WATER OPERATION AND MAINTENANCE

BULLETIN NO. 81

SEPTEMBER 1972

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.

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Division of Water Operation
and Maintenance
Engineering and Research Center
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COVER PHOTOGRAPH:

East Bench Canal, Montana - Backfilling of the 18-inch anchor berm is done by hand to hold the PVC lining in place until a blade and dragline complete the 16-inch-deep covering of selected material.
Photo P699-600-2287NA

UNITED STATES DEPARTMENT OF THE INTERIOR
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Commissioner

WATER OPERATION AND MAINTENANCE
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INTRODUCTION

On page 1 the value of flexible liners to control water seepage in canals is portrayed.

"Protection from Wasps" is the title of a short article on page 4. The article describes how mothballs give employees protection from wasps when servicing water fluctuation recording machines installed on the Corning Canal.

A professional truckdriver knows instinctively what to do for various road conditions. However, the article on page 5 gives some facts for us to follow when driving gravel roads.

Ten different cylinder-type fire extinguishers that everyone should be familiar with, are described on page 7.

Joint sealant costs can be fairly well estimated, as shown in the article on page 8, and in the cost graph on page 9.

Several articles on cattle guards have been printed in various issues of the bulletin, however, the article starting on page 10, is the first one on cattle guard modification.

Practical pointers are listed for all heavy equipment personnel as to what they should know about Alternators, beginning on page 14.

WATER LOSS BY SEEPAGE HALTED WITH FLEXIBLE LINERS[1]

The world over, vinyl plastic liners are proving to be the answer to the age-old problem of the loss of precious water supplies by seepage into permeable subsoils.

A recent application of PVC vinyl demonstrates how water supplies can be saved in an irrigation canal project. From the contractor, supplier and stockman standpoint, the loss of water along 2 stretches of irrigation canal in the Helena and Dillon areas of Montana was tremendous. Freeze-thaw cycles during the cold season caused the concrete bottom of the canals to craze, crack and pop up.

During the fall and winter of 1968, some 68,000 square yds. of vinyl sheeting were laid as an impermeable membrane in the Helena Valley canal. That stopped the leaking there. In Figure 1 below, folds of PVC sheet are loosened before covering sides of the canal slope. The sheet measures 63 feet wide and from 530 feet to 800 feet long.

Figure 1 Photo P596-D-71927

[1] Article from the July-August 1971, issue of the Irrigation Journal, recently called to our attention and reprinted here by special permission of the editor.

In a section of the 40 mile long East Bench canal in Dillon which serves to irrigate some 20,000 acres along the eastern slope of the Beaverhead River, the water flows through a critical 2-1/4 mile stretch of sand and gravel. Here the rate of loss was calculated to be about 48-acre feet every 24 hours. The escaping water caused destruction, too. It seeped downslope into a housing development, and it saturated a hillside above an interstate highway, causing the slab to heave and buckle.

To rectify this condition, the Bureau's Regional office in Billings, Montana, installed more flexible plastic. The old material was removed from the bottom of the dry canal bed. As with the first section of liner, new liner was laid down, 84,000 square yds. of it, and was placed in 4 sections of the canal.

Flexible PVC sheeting rivals or betters concrete and asphalt for impermeability. In addition, its flexibility is an advantage over the rigid construction material. It "gives" during freeze-thaw periods which are the result of severe winter weather changes. Another advantage is that the vinyl sheeting can be laid down faster than hard-setting materials.

At the Dillon project, the dirt was removed and the canal basin cleared. The large vinyl sheets were unfolded from the bottom and laid up the 2:1 slope, one side at a time. Then the loose sides of the material were covered with screened backfill along the berm. More backfill, taken from the canal right-of-way, was placed with a dragline over the entire lining to a depth of 16 inches. See Figure 2 on next page, and note the 18 inch anchor berm for the PVC Membrane on both slopes. Figure 3 shows the back-fill operation. Prior to lining, this stretch of the canal seeped water through breaks in concrete bed at a rate as mentioned above.

The canal was flooded. The water carried without any seepage directly over the East Bench canal bed. The watertight PVC held the water, which then flowed into lateral ditches.

As a result, farm and grazing land in the area is obtaining all of the moisture intended for it--from April 15 to October 15. During the rest of the year the canal is empty, a period when the bed is subjected to crazing, cracking and popping up due to the freeze-thaw. However, the PVC lining now prevents leakage.

The East Bench canal in Dillon is an important segment of the Three Forks Division of the Missouri River Basin project, which is under the jurisdiction of the Bureau of Reclamation. The Bureau has been using PVC as impermeable membrane lining in the U.S. since 1955.

One of the contractors said, "We like working with this material, it is impervious to cracking, goes down fast, and does a good job."

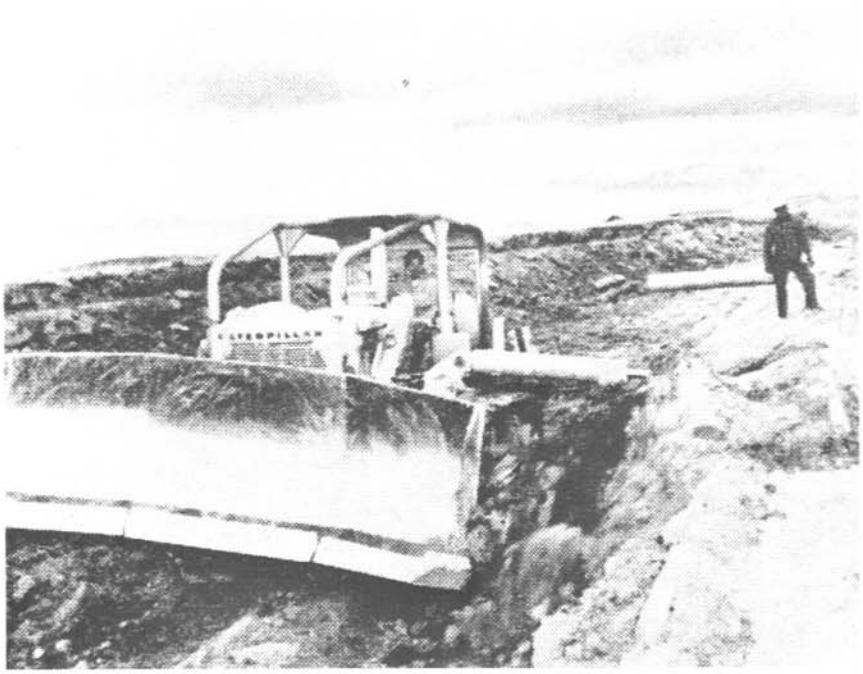


Figure 2 Photo PX-D-71929

Figure 3 Photo PX-D-71928

PROTECTION FROM WASPS

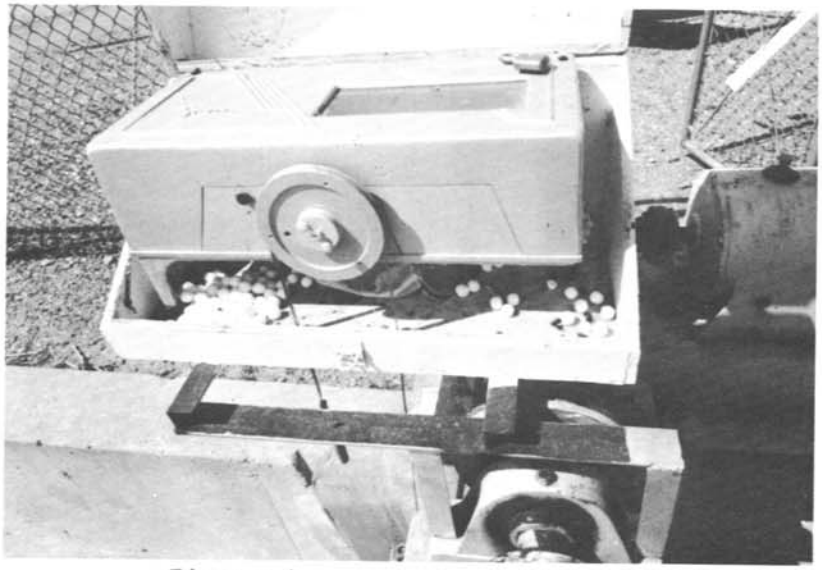


Figure 4 Photo P602-D-71930

Figure 5 Photo P602-D-71931

The monitoring device shown in Figure 4 above is used by the Central Valley Project, on the Corning Canal. The device can be used for any installation where long term operation is required or in which wide fluctuations in water levels occur. Although the recording device itself is insect proof the housing used to protect the recorder is not, and stinging insects can cause trouble. (See Water O&M Bulletin No. 40, page 12)

On various occasions employees who service and record the data on these machines have been stung by wasps. It was discovered by installing mothballs in the machine protection box, that adequate protection from various insects was provided. See Figure 5, and note the dead black widow spiders and wasps at the bottom of the box.

* * * * *

GRAVEL ROAD DRIVING TECHNIQUES

A high incidence of single-vehicle accidents on gravel roads, at about normal driving speeds, points up the need for special driver education and training in this area.

Most drivers involved in gravel road accidents are not traveling at excessive speeds, but the accidents in almost every case were avoidable.

They were caused by the driver ignoring or being ignorant of the warning signs of a pending loss of control. Typically, the vehicle started off the right side of the road, was steered to the left side, sharply cut back to the right and off the road into the ditch. Once in the ditch, the driver frantically tried to get out and the vehicle rolled.

Once the sequence starts, the pattern is identical. A meeting of a unit's drivers to discuss this sequence will do a great deal of good in preventing this type of accident.

In your discussion there are a few points to consider:

a. The vehicles involved in these accidents are usually pickups, 4 x 4, or power wagons. These vehicles will normally be lighter weight than the average passenger car. This will cause the vehicle to have a greater tendency toward a rear end sway or "dance" on gravel roads.

b. These vehicles are also built with a high center of gravity. The reason is that they are built for field work. Also, they ride high on the springs when there is no load in the bed. Passenger cars are built lower to the ground and, as a result, have far better steering control. When an empty pickup is driven on gravel, the high center of gravity makes the vehicle "oversteer." In other words, when the vehicle is turned it tends to tighten the turn. A passenger car is designed specifically not to have this characteristic. When you couple these two facts together and put a driver behind the wheel who has driven only passenger cars, you can begin to understand how and why a man can be driving on a straight road at high noon and by himself lose control of his vehicle.

A professional truckdriver, one who is familiar with driving different types of equipment, knows these facts. He may not know the reason for it, but he can feel it in the vehicle and automatically make adjustments for the feel. When the rear end begins to sway or "dance" he will ease up gradually on the accelerator and reduce his speed to stop the rear end sway. This is the key to preventing an oversteer pattern from starting. The second thing he will do is adjust his steering

inputs so that he has a "light" touch on the wheel and he will make all steering corrections firmly but gradually.

His steering inputs also will be made more frequently. In other words, on a straight stretch of road he will be making a few more steering inputs than the average driver.

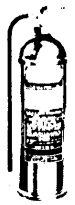
The biggest trap that a gravel road can present is an uneven gravel surface. Frequently you will find more gravel in the center or sides of the road. This will aggravate control of a light truck far more than any other type of vehicle. When conditions such as these exist, speed absolutely must be reduced. The most experienced driver cannot insure that normal vehicle wander will not take him into the excess gravel area. Speeds must be drastically reduced so that the vehicle is controllable if it should enter the heavy gravel. The driver who does not take these steps will find the problem compounds so quickly that no action can be taken to keep the vehicle under control.

Carrying about 400 pounds of weight in pickup beds may help the control problem slightly. The word "slightly" is emphasized. The added weight will not make the pickup drive like a passenger car. The problems inherent to a light truck will still be there and driving habits must still be modified to overcome the steering problems associated with light truck operations. Any excess steering play in the front end is naturally going to aggravate the steering problem. The road and vehicle condition will dictate the speed at which the vehicle must be operated. The driver must continually feel for that speed which will completely stop a rear end sway.

* * * * *

Water is the only common chemical compound or mineral that occurs naturally in 3 distinct phases: gas, liquid and solid. This was recognized by Thales of Miletos, Greece, about 2,500 years ago. Water has been called the "mirror of science" because of its importance in science and in human affairs far beyond its ordinary daily uses. The story of the growth of civilization and science would be written largely in terms of man's concern with water.

KNOW YOUR FIRE EXTINGUISHERS

TYPE OF EXTINGUISHER		WATER			WATER SODA ACID	FOAM	CARBON DIOXIDE	DRY CHEMICAL			
								SODIUM OR POTASSIUM BICARBONATE		MULTI-PURPOSE ABC	
		STORED PRESSURE	CARTRIDGE OPERATED	PUMP TANK				STORED PRESSURE	CARTRIDGE OPERATED	STORED PRESSURE	CARTRIDGE OPERATED
											
CLASS OF FIRE — A — WOOD, PAPER, RUBBER, PLASTICS		YES	YES	YES	YES	YES	NO	NO	NO	YES	YES
CLASS OF FIRE — B — FLAMMABLE LIQUIDS, GASES, GREASES		NO	NO	NO	NO	YES	YES	YES	YES	YES	YES
CLASS OF FIRE — C — ELECTRICAL EQUIPMENT		NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
USUAL OPERATION		PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE	PUMP HANDLE	TURN UPSIDE DOWN	TURN UPSIDE DOWN	PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE	PULL PIN SQUEEZE HANDLE
RANGE		30'–40'	30'–40'	30'–40'	30'–40'	30'–40'	3'–8'	5'–20'	5'–20'	5'–20'	5'–20'
DISCHARGE TIME		1 MINUTE	1 MINUTE	1 MINUTE	1 MINUTE	1 MINUTE	8–30 SEC.	8–25 SEC.	8–25 SEC.	8–25 SEC.	8–25 SEC.
SIZES		2½ GAL.	2½ GAL.	2½ - 5 GAL.	2½ GAL.	2½ GAL.	2–20 LBS.	1–30 LBS.	2½–30 LBS.	2½–30 LBS.	8½–30 LBS.

ESTIMATING JOINT SEALING COSTS[1]

The cost of sealing or resealing contraction joints in concrete canal linings is subject to wide variations depending on a number of factors. The cost of the joint sealing material itself can be rather closely estimated, assuming a fair degree of uniformity in the size and shape of the contraction joints. Affixing a price tag to the installation is a great deal more uncertain. Considerations involved in installation are as follows:

1. Location (convenient vs remote)
2. Cleaning requirements (sandblast vs air jet)
3. Application equipment (machine vs manual)
4. Amount of sealing
5. Removal of old sealant

The above are not necessarily in order of effect or cost; all of them will have a large bearing on the total cost. Location, for instance, will directly affect the amount of time a crew can spend in productive work, which in turn determines the number of feet of joint which can be sealed in a working day.

Similarly, the other items listed are subject to wide variations.

The following graph (see Figure 6 on next page) is offered as an aid in estimating joint sealing costs, taking into account various types of sealants, depths of joint filling and widths of joints.

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[1] Written especially for this publication by Mr. Henry Johns, Materials Engineer, Materials Section, Applied Sciences Branch, Division of General Research, U.S. Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

COST OF JOINT SEALING MATERIAL IN CENTS/ LIN. FT. AND NUMBER OF FEET WHICH CAN BE SEALED PER GALLON OF JOINT SEALANT

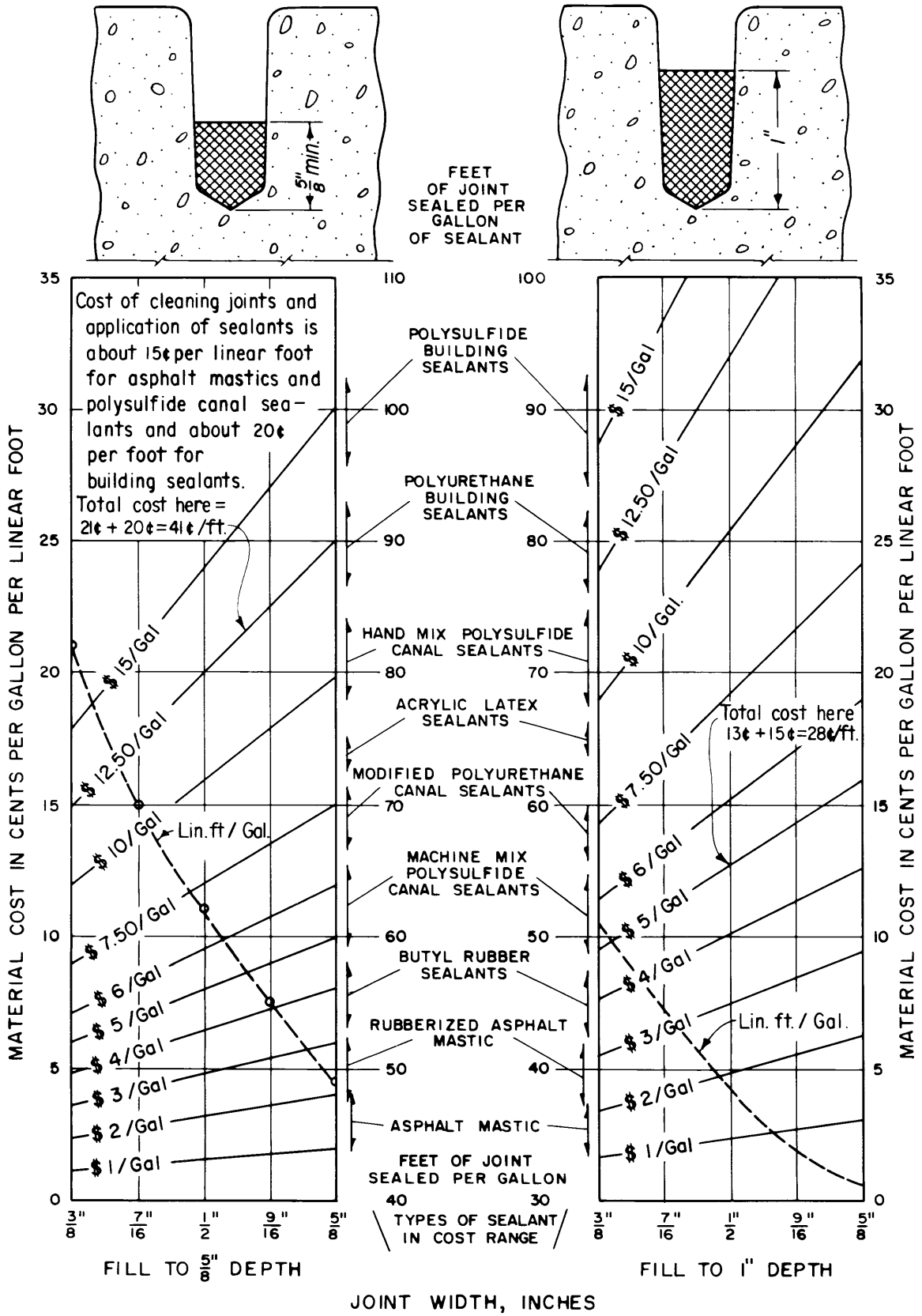


Figure 6

CATTLE GUARD MODIFICATION

The Kansas-Bostwick Irrigation District, headquartered at Courtland, Kansas, has found through their years of operation, that the cattle guards on their system are too narrow for equipment travel, and that the maintenance of the wing guards was time consuming and costly. Figure 7 below, shows an original cattle guard installation. (Note damage to the wing guards.) To eliminate this problem, the maintenance personnel of the District are utilizing a portion of their time during the winter months to modify the cattle guards.

Figure 7 Photo P271-D-71932

The modification consists of using two pipe deck units at each site. The outside ends of the pipe deck are bent upward to desired height and braced to form the wing guards as shown in Figure 8 on the next page.

The sketch on page 12, shows in detail the procedure used to bend the pipe deck ends to form the wing guards, and Figure 9 on next page below shows a cattle guard installation after it has been modified.

The Ainsworth Irrigation District, headquartered at Ainsworth, Nebraska, has also experienced maintenance problems on the wing guards of the cattle guards on their system. To alleviate this problem, the

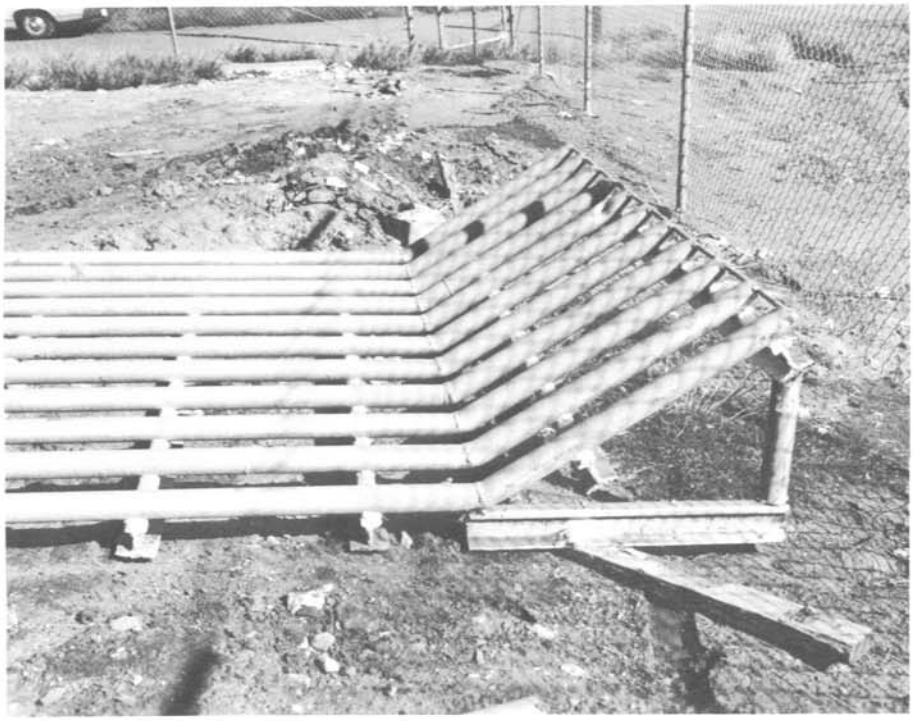
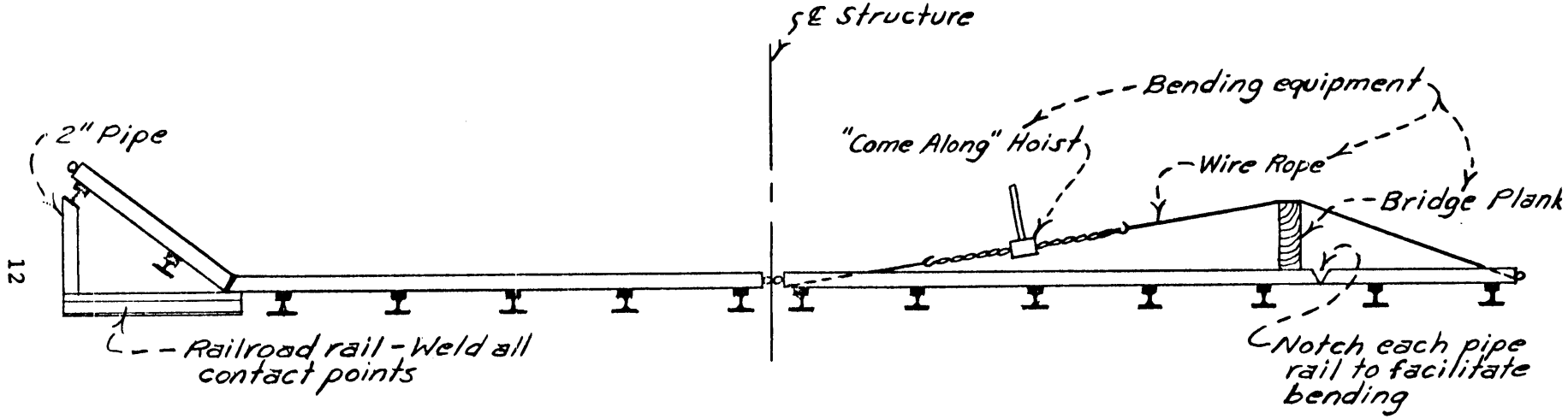


Figure 8 Photo P271-D-71933

Figure 9 Photo P271-D-71934



HALF SECTION - MODIFIED UNIT

HALF SECTION - PRIOR TO MODIFYING
(Showing bending equipment)

district maintenance personnel has been attaching automobile tires to the wing guard support posts to form the wing. See Figure 10 below, showing the tires attached to the support posts.

Figure 10 Photo P271-D-71935

The tires are bolted to the wing guard support posts, and if hit by maintenance equipment, the tires are flexible enough to allow passage of the equipment and then return to their original position. The tires used for this purpose are unfit for other uses; therefore, the material cost to modify the wing guards is neglibible.

* * * * *

The Hydrological cycle or water cycle consists of the continual movement of water by evaporation from the sea into the atmosphere, condensation of water vapor into clouds, by precipitation of rain or snow from the clouds on land and sea, and by return flow in rivers and underground to the sea. Some water precipitated on the land re-evaporates from lakes, wet soil and vegetation; some "percolates" underground and becomes ground water; and only part of the water returns directly to the sea.

WHAT YOU SHOULD KNOW ABOUT ALTERNATORS[1]

For the heavy equipment maintenance manager, it makes sense to examine all aspects of electrical system preventive maintenance in order to hold repair or replacement cost to a minimum. Here, we take a look at some aspects of troubleshooting alternators which comprise the "nitty-gritty" of what you should know about alternators. Like any other precision engineered piece of equipment, alternators must be cared for and checked periodically to assure proper operation.

Most equipment operators feel that the mechanical aspects of alternator maintenance are the most simple so in this article we will discuss mechanical areas that require periodic attention in a sound preventive maintenance program. Especially important are harness connections and insulation checks, where mechanical failures would cause faulty electrical operation.

Aside from the need for proper electrical connections and grommeting of leads through any metal holes, the mechanical parts of an alternator system are:

a. Mounting hardware
b. Pulley
c. Belt
d. Slip rings
e. Brushes
f. Bearings

Mounting Hardware

This includes the lugs or spindle on which the alternator pivots and the bracket assembly to the motor block or chassis. Opposite the pivotal assembly is the adjusting arm assembly that fixes the alternator pulley distance from the driving pulley. These assemblies come in many forms due to the many different engine shapes and under-the-hood space allowances, but the idea behind them is simple and that is to assure proper pulley alignment, distance, and belt wrap from the drive pulley.

Mountings will very seldom have to be re-engineered, but they must always be checked for tightness at any point subject to loosening. For servicing, they need nothing more than common tools.

If some mounting change is necessary, it is wise to seek factory help. Many support brackets, adjusting arm extensions, spacing bars, shims

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[1] Reprinted from an article in WESTERN CONSTRUCTION, dated April 1971, and written by Raymond W. Schmock, Manager, Technical Service of a leading United States Heavy Equipment Manufacturing Company.

etc., are available, but due to the critical nature of alignment, they should be carefully installed.

Problems encountered by neglecting mounting bolts are pulley misalignment, or a loose belt. The first wears out belts, and the second reduces electrical efficiency and can result in polishing the pulley so proper traction is lost.

Glazing of the belt is a definite sign of neglect because the belt howls out a warning on starting, rapid acceleration or rapid loading of the alternator long before the pulley glazes. If you hear this tell-tale squeal, check the mounting immediately.

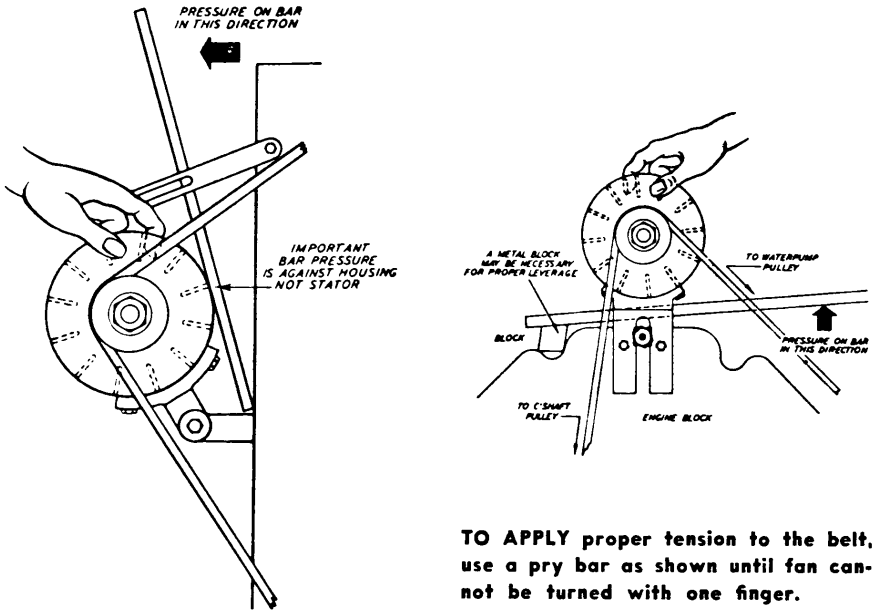

Figure 11

If the alternator mounting has loosened, it should be retightened with care to assure that proper belt tension has been restored as well as pulley alignment maintained.

1. Loosen the lug or spindle bolts only enough to pivot the alternator.

2. Loosen the adjusting arm bolts so it pivots freely. (Do not unseat the belt, however, if this can be avoided).

3. Use a pry bar as shown in Figure 11 above, to tighten the belt until the alternator fan cannot be turned with the pressure of one finger.

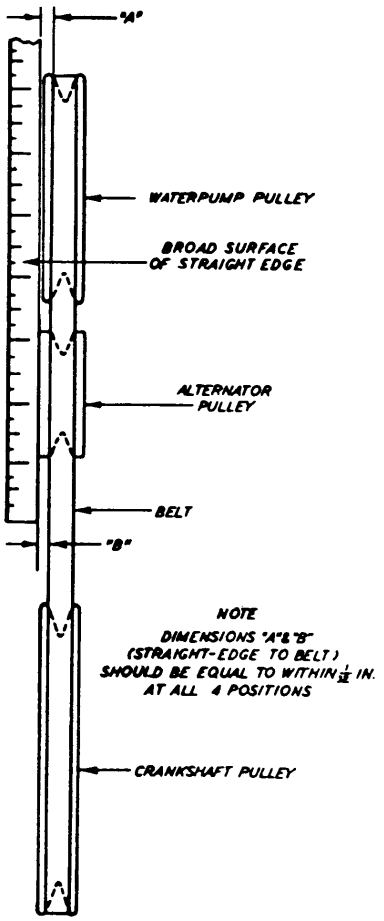

Figure 12

4. Assure pulley alignment with a straight edge as shown in Figure 12, left, and 13-A and 13-B, below. There should be no greater variation than one thirty-second of an inch between the ruler and the belt from one pulley to another. (Dotted lines indicate placement of straight edge on far side of pulleys).

5. Retighten all bolts and recheck alignment and tightness.

Care should be used with the pry bar so that pressure is brought to bear on the casting portion of the alternator frame and the stator laminations are not damaged.

If the belt tension is too tight, bearing damage can result, so it is best to position the alternator exactly at the point where maximum finger tension will not slip the pulley within the belt and no tighter.

Belts and Pulleys

A fully loaded 85-amp alternator on a 12-volt system requires about 1.5 hp. at 4,000 rpm. to be transmitted through the belt and pulley arrangement or it resists

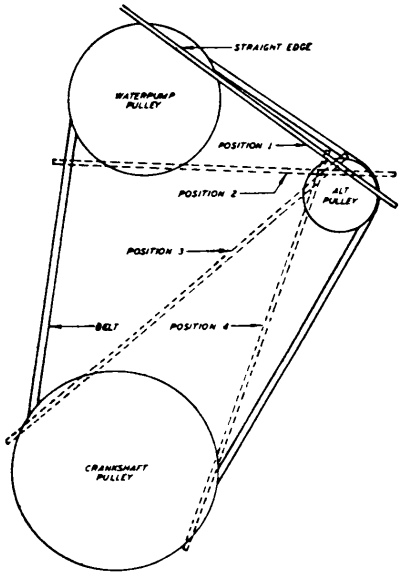

Figure 13b

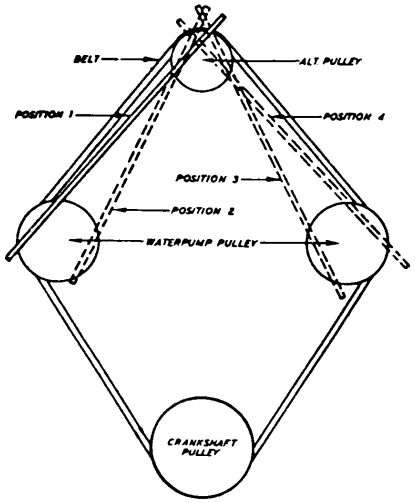

Figure 13a

with 2 lb.-ft. of braking torque however you want to look at it. To transmit this torque range, a belt or belts of proper design are important for long trouble-free service.

A perfect belt pulley arrangement consists of a cog type belt that does not bottom in the pulley. The torque is then transmitted through the sides of the belt and pulley and does not excessively load the bearings or cause rapid belt wear. Top width should be 2 or 2.5 deg. greater than the top width of the pulley grooves.

When replacing belts, the steps outlined above should be performed rather than forcing the new belt over the pulley. A certain amount of run-in may be necessary to seat the belt properly in the pulley and the tightening procedure repeated.

Never replace a single belt in a multiple belt pulley system as mismatched belts defeat the purpose of this type design through uneven belt loading. (Replace them as a set.)

Slip Rings, Brushes and Shaftbearings

Slip rings, brushes, and bearings should cause no trouble during normal alternator operation. In heavy-duty applications on fleet vehicles, brushes and bearings should be replaced as a matter of preventive maintenance at around 100,000 to 150,000 mi.

If premature bearing failure should occur, and there can be no guarantee against it, check for improper loading before assuming the bearings were simply bad and replacing them.

If no excessive belt tension is apparent and the alternator has been properly aligned, the odds are pretty great that the bearings were faulty to begin with. Replace them and, depending on mileage, the brushes along with them.

Bearing design is a science in itself and the reasons for bearing failure can be very complex. Even with the best quality control techniques in the world some inadequate bearings will be shipped or damaged by mishandling. Reputable manufacturers will replace them under standard or normal warranty.

Where regreasable bearings have been supplied with an alternator it is only necessary to note that a definite greasing schedule should be observed with the additional caution that overgreasing has historically caused more problems than under-greasing. Follow recommended procedures as closely as possible.

Wiring Connections

All wiring connections should be checked regularly in routine maintenance to assure that insulation has not been damaged by vibration and that mechanical connections at terminals have not been loosened.

Problems caused by these failures have a high nuisance value, but normally will not result in severe damage to the system.

The possibility of improper and inefficient operation leading to battery deep cycling or intermittent open circuits make these areas an intelligent preventive maintenance check point.

Holes through metal parts of the frame and chassis should be checked for grommets and all external terminal connections should be checked for snugness of fit and clean connection points.

Checking all of the above points at each routine maintenance check will bring your electrical system most of the way to trouble-free operation by finding the problems before they happen and in the shop rather than on the job.

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