ENVIRO-MANAGEMENT & RESEARCH

- CONSTRUCTION CONSULTING
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- RESEARCH AND DEVELOPMENT

901 8th Street, N.W., Washington, D.C. 20001 Telephone: 202 638-4944

SOLDERING AND BRAZING

SAFETY GUIDE

A handbook on safe practices for those

involved in soldering and brazing

Prepared By

ENVIRO - MANAGEMENT & RESEARCH, INC.

for

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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I. INTRODUCTION

Soldering and brazing are processes used for joining metal parts by means of alloys which are easily fused. While essentially similar, soldering and brazing are not identical. Base metals involved, alloys or filler metals used, degree of heat, specific type of work being done and many other variables separate one process from the other.

As with most other industrial operations, soldering and brazing may present many different kinds of hazards. These generally come from the byproducts of the materials and processes you use, and involve gases, fumes, dusts, vapors, heat, chemicals, electricity, fire and so on, as discussed throughout this publication.

While most hazards possess the potential to cause illness or injury, their ability to do so is strictly up to you. By being aware of what the hazards are, you obviously have the ability to at least minimize them or, in most cases, to avoid them altogether. It's merely a matter of taking a few precautionary steps which, when you consider that your health and general well-being are at stake, are well worth taking.

The National Institute for Occupational Safety and Health (NIOSH) has prepared this manual as part of its responsibilities in meeting the requirements of the Occupational Safety and Health Act of 1970, as passed by the U.S. Congress and signed into law by the President of the United States. The purpose of this manual is to provide you with good practice safety tips which have been gathered from those with long experience in the soldering and brazing industry. By becoming familiar with these safe practices, you should be able to recognize, understand and so avoid the hazards which may confront you every working day.

II. GENERAL PROCESS HAZARDS

Several kinds of hazards exist in the four types of general soldering and brazing processes - cleaning, application of flux, application of heat and filler metal, and residue cleaning. For the most part, however, you can protect yourself from these hazards very easily simply by using proper ventilation, protective clothing and equipment, and a sensible amount of care. The chemical and physical hazards discussed in the following paragraphs - and throughout this publication, for that matter - are pointed out not to alarm you, but rather to alert you to what they are. In the case of "old hands", much of what follows may just be a repetition of what you already know. But even so, no one should ever consider himself beyond learning something new, or taking a few extra moments just to "make sure."

CLEANING

For the most part, you receive workpieces which are clean. In some cases, however, you may be required to do some cleaning to make sure the surfaces of workpieces are ready for proper joining. When that is the case, you probably perform some type of chemical cleaning which involves the use of acids, alkalies, or solvents. Use of chemicals possess hazards. Breathing fumes or vapors may cause illness. Skin contact may cause irritations or burns. Mechanical cleaning which involves grinding, filing, machine blasting and brushing also presents hazards. In most cases, however, these exposures can be controlled by using adequate ventilation and proper protective equipment.

APPLICATION OF FLUX

A flux is a solid, liquid or gas, which, when applied to a clean workpiece, removes impurities and helps you make a better joint. Application of the flux itself usually, involves only minor hazards. However, once the flux is heated along with the workpiece and solder or filler metal, it can give off toxic or irritating fumes. Again good ventilation is required to minimize risk.

APPLICATION OF HEAT AND FILLER METAL

Usually you will apply heat to workpieces before you apply the filler metal -- solder or brazing filler metal. At such time, toxic fumes may be given off by the flux. Occasionally, however you will be applying

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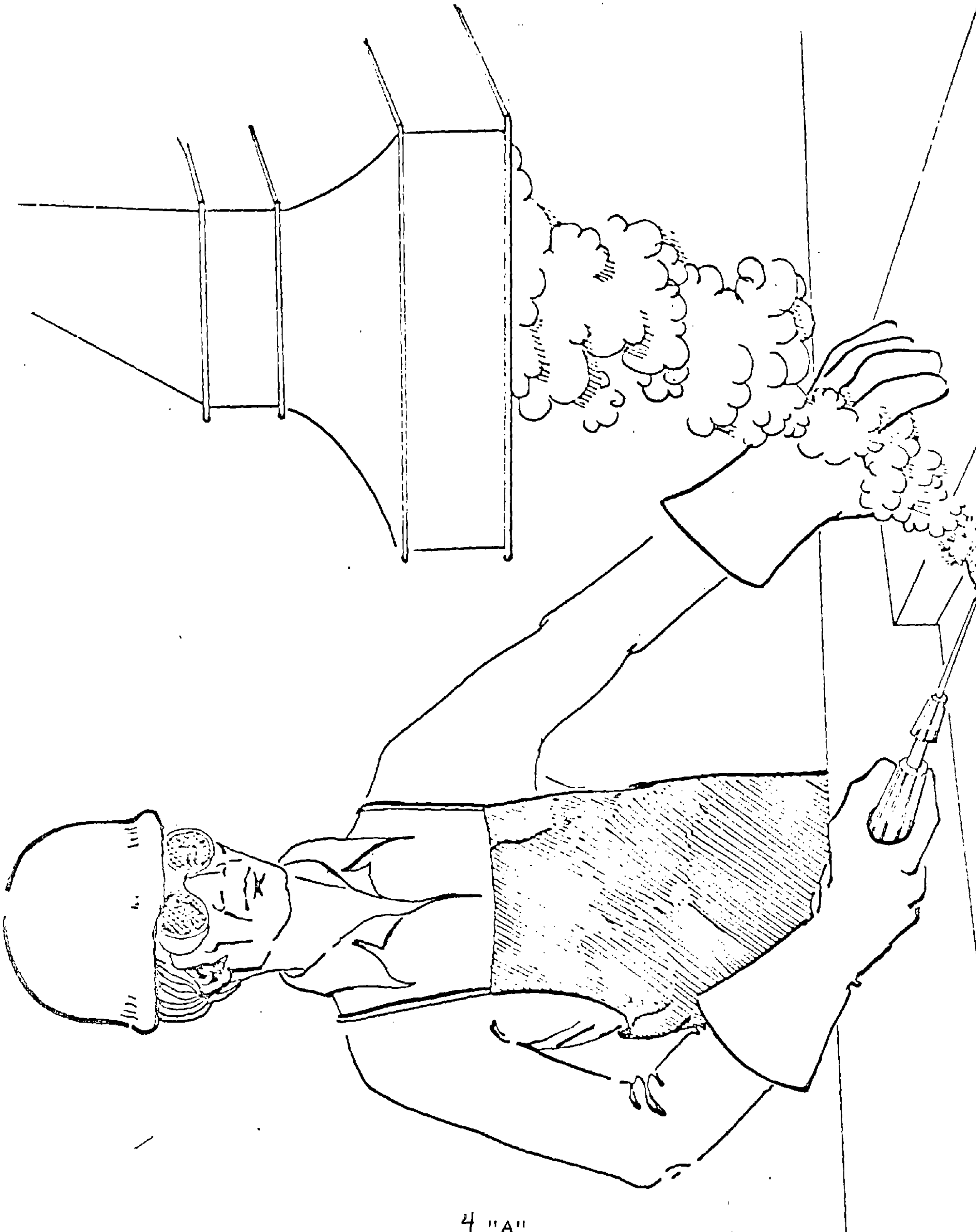
heat to the workpieces and filler metal at the same time, or almost at the same time, so that fumes created involve workpieces, workpiece coatings, filler metals and fluxes. Also, if the workpiece hasn't been cleaned well, remaining impurities, such as grease and oil, may smoke in the air. In other words, numerous different kinds of gases and fumes can be created, some of which may be toxic. Some may be flammable or explosive as well. Again, good ventilation is needed. Also, of course, you must be aware of all the dangers which relate to heat, molten metal spatter, flame from a torch, gas used to fuel the torch, electricity, and so on. Protective equipment may be required here.



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RESIDUE CLEANING

After the joint has been made and the piece has been cooled, it is necessary to clean off the flux residue which may remain. This usually involves the same processes and hazards involved with cleaning, although chemicals or some light wirebrushing also may be involved.

III. KNOW YOUR MATERIALS

One of the most essential first steps you must take to maintain safe practices is to know what you're working with, what its properties are, and what some of its hazards may be. This includes materials you come into contact with if you do some cleaning, as well as actual workpieces, coatings, solders and filler metals, fluxes, and gases. Accordingly, here follows a listing of some of the materials you're most likely to run into at one time or another.

CLEANING MATERIALS

Acids

For the most part, the acids used for cleaning have been diluted with water. If you must do the diluting yourself, however:

1. use extreme care when handling concentrated acid;
2. always put the acid into the water; never put water into acid, and;
3. protect your eyes and skin at all times.

Since even diluted acids present hazards, avoid breathing what may be toxic vapors and be sure you have good ventilation. Also, because even some diluted acids can cause skin burns or irritations (called dermatitis), keep acid off your skin and wash immediately if you have a spill.

Acids you probably use include:

Hydrochloric or Muriatic Acid: In concentrated form usually yellowish. Very corrosive. May cause a choking sensation if fumes are inhaled.

Sulfuric Acid: When heated at full strength gives off an intensely irritating gas. (Diluted sulfuric acid will do the same thing after the water has evaporated.) When you use it to remove rust, scale and oxide from metals, it forms hydrogen. Hydrogen is flammable, so keep all flames away during this process.

Phosphoric Acid: Relatively mild, but continued skin contact can lead to dermatitis.

Nitric Acid: Frequently the cause of dermatitis and particularly hazardous if concentrated vapors are inhaled. Be very careful when using it. Be sure you have adequate ventilation. Nitric acid vapors can affect any part of your respiratory system, including your lungs.

Hydrofluoric Acid: Has an odor so sharp and penetrating that it's unlikely you'll be able to inhale enough vapors to cause any serious harm. It has been known to cause deep skin burns which heal slowly.

Alkalies

You also may use alkali mixtures for certain cleaning operations. Typical mixtures involve silicates, phosphates, carbonates, detergents, soaps, and, in some cases, sodium or potassium hydroxide. It's the last two -- sodium and potassium hydroxide -- which are most hazardous. When sodium or potassium hydroxide is put into water to make a solution, it causes the water -- even cold water -- to boil. This causes bubbling and splashing, so that concentrated solutions or bits of the solid alkalies can wind up on the skin or in the eyes of the person making the solution. Inhalation of vapors can damage tissues and membranes of the respiratory tract. Like almost all other alkalies, prolonged contact with the skin will cause irritation. The more concentrated the solution, or the stronger the alkalies, the greater the irritation. The more caustic ones in higher concentrations can cause severe burns.

Organic Solvents

Organic solvents are used on your job to remove oils and grease from the workpiece. Use care when handling them. Be sure you have adequate ventilation. Avoid breathing vapors of evaporating solvents. Also, be sure to keep solvent vapors away from flames and hot surfaces. Those containing chlorine, while not flammable, may break down due to the heat and give off phosgene gas which smells similar to new-mown hay. While it may smell pleasant, its effects aren't. It was used as a weapon in World War I. Other organic solvent fumes should be kept away from flames and heat because they are flammable. Carelessness can lead to burns. Fires and even explosions. It's also a good idea to wear protective gloves when handling organic solvents. Prolonged or continued skin contact can result in removal of essential skin oils. This, in turn, can lead to

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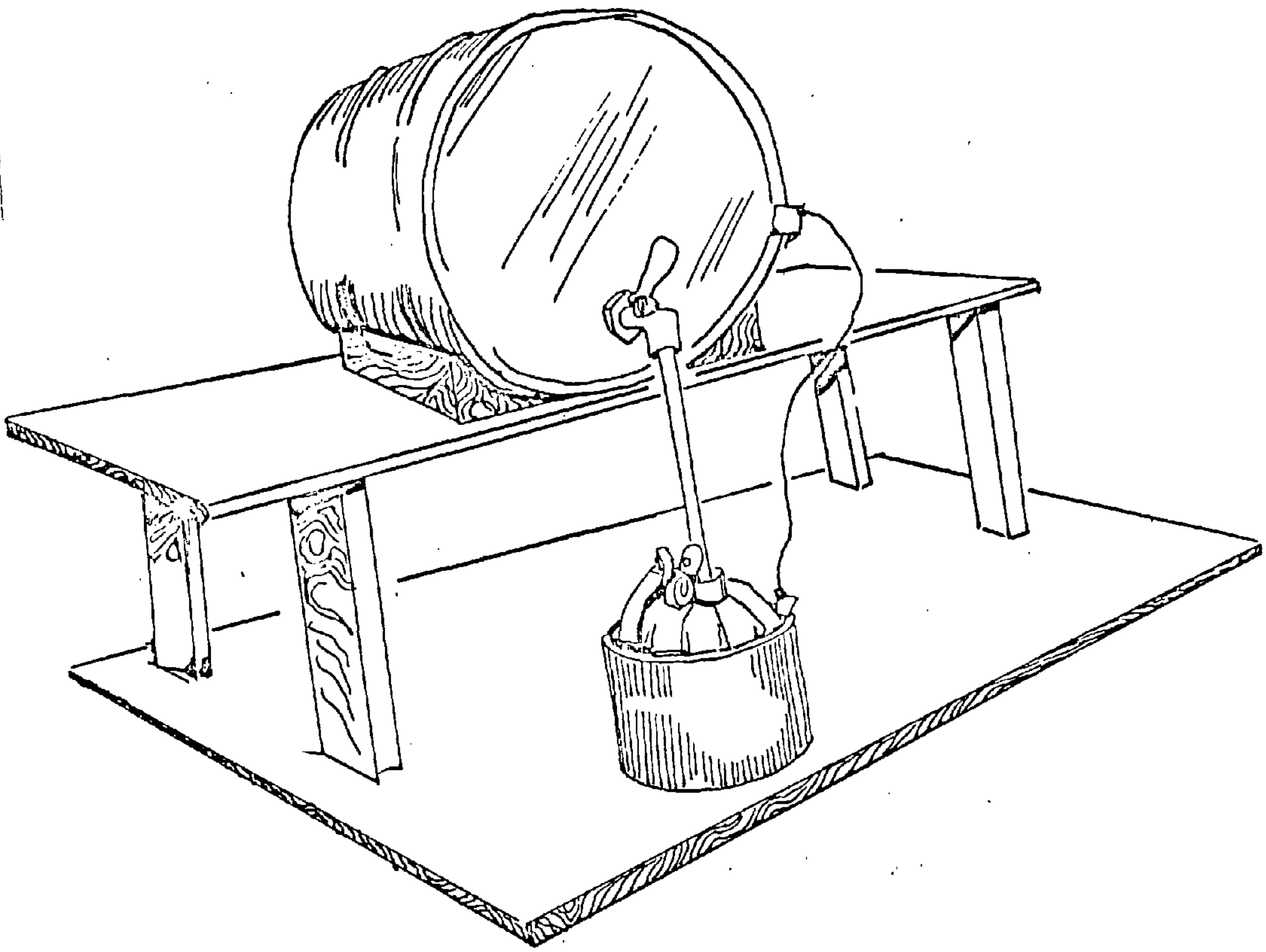
dry skin which may crack and so lead to dermatitis or infection. Never use organic solvents to clean your skin. Sure it works well. But your skin isn't made of metal! It may take a bit longer to use a commercial crean skin cleaner or a good hard soap -- but your skin will last longer.

Some of the solvents which you may use include:



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Trichloroethylene: May decompose into phosgene gas or hydrochloric acid when vapors contact open flame, hot metal surfaces or electric arcs.

Perchloroethylene: Similar to trichloroethylene. Same possible decomposition products. Provide good ventilation. Avoid breathing vapors.

Carbon Tetrachloride: Dangerous. Should not be used in the workplace, especially since many safer substitutes are available. It is absorbed rapidly through the skin and by breathing. Can cause severe damage to internal organs. Many persons have died from failing to take adequate precuations while using this substance in a confined space.

Methyl Chloroform: A common substitute for and much safer than carbon tetrachloride. Requires good ventilation nonetheless. Should be "inhibited" to prevent damage to softer metals.

Xylol: Also known as Xylene. Flammable at room temperatures.

Toluol: Also known as Toluene. Strong aromatic odor. May be absorbed through skin.

Benzene: Also known as Benzol. Similar to xylol and toluol but more toxic when inhaled. Flammable.

Alcohol: Inhaling high concentrations will cause an effect similar to drunkenness. Under no conditions should anyone drink industrial alcohol. It easily could prove fatal.

Gasoline and Other Petroleum Solvents: Not generally used due to fire hazard. Also, they tend to leave a greasy residue on the workpiece.

Ultrasonic Cleaning

Passing an ultrasonic soundwave through a solution creates a vibratory force which breaks off particles and contaminants from small metal parts that were placed in the solution for cleaning. In most cases there's little danger involved because the ultrasound is not very effective in air. However, there can be danger if you put your hand in the solution during the cleaning process. If you're called upon to use ultrasound, follow manufacturer's instructions and listen to your supervisor. Often you will be given special gloves to hold the workpiece with, or will be told to shut down the machine if the workpiece has to be moved. In some cases remote control machines are used so you do not have to get near the sound waves.

FLUXES

There are many different kinds of fluxes that you probably work with on a daily basis. They can be broken into different groups depending on what you're working on. In most cases, when heated, these fluxes give off fumes. Do not inhale fumes. Be sure that you have good ventilation. Fluxes will irritate your skin so be sure to keep them off your skin.

Soldering Fluxes - Corrosive

Zinc Chloride: The main ingredient in corrosive fluxes, used in soldering of stainless steel, galvanized iron, cast iron and aluminum. It is a very caustic compound. Avoid inhaling zinc chloride fumes. Also, don't let it stay on your skin for any length of time. It can cause a rash, burns or ulcers.

Ammonium Chloride: Used frequently in corrosive fluxes, Ammonium chloride is a relatively mild irritant to skin or membranes. Other chlorides often used, such as stannous, sodium, potassium and aluminum, are, like ammonium chloride, only relatively mild irritants. Nonetheless, you must avoid prolonged inhalation or inhalation of heavy concentrations.

Cadmium Fluoborate: Present in certain fluxes used for soldering aluminum. Cadmium is a very toxic material and should never be breathed. The fluoborate becomes a fluoride after flux ingredients have been mixed, and can cause toxic effects when inhaled. The concentration of the fluorides in the solderi process usually is so small, however, that there is almost no hazard. It is slightly more hazardous when used in brazing.

Acids: Frequently used as ingredients with fluxes. For example, hydrochloric acid is applied to galvanized iron, or hydrofluoric acid is added to zinc chloride base fluxes to dissolve silicate inclusions on the surface of cast iron. Acid hazards have already been discussed under chemical cleaning.

Soldering Fluxes -- Intermediate

Acids: Lactic, benzoic, and glutamic acids frequently are used in the relatively mild intermediate fluxes. Even on prolonged contact, these organic acids produce only mild irritation.

Organic Compounds: Certain intermediate fluxes contain complex organic compounds whose names only a chemist could love or pronounce! Typical compounds are hydrazine hydrobromide and ethyldimethylcetylammonium bromide. Humor aside, if these compounds are accidently overheated in the soldering process, they can decompose, giving off toxic fumes. Do not inhale them. In addition, most of the hydrohalides are flammable.

Diethylenetriamine: Sometimes used in intermediate fluxes. Use due caution. Can cause severe skin damage as a liquid. As a hot vapor, it can cause irritation to the respiratory tract if inhaled.

Soldering Fluxes - Noncorrosive

Rosin or Petrolatum are the most common type of noncorrosive fluxes.

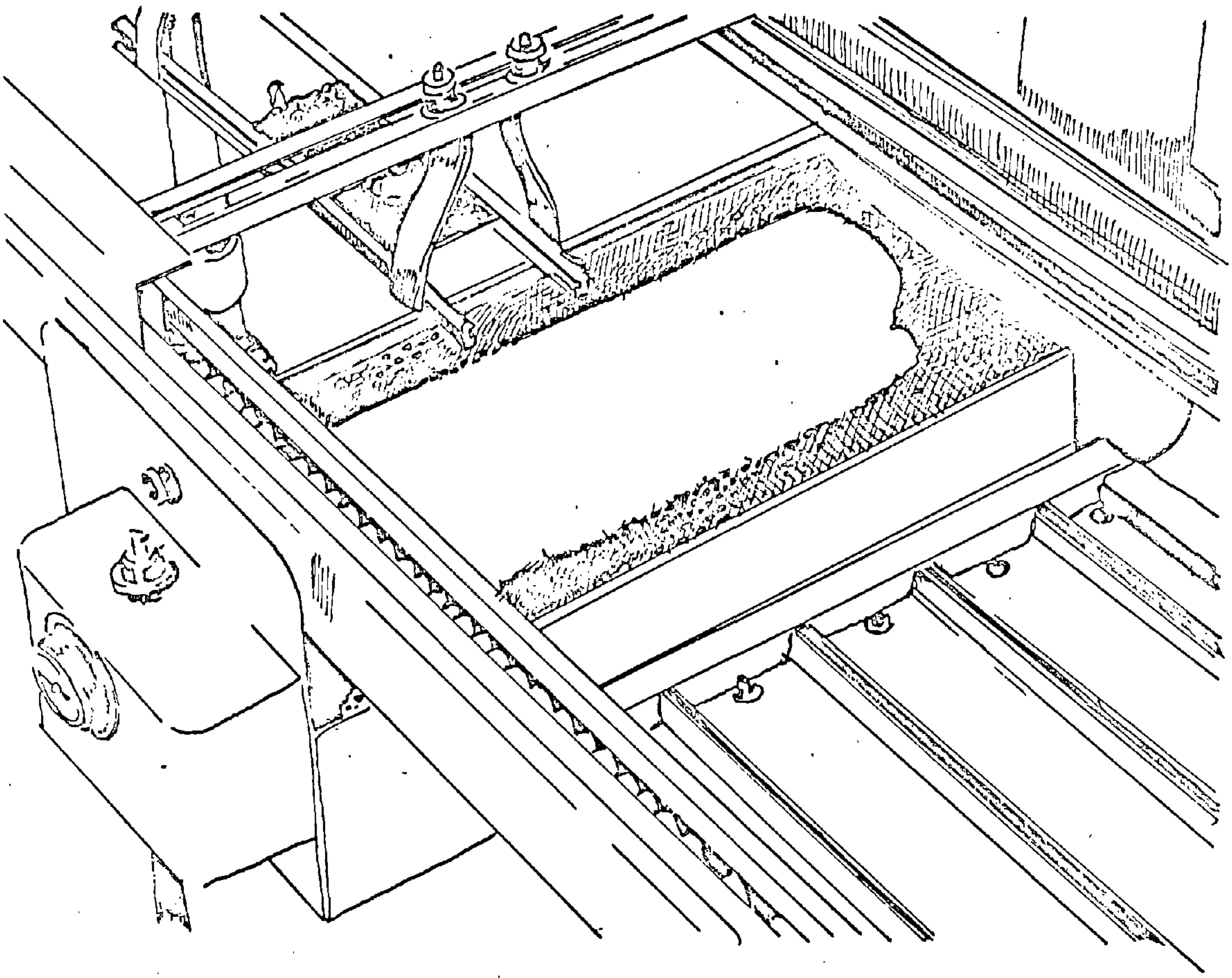
Illust. "C" Many of the rosin-based fluxes include large amounts of alcohol, turpentine or petroleum spirits, all of which are flammable. Smoke and vapors are irritating and in some cases toxic. As always, good ventilation should be provided. Avoid breathing smoke and vapors

Brazing Fluxes

The most hazardous brazing fluxes are the fluoborates, fluorides, and potassium and sodium hydroxide.

Fluoborates: Hazardous. After fluoborates are mixed with the other ingredients of a flux, fluorides are formed.

Fluorides and other Fluoride Compounds: Found most often in brazing fluxes used with silver, magnesium, aluminum-silicon filler metals. Excessive breathing of fluorides will cause respiratory symptoms similar to cold or flue. Do not breathe these compounds. Have adequate ventilation.



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Observe cleanliness to prevent absorption of these compounds through the mouth or skin openings (such as cuts). All commonly available commercial fluxes containing fluorides or other fluorine compounds are labeled with a standard precaution such as:

CAUTION

Contains fluorides. This flux when heated gives off fumes which may irritate eyes, nose and throat.

(1) Avoid fumes - use only in well ventilated spaces.

(2) Avoid contact of flux with eyes or skin

(3) Do not take internally

(4) Keep out of reach of children

The above instructions should be followed to the letter.

Potassium and Sodium Hydroxide: Alkalies often added to fluxes used on molybdenum alloy steel. They have already been discussed under chemical cleaning.

BRAZING ATMOSPHERES

Controlled atmospheres are required for certain brazing applications. They most commonly are used in furnace brazing, but you can also use them when induction or resistance brazing is involved. Caution always is required when working with controlled atmospheres. Some atmospheres may be explosive or toxic. Good ventilation always is required. At times you may need some facility for burning or otherwise eliminating waste gas.

WORKPIECES, COATINGS AND FILLER METALS

You come into contact with a variety of different metals and alloys during the actual soldering or brazing process. You work with them as workpieces, as coatings on workpieces, as solders or as brazing filler metals. For the most part, the hazards associated with these metals are created during the heating process when fumes are given off. Therefore, you must again be very sure that you do not breathe these fumes. Good local ventilation must be provided at the workpiece.

The four most hazardous metals are the ones discussed first -- lead cadmium, beryllium and zinc -- although there are others. In most cases, the illnesses which you can get from inhaling these metal fumes are very serious, but easily can be prevented if you have adequate ventilation. Nonetheless, you should be aware of the symptoms of excessive exposure to any of these metal fumes. If for any reason you think that you have been exposed to high concentrations, see a physician immediately.

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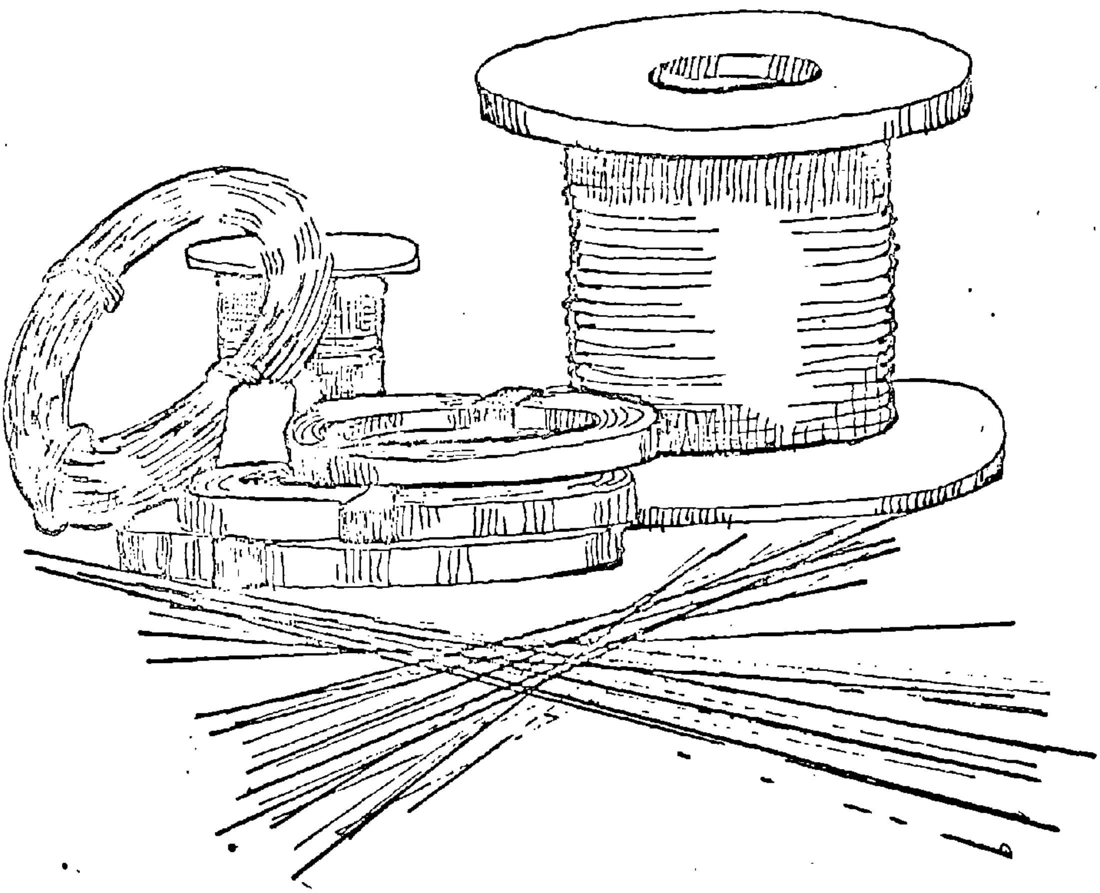
Lead

Lead is one of the most common metals found in the soldering process. It's used in workpieces or as a workpiece coating, and it's often found in solders, such as lead-tin and lead-silver solders. You can even find it in paint which a workpiece might be coated with. The most significant hazard posed by lead is



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lead poisoning. Its symptoms include loss of appetite, indigestion, nausea, vomiting, constipation, headache, abdominal cramps, nervousness and insomnia.

Cadmium

Cadmium is found in some silver and zinc solders. In all cases, cadmium based filler metals should be clearly marked with warnings and instructions for use. Symptoms -- which usually don't show up until 20 to 30 hours after you've been exposed -- are a slight dry cough, irritation of the throat, tightness of the chest, and restlessness.

Beryllium

You can find beryllium in workpieces and filler metals as well as in soluble beryllium compounds. Beryllium is hazardous, especially to the lungs and skin. Continued exposure to concentrated beryllium oxide or related fumes can lead to a lung disease called pneumonitis, which can be fatal, or berylliosis, which affects all systems of the body even though it enters through the lungs. The soluble compounds easily can lead to a condition called beryllium itch - which in some cases will cause open sores on your skin that won't heal unless the beryllium is removed surgically.

Zinc

Zinc is used in large amounts in zinc-cadmium and zinc-aluminum solders and, to a lesser extent, in base metals, coatings and paints. When heated, zinc like most other metals, creates an oxide. Excessive exposure to zinc oxide can give you an illness called metal fume fever, also called zinc or brass chills.

First symptoms are a sweet or metallic taste in the mouth, then others that are almost identical with the flu. Usually the illness disappears in a day or so with no permanent after-effects. It is important that a correct diagnosis be made, however, because symptoms are very similar to more serious illnesses.

Other Metals

Other metals which may give off toxic fumes include antimony, arsenic, chromium, bismuth, cobalt, nickel, selenium, thorium, vanadium or their compounds. In most cases, however, the hazards are relatively slight, and usually result only when high concentrations of vapors are inhaled. Proper ventilation will provide sufficient protection.

GASES USED IN TORCH SOLDERING AND BRAZING

You can torch solder and braze with air-acetylene, air-natural gas, air-propane, air-butane, and air-gasoline. Blow torches with oxygen are also often used instead of air. There are many potential dangers.

Acetylene

Under pressure, and under certain conditions, acetylene can break down in an explosive manner. It can form an explosive compound with copper and copper alloys. Mixtures of acetylene and air, with acetylene in significant quantities can be explosive.

Natural Gas

Natural gas is flammable in air and explosive when mixed with air. It can therefore be hazardous if it leaks into unventilated work areas.

Propane and Butane

Propane and butane are liquified gases which are heavier than air. When freed, they collect at the floor or in depressions forming an explosive mixture with overlying air. They are nontoxic, but can cause asphyxiation at volumes above 10%.

Oxygen

Required for combustion. Many materials burn explosively in pure oxygen. Clothing permeated by oxygen is almost impossible to extinguish. Use caution when handling oxygen in the presence of oil, grease or similar materials which decompose explosively. (Safe practices for storing and handling, of gases is discussed in Section V.) Be aware of the radiation hazard from oxygen/gas flames. They emit both infrared and visible radiation, both of which can be reflected from different surfaces. The visible light might dazzle your eyes, not only blinding you momentarily so an accident may happen, but also possibly causing -- through continual exposure -- permanent damage to the eye itself. Infrared rays, which are heat rays, can cause gradual deterioration of your eyes over the years, often leading to cataracts.

IV. KNOW THE SPECIFIC PROCESS HAZARDS

There are a variety of different soldering and brazing processes which you may use. You should be familiar with those you work with and the hazards they present.

SOLDERING IRONS

One of the most common hazards associated with use of a soldering iron is burns. Therefore, it is strongly recommended that you use an insulated holder with a soldering iron. By placing your soldering iron in the holder whenever leaving it unattended, you will prevent people from accidently picking up the iron and burning themselves, or knocking the iron off a table or wherever it may otherwise have been left. Never put the soldering iron on any combustible surface, including a wooden table which has a metal covering. Very often the heat from the soldering iron can go right through the metal covering and cause the wood underneath to ignite. When leaving the iron for more than 30 minutes, either turn it off or disconnect it.

When using an electric soldering iron, follow all guidelines laid down in discussion of safe handling of electricity in Section VII. Make sure that the thermostatic control is working properly and has not been tampered with. Transformers of low voltage irons must be grounded properly.

Internally gas-fired soldering irons must be checked for gas leakage from joints and old pipes in the vicinity of your workplace. Because gas-fired irons are not thermostatically controlled, there is more risk of overheating. Therefore, make sure that you have sufficient ventilation to carry off any toxic fumes which overheating may cause.

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When working with a gas soldering iron heated in a small furnace, locate the furnace where it will not present a fire hazard. Make sure the furnace is vented properly so it won't contaminate local workplace air.

TORCH SOLDERING AND BRAZING

Torch soldering and brazing presents hazards relating to the gases involved as well as the torch itself.

Mixtures of fuel gases with air or oxygen are flammable and explosive and, of course, must be treated with care. Hazards can occur because of improper operation, use of defective equipment, or careless behavior in the work area. A discussion of gases is included in Section III, and of gas cylinders in Section V, and elsewhere.

Safety glasses are necessary when using a torch. Use a #2 lens for soldering and a #3 or #4 lens for brazing.

Correct handling of the torch itself is imperative. Here follow a few safe handling guidelines which you should follow:

1. Inspect torches and hoses to make sure they are in good working order.

If not, your torch could backfire and cause hoses and equipment -- even the cylinder -- to explode.

2. Before changing torches, shut off gas at the pressure reducing regulator. Never try to shut off pressure by crimping the hose.

3. Select the proper brazing head or mixer and screw it firmly into the torch.

4. Use a friction lighter, stationary pilot or other suitable source of ignition to light the torch. Never use a match.

5. When there will be considerable movement of torch or flame, wear proper gloves made of flame-resistant material such as asbestos or chrome-tanned leather to protect your hands from burns.

6. Do not put down torch until gases have been shut off completely.

7. Extinguish the flame by closing valves in the order recommended by the torch manufacturer. (Be aware that when the oxygen valve is turned off first, it usually results in the acetylene flame becoming appreciable longer, so it could burn you accidently. If the acetylene is turned off first, a loud bang results which could distract a fellow worker nearby and so cause an accident.)

8. When discontinuing soldering or brazing for only a few minutes, at least close down torch valves or follow procedures for closing down for longer periods

9. When discontinuing soldering or brazing for a half hour or more:

    * close oxygen and acetylene cylinder valves

* open torch valves to relieve gas pressure from hose and regulator
* close torch valves and release regulator pressure adjusting screw

10. Do not hang torches from a regulator or other equipment in a manner which would enable them to come into contact with the side of gas cylinder. The torch may be hot enough to cause the gases to expand in the cylinder resulting in an explosion. In some cases, the flames may not have been extinguished completely.

Have Adequate Ventilation

Torch soldering and brazing also can present a special problem with fumes. If you're working with lead solder, for example, the high torch heat causes lead to form a powdery dross very quickly. If you're working with large quantities of materials, as often is the case, this hazard is increased still more. Likewise, because fluoride fluxes are often used with torch brazing, you must have adequate local ventilation.

DIP SOLDERING AND BRAZING

While it is necessary to point out several of the hazards associated with dip soldering and brazing, it should be pointed out that use of safety glasses, protective head gear and protective clothing will go a long way to minimizing your exposure.

The thing you have to be most wary of in dip soldering and brazing is getting burned either by touching the molten metal bath in the pot or the pot itself. Your best protection against burns, of course, is to work carefully and wear safety glasses and proper protective clothing. But there are other hazards which you also must watch.

Be Cautious of Water

At operating temperatures, any water introduced into the pot below the surface of the molten solder becomes superheated steam. It expands rapidly and violently and can cause the molten solder to blow out of the pot in all directions. It can not only burn people, but also start fires. Accordingly, if you are working with parts on which fluxes have been dissolved in water, immerse them in the pot ver slowly and carefully to be sure that any excess water evaporates above the surface of the solder. On large parts, it may be more desirable to dry the excess water out of the flux before putting the part into the pot. Before a new pot is used, it should be allowed to heat up enough to evaporate any moisture before solder is put into the pot. Also, solders or filler metals which have been stored out of doors over the winter will have a lot of condensation in them when brought into the workroom. The solder or brazing filler metal should therefore be allowed to dry, and even then should be put into the pot very slowly and carefully to avoid any steam problems.

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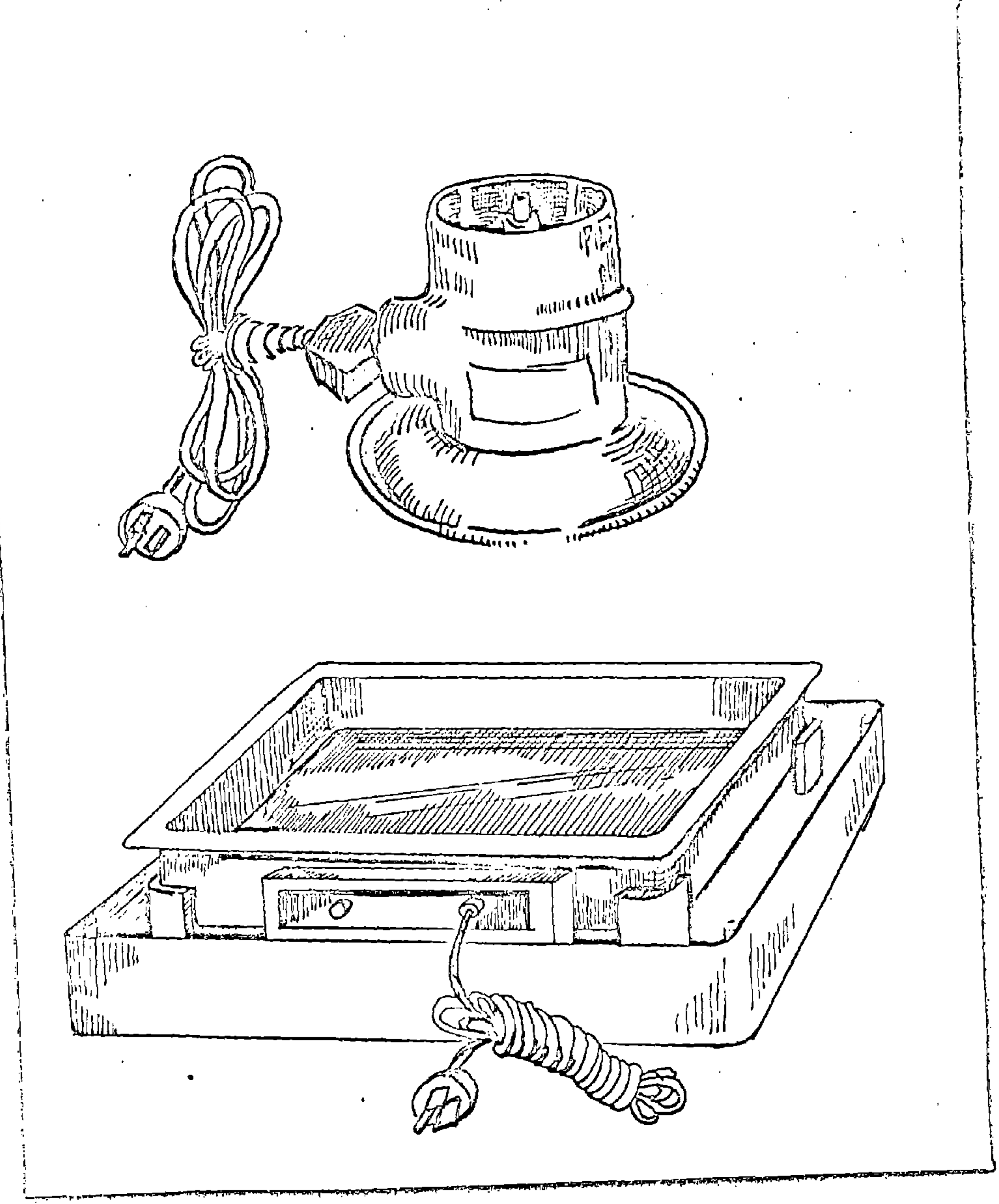
You also must take care of placement of the pot in the event that your workplace has a sprinkler system. If so, the pot should not be directly below a sprinkler head. In this way, if the sprinkler does go off, water will not get into the pot.



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Check Pot for Safety

Before working with your pot, you should make several checks to ensure that it is in good operating condition. Check for leaks or cracks in the pot which could permit the molten solder to spill onto the floor. If an electrical immersi heater is being used, make sure it is of the proper voltage; that the pot is properly grounded, and that thermostatic controls are working properly so that solder or filler metal won't overheat and release toxic fumes.

If you're going to be draining the pot, make sure that the drain tube is clean and that the drain stem is tightly closed after draining.

FURNACE SOLDERING AND BRAZING

Furnace soldering and brazing is used extensively for production of high quality joints. The four types of furnaces generally used are box, conveyor, retort and bell. They usually are heated by electrical resistance elements, gas or oil, having automatic time and temperature controls. Regardless of which type furnace is involved, the same type hazards exist, namely those which relate to heat and electricity. Proper ventilation and the use of appropriate safety glasses and protective clothing can minimize these hazards. In addition, furnaces at high temperatures radiate significant amounts of heat, Radiant heat shields will make your workplace more comfortable. These shields may be constructed of aluminum or stainless steel sheets.

Special hazards may exist when a brazing atmosphere is utilized in a furnace. As already discussed in Section III , some of these atmospheres maybe combustible or explosive if air infiltrates. Few problems are found with vacuum and inert gas (argon and nitrogen) atmosphere furnaces. Metal oxide fumes from fluxes and coatings should not be inhaled.

It is necessary that the furnace or retort to be used as a container for flammable brazing atmosphere be purged to remove all oxygen and air below an explosive level. Adequate ventilation must be provided unless the exhaust gases and fumes are trapped and burned.

INDUCTION SOLDERING AND BRAZING

In the induction soldering or brazing process, parts that are good electrical conductors are placed in or near an alternating high frequency current carrying coils which are an integral part of the standard power source. Because of the magnitude of the power supplied by these units, you must be especially careful not to come into contact with the coil. In fact, you should not even come close to the coil because it is possible that you could draw an arc which can cause severe burns, and possibly be fatal.

It is essential that all equipment be properly grounded, all cables well insulated, and all controls properly guarded. In general, rules given in Section VII, on safe handling of electricity apply.

RESISTANCE SOLDERING AND BRAZING

When using resistance heating with carbon blocks for soldering or brazing, make sure that the voltage is not greater than 24 volts. It should be obtained from the secondary winding of a dual winding transformer where the secondary is electrically isolated from the primary winding. Transfer of dangerous primary voltages (often 220V or 440V) over to the soldering or brazing current side due to faults in insulation or grounding can be fatal. Accidental touching of the energized electrodes or heated parts can cause severe burns.

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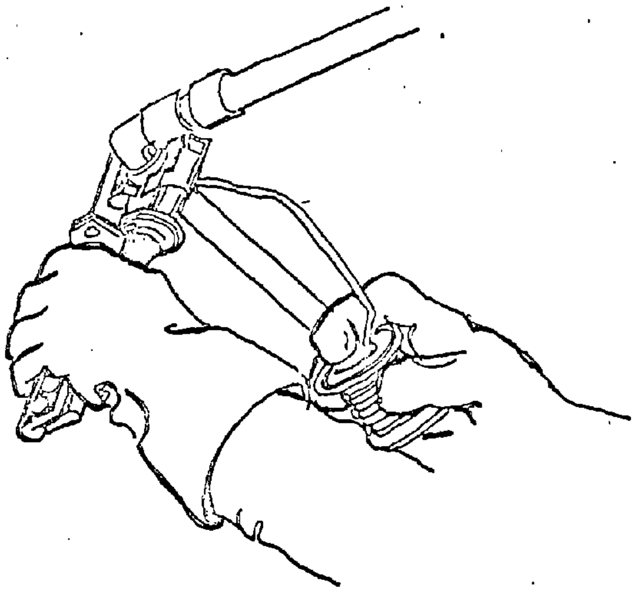
When working with the equipment do not apply too much pressure to the electrode because it can crack it. Also, do not interrupt pressure during current flow. If you do, arcing may occur.

Follow all precuations laid down in Section VII on safe handling of electricity.

SPRAY GUN SOLDERING

Spray gun soldering involves spraying of molten solder on previously fluxed and heated workpieces. The spray guns most commonly used utilize propane with oxygen, natural gas with air, or electricity as a heat source. Hazards from those which use gas are similar to hazards present when using a gas-fired torch. Those which use electricity present hazards similar to those encountered with the use of an electric soldering iron. In all cases, there is the danger of accidently spraying molten solders on combustible surfaces, such as wood, paper, etc., or getting a burn by accidently touching the hot parts of the spray gun, the preheated workpiece, or the work surface where the preheating of the workpiece is accomplished. For best and safest results, all spray gun equipment must be used in accordance with manufacturer's recommendations.



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INFRARED BRAZING

Infrared brazing uses high intensity quartz lamps. It is used most often in brazing of honeycomb assemblies. In addition to presention typical hazards of a hot surface, infrared brazing also presents radiation hazards relating both to visible radiation and invisible infrared radiation. Visible radiation or glare can dazzl your eyes causing monentary blindness which can lead to an accident. This becomes especially hazardous when you are working high above the floor or in areas where there are many reflective surfaces. Because infrared radiation, which is heat radiation, is invisible, you may not realize that you are being exposed to it. Very long exposure may result in severe eye damage. It is essential that proper protective clothing and face and eye protection be worn while working with infrared brazing equipment.

V. HANDLE GAS SOLDERING AND BRAZING EQUIPMENT SAFELY

Gas soldering and brazing equipment presents a variety of hazards, some of which already have been touched on. To be really safe, however, you must know all the items you're working with, and handle them well.

GENERATORS

Most safety experts agree that a solderer or brazer should not become involved in the use of an on-site acetylene generator. It is far simpler and far safer just to obtain the gas from a supplier. Nonetheless should you be required to become involved in use of an on-site acetylene generator, here follow a few safety tips which you should observe.

Never use a home-made generator. To do so is to invite an accident. Placement of the generator is critical. Be sure that the area is free of all clutter and debris. The generator must be quickly and easily accessible for adjustment or charging. Make sure it is solidly grounded.

Make sure that your generator has an approved hydraulic backpressure valve. Check it regularly and keep it properly filled with water, according to manufacturer's instructions.

When repairing a generator, be sure to fill the water chamber completely. This eliminates the possibility of having an explosive gas pocket of dripping carbine into an insufficient amount of water. Hot repairs should be done out-of-doors if at all possible.

Clean a generator only during daylight hours and in natural light. An extension cord or light could be defective and cause an explosion.

Portable generators should be stored in well ventilated rooms when not in use. If they are stored when charged, there should be no open lights or flames in the room. It is best if they are stored uncharged.

A portable generator should not be moved by truck or derrick when charged. While being transported, the generator should be anchored firmly to the vehicle. The vehicle motor should be turned off when the generator is being charged, cleaned or is in operation.

Always set the generator to the manufacturer's suggested pressure, which usually should not exceed 15 p.s.i. Excessive pressure scatters sparks needless, causes faulty torch operation, and can lead to backfires and flashbacks.

CARBIDE STORAGE

Carbide must be stored in a dry, well-ventilated location. Containers which are only partly full should be closed tightly. All containers must be clearly marked "CALCIUM CARBIDE -- DANGEROUS IF NOT KEPT DRY." Post a sign that reads: "CALCIUM CARBIDE -- DO NOT USE WATER IN CASE OF FIRE", in at least one conspicuous location in the storage area.

GAS PIPING SYSTEM

Only steel and wrought iron piping should be used for acetylene. Never use unalloyed copper. Surface temperature of piping should not exceed 130 degrees F. Where there is more than one line, each line should be identified, as through color coding or tags.

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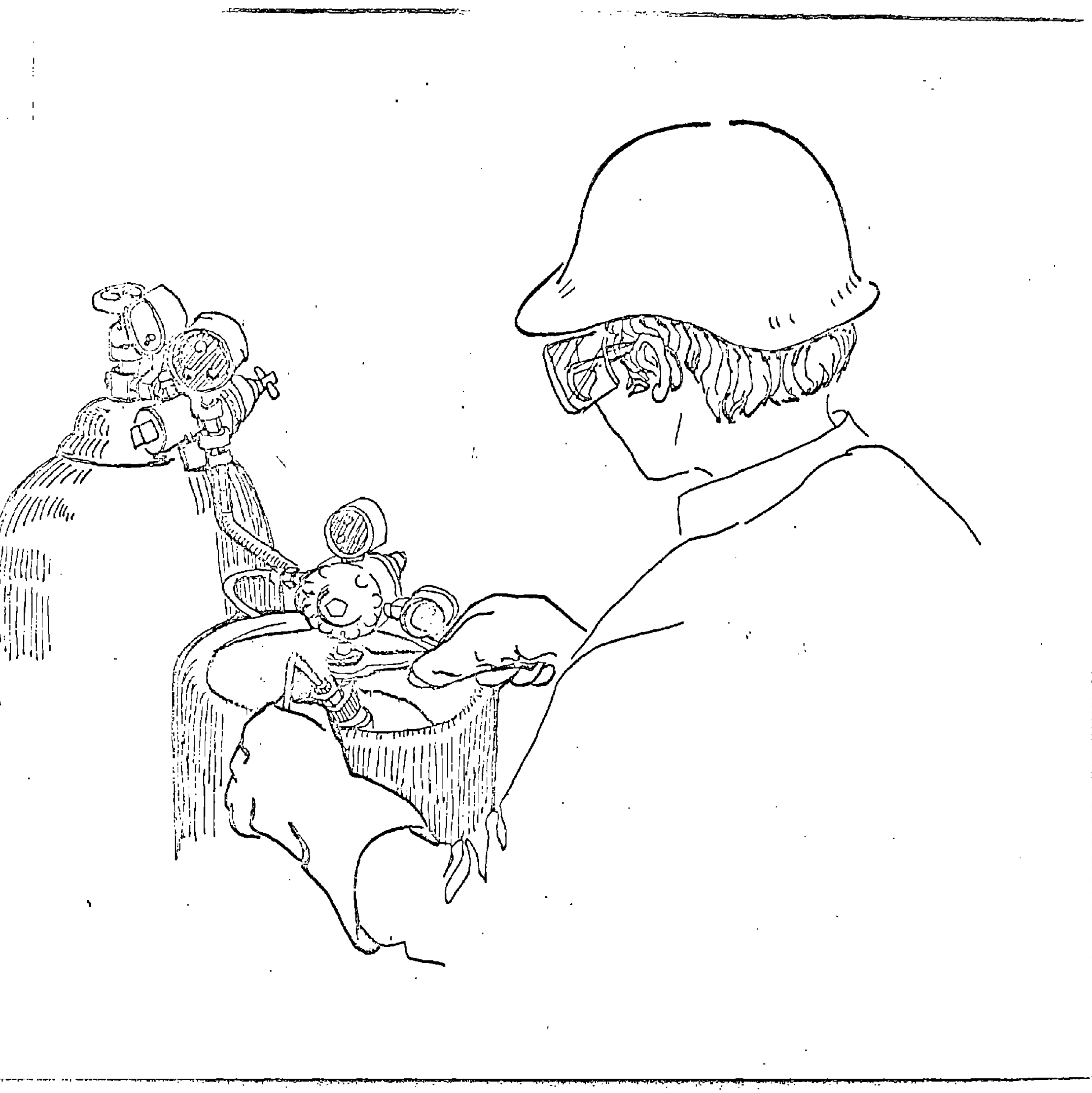
Before using a gas piping system, check for leaks with grease-free soapy water. Never use a flame to test for leaks.

Do not try to operate torches until gas supply is turned on. This will prevent formation of oxy-acetylene mixture, poor torch operation and possibility of serious flashback.

GAS CYLINDERS

Contents of every gas cylinder should be labeled clearly. The cap should by on each cylinder to protect valve mechanism when not in use. If empty, the cylinder valve should be closed and the cylinder should be marked "EMPTY" or "MT".

Storage of cylinders is very important. Keep them away from stairways, elevators, gangways and shop trucks. They should not be placed near radiators, or where they can be affected by other forms of radiated heat, such as the sun's rays or sparks from a work area. Oxygen cylinders should be well separated from acetylene and fuel gas cylinders. Cylinders should not be near oil, excelsior, grease or any other highly combustible material. Acetylene cylinders must be stored valve-end up so the fluid they contain cannot escape and cause an explosion. The storage area itself should be well-ventilated, well-protected and dry. The entrance area should have a sign which reads: "DANGER -- NO SMOKING.



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Always handle cylinders carefully. Knocks, falls, or rough handling may cause leakage.

Never try to transfer gas from one cylinder to another.

Anchor cylinders securely before using them. Keep space clear between cylinders for quick access to pressure regulators. Never use cylinders as a work support.

Keep oil and grease well away from oxygen cylinders. Oxygen reacts violently with oil or grease and causes fires or explosions. Oxygen cylinder fittings require no lubrication. Do not apply oil or grease under any circumstances. Be sure, too, that your hands, gloves and clothes are free of oil and grease when handling oxygen cylinders or valves. When opening oxygen cylinders, do not use a wrench or similar tool. Call the supplier if the cylinder does not open with ordinary hand effort.

If cylinder valves are frozen because of cold weather use only warm - not boiling - water to thaw them out. Safety releases (fuse plugs) melt at the temperature of boiling water.

Open gas cylinder valves slowly and stand to one side of pressure regulator gauge face as you open the valve.

Acetylene cylinders should be opened only with the special T-wrench. Leave the wrench in place for emergency closing. Do not tamper with fuse plugs.

Recessed tops of acetylene cylinders must not be used to hold tools. Do not let water accumulate on the top of cylinders. If you do, the safety releases may become ineffective.

Do not use electro magnets to lift oxygen or acetylene cylinders. Use a cradle when lifting by derrick or cable.

To stop acetylene leaks around the valve spindle when valve is open, close the valve and tighten the gland nut. If that doesn't work, put a defective tag on the cylinder and follow supplier's instructions regarding returning the cylinder. If the cylinder leaks when the valve is closed, or if the leak is from the area of a fusible plug, remove the cylinder from the storage area and take it to an open area where there is no danger of ignition. Open valve slightly to let all acetylene escape. Once all the gas is out, tag the cylinder with a warning not to approach it with any ignition source, such as a cigarette, cigar, etc. Follow supplier's instructions regarding further disposal.

Any problems with an oxygen cylinder should be reported to the supplier immediately. Follow his instructions to the letter.

MANIFOLD

Place approved flash arresters between each acetylene cylinder and the coupler block. With only three cylinders or less, only one arrestor is required between the coupler block and the regulator. Make sure that each cylinder lead has a back-flow check valve. Aggregate capacity of fuel gas cylinders connected to a portable manifold should not exceed 300 cubic feet of gas.

REGULATOR

Regulators always must be fitted to cylinders to reduce cylinder pressure to the working pressure of the torch. Use only that regulator which has been designed for the gas being used. Never try to force a connection that does not fit. Oxygen regulators must be kept free of oil and grease.

Before attaching the regulator, "crack" the cylinder valve to clear the valve of dry dust or dirt that might damage the regulator. Never "crack" a hydrogen cylinder or a fuel-gas cylinder near a workplace which might have an ignition source, such as flare or sparks.

If a cylinder leaks after the regulator is put on, remove it from use immediately.

Do not hang a torch and hose on regulators or valves. The weight can damage the regulator and interfere with fast closing of the valve.

If you stop work for 15 minutes or more, disconnect the torch and place it in the tool box. Release the pressure in the regulator to prevent accidental release of gas.

When detaching a regulator, close the cylinder valve, open the torch valve, turn out the pressure adjustment screw, close the torch valve and then uncouple the regulator. Always release the gas from the regulator and close the cylinder valve before removing the regulator.

Test gauges and regulators periodically for leaks. Use an approved leak test solution or soapy water. Never test oxygen gauges with oil. "Creeping" regulators should be repaired at once. Don't try to do it yourself! Send them to the supplier for repair.

HOSE LINE

The inside of a new hose usually is dusted with a fine talc. Blow it out with air -- never acetylene.

Once a hose has been used for one gas, never use it for another. Oxygen passing through a hose usually used for acetylene, for example, may form a combustible mixture. Red hose customarily is used for acetylene; green or black for oxygen. Don't mix them up.

If metal-reinforced hose is used, the metal never should be exposed. Metal-covered hose adds extra hazards if accidental bursting pressures are built up in the line.

Never use pneumatic air hose or fittings.

All hoses should be kept away from grease and oil since these can cause the hose to deteriorate.

Use hoses of minimum length. Hoses that are too long can cause a drop in pressure. Also, they're more likely to get tangled up or develop kinks in the line. Nevertheless, on some jobs it may be more practical to use a longer hose than to hoist a cylinder up to a particular construction site and anchor it into place.

Parallel lengths of oxygen and acetylene hose taped together to prevent tangling should not have more than any four of any eight inches covered by tape.

Hose reels should be of approved design only.

Check all hoses for leaks, burns, worn spots, etc. Any burns or leaks should be repaired immediately by splicing -- not taping. Wear at the connections should be repaired by cutting the hose and reinserting connections securely.

Connections should be fastened so not less than 300 p.s.i. can be accommodated without leakage. Do not use white lead, oil, grease or pipe fitting compounds for sealing joints. Joints are made to seal without compounds.

At least once a year, or whenever there is flashback or excessive wear, test lines with oil-free air or oil-free inert gas at double normal pressure or at least 200 p.s.i.

BACKPRESSURE VALVE

A backpressure valve must be fitted between the cylinder and each torch to prevent a backfire from reaching the cylinder. The backpressure valve must be properly designed and inspected regularly. If several torches are connected with the cylinder, also use a central backpressure valve connected directly to the cylinder. If pressure reducing valves are fitted to the torches and used as backpressure valves, make sure they comply with regulations.

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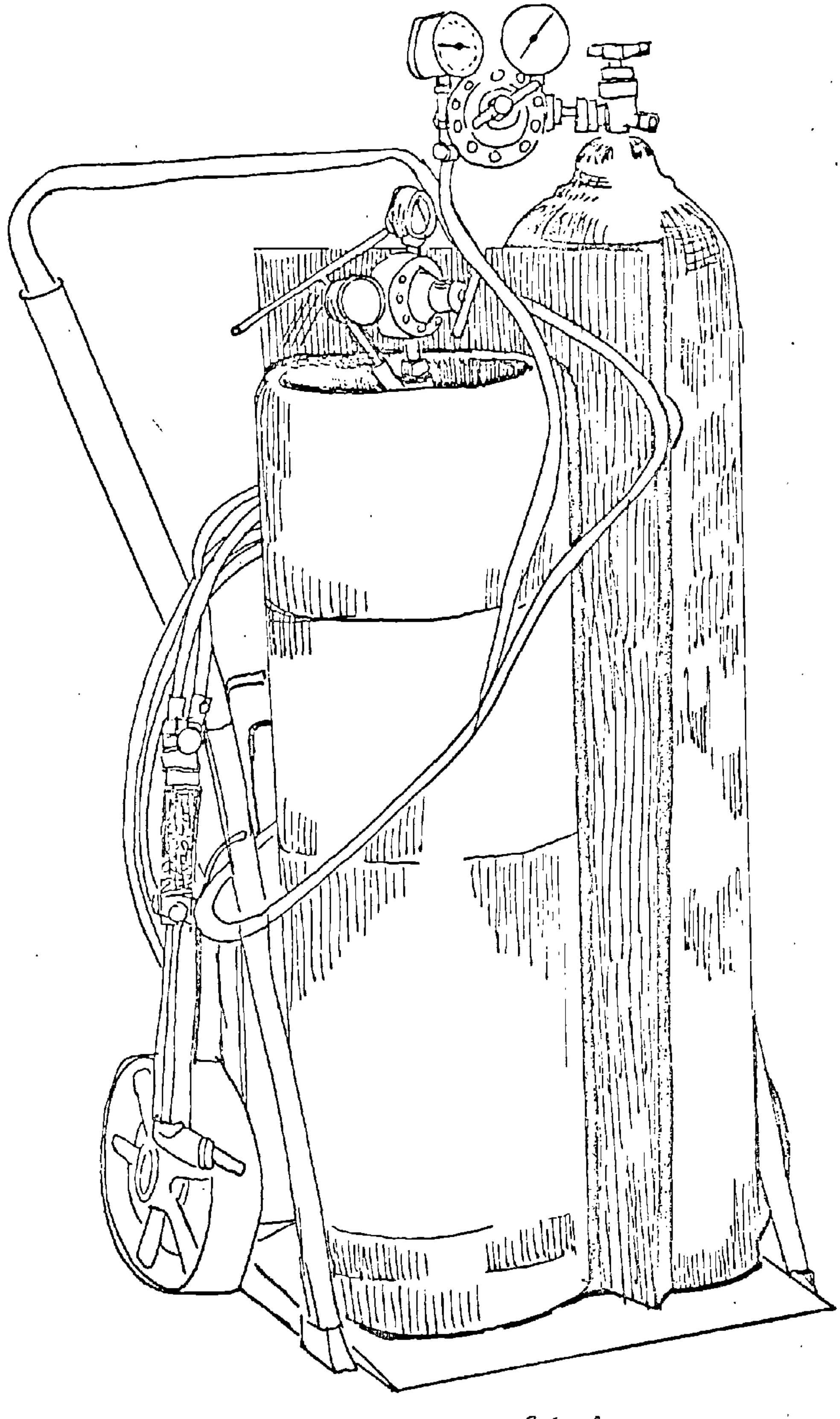
TORCH

Leakage around torch valve stems should be corrected by repacking with the manufacturer's supplied packing. Do not use oil.

Clogged tips should be cleaned with the proper sized cleaner, drill, or copper or brass wire. Never use a sharp, hard tool which could enlarge the hole. Always clean from the inner end.

A defective shut-off valve should be disassembled, cleaned, and have new parts put in as necessary for the safe seating of the valve.



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VI. CHECK YOUR VENTILATION

Adequate ventilation is the best protection you can have against dangers connected with accidental inhalation of gases, fumes, or dusts given off by toxic base metals, coatings, fluxes and filler metals used in the soldering and brazing processes. Ventilation not only helps remove toxic elements from the air, but actually can help improve the quality of the air you do breathe.

In many cases, all you'll need is natural ventilation. In some cases, however, particularly when your work involves cadmium, zinc, beryllium, lead or fluorine fluxes, you must have a good local ventilation system you can rely on. In some cases, even good local ventilation will not be adequate and you will need respiratory protective equipment.

Be Familiar with the Ventilation System

The first thing necessary is that you know what kind of ventilation system you should be using.

Out of Doors: If you're working outside in the open you don't need any more ventilation system than that provided by Mother Nature -- usually. But use good common snese. For example, you may be called upon to work during a very humid, breezeless day when heavy gases or other substances may not be blown away or dispersed with quickly enough. If that's the case, bring it to the attention of your supervisor. Mechanical assistance -- such as a portable electric blower -- may be well advised. The same holds true if you're working in a canopied area, providing that not more than half the sides are somehow blocked off. Use good judgement when directing the air stream so fellow workers are not exposed to heavy concentrations of contaminated air.

Inside: Under certain conditions you can work inside without mechanical ventilation. But these conditions are pretty well defined: To work inside without mechanical ventilation, requires that windows be open and that there is a good natural cross ventilation; that you're working with nontoxic materials, and that fumes from your work are not visible in any work areas -- your own and that of fellow employees. And even if all these conditions are met, check air flow carefully. It's still possible for some fumes and gases to gather in places where air flow is not completely effective. If that is the case, consider use of a portable fan to help disperse air-borne materials, being sure that the the fan doesn't blow it in the direction of fellow workers.

In many cases, it will be difficult to meet these conditions, so it will be necessary to have mechanical ventilation. The most common types are enclosed booth, open-faced booth, stationary hood, or movable exhaust hood. Whenever these or any mechanical device is used, you first must check it out carefully to be sure it's in good operating condition.

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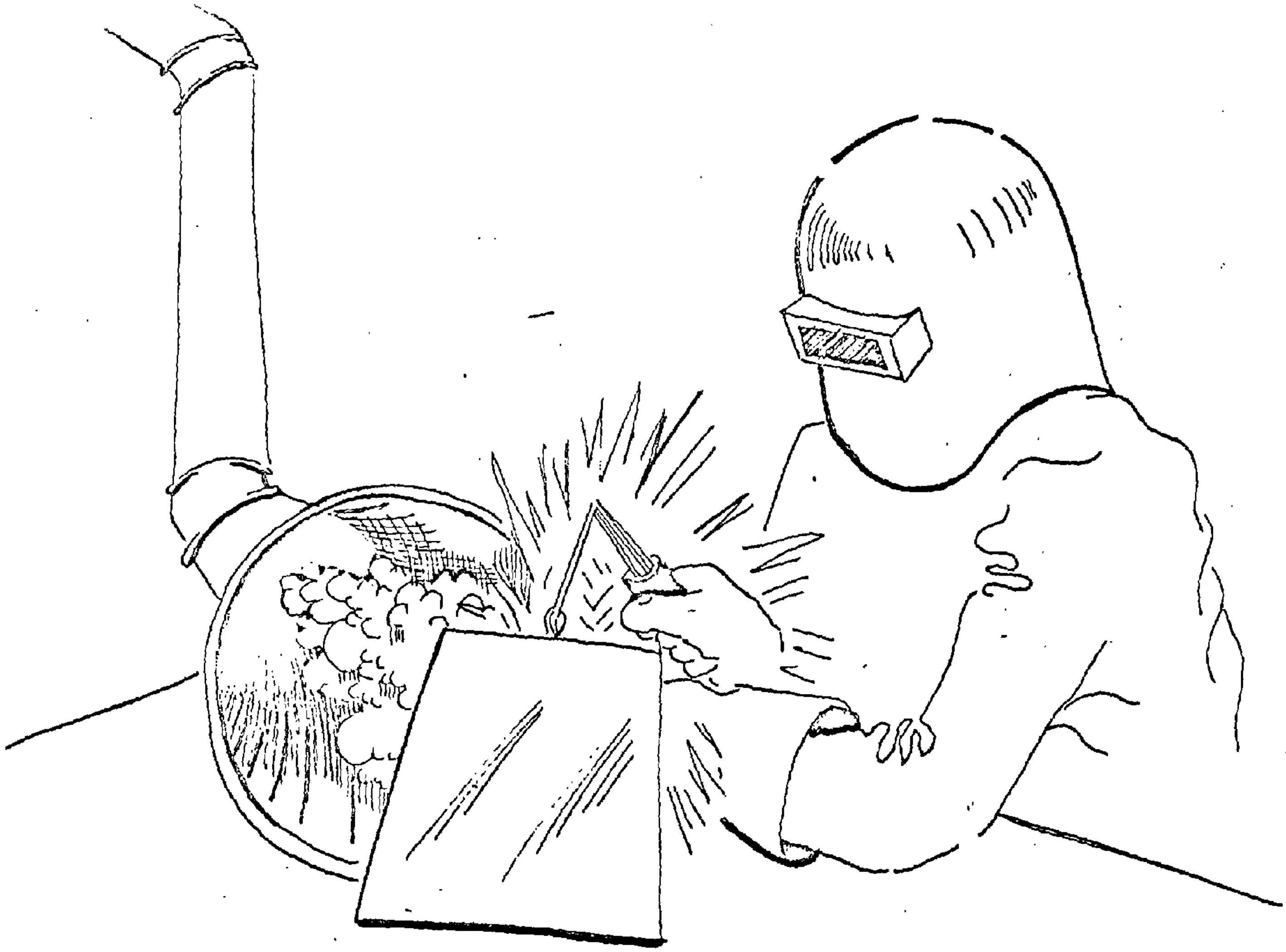
Make Sure It's Working Correctly

Whatever mechanical exhaust device is involved, it must be connected to a system that will carry off gases, dust and fumes that may be produced during the soldering and brazing process. A convenient check of the system



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efficiency is to hold a smoking cigar or cigarette at the point where you may do soldering or brazing. If this smoke is carried away rapidly, the system is probably working well. A more accurate check may be made with an "anemometer" which should read at least 100 feet per minute.

Get a feel for the correct air speed so, in the event that something goes wrong with the ventilation system, you may be able to sense when it dips below what should be provided.

Check all flexible connectors to the hood, too. Leaks will "rob" the exhaust capacity where needed and could endanger you or your buddy.

At no time should you take a chance if you feel that the exhaust velocity provided is less than what is required, or if you see a build-up of gas or vapors. Notify your supervisor to find out what the problem is and correct it before continuing work. If necessary, you and anyone else who may be affected should wear a respirator until the problem is fixed.

Make Sure It's Adjusted Correctly

Make sure that you're exhaust system is adjusted correctly, too.

Enclosed Booth: If you're working with an enclosed booth, your position and the position of your work should be such that fumes, dust, etc., are drawn from your breathing space. Obstructions must be kept out of the way of the air entering the booth, going past the work area and being drawn out.

Open-Faced Booth: With an open-faced booth, position yourself and the work so fumes and dust are drawn directly into the inlet face of the booth and away from you.

Stationary Hood: With this type device, materials you're working with should be as close to the hood as possible. When more toxic materials are involved, the hood should be able to pick up all the gases and fumes, If you're working with a furnace or other automatic equipment that has its own exhaust system, be sure that there's a flue connecting the equipment's exhaust system to the work area's exhaust system.

Movable Exhaust Hood: When the size or location of what you're working on won't allow use of a stationary booth or hood, a movable hood is advisable. It should be placed about six inches from the torch or iron so the air is pulled away from your breathing space to the face of the hood inlet. After you set it up, check the flexible tubing connecting hood to the exhaust system to make sure it's supported properly and counterbalanced so the hood will stay in the proper place. It is also important to move the hood as you move your point of work.

WORK CAREFULLY IN CONFINED SPACES

At times you may be called upon to work inside a tank, boiler, pressure vessel or some other kind of small, enclosed space where there is no natural circulation or where there may be a deficiency of oxygen. When that is the case:

Get an Outside Assistant

Check the space involved to determine whether or not you're going to need an assistant. You will if the entry way -- exit way is less than 6-feet high by 20-inches wide, or if it is not on the same level as the floor, ground, or a platform. Assuming you do need help, it will be your assistant's job to service the hoses, electric lead cables, respiratory air line, life lines attached to safety belts, and whatever else is necessary to help ensure your safety and whomever else may be inside.

Have Personal Protective Equipment

Be sure you have the necessary personal protective equipment on hand. When effective ventilation can't be provided by mechanical means, you and others inside must wear a NIOSH-approved air supplied respirator, hose mask, or self-contained breathing apparatus which fits properly. If the air supplied to these devices comes from the plant's compressed air line, then the compressor should be oil-free and should have a thermal cut-out switch in case of compressor overheat, to prevent formation of carbon monoxide in the line. Preferably, air supply should be taken from a low pressure air line with a special blower. Regardless of what kind of compressor is used, however, check it's air-intake position. It shouldn't be drawing in any contaminated air.

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In no case should oxygen be used to "sweeten" the air in a confined space. It can cause a severe fire or explosion hazard.

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Do Not Leave Hoses or Torches in Confined Spaces

Don't leave hoses or torches in confined spaces when you're not using them. A small leak of oxygen or fuel gas could develop creating a very dangerous atmosphere.

Check Make-Up Air

When contaminated air is removed from a confined space by an exhaust system, you must be sure that the same amount of air is replaced. Also, the replacement or make-up air must be free of contaminants. If you're working in a heated area, be sure that the air is properly filtered and heated too.

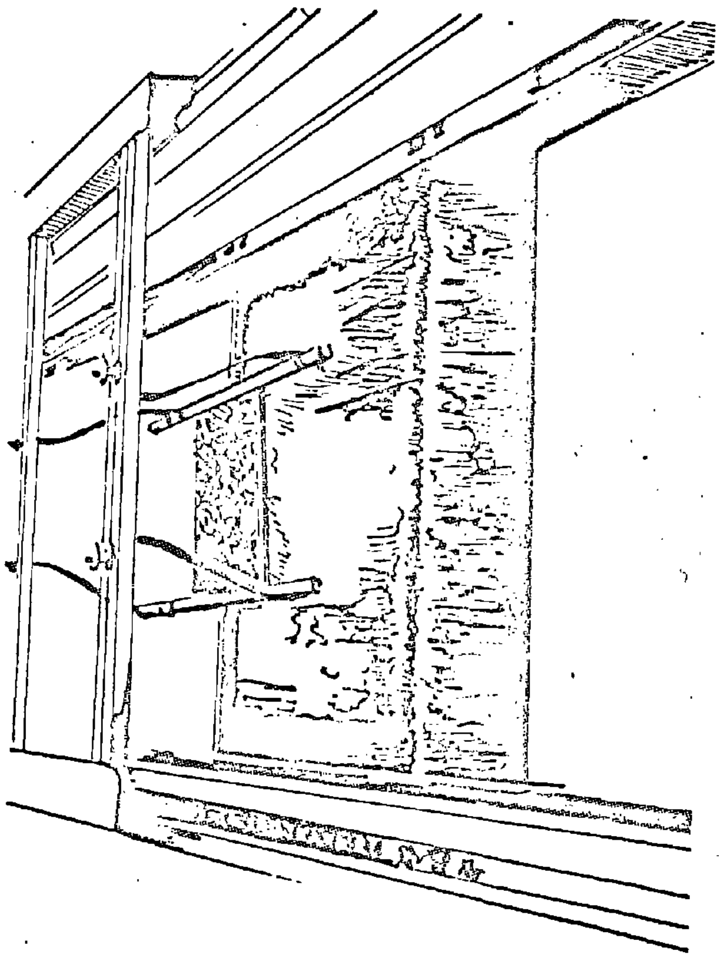
VII. HANDLE ELECTRICITY SAFELY

Because electricity always is nearby in one form or another, the hazards of electricity also are nearby. These hazards are especially prevalent when it comes to induction and resistance soldering and brazing, infrared brazing, electrical furnace brazing, electric iron soldering, and in all automated systems where electricity is used to power conveyors and belts to move the

Illust. "L" workpiece or to pump the molten solder to develop a wave, as in wave soldering.

Improperly controlled electricity can cause fires through arcing or overheating of parts or burns through contact with parts which have become energized through faulty conditions.

The most common and dangerous of all electrical hazards is shock. It is also the most easily prevented. The reason why electric shock is so common is because most people think you can get a bad shock only from a high voltage. Low voltage, however, depending on the route it takes through your body can cause: chest muscles to contract, interfering with breathing and in some cases smothering the victim; paralysis of the nerve center, which can also stop breathing; upset to heart rhythm, causing blood circulation to stop, as well as "bleeding" and destruction of tissue, nerves, and muscles from the heat of the current. In other words, don't let the voltage fool you. All electrical equipment presents some sort of hazard. These guidelines should help you minimize them:



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Read Instructions:

Read and follow maintenance and operating instructions provided by the manufacturer. Use the device only for the purpose it is intended.

Use the Right Tools:

Check with your supervisor to determine whether or not the tool you want to use in an explosive atmosphere can be used in such an atmosphere. Electrical devices must be certified "explosion proof".

Check Cables:

Check insulation of cables, especially those of induction equipment which includes high-voltage oscillators. Be sure grease and oil are kept off cables, and that cables are kept out of walkways where they could present a tripping hazard.

Check Dryness:

All portable electrical equipment should be stored in a dry place. Portable or not, check all electrical equipment before using to be sure it's dry.

Check Circuits:

For other than controlled circuits, be sure that there are no plug connections. Safety demands that power lead terminals be permanently attached with screws or bolts. Resistance holder and electrode should be water cooled to minimize danger of heat softening the metal and the danger of heat burns. Electrodes should be redressed and replaced frequently due to wear.

Keep Away from Flammables:

Do not allow any electrically-energized equipment to come in contact with flammable materials or gas cylinders. A fire or explosion could result.

Place in Holders or Turn Off:

When leaving an energized tool for a short period of time be sure it is in a holder of some sort so that it cannot fall on the floor or come into contact with some sort of combustible surface. When leaving it fore more than 15 minutes or so, turn it off.

Extension Cord:

If you have to use an extension cord, use only the approved type which has a three-prong grounded plug.

Disconnect:

Disconnect any piece of electrical apparatus before moving it. It could turn on accidently, cause a tripping hazard, or damage electrical connections.

Production Line Safety:

If you're working on a production line which uses heavy electrical induction or resistance equipment, be sure you are properly protected from chains, gears operating bus linkages, as well as belts, rotating jigs and fixtures holding the workpiece.

Keep Switches Unobstructed:

Keep control switches, such as buttons, unobstructed so you can cut power in an emergency and avoid turning the piece on or off accidently.

Don't Repair or Customize:

Do not alter the function of a piece of electrical apparatus in any way, as by adjusting a thermostat. Do not make any repairs. If something is wrong, get the device repaired by someone who knows precisely what he is doing. Do not work with any tool which is in any way defective.

Enclose Stored Energy Equipment:

Any stored energy equipment, such as that using capacitors or combination transformer reactors, is very hazardous and must be completely enclosed.

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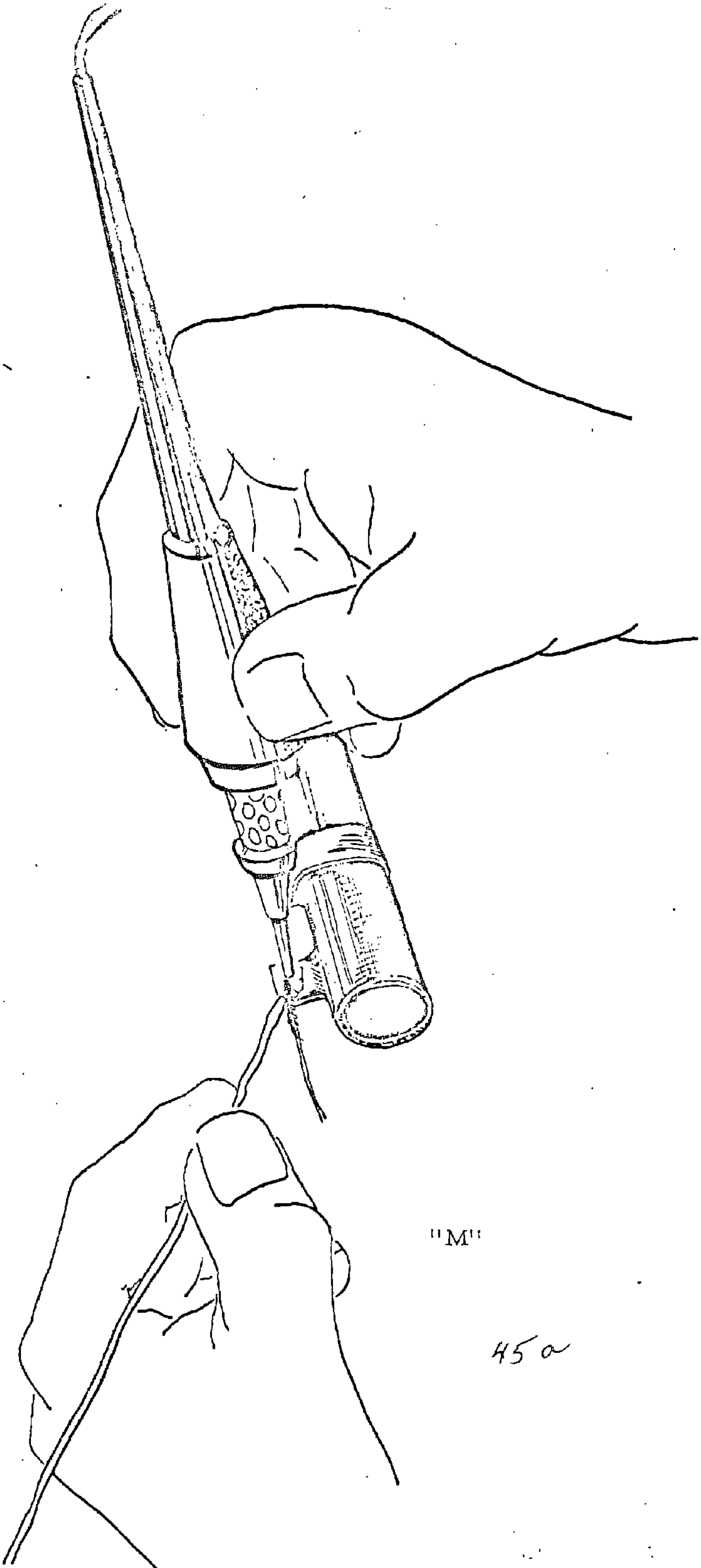
Check Grounds:

All electrical equipment must be grounded correctly. This means that you should ground by using a conductor that is a good solid ground. Using improper grounding, such as a scaffold, central heating pipes, etc., could result in creating shock or fire. Also, be certain that all electric tools and extension cords use a three-prong plug for proper grounding.



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VIII. REDUCE THE RISK OF FIRE AND EXPLOSION

You know that soldering and brazing involves significant fire and explosion hazards. The heat generated usually is enough to ignite most combustible substances, such as wood, paper, cloth and rubbish, as well as many of the gases which produce flammable and sometimes explosive mixtures with air, such as methane, hydrogen, carbon monoxide, acetylene and manufactured gas. You also have to beware of highly volatile liquids which give off flammable fumes, including gasoline, benzene, alcohol, turpentine, and so on. You also have to consider the hazard of a dust explosion. Dusts from aluminum, magnesium, zinc and iron, if blown in the air in the right concentration with a flame source, can explode. And that's not even a full list of hazards.

Below are listed some of the steps you should take to help minimize the chances of a fire or explosion which could cause serious injury to you or your fellow workers.

Check your Workplace

Check your workplace for hazards with your supervisor. Soldering and brazing must not be undertaken in or near rooms containing flammable or combustible vapors, liquids, fumes, dusts or similar materials, or on or in any type container which holds or may have held such materials. Assuming your workplace is not in or near such rooms, or that such hazards are removed, be certain that there is enough general or local ventilation to remove hazardous gases, vapors, fumes, etc., which possibly could build up flammable or explosive concentrations. Follow guidelines given in Section VI.

Remove all Combustible Materials

Clean your workplace of combustible materials such as oil waste, soiled rags, woodchips, waste paper, paint residue, and other items which if touched by a random spark or flame possible could ignite or explode. If you're working near combustible material which can't be removed, use sheet metal, flame resistant tarpaulins or asbestos curtains. Wear clothing free of grease and of flammable liquid. In some cases another employee with a fire extinguisher should serve as a "fire watcher".

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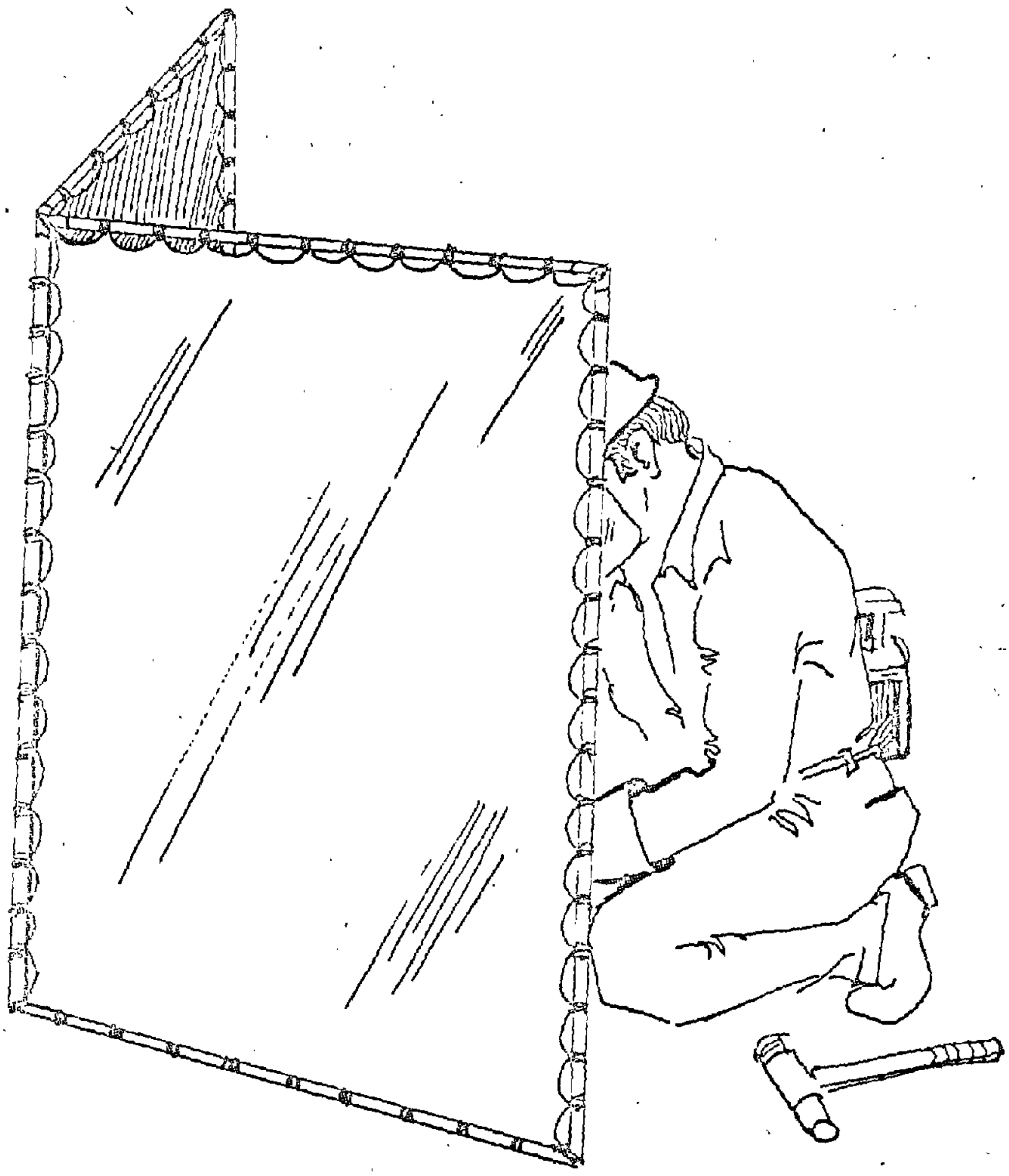
Remove Dust and Rubbish

Remove all dust and rubbish from your workplace, especially metallic dust. If dust is allowed to remain, it sometimes can become dispersed in the air creating not only a risk of fire, but also a very serious risk of explosion as well.

Fireproof the Floor

Assuming that the floor is free of combustible materials, determine if its composition could be hazardous. If the floor is concrete, there is relatively little hazard. But if the floor is made of wood or some other combustible material,



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cover it with an asbestos cloth or other fire resistant material. Remember that a wooden floor, even though covered; can be ignited if the covering is open in areas or if a substance landing on the covering is hot enough to ignite the floor below.

Fireproof all Wood Nearby

All wooden construction nearby, including the floor, and partitions, should be protected from heat or hot materials or tools, as well as flame.

Check Electrical Apparatus

Be sure to check all electrical apparatus as discussed in Section VII Electrical problems often can lead to fire hazards.

Check Fire Extinguishing Devices

While fire extinguishing equipment won't prevent a fire, it can easily prevent a small fire from becoming a major catastrophe. Check with your supervisor to determine exactly what kind of fire extinguishing equipment is on hand. Learn what type of fire each extinguisher should be used for. Be sure that used extinguishers are properly recharged. If there is a sprinkler system, and if you're going to do any soldering or brazing near a sprinkler head, shield it with a damp cloth or asbestos sheet. If the sprinkler system must be shut down temporarily for repair or for some other reason, make sure it's turned back on when you're finished with soldering or brazing operations.

Contact Supervisor Before Beginning Operations

Before you begin operations, have your supervisor inspect your workplace with you to look for any possible fire risks which you may have overlooked. Take whatever safety precautions necessary. If you notice any hazards developing while working, stop work and contact your supervisor.

Post Fire Watchman

When you are brazing or soldering in what might be considered a dangerous area, be sure to post a fire watchman with the correct fire extinguisher. He's needed because you cannot see around you while you're working. Make sure that your watchman is alert and capable so he can spot a fire if one starts, and immediately begin to put it out.

Inform Watchman when Leaving Work

Especially when working at temporary sites, you should let the watchman know when you are leaving work and show him where the work took place. Let him know that while everything appears fine, it is possible that something may be smoldering and possibly could break out in flame in an hour or more after you leave.

Know Your Materials

Know the materials you'll be working with, as discussed in Section III Know what their inherent qualities are as they pertain to fire safety. Could dusts cause an explosion? Could fumes be flammable?

Don't Smoke

Smoking can be bad for your health if it causes a fire or explosion. And this is just what does happen sometimes when a cigarette, cigar or pipe ashes are discarded carelessly when flammable materials, gases, vapors or fumes may be present. So don't smoke near your work area. And don't let anyone else do it.

Avoid Overheating

Overheating often can result in production of a lot more gaseous material from solders and filler metals than necessary. But from the point of view of fire safety, do be careful especially when working with thin metal workpieces containing magnesium or zinc which can ignite.

Observe Special Care when Working with Closed Containers

Working with closed containers requires special care, primarily because of the explosion hazard which exists. The hazard is especially prevelant if the container at one time held any flammable liquid such as gasoline. Before you start the soldering or brazing operations on closed containers, clean them thoroughly.

Steam is generally recommended for removal of materials easy to evaporate Hot caustic soda or similar chemical removes heavy oils. Because chlorinated solvents give off toxic vapors when heated it is recommended that these solvents not be used.

After the container is thoroughly cleaned, it is wise to fill it with water to within a few inches of the joint. Be sure to vent it to permit release of hot air and vapors. Carbon dioxide or nitrogen gas are good substitues for water. Be sure the gas is always in sufficient concentration to prevent occurrence of explosive or flammable mixture.

Replace Gas Cylinders

After working, replace gas cylinders you may have been working with to the specified area so they can be moved. Others will know where to find them in case of a fire, and so be able to move them quickly.

Maintain Equipment Properly

Proper maintenance of equipment and machinery is important for many different reasons. In terms of fire safety, proper maintenance means reduction of the risks of fires started by excessive heat generated by friction due to hot bearings, misaligned or broken parts, poor adjustment of power drives and belts, etc.

IX. CHECK YOUR PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment can go a long way to reducing some of the hazards you come up against.

PROTECTIVE CLOTHING

You always should wear coveralls made of fire-proofed cloth. The fire-proofing materials should be guaranteed against washing out in cleaning. Cut out any exposed pockets of the coveralls to prevent sparks or molten solder from lodging in them. Remove cuffs for the same reason.

Over the coveralls you should wear a sturdy leather apron or similar protective device. The apron is needed both as protection against spatter and as protection against radiated heat from furnaces, ovens and retorts.

Under the coveralls you should wear clothing made out of wool or cotton. Wool is preferred because it ignites less easily than cotton. Synthetic fabrics should be avoided because they ignite very easily. Wear only cuffless trousers. Be sure to button sleeves and collar.

At all times, wear high, snug-fitting safety shoes which cannot catch spatter. When doing very heavy work, you may need even higher boots or fire-resistant leggings.

For light work, you should wear flame-resistant cotton gloves to protect your hands from heat and spatter. Heavier work requires gloves made out of leather or some other heavy, flame and heat-resistant material. (Because flux can irritate the skin under your fingernails, it's also a good idea to keep your nails trimmed and to use a protective cream that's insoluble in the flux.)

When you're working in an overhead position, facial and eye protection is necessary, and you should wear either a hard hat and face shield or a leather cap with helmet. The hard hat provides extra protection from falling objects.

Be sure to keep your clothing free from oil or grease, which can ignite. Hang all your protective clothing in a clean, well-ventilated area, too. This will ensure that you'll have dry clothing at the start of operations.

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FACE AND EYE PROTECTION

Face and eye protection usually can be assured through use of safety glasses or face shields depending on the particular job.

Safety Glasses: provide adequate eye protection for all basic hand soldering or brazing operations.

Special Lens Glasses: must be worn to protect the eyes from invisible radiation, glare and hot metal particles when torch operations are involved.

Face Shields: provide best protection for operations which involve a lot of spattering, such as tinning. (Safety glasses also should be worn under the face shields.)

Chemical Resistant Face Shields: should be used when handling acids and alkalies to protect you from splash, burns and fumes.

Wear Your

Eye

Protection!

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Know the job and know the protection you'll need. Be sure that what you wear fits comfortably, because loose shields or goggles can cause accidents by obstructing your vision.

If you sweat a lot, it may be a good idea to also wear a sweat band to avoid getting your goggles or face shield wet and obstructing your vision. Contact lenses do not provide protection and may contribute to a serious eye injury if corrosive materials get under them.

RESPIRATORY PROTECTIVE EQUIPMENT

Respiratory protective equipment, as we've already discussed under ventilation, must be used whenever you're working in a confined area. Respirators also should be used when no local exhaust is available and you're working with fluorine compounds, zinc, lead, beryllium, and cadmium. Because your personal respiratory protective equipment is so important to your health and safety, it is essential that you inspect, service and maintain it on a regular basis. If you have an airline respirator, check the pressure regulator, hose and face piece frequently for deterioration. For hose masks, lubricate blowers, and replace inhalation and exhalation valves periodically and clean rubber parts regularly. Store your respirator in a cool dry place to slow down the rate of deterioration. Should you notice any odor of flux or solder fumes or irritation to nose, throat or respiratory tract, while wearing respiratory equipment during operations, it is an indication that a problem exists. Leave the space immediately and get fresh air. Check the equipment for leaks. If you're using a self-contained. breathing apparatus or ordinary respirator something may be wrong with it. If you're using an airline type device, the problem could be either with the device itself or with the fresh air supply.

SAFETY BELTS AND LIFE LINE

Safety belts and life lines have been mentioned. In most cases, a leather belt with a one-half inch nylon rope will suffice. Check it regularly to make sure that there are no cuts, frays, or burns. Try not to expose them to excessive heat. Also be sure you know how to wear a belt and line correctly. You don't want them interferring with your movement if you have to make an emergency exit from a confined space.

X. MAINTAIN GOOD HOUSEKEEPING

It is essential that you keep your workplace in good order. By doing so, you will be able to prevent hazards from becoming accidents. While the following list certainly is not complete, it serves to provide you with some guideposts. Common sense should be able to fill in the rest. Basically, if you can get into the habit of keeping your workplace clean and neat, you will be able to prevent accidents before they occur.

A Place for Everything

There's an old adage, "A place for everthing and everything in it's place." The adage has been around so long simply because it is very valid. If, in fact, you create a certain place for everything you use, such as tools, rags, cleaning solvents, and so on, it is very easy to put an item back where it belongs, so you don't lose it. By the same token, when you need something, you will know exactly where it is. And just a quick check will let you know whether or not something is missing.

Store Materials Properly

Make sure all materials are stored properly. This means not only that

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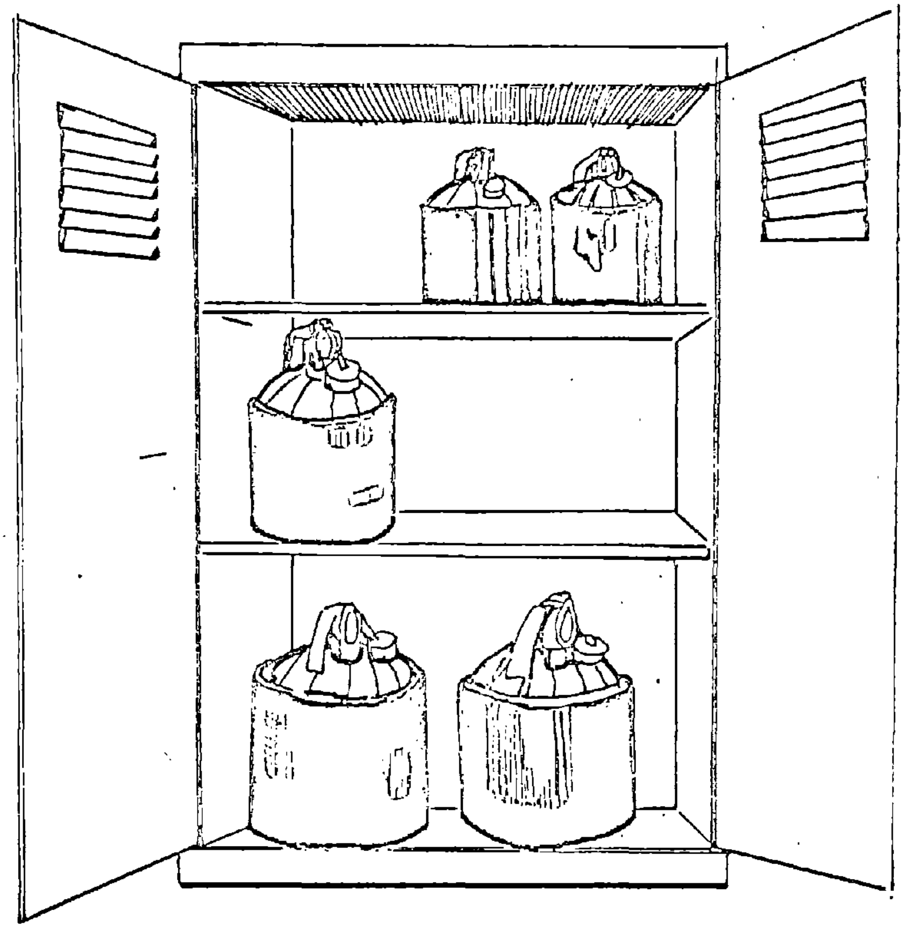
they should be stored where they are accessible, but also that they are stored under proper conditions, for example, a respirator being kept in a dry place, Are all bottles kept where they cannot be broken easily? Are all lids on tight? Make sure contents of any leaking containers are transferred to proper containers.



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Get Rid of Trash

Have a receptacle on hand for trash. Preferably it should be metal and have a metal cover. Place all rubbish, trash, dusts and other materials in this receptacle and empty it in an approved location regularly. By doing this you will greatly reduce the chance of accidental fires.

Clean up Spills

Clean up all spills of any type liquids or other materials as quickly as possible using proper protective equipment. If you do not, toxic vapors could be given off, or additional spills of material could create dangerous vapor or fumes, or possibly could result in creation of flammable mixtures on the floor. Dispose of materials used for cleaning promptly and properly.

Inspect Tools

Inspect all your tools on a regular basis. In most cases, this means more than just a spot check before you use something. Look everything over carefully for frayed wires or lines, build-ups of grease or oil.

Maintain Cleanliness

Maintain cleanliness not only of your workspace in general, but also of all tools, hoses, wires, and other equipment. Check for oil and grease. Remove build-ups of solder. By so doing your tools and equipment will not only last longer, but they'll operate more efficiently and will probably help you work in more accident-free conditions.

Check Lights

It is very important that you have a good illumination system in your work area. Check the lighting. Is it adequate? Are all bulbs working? Are deflectors clean and clear? If there are deposits from chemicals or other materials you have been working with on lighting fixtures, it could mean that your ventilation system is not adequate.

Check for General Chemical Build-ups

Look for chemical build-ups on areas other than lighting fixtures. If you find any, or if you feel that for any reason your ventilation is not what it should be, call the supervisor in for inspection. Utilize special equipment for checking the air for toxic vapors, adequacy of ventilation, etc.

XI. MAINTAIN GOOD PERSONAL HYGIENE

Good personal hygiene can go a long way in helping cut down exposure to hazar

Wash Hands Frequently

It's a good practice to wash your hands (and face) several times a day. Not only does frequent washing reduce the risk of hazards due to toxic materials being absorbed by your skin, but it also reduces the risk of your contaminating something which you might eat. You always should wash before eating.

Store Food Carefully

Be careful about storing your food. It should be kept in a closed container stored away from your workplace. This prevents dusts and fumes from settling on the food.

Watch Your Smoking

If you have been working with particularly toxic materials , such as lead or cadmium, it is good practice to wash your hands before smoking. Otherwise the toxic substance on your hands could contaminate the tobacco which you inhale.

XII. TAKE CARE OF ALL INJURIES

All injuries should immediately be reported to your supervisor. Even minor cuts and bruises can become much more serious if they are not treated. A record of equipment, tools and material contributing to injuries will also lead to correction of hazards that may prevent future injuries.

EMERGENCY FIRST AID TREATMENT

Chemical Burns

1. Follow instructions on the container label
2. Remove acid, alkalies and solvents from the skin by flushing with large amounts of water followed by gentle scrubbing with soap and water.
3. Remove all contaminated clothing and wash skin underneath. Do not wear the clothing again until it has been thoroughly cleaned.
4. In case of eye exposure, spread lids with clean fingers and flush the eye with large amounts of water. Continue the application for 15 minutes or longer.
5. Do not use chemical neutralizers.

Burns from Heated Surfaces

Cool minor burns by placing affected area in cool or cold water or by flushing with cool or cold water. Then cover the burn with a sterile dressing to prevent infection. Do not use ointment, powder or any other type of treatment because it may interfere with subsequent treatment. In case of severe burns, don't do anything until the physician arrives.

Wounds

Treatment of wounds should be undertaken only by someone trained in first aid. All wounds, no matter how small must be reported.

WHAT TO TELL THE PHYSICIAN

The more information you can supply the physician, the better able he will be to treat your problem. The information most important to him will be:

The Cause

Describe the type of work you were performing which resulted in the illness or injury.

Duration of Exposure

In cases of exposure to fumes, vapors, and gases, inform him of how long you were working under certain conditions; what the ventilation was, the protective equipment you were wearing, etc.

Material Content

He will also want to know what base metals, coatings, solders, brazing filler metals, fluxes, solvents, acids, alkalies, etc., you were working with.

XIII. JOIN THE SAFETY TEAM AT WORK

Sometimes you probably think that all the various things you have to do to help establish safety on the job are a pain. And chances are you probably know a few shortcuts to make the job a little easier. "After all," you may think, "I know my way around. There's no way that anything can happen to me."

You know, cemetaries and hospitals are filled with guys who used to think like that -- that they knew their way around and nothing could bother them. They were wrong. They finally realized that, the more you tempt fate, the more likely it is that you're going to wind up being the "other guy" someday. Of course, most of them realized that too late. Maybe you know someone who found out the hard way.

So when you get right down to it, how much of a pain is safety? All you're being asked to do is take a few extra minutes here and there; use a little extra caution; look a little more before you leap, so to speak, primarily for your own safety and for that of your fellow workers. After all, you aren't alone. There are people who work with you. How would you like it if they were careless? How would you like it if one of them accidently forgot to check his ventilation system and as a result you inhaled cadmium fumes? Chances are you'd be pretty upset, providing you recovered. It would be one thing if the guy couldn't have prevented the accident. But it's really something else when you do harm to someone else or yourself because of something stupid; something you could have easily prevented through using a little precuation.

In fact, maybe what occupational safety and health really gets back to is the old saying, "An ounce of prevention is worth a pound of cure." And basically, that's what you should be doing -- providing yourself with that ounce of prevention.

In most cases, you can get the best advice on prevention from your supervisors at work, and the company for which all of you work. The company is concerned about your safety and health, not only because you are an essential part of their overall operation but also because it must abide by the very tough rules and regulations included in the Federal Occupational Safety and Health Program, as well as, in some cases, state programs that are even tougher. So what they're doing, and what others all over the country, are doing, is developing safety programs for you to follow -- ways and means to make your job less hazardous. But these programs and plans can only be as effective as those people who are involved in the work itself. Abide by the safety rules. Don't use shortcuts. If you see others making mistakes, correct them or report them. Their mistakes could mean your life. If you see new ways in which safety can be increased or dangers reduced, tell your supervisor about it. Remember, life is a one-way street. There's no turning back. You owe it to others not to cause them hardships through an accident you could have prevented. And they owe the same to you. So get on the safety team. Encourage your fellow workers to do the same. Because it's pretty tough to have a good life without good health.

XIV. SAFETY DO'S AND DON'TS

These brief do's and don'ts have been prepared to highlight some of the main points which have been discussed throughout this manual. They don't substitute for reading the publication. Therefore, do read the complete manual. After all, isn't your safety and health worth the investment of the 30 minutes or so it will take you to read it?

DO

1. Know the materials you are working with and what their hazards are.
2. Add acid to water; never add water to acid.
3. Keep oxygen from combustibles and combustibles from oxygen.
4. Check the ventilation system for adequacy.
5. Use local exhaust or air supplied respirators when working in confined spaces with workpieces, fluxes and filler metals containing cadmium, lead, zinc, beryllium or fluorine compounds.
6. Be alert to possible fire hazards.
7. Wear protective equipment required by the job.
8. Maintain equipment in good condition and use only equipment which is in good working order.
9. Keep your workplace, tools, equipment and materials in order.
10. Read manufacturer's warning labels and follow instructions.
11. Report all injuries, ill effects and skin disorders.
12. Follow the safe practices recommended in this manual .

DON'T

1. Solder or braze in areas where flammable materials are used or stored.
2. Use oxygen for ventilation.
3. Solder or braze at high places without first taking special safe-guards to prevent falls.
4. Solder or braze metal degreased with organic solvents until thoroughly dry.
5. Use compressed gas cylinders as a work support.
6. Replace fuses, electrodes, holders, cables or cable reels with current on when working with electric soldering and brazing equipment.
7. Use electro-magnets to lift cylinders.

APPENDIX "A": SUGGESTED FORMAT & LAYOUT

1. Format: Suggested format is 5-1/2 x 8-1/2 inches or 5-1/4 x 4 inches, either of which will be handy and economical to produce.

2. Cover Art: It is suggested that the cover art be limited to the judicious use of type and coloration only. It is advised that the main title of the handbook be set in very large type; the full title be centered from top-to-bottom, and that all copy be centered from side to side. Bright colors should be utilized, such as, for one color printing with white stock, bright red with lettering reversed, or -- with two colors -- bright yellow background with black lettering.

3. Illustrations: Illustrations are identified by letters A, B, C, etc., Corresponding letters in the margins of the text indicate that the illustration referenced should be placed in general proximity to the copy closest to which the letter in the margin appears.

4. Type: It is suggested that a contemporary, but easy to read type such as "Souvenir" be used either 11/13 or 12/14, justified at a pica measure allowing for a 2-1/2 to 3 pica margin on either side, and approximately 3 to 3-1/2 picas for both top and bottom.

5. Binding: Saddle stitched.

6. Stock: Relatively heavy weight cover offset stock is suggested for the cover (65# - 80#) and text (70# white).