WATER OPERATION AND MAINTENANCE

BULLETIN NO. 121

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IN THIS ISSUE

PIVOTAL TRASHRACK ON THE CHARLES HANSEN FEEDER CANAL
VALVE BOXES FOR SECTIONALIZING GATE VALVES
CORROSION PROBLEM ON TRASH SCREEN
THESE SIX STEPS CAN ADD UP TO BETTER WELDS
REMEMBER SAFETY WHEN YOU WELD

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 Suggestion Award Committee when a suggestion is adopted.

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Cover Photograph:

Consider the type of metals being welded, match the electrode and then use the right welding techniques for a strong weld.

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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

A pivotal trashrack structure that prevents debris and other material from entering the reservoir has been designed, constructed, and is in operation on the Charles Hansen Feeder Canal. See article beginning on page 1.

Preventing farmers from covering and damaging valve boxes for sectionalizing gate valves is described on page 5.

Having a problem with corrosion of trash screens? The article on page 6 points out how one District solved this problem.

Informative articles on quality welding and safety precautions are found on pages 7 and 20.

PIVOTAL TRASHRACK ON THE CHARLES HANSEN FEEDER CANAL [1]

The Bureau of Reclamation's South Platte River Projects Office in Loveland, Colorado, designed, constructed, and now operates and maintains a trashrack structure located on the Charles Hansen Feeder Canal near Horsetooth Reservoir. Recreation activity, as well as municipal water requirements, made it necessary to install the structure to prevent debris and other objectionable material from entering Horsetooth Reservoir.

Previously constructed trashracks were difficult to operate by one person because of the large accumulation of debris held on by the force of flowing water and were only marginally effective in the removal of debris. Efficiency and flexibility of the canal system were severely restricted as much time was required to remove debris by the irrigation system operator.

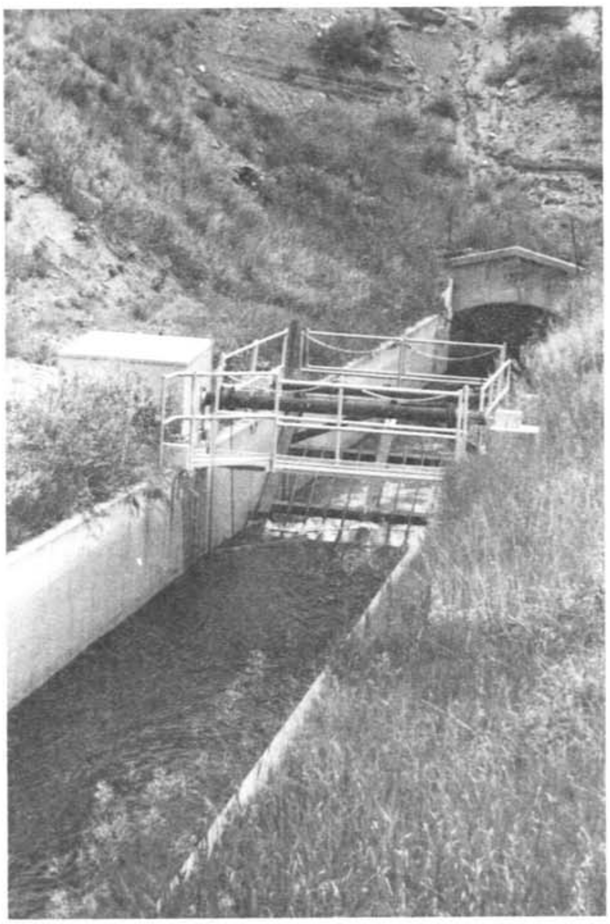

Figure 1.–Upstream view of the trashrack structure showing the motor and gear reducer house, hoist cable shaft, and retrieval cable.

[1] This article written especially for this bulletin by Stuart Hirai, South Platte River Projects Office, Bureau of Reclamation, Loveland, Colo.

Recently, a motorized trashrack was installed and equipped with the following features:

1. Pivoting trashrack to allow raising for trash removal

2. Hoist cable shaft with cable

3. Walkways upstream and downstream

4. Housing for motor and gear reducer

5. Shear and hoisting pins

6. Retrieval cable

These features illustrated by figures 1 and 2 and drawing 245-713-1425, permit total accessibility, are virtually maintenance free, and provide additional safety from overtopping the canal following storms.

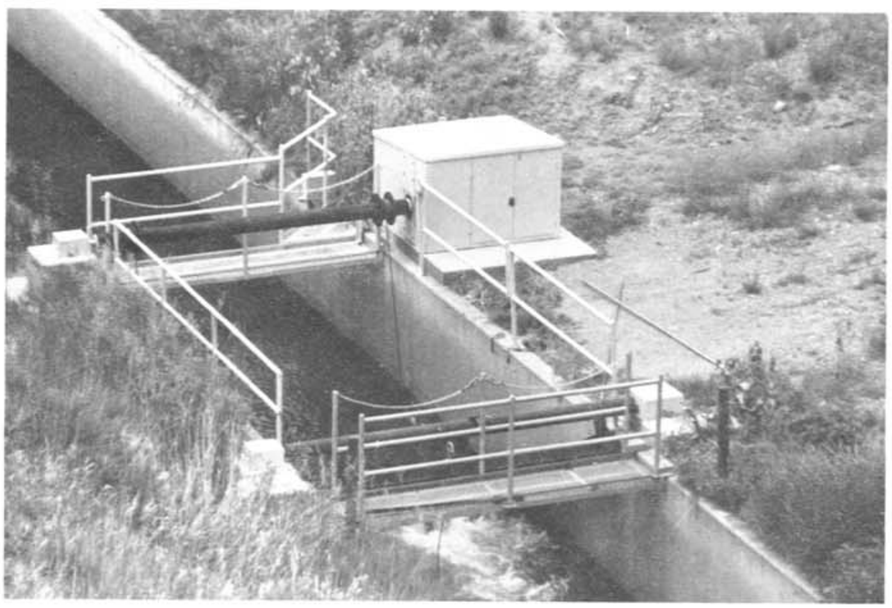

Figure 2.–Downstream view of structure showing the pivoting trashrack, walkways, and railing.

Overtopping could occur when weeds are blown into the canal by high winds and carried into the trashrack, thus plugging it. If an operator is not available to clear off the debris in time, the shearpin will fail when about 17 800 N (4000 lb) of shearing force is exerted on the pin. The trashrack is designed to handle a loading of 27 200 Kg (30 tons), including the dynamic force of flowing water. Retrieval cables which are used to reposition the trashrack following shearpin failure also prevent the trash from being swept downstream during such failure. A winch or other means of lifting the trashrack is used to raise and reposition the trashrack. Hoisting pins are used for lifting the trashrack to allow removal of debris and removed when the trashrack is placed back into operation so that all force is exerted on the shearpin.

The trashrack is performing as designed and is operating very satisfactorily.

If you should have further questions regarding this structure, contact: Chief, Water and Land Operations Division, or Chief, Engineering Division, South Platte River Projects Office, P O Box 449, Loveland CO 80539.

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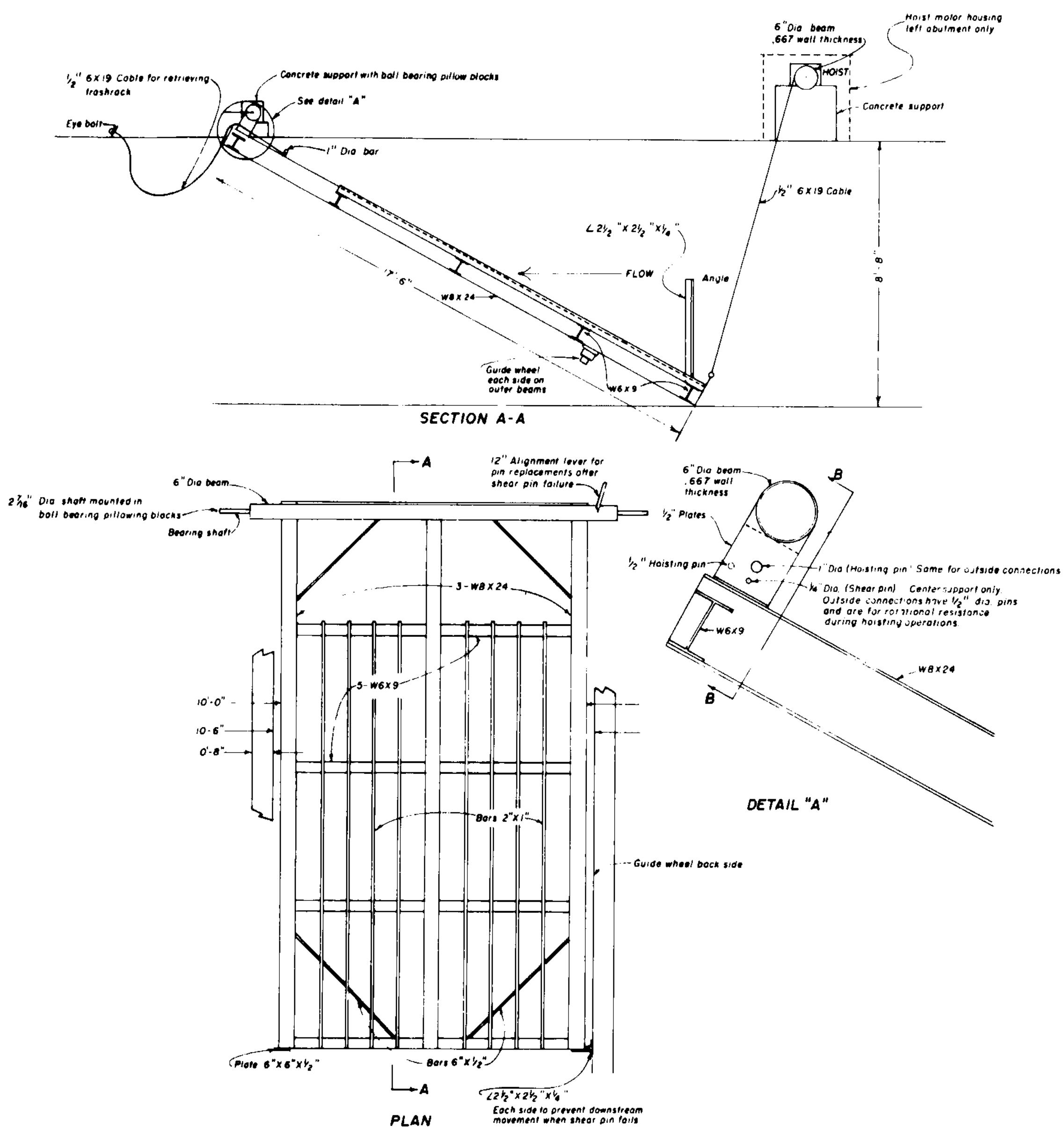

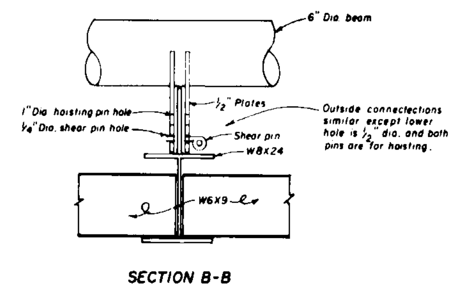

NOTES

1. Hoist motor-1.5 H.P., 115/230 volts, 1-phase, 60 HZ: with 556.8:1 gear reduction ratio

2. Anchor blocks - concrete design based on f'c = 3000 psi at 28 days. Stability against overturn provided by epoxy bonded No. 6, rebar dowelled into canal wall. Allowable soil pressure, 2000 p.s.f.

Figure 3.–Drawing No. 245-713-1425, Trashrack, Charles Hansen Feeder Canal.

VALVE BOXES FOR SECTIONALIZING GATE VALVES [2]

In a Review of Operation and Maintenance examination of the carriage and distribution facilities operated and maintained by the Shafter-Wasco Irrigation District, it was noted that in the past, farmers were covering valve boxes or damaging them with their equipment. To remedy this situation, the District has extended the valve boxes above the ground and placed posts on the sides to prevent farmers from hitting them. This new method has cut down on the required maintenance and also makes it easier to locate the gate valves in emergency situations.

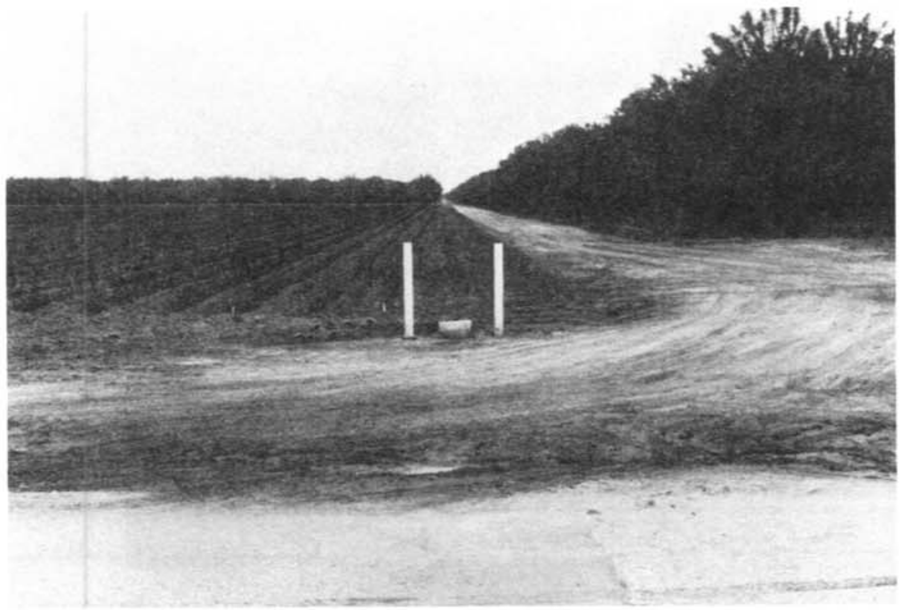

Figure 4.–Valve boxes extended above the ground and posts placed on the sides to prevent farmers from hitting them.

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[2] Article excerpted from Review of Operation and Maintenance Examination Report by Gary Egan, Civil Engineer, Mid-Pacific Region, Bureau of Reclamation.

CORROSION PROBLEM ON TRASH SCREEN [3]

In a Review of Operation and Maintenance examination conducted on the Corning Water District distribution facilities, it was noted that the stationary trash screens on the pumping plant intake structures had experienced corrosion problems. The corrosion was due to galvanic action resulting from contact between the aluminum screen frames and the steel supports. The District solved the problem by installing plastic strips on the frames to break the aluminum-steel contact (fig. 5).

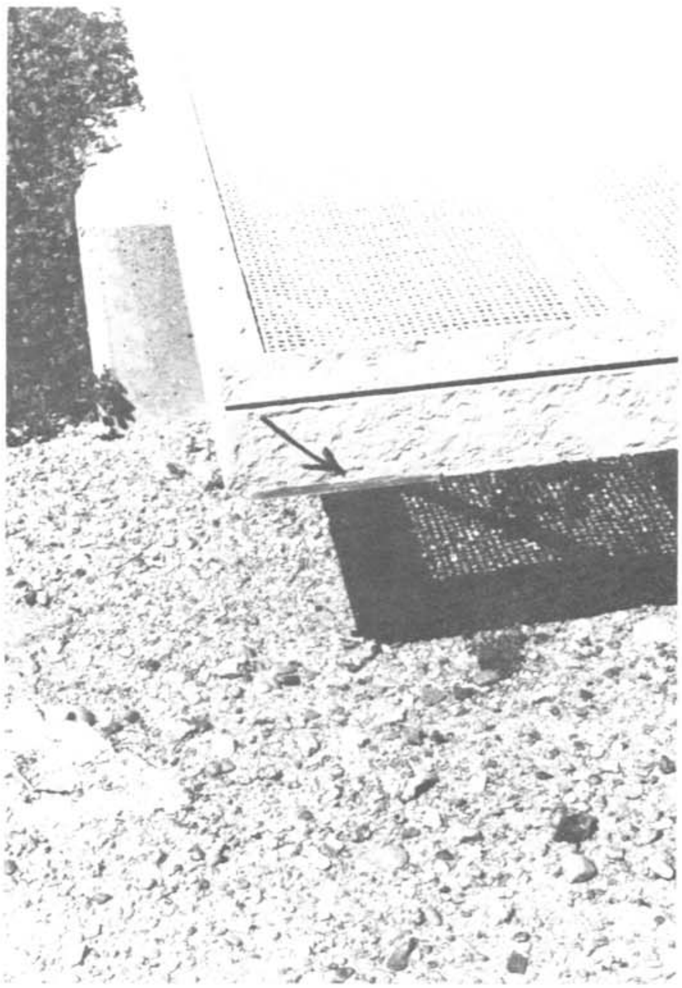

Figure 5.–Plastic strip (arrow) installed on aluminim screen frame to break contact with steel supports.

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[3] Article excerpted from Review of Operation and Maintenance Examination Report by Robert J. Stuart, Civil Engineer, Mid-Pacific Region, Bureau of Reclamation.

THESE SIX STEPS CAN ADD UP TO BETTER WELDS [4]

By Thomas A. Silleto

Welders occasionally complete a weld by electric arc process only to see the weld bead crack from end to end. Also, unseen underbead weld cracking often occurs. In either case, the weld beads may not be very strong.

There are six basic steps to quality welding. They include knowledge of metal identification, electrode selection, amperage, arc length, electrode angle, and welding speed. Incorrect process or application of any of these welding basics, or several of them collectively, may result in weld beads which have inadequate strength. The following is a rundown on each of those six steps.

Metal identification is a must for persons who do maintenance welding. Too often, farmers or ranchers grab a welding "rod" and "burn in" a weld without regard to what is being welded. Ferrous metals used in construction of agricultural machinery are usually carbon or alloy steel or cast iron. Carbon steels may be grouped as low-carbon (mild), medium-carbon, or high-carbon steel.

Low-carbon steel is readily welded with a mild steel electrode. Medium-carbon steel is less easily welded without special technique. Weldable high-carbon steel, up to 0.65 percent carbon content, can be welded successfully only when special treatment or technique is followed.

Modern agricultural machinery is often constructed of medium-carbon and weldable high-carbon steel. The blacksmith of a generation ago and some machine shop workers often determined the carbon content (and estimated strength as well as heat treatability) of carbon steel by listening to the sound of the "ring" of the metal when the metal was tapped or when dropped on a hard surface.

The spark test is readily used in metal identification by observing the sparks showering from a grinder wheel as the metal is ground. Low-carbon steel sparks result in long, yellowish carrier lines. Generally, as carbon content increases, the spark lines, forks, and bursts also increase. Many metals are identified by appearance.

Nonferrous metals, such as aluminum, copper, or bronze, are different colors. These metals will not have visible spark lines when spark tested, because they consist of little or no iron. Aluminum should not be ground because the metal chips will fill the surface of the grinder wheel.

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[4] Reprinted by special permission of Editor, Nebraska Farmer, from March 6, 1982, issue.

Figure 6.–Low-carbon steel emits long yellowish lines and occasional forks.

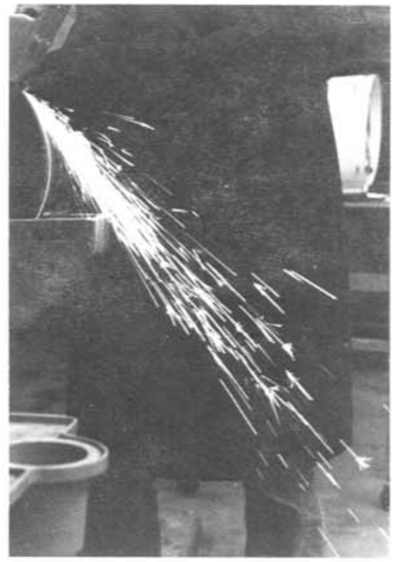

Figure 7.–Medium-carbon steel emits white lines, sprigs, or forks (branched sparks) and some bursts.

Figure 8.–High-carbon steel emits white lines and bright bursts when ground.

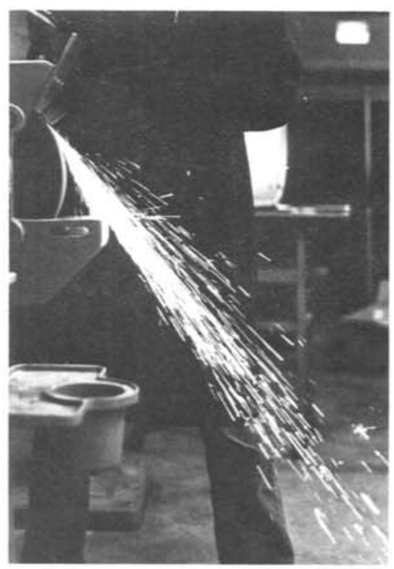

Figure 9.–Malleable cast iron emits somewhat reddish carrier lines, when ground.

Gray cast iron, a ferrous metal, is often identified by appearance. Cast iron has an irregular shape, casting marks, and casting skin, as well as a gray, porous fracture. Gray cast iron does have a distinctive spark test result. The spark lines are red in color, and are curved. Malleable cast iron has longer lines. They are somewhat reddish in color and curve less than spark lines of gray cast iron.

The correct identification of metal is an important first step toward quality welding. Electrode selection and weld process are determined correctly only after metal to be welded is identified.

Weldability of higher carbon or alloy steels may be readily determined by use of a clip test (see fig. 10). In the clip test, a piece of low-carbon steel is welded at the tee or fillet weld position, using a short bead. The upright piece of metal is struck on the side away from the bead, in a root bend, by use of a machinist's hammer. Weldable carbon or alloy steel, when tested by the clip test, results in a bead which bends. Or the bead may fail, due to cracking when excessive force is used, but a section of the bead holds to the unknown metal. If the bead tears away from the base metal, the steel is probably not weldable.

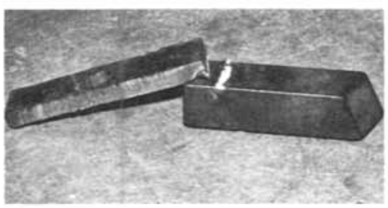

Figure 10.–Clip test determines whether two pieces of metal are weldable. Pieces are welded and then broken apart in a vise. Bead that pulls away from the metal, rather than breaking along the center of the bead, indicates the metal is not weldable.

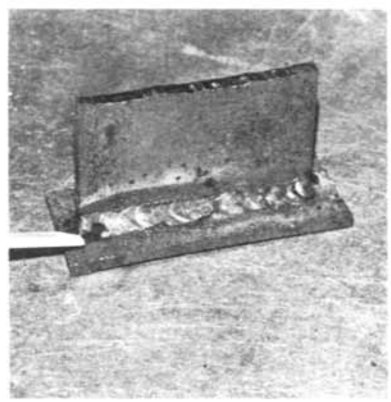

Figure 11.–Dark area pointed out in the bead in this picture is a slag inclusion, which can weaken a weld bead.

Electrode identification includes correct selection of electrodes for specific welding jobs. Many electric arc welding electrodes are available. Manufacturers classify electrodes in several ways. The National Electrical Manufacturers Association and the American Welding Society are organizations which have developed electrode identification systems.

Common classifications include fast freeze, fill freeze, fast fill, low hydrogen, and iron powder electrodes. An E6013 electrode is a fill freeze electrode. The identification number E6013 indicates E, electrode; 60, strength per 413 685 kPa (60,000 lb/in^2); 1, for all position use; and 3, alternating or direct current power use with shallow penetration, convex bead, and fill freeze weld characteristics related to flux type.

The position use is indicated by the third digit in the electrode number. Number 1 indicated all-position use, 2 is for horizontal- or flat-position use, and 3 is for flat-position use only.

Most manufacturers stamp identification numbers on their electrodes. In addition to the types of electrodes listed earlier, there are many special use electrodes. These include cast iron, hard surfacing, stainless steel, cutting, spot welding, and many alloy steel electrodes. In each of these classifications, one may identify several electrodes designed for a specific purpose. With the rapid development of metallurgical technology, a large array of electrodes is now available from welding suppliers. With similar electrodes identified by several company numbers, it is important to follow manufacturer's recommendations (see table 1 on following page).

Amperage settings are usually indicated for specific electrodes and for thickness of metal to be welded. Excessive amperage is indicated by undercutting or flat beads with a vee-shaped ripple. Inadequate amperage results in beads which are high and narrow, with little penetration. Correct amperage and correct weld speed result in quality beads which have adequate penetration, curved ripple patterns, and an oval cross-section shape. In setting amperage, a "hot" setting is preferred (see figs. 12 and 13).

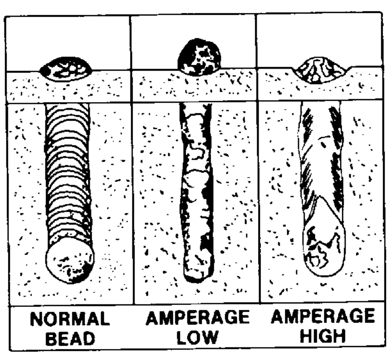

Figure 12.–Amperage.

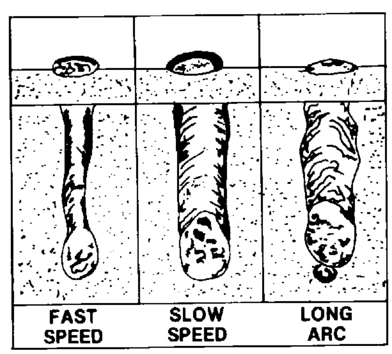

Figure 13.–Speed.

TABLE 1

Welding Electrodes Commonly Used in Agriculture

Electrode*	Class	Characteristic	Use
E-6011	Fast-freeze	Deep penetrating forceful arc, rapid solidification, light slag coverage, smoke (gas) shield, little chipping, rough appearance.	Metal not clean, poor "fit-ups," vertical and overhead cutting and burning holes, a-c or d-c, d-c reverse polarity power is best.
E-6013	Fill-freeze	Moderately forceful arc, moderate deposit rate, complete slag cover, much chipping, attractive bead.	Clean metal, flat position is best, a-c or either d-c power.
E-7014	Iron powder fast-fill or fast-freeze	"Drag" rod, low spatter, much slag, tensile strength exceeds that of "mild steel" electrodes, attractive bead.	Clean metal, all position, a-c or either d-c power.
E-7018	Low hydrogen and iron powder	Fast deposit, X-ray quality, heavy slag cover, average smoke, much chipping, attractive bead.	Clean metal, all position, carbon steels, unknown alloy steels, d-c reverse polarity power is best.

* Other electrodes are available in each class. Also, select hard-surfacing, cast iron, stainless steel, or other electrodes according to type of metal and specific use.

Correct weld speed is achieved by watching the formation of the weld bead. A weld bead made without a weave pattern should be about twice the width of the electrode used. The bead is about the same length as the electrode.

The arc length should be equal to the electrode diameter. This results in an arc which gives off little light. The sound of the welding process is usually described as the sound of eggs frying if the arc length is correct. Changes of arc length are accompanied by changing amperage levels. A difference of 10 to 40 amperes may occur when the arc length is changed. A short arc produces the "hottest" weld.

Electrode angle is another factor related to quality welds. The welding angles usually recommended may be seen as side and incline angles in table 2 (also see figs. 14, 15, 16, 17, 18, and 19).

Table 2.—*Welding Angles Recommended*

Weld type or position	Side angle, degrees	Incline angle, degrees
Flat	90	15
Lap or fillet	45	30
Corner	45	30
Horizontal	5-10	20
Vertical	90	5-10
Overhead	90	10-15

Use of the correct electrode angles will result in improved weld beads because the force of the electric arc positioned at the correct angle will increase the weld bead penetration.

Each of the six basic steps to quality welding is important. Welders should know and be able to apply the six basic steps. The steps are especially applicable to maintenance welding commonly done on farms and ranches.

WELDING ISN'T WHAT IT USED TO BE

Welding is changing. LH (low hydrogen) electrodes, a-c, d-c, and high OCV (open circuit voltage) are becoming passwords to successful electric are welding.

These and other factors should be considered in selecting a "stick electrode" welder and in determining correct electric arc welding processes for use in agricultural construction and maintenance.

Figure 14.–In flat weld, hold electrode at 15-degree incline angle (in addition of bead).

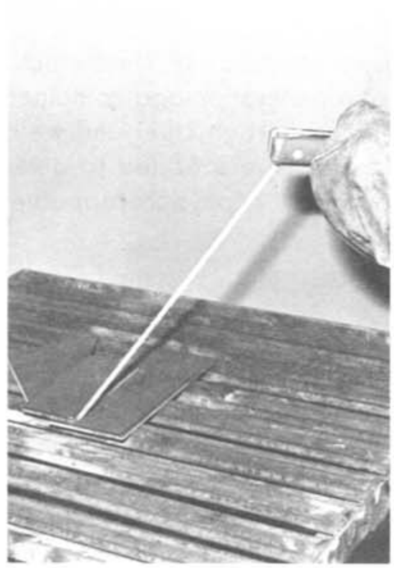

Figure 15.–For lap or fillet weld, electrode should be 45 degrees from side to side of bead. Incline angle should be 30 degrees.

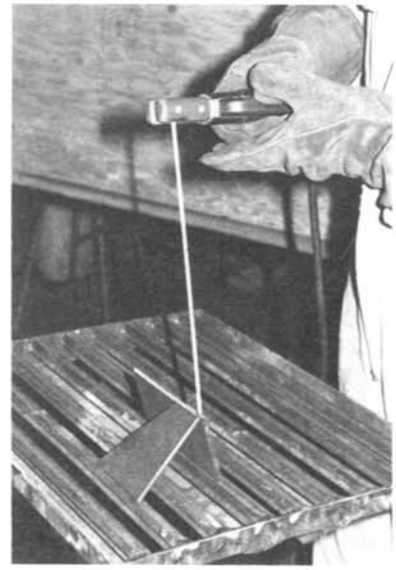

Figure 16.–For corner weld, side angle should be 45 degrees (bisecting the corner angle) and incline angle should be 30 degrees.

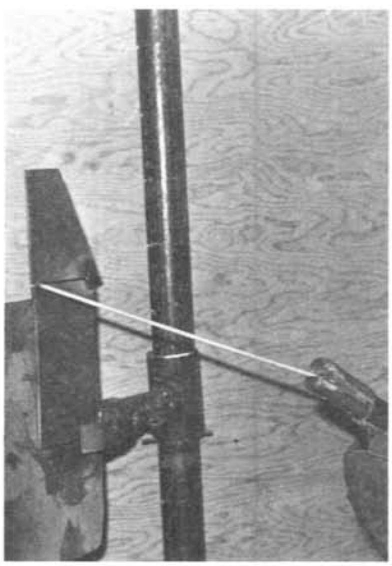

Figure 17.–Horizontal weld is done with 5- to 10-degree electrode side-angle, 20-degree incline angle. (Note handy spring-loaded clip that holds pieces to be welded. Clip is on a swiveling work surface that adjusts for height.)

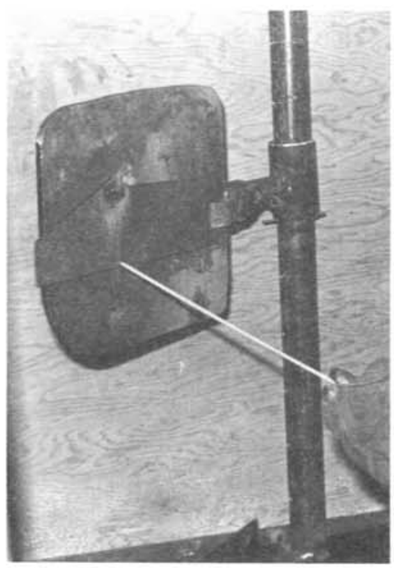

Figure 18.–Electrode is held at 90-degree side angle and 5- to 10-degree incline angle for vertical up weld.

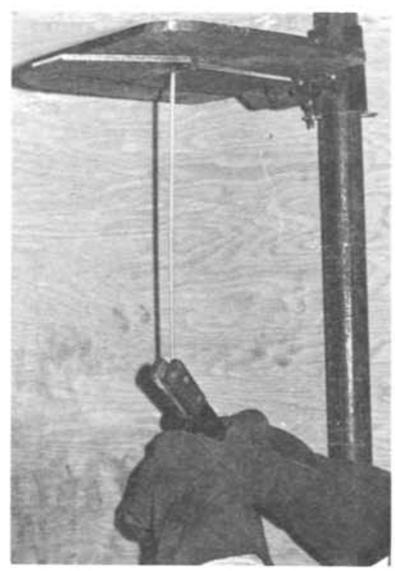

Figure 19.–For overhead weld, electrode side angle is 90 degrees and incline angle is 10 to 15 degrees.

Modern agricultural machinery is constructed with steel which contains alloys and increasing amounts of carbon. Machinery of a generation ago contained low-carbon steel. Machinery of the 1980's will consist of medium-carbon steel and weldable high-carbon steels. The carbon content (and alloying elements) are added to give steel more strength, greater toughness, or other desirable mechanical or physical properties without increasing the weight of the machinery.

LH (Low Hydrogen) Electrodes

Low hydrogen electrodes, or similar electrodes, should be used in the welding of medium-carbon steel, high-carbon steel, and carbon steels of unknown carbon content or unknown alloys. LH electrodes are designed to reduce hydrogen (from the air) in the area around the weld. This results in improved welds. Segregation of carbon or alloys and underbead cracking in the weld area are common weld defects which are controlled by use of LH electrodes. General purpose electrodes, when used with heat treatable carbon or alloy steels will usually result in weld defects.

Older a-c (alternating current) welders and some newer models which work well with general purpose electrodes may not work well with use of LH electrodes. This is because an OCV (open circuit voltage) of 75 to 80 volts is needed for use of the LH electrodes. Older a-c welders of limited input, utility type, have a 180-ampere capacity with OCV ranging from 40 to 60 volts.

DC (Direct-current) Polarity

A farmer or rancher interested in securing a new welder should consider an a-c d-c welder. The capability of using a welder with a-c d-c capacity allows change of d-c polarity. That results in change of the flow of current to the electrode and to the work. In straight polarity which works well in flat-position welding, two-thirds of the heat is concentrated on the work. Reverse polarity works well for out-of-position welds because two-thirds of the heat is concentrated at the electrode. This allows faster welding with less drip of molten metal from the weld bead. A disadvantage of less penetration of welds does accompany the increased welding speeds.

DCRP (direct-current reverse polarity) works well with LH electrodes in the welding of carbon steels and alloy steels in all welding positions. Many farmers or ranchers are purchasing a-c d-c welders. While more expensive than most a-c transformer welders general purpose a-c welding coupled with the advantages of d-c welding are a desirable combination for use in the welding of modern agricultural equipment.

Some farmers and ranchers prefer portable electric arc welding equipment. These may be powered by engines or may be power-take-off driven. A farm service truck may be equipped with an engine driven d-c welder for "in the field" operation. These units have the advantages of d-c operation plus the versatility afforded by being portable.

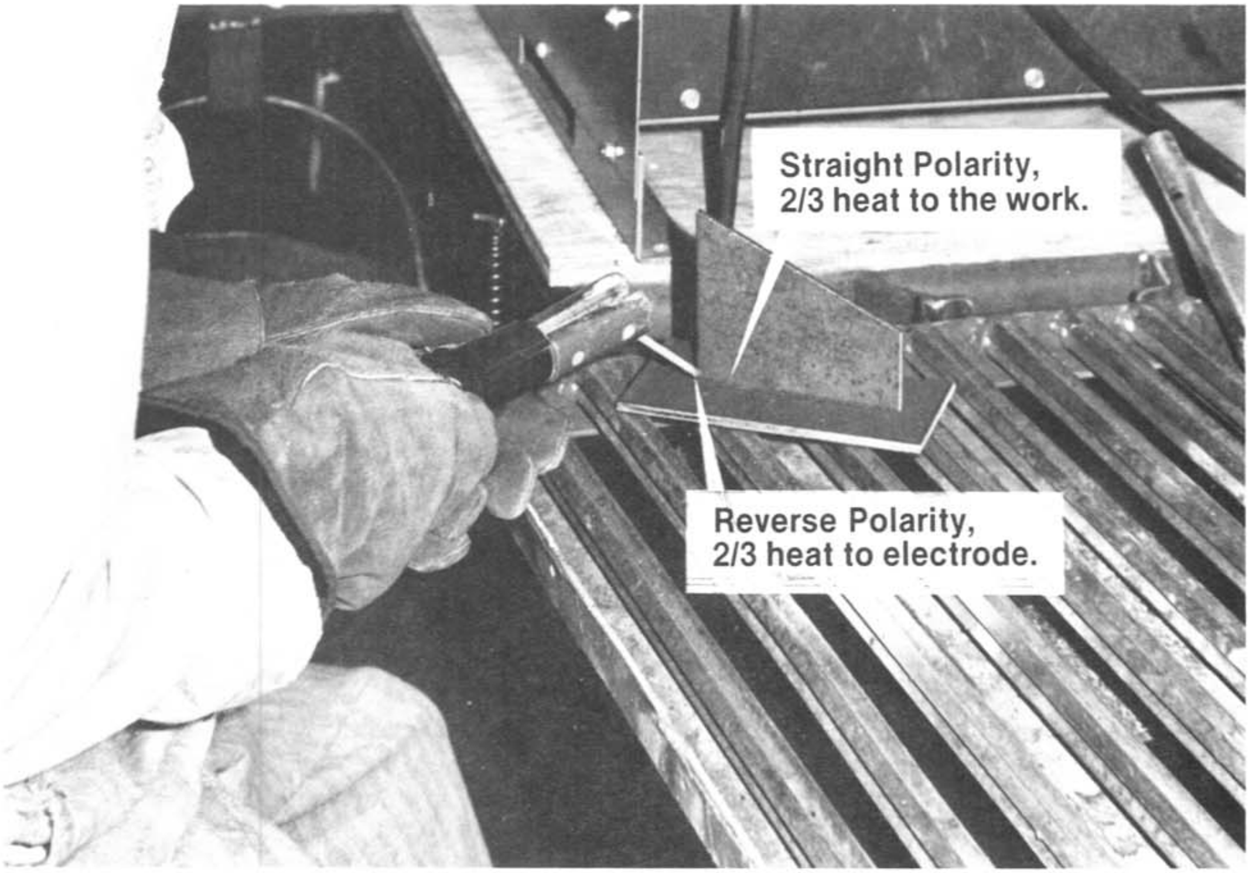

Figure 20.–Changing polarity changes proportions of heat going to electrode and material being welded.

The technological advances in machinery design and development of steels or other metals will increase the need for improved welding equipment and welding processes. The informed farmer or rancher will investigate existing future welding needs while selecting the most suitable welding equipment. Chances are those needs will include use of low hydrogen electrodes and an a-c d-c welder with a high open circuit voltage.

HONE YOUR WELDING SKILLS WITH THESE TIPS

There are excellent references available for welders. The purpose of this article is to identify techniques which a good welder should know. These include identification of weld defects and ways to control them. Residual stress control methods are listed as well as thirty tips to better welding.

In fabrication of steel structures by welding, residual stresses (increase of structural forces) may fracture due to internal stresses. Ways of controlling residual stresses include: (1) Reducing the shrink area; (2) using shrink to advantage; and (3) balancing shrink effect with other forces.

Controlling Electric Arc Welding Defects

Defect	Description	Control measure
Porosity	Surface pin holes extending into the weld bead. Caused by oxygen and nitrogen from the air entering bead metal while molten.	Improve protective shield. Shorten arc. Avoid use of electrodes with damaged flux coating.
Segregation	Carbon and alloys in steel concentrate at the edge of the weld bead, resulting in irregular deposits. Concentrations cause brittleness and cracking.	Preheat metal before welding. Post heat and/or slow the cooling rate of welded steel.
Slag inclusion	Slag is trapped in the weld bead.	Preheat the weld bead end. Hold shorter arc. Use correct bead manipulation to maintain a molten pool long enough to allow slag to float to the top of the bead.
Blow holes	Gas entrapped in weld beads.	Maintain a uniform weld speed with correct electrode manipulation to allow an even rate of solidification.
Grain growth	With heat treating of carbon steels, the grain size changes. Large grain is accompanied by softening of steel; grain size decreases in hardening of steel. Any change in steel grain structure or change in the level of hardness is undesirable when repairing machinery by welding.	Preheat before welding. Use successive weld passes and post heat if possible to reduce grain growth of welded steel structures which consist of heat treatable steel.

Methods of Controlling Residual Stress in Welding

1.	Reduce shrink area.	Use vee preparation of less than 60 degrees. Skip weld, use largest electrode practical with few passes. Backstep weld and/or use a chill plate to reduce excess heat in the weld area.
2.	Use shrink to advantage.	Prebend, space, or precaster in anticipation of the distortion effect.
3.	Balance forces.	Clamp or use a jig assembly. Fabricate by constructing subassemblies. Alternate welds, peen weld with a hammer, or stress relieve by post heating mild steel to 590 to 645 °C (1,100 to 1,200 °F) and allow steels to 870 °C (1,600 °F).

Thirty Welding Tips

1. Remove combustibles from the welding area and observe other safety rules.

2. Use single or multipass beads with no weave for best penetration.

3. Use a weave to widen beads where width is more important than penetration.

4. For the strongest possible joint, use a double-lap weld.

5. Begin multipass welds, using a straight bead with high amperage for a deep-root weld.

6. Avoid overwelding – the leg of a tee (fillet) or a lap weld should be no longer than the thickness of the thinner metal being joined.

7. A vertical down weld works best for joining thin metals.

8. A vertical up weld, if correctly made, is considerably stronger than a vertical down weld.

9. For butt welding metal, use a vee joint when needed (over 6-mm thickness (1/4-in)): (a) 6 mm 20 mm (1/4 in to 3/4 in) use a single vee; and (b) over 20 mm (3/4 in), use a double vee.

10. For welding rusty metal or metal that is not clean, use E-6011 or E-6010 electrodes.

11. American Welding Society identification numbers for electrodes indicate use. For example, E-6011 means: E, electrode; 60, 413 685 kPa (60,000 lb/in^2 strength of bead;

1, all-position use; and 1, a-c or d-c reverse polarity, use with a flat bead and fast freeze characteristics (see table 2).

12. Use a threaded carbon rod (from a dry cell battery) to protect threads or to maintain a hole size while welding adjacent to a hole.

13. Locate welds to restrict motion of the fabricated parts.

14. Welds across line of pull are stronger than welds parallel to the line of pull. Place welds to provide maximum resistance to loads, as transverse shear loaded welds are stronger than longitudinal shear loaded welds.

15. Avoid fabricating angle iron or other frame members in positions which result in water pockets or cause buildup of feeds, manure, or other corrosive materials.

16. Place welds on the outside of angle iron joints.

17. Plan the placement of welds which provide ready accessibility.

18. Excessive weld joint preparation should be avoided.

19. Proportion welds for expected loads; avoid inadequate and excessive weld bead size.

20. Fabricate structures so that the stress from loads is distributed evenly through the weld bead.

21. A U-shaped joint or a 45- to 50-degree vee joint is preferable to a wide vee joint for reducing distortion.

22. Use a "clip" test to determine weldability of unknown steels.

23. Drill a hole at the end of a crack in a cast iron casting to eliminate the extension of the crack while welding. Weld in a backstep process with 25-mm (1-in) beads and allow the casting to cool to touch between welds if preheating of the structure is not used.

24. Preheat medium carbon steel and weldable high carbon steels when possible before welding. Preheat temperatures: Medium carbon steels, to 93 °C (200 °F); and high carbon (0.45 to 0.60 percent carbon) steels, 93 to 204 °C (200 to 400 °F). Steels above 0.60 percent carbon are not considered weldable with most farm welders. Temperature indicators are available from welding supplies. Or, you can use these temperature indicators: Water evaporate, 100 °C (212 °F); pointed pine stick burns, 260 °C (500 °F); soft solder melts, 260 to 426 °C (500 to 800 °F); hot to hand at 150 to 200 mm (6 to 8 in), 398 °C (750 °F); soot from an oxyacetylene flame burns off, 454 °C (850 °F); paint

(first) red color, 537 to 593 °C (1000 to 1100 °F); and cherry red color, 815 °C (1500 °F).

25. To relieve stresses, post-heat welded heat-treated steels at 480 to 675 °C (900 to 1250 °F) (paint red color) for 1 hour per 25 mm (1 in) of thickness.

26. To mark pipe or round stock ends of angle cutting, place the stock end in water, at the angle desired, and mark around the water mark.

27. Weld angle iron miter corners by starting at the inside miter edge and proceeding to the outside thick edge to avoid excess burn-through.

28. Preheat a weld bead end by holding a long arc momentarily before shortening the arc to continue the bead.

29. Fill a weld bead crater end by (a) breaking arc and tapping the electrode on the hot crater, or (b) reversing weld bead direction and lifting the electrode to break the arc, or (c) holding the electrode at the crater before breaking the arc. (Step a or b is usually preferred.)

30. Follow welder and electrode manufacturer's instructions for amperage settings and operational procedures.

Hone Maintenance to Help Hold Line on Equipment Cost

Most farm equipment is built to last longer than most farmers keep it.

That is a point to keep in mind, in trying to whittle machinery costs, says Kansas State University Agricultural Engineer Gus Fairbanks. Some larger farm operators may have a machinery investment representing a half million dollars.

More attention to timely lubrication, storage, and all-around maintenance may help wring more life out of machines. Pencil out comparisons of custom work or machinery rental, to see if those options could give you a financial edge over owning some pieces of equipment, Fairbanks advises.

* * * * *

REMEMBER SAFETY WHEN YOU WELD [5]

By Thomas A. Silletto

The correct operation of any electric arc welding equipment must include concerns for safety.

Six welding hazard areas are identified here. They include welding fumes, electric shock, fire, physical burn, radiation burn, and weld failure.

Welding fume hazards occur when paints or other coatings of metal are present. Zinc oxides are toxic fumes which are present in welding of galvanized metal. Painted or galvanized metals should be welded only with sufficient ventilation to blow the fumes away from the welder. Galvanized metals (if they must be welded) may best be fabricated out-of-doors because of the toxic nature of the fumes. A fan is often used to blow fumes away from the welder.

Hazards of electric shock may be reduced by correct installation and correct maintenance of welding equipment by qualified electricians. The welder should be correctly grounded. Cracked or damaged insulation on welding cables indicate replacement time. While it seems best in the interest of time to pull machinery up to the shop, drag the cables out, and proceed to weld while standing (or lying) in the mud, such practices are not very safe. Damp concrete floors may also be a factor in electric shock injuries. In damp conditions, the welder should be sure the electric arc welder is turned off when replacing electrodes and the welder should stand on a dry wood grating or a similar nonconductor of electricity.

Combustibles and fire hazards should be removed from welding areas. Examples include paper, cleaning rags, greases, oils, and fuels. Tragic examples of failure to identify combustible liquids or combustible materials indicate serious nature of this hazard. An employee was welding near a 18.9 L (5-gal) pail of oil. The oil caught fire. The worker tried to move the container, spilled the oil and was fatally burned. (A sheet of plywood or metal, or class B fire extinguisher would have put out the fire.) Other students have been fatally burned when their oil-covered coveralls caught on fire while they were electric arc welding.

Most burns from handling hot metals could be eliminated. Usually a burn occurs due to hurry and failure to wear protective gloves. Hot metals should be marked as such by using chalk or other suitable marking. The date and time should be indicated if other workers may return to the welding area in which the hot metal is to be left. Hot metals should never be left where small children may come in contact with the metal. Preferably, small children should never play in the areas where machinery is operating or near the machinery service area.

[5] Reprinted by special permission of Editor, Nebraska Farmer, from March 6, 1982, issue.

Figure 21.—Materials being welded may be coated with substances that produce toxic fumes during welding. Without proper ventilation, fumes can engulf a welder.

Figure 22.—Set up a fan or some other ventilation system that pulls or blows fumes away from the welding site, as is being done by a portable fan.

Figure 23.—Mark hot, just-welded parts, to avoid accidental burns.

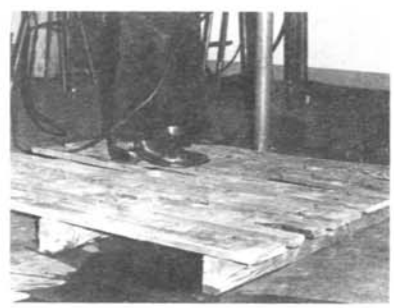

Figure 24.—Wooden pallet can give welder a dry place to stand, when area is wet.

Radiation burn hazards are the "sunburn" of electric arc welding. In addition to protecting against serious skin burns, the welder must use correct eye protection. Welding helmets should be in good condition. Lenses of correct shade should be used. A No. 10 shade lens is usually recommended for welding at less than 200 A; a No. 12 lens is used for welding at 200 to 400 A and for inert gas welding, and a No. 14 shade lens is used in welding processes at over 400 A of current. Some individuals should use darker lenses if they are less tolerant of the intensity of the electric welding arc. The naked eye should never be exposed to the electric welding arc within 15 m (50 ft) of the arc.

When workers in the area could be exposed to the arc, a welding screen should be used. Small children are fascinated by the intensity of the electric welding arc. They, as well as youths or adults, may suffer permanent eye damage while observing the welding arc without correct eye protection. The eyes should also be protected by use of clear goggles or a clear face shield when chipping slag from weld beads and when grinding metal for welding.

Correct protection recommendations for eyes include the wearing of industrial quality eye protection under the welding helmet so that eyes are not exposed to flying object hazards when the welding helmet is raised from welder's face. The price of a pair of good "shop" glasses, such as prescription industrial quality spectacles, is cheap compared with an eye injury.

The final welding hazard listed earlier is weld failure. Weld failure is the result of incorrect fabrication of metal by welding. Weld failure is eliminated by the welder's knowledge of his limitations in his welding ability. No welding of equipment which may affect the well-being of a person should be attempted unless the welder knows that the weld can be completed correctly. Specifications for construction often include weld strengths of 125 percent of the metal being fabricated. It is better to observe one's limitations and seek assistance than to subject someone to possible injury.

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Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled, "Publications for Sale". It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.