuser.
5. Off-level Scientific Method. You can fool the best pump authorities and mechanics with this one. Since pump manufacturers specify that, for maximum performance and to prevent engine failure, pumps should be level, make sure yours is not parallel with the surface of the ground. Being off level will cause eventual engine failure as well as make the pump ineffective.
6. Engine Power Failure. There are two ways of accomplishing this: lack of lubrication and lack of coolant. Let the radiator run dry, don't refill with coolant--and watch the engine burn up.
7. Ruining Seals. Two of the most effective ways to ruin seals are to run pumps for a long time with no liquid circulating through them, or with the suction hose buried in mud, which prevents the flow of liquid.
8. Hose Deficiencies. Pump failure can be caused by using a hose over which you first run your truck, damaging the inner liner. Another just as effective method is using a hose with twisted or damaged washers. A third is to neglect to use washers at all and leave hose connections loose.

^{1/}This article and one on the next page are reprinted from Contractors and Engineers magazine, October 1966 issue, by permission of the editor.

9. Air-cleaner Method. This has been tried over millions of miles of highways by the American driving public. You simply don't bother to change the air cleaner when it becomes clogged and dirty. This starves your engine and creates intermittent failure. Or you remove the air cleaner and never replace it!

* * * * *

MISCELLANEOUS TIPS FOR REPAIRING CRANES

Before starting a repair job, move the machine to a dry, level spot. If it is complete overhaul, put the machine in a building where weather will not delay the job or damage the parts removed.

Loosely reassemble parts whenever possible to prevent small ones from being mislaid. Keep subassembly parts together, but be careful not to get right and left-hand parts mixed up.

It is a good idea to recondition the whole assembly rather than make piece-meal repairs as trouble comes up.

Because most gears are heat-treated and flame-hardened, it is not good practice to remove one by heating unless absolutely necessary. If a gear has to be heated, great care must be taken not to get it too hot or the heat treatment may be destroyed. Use a gear puller whenever possible.

When removing cranks or other parts with split hubs, loosen the clamp bolt and expand the hub by driving in a small wedge.

When keyed parts are to be replaced, keyways should be in perfect alignment before insertion of the keys.

Parts that require a press fit are more easily assembled if the shaft is coated with white lead.

When bevel gears are replaced, care must be exercised in aligning the teeth. They should be adjusted for proper tooth contact and backlash by means of shims.

All bolts that are defective in any way should be replaced. This applies particularly to pillow block bolts.

When any one of the shaft assemblies has been reconditioned, great care must be used when replacing it in the machine. After it is installed, check the alignment and relationship with adjoining assemblies before the machine is started. Check the shaft assembly again after operating the machine for a few hours.

* * * * *

REMOTE SERVICING AND OPERATING IDEAS (Suggestion No. R7-66S-56 & No. SPRP-66-7)

Two suggestions by Mr. Oscar D. Spenard of the Granby Branch of the Operation and Maintenance Division of the Colorado-Big Thompson Project, were made to save time, provide safety and reduce the cost of maintenance and repair. Although the suggestions were made specifically for the operation and servicing of a ring follower gate and a hollow jet valve at Granby Dam, similar arrangements could be made to service and operate other valves and equipment.

Operating the Blow-off Valve

With reference to the drawing on the following page, it is required that blow-off valve G, located in the outlet works tunnel, be open for 5 minutes once each month of operation to remove any accumulation of silt from the lower bonnet of the 30" Ring Follower Gate.

Originally the decking above the valve had to be removed, and a man with a wrench stepped down through the opening on to the body of the 30" hollow jet valve, then down a stepladder to the bottom of the tunnel, and before opening the valve, put the stepladder up and across the 30" hollow jet valve to be out of the line of flow from the blow off valve. Due to limited standing room, it was necessary to put ones back toward the bulkhead and straddle the valve, stand sideways on the curve of the tunnel while opening the valve or get wet. Footing was very poor and the greatest danger was in slipping and falling into the line of flow from the valve.

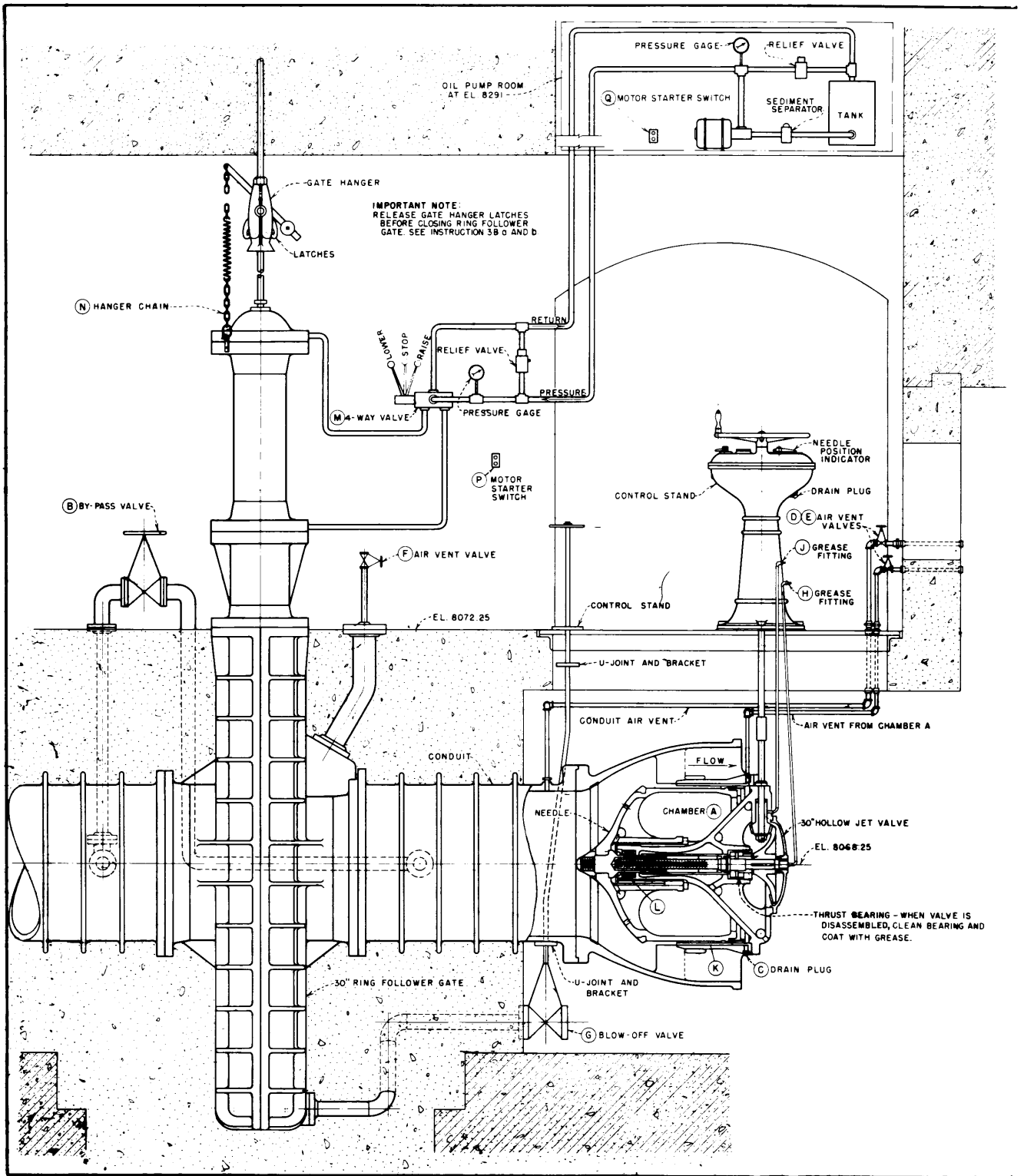
The extension of the valve stem by use of "U" joints make it possible to operate the valve from the control stand set on the decking.

Greasing the Hollow-jet Valve

The second suggestion also shown on the same drawing concerns a means of greasing the hollow jet valve without necessarily closing the valve.

Pipe nipples were provided to grease the valve bevel pinions and control screw respectively. Grease fittings "J" and "K" were removed and pipe nipples were installed in their place. Pipelines were extended upward to the control stand where the grease fittings were reinstalled. The piping was not affected by the flow of water, since there is a 4" splitter behind the bevel pinion drive shaft and the grease piping extends up through this space.

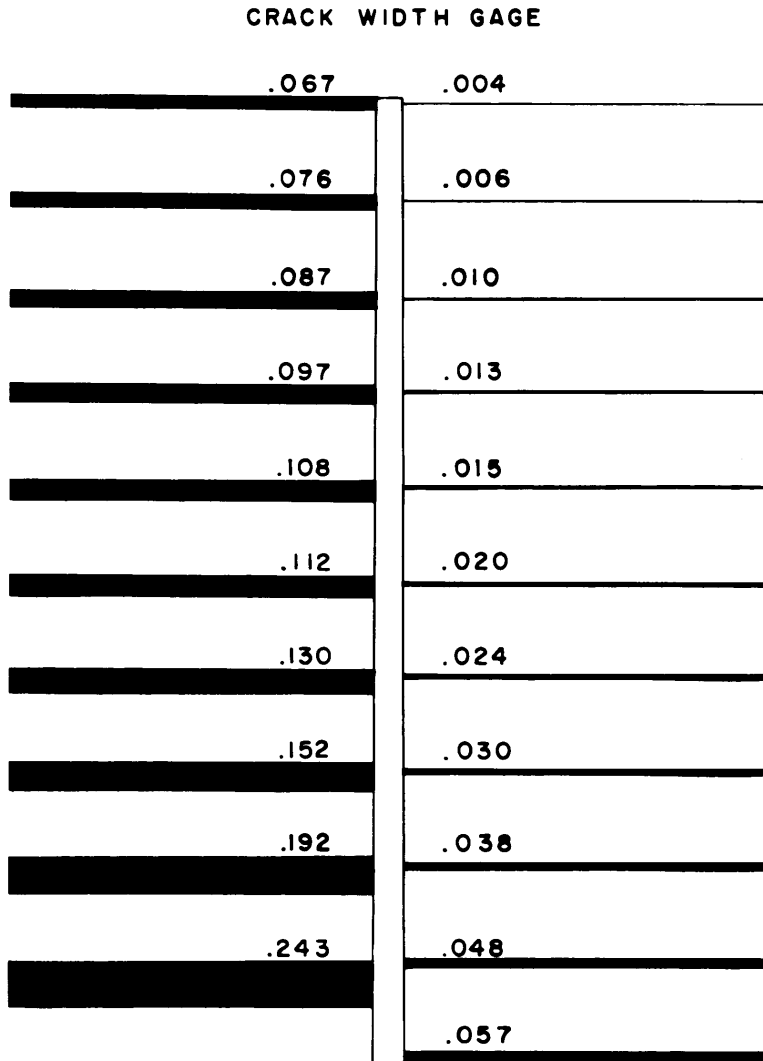
This piping arrangement permits greasing periodically without going into the tunnel, whether the valve is in service or not.



* * * * *

HANDY GAGE FOR ESTIMATING CRACK WIDTHS

Occasionally it may be desired to obtain a general idea as to the widths of cracks in concrete, say, the widths of random cracks in concrete canal linings.



The gage shown in Figure 1 below, is made of photographic film having a range of line widths from 0.004 to 0.243 inches. The visual matching of the closest line width and the crack as shown in Figure 2, on next page, will provide a measurement which is accurate enough for many purposes. The gage is more convenient to carry and handle than, for instance, a variety of drill bits.

These crack width gages may be obtained from the Office of Chief Engineer, U.S. Bureau of Reclamation, Denver Federal Center, Denver, Colorado 80225.

COATINGS SEALERS AND PLASTICS SEC.
U.S.B.R. DENVER, COLO.

Figure 1

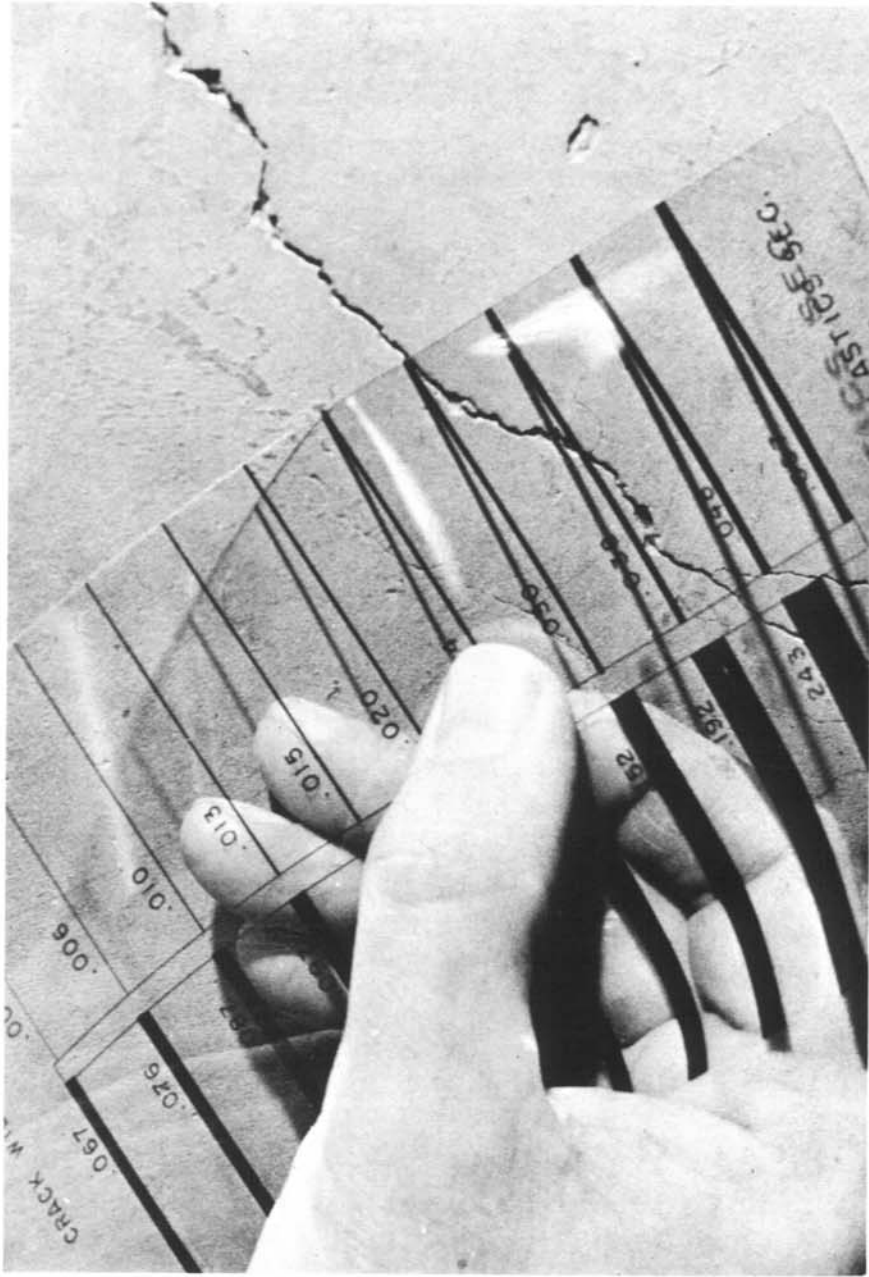


Figure-2

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OPERATION AND MAINTENANCE STANDARDS FOR IRRIGATION PROJECT DRAINAGE SYSTEMS^{1/}

Efficient drainage systems must ultimately be provided on all irrigation projects when natural conditions are inadequate to remove water surplus to crop needs. Surplus water may include waste from the irrigated farms, surface runoff from snow and rainfall, seepage and leakage from project canals and distribution systems, artesian water, and percolation from farm irrigation. Timely performance of preventive and regular maintenance of project drainage systems is absolutely necessary if the systems are to perform the functions for which they are designed and built. Project drainage systems should be thoroughly examined periodically to determine if they are functioning properly and if maintenance is required.

Occasionally, Operation and Maintenance Forces are required to design and construct open and pipe drains. These drains must be designed and constructed under the same criteria used when the work is done by the Bureau of Reclamation.

Buried Pipe Drainage Systems

Pipe drainage systems, properly installed, generally need very little care to keep them operating satisfactorily. Newly constructed systems require close vigilance during early years of operation. Proper care of the system during this period will increase the effectiveness of the drains, and many times eliminate the need for expensive repairs. Drainage system failures or partial failures usually are associated with unstable soil conditions which cause shifts in pipe alignment and grade, pulled joints, plugged outlets and pipes and plugged manholes.

(a) Pipe Drain Outlets: All pipe outlets should be inspected in the spring and after heavy rain storms to see that the pipe still has free fall into the open drain and that there has been no erosion on the side slopes which could cause the outlet pipe to be displaced.

Flap gates, when required on the pipe outlet to keep flood water in the open drain from backing up into the pipe, should be inspected at least once a month. Rodent screens should be checked periodically to determine that they have not been pushed out of place. Where rodent screens have not been installed, the corrugated metal pipe outlet should be inspected periodically during the summer for nests. All pipe outlets should be fenced if cattle and sheep are allowed in the area.

(b) Manholes or Sand Traps: Manholes are usually constructed at bends in the tile lines, and at a horizontal grade change. The bottoms of the manholes are set 1 foot to 18 inches below the invert

^{1/}Prepared as a guide by Mr. Owen A. Dolven, Irrigation Operations Branch, Region 7, Denver, Colorado, dated September 6, 1967.

of the outlet pipe to provide a trap for silt and sand. It is very important that the manholes be kept clean, and particularly important during the initial operation of the system. Check them once a week when the lines are first laid. Failure to clean the manholes has caused many well constructed drainage systems to become plugged. Pumps are available which can be used to remove the sand from the manholes. Any erosion or settlement around the outside of the manholes should be repaired as soon as it is reported or observed. Farmers should not be allowed to use manholes as surface waste disposal outlets. Heads should not be built up in the manholes more than about 2 feet above the top of the inlet pipe.

When using the mechanical cleaning rods in manholes, care should be taken that the whipping of the cleaning cable does not break the ends of the inlet and outlet pipes. Silt and sand trap in the manhole should be cleaned following any pipe cleaning upstream.

Manhole covers should be fastened down securely at all times, except during cleaning operations or inspection. This is to keep people from throwing trash into the manhole and to prevent small children and animals from falling into the manhole.

(c) General Maintenance of Tile Drains: A record should be established immediately after a drain is completed of the flow at each manhole and at the outlet. This can be done by measuring the depth of water in the pipes that discharges into the manholes and by actually measuring discharge at the drain outlet. If the discharge at any of the measuring points drops suddenly, additional investigations should be made because there is a good possibility a segment of the drain is plugged or partially plugged. The area along the tile lines should be inspected for sink holes, wet spots or tree growth, as these are indicators of potential trouble.

If a small sink hole is discovered, it should be backfilled and checked later for additional settlement. If a large sink hole is found, a good-sized hole should be dug down to the tile. Quite often, holes like these develop over broken tile or joints that have separated. If the tile is broken, it should be replaced immediately. Joints that have pulled apart can be repaired satisfactorily by placing tile butts (broken pieces of tile) over the joint and backfilling around the joint with coarse gravel.

Wet spots that suddenly appear over tile lines are good indicators that the line may be plugged or partially plugged. If the drain is only partially plugged, the plug may be removed by placing a ball somewhat smaller than pipe in the pipe upstream from the wet spot. Balls have been used very successfully to remove sand and silt from tile lines. Sewer rods can also be used to probe and clear the pipe.

If these measures fail, the plug will have to be located by uncovering and opening up a section of the tile line.

Broken pipe, pulled joints or plugged pipe should be repaired at the earliest date possible so the drain system will function as intended. Plugs in older pipe drains are usually caused by tree or plant roots. Copper sulfate injected into the system will usually kill the roots and then by using a power cleaning rod and cable operated from the downstream side, the dead roots can be broken off and washed out to the nearest manhole and removed. When manholes are not available, a hole should be excavated to the drain downstream from the plug and one or more pipe joints removed so the power cleaning rod can be inserted into the pipe. A screen should always be placed over the pipe opening on the downstream side so water can flow on down the drain, but no roots or material falling into the hole will get into the drain.

Periodic checks should be made along the lines to see that trees and willows have not started to grow over or near the drains. New growths should be sprayed with 2, 4-D. If there are trees and willows growing near the drains that cannot be removed, the drain should be treated with copper sulfate. The first treatment should be made in April or early May. If the tree and shrub roots are a serious problem, a second treatment should be made in August. The copper sulfate will not kill or harm the trees and shrubs so the treatment will have to be made annually. State water quality standards must be followed closely when drains are treated with copper sulfate.

Open Drainage System

Open drains require regular maintenance to keep them functioning as designed. The frequency and degree of cleaning depends upon the climate, amount of rainfall, and the depth the ground water table must be kept below the ground surface. Shallow surface drains in stable material generally require only spot cleaning each year and a complete cleaning about every 5 years. In unstable soils, yearly cleaning by clamshell or similar equipment might be required in the bottom of the drains to maintain depth, particularly if pipe drains outlet into the open channel. In the more stable, deep, open drains, chemicals used periodically will prevent the growth of weeds, willows, and tules. Burn the weeds and tules after they have been killed by chemicals, so the drain section is kept clean. All open drains will require some degree of maintenance after each large storm. Tumbleweeds are a special problem in open drains and can cause serious erosion problems around structures and in the flatter reaches of the drains.

All spoil banks should be planted to grass if not done during construction and should be releveled and replanted after cleaning, mainly to stabilize

the excavated material so it will not blow or wash back into the drain and to provide a roadway for maintenance and control of weeds. The sides of the channels, particularly above the water surface, should also be planted to grass and fertilized every 2 years. Maintenance roads require spot repair in the spring and after every large storm.

Openings through open drain banks for surface water should be by well maintained pipe inlets or lined channel. Properly installed, these inlets usually require inspections only after large storms and when the open drain is being cleaned. Under no condition should an unlined cut be allowed through the drain bank. When pipe smaller than 18-inch-diameter is used for surface inlets, they should be inspected frequently during the spring to see if weeds have plugged the pipe. All grade control structures should be inspected periodically to see that there is no undercutting or settlement and the trash racks and baffles are not plugged with weeds.

Drain should be covered with rock riprap or paved with concrete and fenced to all livestock watering accesses. All fences across the drain section should be inspected and cleaned of weeds and trash each spring and after a large storm.

Wide-bottomed, shallow floodway channels should be grassed on the bottom and sides as soon as practical if this has not been done in the construction stage. The grass should be clipped to a 4- or 5-inch height about June 1. When practical, the banks and sides should be fertilized in the spring every 2 years with about 40 pounds of nitrogen per acre. Grazing should be controlled, particularly in early spring.

Natural waterways used as drains should be left in their natural condition as much as possible. Spot filling of eroded sections with rock or gravel should keep the channel stable. Smaller sections that erode under perennial flows should be rock-lined along the bottom. All inlets for surplus irrigation or rainfall runoff should be by pipe inlets with riprap at the bottom.

Wastewater Disposal Ponds

Wastewater disposal ponds are effective only in areas where the ponds can be bottomed in permeable sands and gravel with an adequate natural outlet. The ponds will operate as planned, provided the silt which accumulates in the bottom is removed periodically. A record should be kept of the discharge of ponds. Staff gages can be installed and readings taken at regular intervals to determine how fast the water seeps out of the depressions. When the rate of discharge decreases considerably, it is time to clean the ponds.

A good grass cover should be maintained on the dikes around the pond by periodic fertilization and watering if required.

Inlet structures, which have been constructed to bring surface waste-water from the fields into the ponds, should be kept in good repair. The settling basin or silt trap ahead of the inlet pipes should be kept clean. This will minimize the need for cleaning the ponds.

To control vegetative growth and maintain permeability, the bottom of the pond should be treated as required with a soil sterilant.

Drainage Observation Wells

Observation wells, properly installed, require minimum maintenance. However, any sudden change in the water table depth or a constant water table depth over a 3- or 4-month period usually indicates a plugged well. The amount of work involved in cleaning the well could vary from pumping out the silt and sand from the well to pulling the pipe and installing it in a new hole. The most common need for maintenance results from the pipe in the well being bent over or pulled out by farm or highway equipment. In order to keep a reliable, complete record of the water table, these wells should be reinstalled and protected by a 4" x 4" painted post. All automatic recorders installed on observation wells require constant maintenance to keep the clock and recorder operating properly.

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