VICTORIAN RAILWAYS

Instructions concerning the

Care and Management of OXY-ACETYLENE CUTTING and WELDING APPARATUS

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Instructions concerning the Care and Management of

Oxy-Acetylene Cutting and Welding Apparatus

This book is issued for the use and information of employes only, and the instructions contained therein supersede all others of prior date that are contrary thereto.

Every employe to whom a copy of the book is issued must forthwith make himself fully conversant with the instructions contained therein and will be held responsible for fully complying with such of the instructions as are applicable to him in the performance of his duties.

This book is the property of the Victorian Railways Commissioners and is issued to :—

NAME	OCCUPATION
XXXXXXXXX	Apprentice Fitter + Turner

who, by accepting it, agrees to return it to the proper Officer when called upon to do so.

INTRODUCTION

This booklet is issued to employes engaged in or being trained in the use of oxy-acetylene equipment for welding and cutting. It is primarily intended to give guidance in obtaining a knowledge of the details of the equipment, its care and operation together with the necessary safety precautions.

The booklet is your guide, your advisor, your friend—Take good care of it.

The instructions contained herein are not intended to cover the whole field of oxy-acetylene welding and cutting nor are they intended to enable people without basic training to become operators.

The successful use of oxy-acetylene equipment in either welding or cutting is dependent upon good equipment kept in good condition and a thorough understanding of the principles underlying its operation and of the materials being used.

Fundamental training at least is necessary both in the handling of the equipment and in acquiring the necessary skill to enable the operation to be performed in a tradesman-like manner.

Operators of the equipment should not attempt the repair of defective apparatus but should confine their interests and activities in preserving the efficiency of their plant and seeing that it is not abused and that it is stored and handled with due care.

SAFETY PRECAUTIONS.

1. Persons not trained in the use of oxy-acetylene apparatus are not under any circumstances to interfere with it or use it except when receiving tuition from a competent operator.

2. Keep all cylinders, empty or full, away from radiators, furnaces and other sources of heat and from contact with electric circuits. Close valves of empty cylinders.

3. No oil or grease whatever must be used on oxy-acetylene equipment or be allowed to come in contact with oxy-acetylene equipment as an explosion may result.

4. Never tamper with or alter cylinder numbers or other markings. Never try to refill a cylinder. Never try to mix gases in a cylinder. Never use a cylinder or its contents for other than its intended purpose.

5. Protect cylinder valves from bumps, falls and falling objects and from weather. Keep them clean. Never allow anyone to strike an arc or tap an electrode against a gas cylinder.

6. Never draw oxygen or acetylene from cylinders except through properly attached pressure regulators.

7. Whenever the flow of either oxygen or acetylene is stopped by some obstruction, immediately close the valves on both cylinders and leave them closed until the obstruction is removed.

8. Should the oxygen regulator freeze, it should not be melted by flame or heaters, but by the application of hot water applied by clean waste.

9. When regulators are attached, the sudden opening of cylinder valves may cause damage to regulator. Always open cylinder valves slowly.

10. If an acetylene cylinder is seriously heated accidently or the gas ignites through a severe flash-back or leak, shut valve, detach regulator and take cylinder into open air, cool with copious supply of water ; open valve fully and keep cool with water until cylinder is empty. Leave outdoors with valve open : notify supplier immediately.

11. In case of accidents always close cylinder valves and remove cylinders to a cool place.

12. Never use oxygen as a substitute for compressed air.

13. Do not attempt to weld or cut a drum or tank which formerly contained petrol or other inflammable liquid until you are quite certain that all trace of inflammable vapour has been removed from the vessel. The best method of clearing a vessel of liquid gas is by

blowing live steam through it until the interior is thoroughly steamed out. If steam is not available, submerge the drum or tank in boiling water and keep it boiling for about 20 minutes. After steaming or boiling, scavenge the inside of the tank with air until the vapour is entirely removed. This can be done by air from a compressor or by hand or foot pump as used for inflating tyres.

14. Never use copper for the piping or manifolding of acetylene, nor in any way allow it to come into contact with acetylene. Copper, when exposed to the action of acetylene, forms copper acetylide a highly explosive compound which is readily detonated by heat or friction.

15. Should a flashback occur and burn the inside of the tubing, discard that length of tubing. A flash-back of this nature renders a piece of tubing unsafe, because it burns the inner wall. Sooner or later this part will disintegrate and cause trouble by clogging or otherwise interfering with the proper operation of the torch.

16. Precautions should be taken to avoid the risk of fire, by keeping the working area clear (within a radius of 25 feet) of inflammable materials or by effective shielding of the cutting operation.

17. When low pressure acetylene is being used the operator must check to see that the hydraulic blow back valve on the acetylene pipe line is filled with water to the prescribed level.

Goggles:

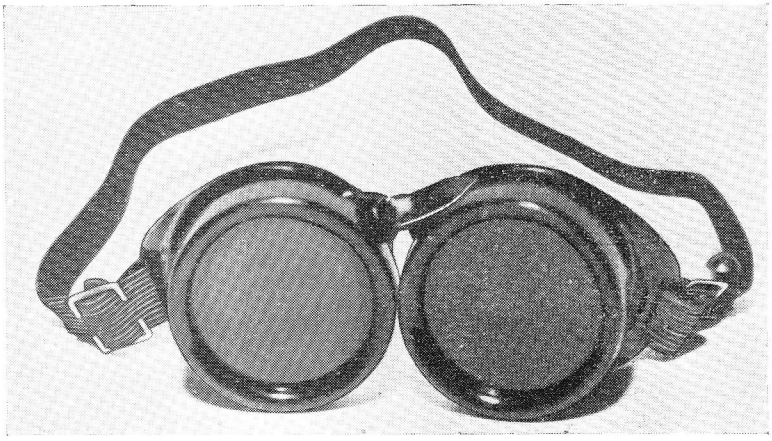


Fig. 1.—Protective Goggles.

The use at all times of welding goggles of an approved type is of the utmost importance for eye protection.

The only type of goggle to be used is that recommended by the Safety Council from time to time and approved by the Commissioners.

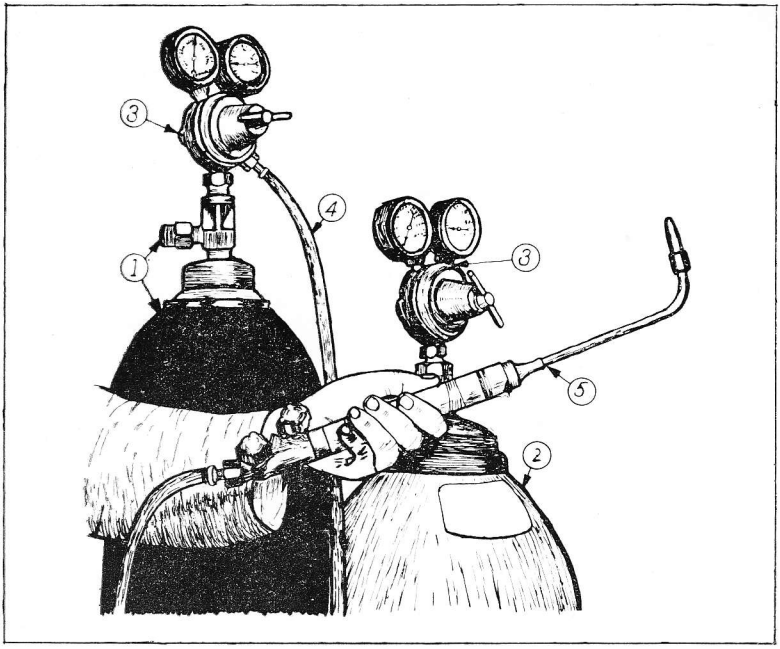


Fig. 2.—1–5 Oxy-Acetylene Apparatus.

GENERAL DESCRIPTION OF APPARATUS.

The equipment necessary to effect cutting or welding of metals by the use of the oxy-acetylene flame consists of the following :—

Fig. 2/1 A cylinder of oxygen to which is permanently fixed a stop valve.

Fig. 2/2 A cylinder of acetylene to which is permanently fixed a stop valve.

Fig. 2/3 Regulators to control the supply of gases from each of the cylinders, oxygen and acetylene.

Fig. 2/4 Flexible hose and connections between regulators and torch.

Fig. 2/5 Cutting or welding torch.

Oxy-acetylene equipment in industrial use is not particularly dangerous but there are certain fundamental safety precautions which must be adhered to. Certain somewhat delicate instruments included in the equipment must be handled with care.

MAINTENANCE OF EQUIPMENT.

Minor Repairs :

Operators are permitted to undertake minor repair work only as indicated hereunder :—

(a) **Welding and Cutting Torches.** Defective tips may be renewed or cleaned. (See reference to " Care of Torches ".)

(b) **Welding Hose.** Damaged hose may be replaced or cut and the defective section replaced. (When repairing standard $\frac{3}{8}''$ 3 ply oxy hose, brass tubing $\frac{1}{2}''$ diam. x 17 gauge approx. $3\frac{1}{2}''$ long is to be used at the junction. The hose is then to be bound with 18 gauge copper wire. Only water may be used to assist in mounting the hose on the tube and under no circumstances is any other lubricant whatever to be used owing to risk of explosion.)

(c) **Regulators.** The replacement of defective gauges alone is permitted.

Defective Apparatus :

All other repairs to any essential parts of the equipment must be forwarded to the undermentioned locations according to Branch :

Branch	Location
Rolling Stock	... Newport Workshops (Tool Room)
Way and Works ...	... Spotswood Workshops
"	... Ironworks Division, Laurens Street.
"	... Bonding Depot, Batman Avenue.
Electrical Engineering ...	... Electrical Workshops, Spencer Street.

NOTE :

Equipment used by the staff of the Way and Works Branch, Engineer of Special Works Division, is to be sent to the Engineer in charge of Ironworks Division, Laurens Street.

GASES.

Oxygen (O2) :

Oxygen is an odourless and colourless gas. It is itself non-inflammable, but has the property of vigorously supporting and accelerating combustion, hence its value to the welding and cutting industry.

Oxygen cylinders are of weldless drawn steel tested to a pressure of 240 atmospheres and are supplied filled with oxygen to a pressure 2,000 lbs. per square inch. The cylinder valve on an oxygen cylinder is opened and shut by the application and turning of a key. The connection to the regulator is right hand female. Cylinders used for containing oxygen are painted black. See Fig. 3, page 9.

Acetylene C_2H_2 :

Although other combustible or fuel gases are sometimes used in welding and cutting they may be disregarded as acetylene is the gas in most general use owing to the following desirable properties :—

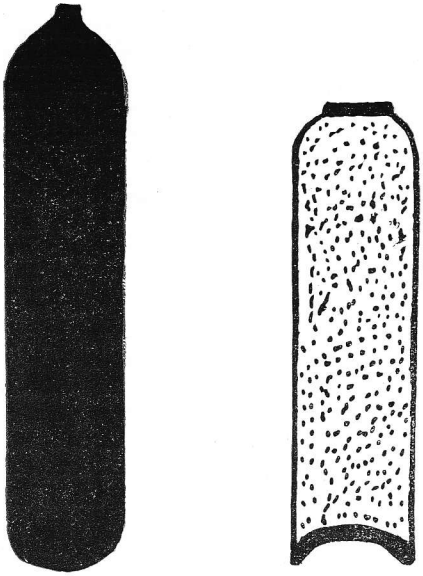


Fig. 3.—Cross-section view of cylinders.
left : oxygen right : acetylene.

1. It is essentially pure gas carbon having a carbon content of 93% and 7% of hydrogen and is completely consumed in the presence of oxygen leaving no residue.
2. Upon ignition it gives off heat so rapidly that the maximum flame temperature is produced almost instantaneously. It has a high calorific value approximately 1,650 B.T.U's. It is one of the few endothermic gases that is to say it gives off chemically stored up heat during combustion.

   These factors cause the oxy-acetylene flame to be the hottest produced by the combustion of any two gases i.e. 6,300°F.

Acetylene is colourless but has a peculiar odour when mixed with air. It has a very high explosive range commencing from as low as 2% acetylene and when mixed with oxygen the range is even greater. Therefore acetylene escaping into the atmosphere may spontaneously explode without ignition. Furthermore acetylene will explode if compressed to more than 15 lbs. per square inch so that when compressed into cylinders for transport special precautions are necessary. The cylinders are filled with a porous substance so as to ensure that the gas is present only in minute quantities in the pores. As a further precaution it is dissolved in liquid acetone. This enables acetylene to be compressed to a pressure of 15 atmospheres or 220 lbs per square inch and safely stored and handled. See Fig. 3, above.

In this Department, acetylene comes from three sources.

1. In depots and other locations where convenience and portability are the paramount consideration, it is used from high pressure cylinders.

2. At certain major workshops where there is a large concentrated demand, acetylene is generated by the water to carbide system and piped at low pressure to appropriate points, but :
3. At some workshops, high pressure acetylene (12 lbs/sq. in.) is supplied from a bank of cylinders by pipe-line to appropriate outlet points and provided with suitable safety valves and hydraulic check valves.

Acetylene cylinders are of weldless drawn steel and the cylinder valve is similar to that on an oxygen cylinder except that the connection to the regulator is left hand female. Cylinders used for containing dissolved acetylene are painted maroon.

When acetylene is drawn from a cylinder a reaction similar to the opening of a soft-drink bottle occurs. By removing the bottle-top the pressure is reduced and carbon dioxide gas bubbles are released. The same principle applies to acetylene cylinders. When the cylinder valve is opened the pressure falls and acetylene gas comes away from the liquid acetone in the cylinder. If the rate of flow becomes too great, the gas does not have time to separate from the liquid, and the acetone may be lost.

Acetylene cylinders therefore should never be left lying on their sides but should be stood in an upright position.

Reverting to the previous example, when a soft-drink bottle is shaken and the top lifted, the flow of gas from the bottle is excessive and liquid passes out with the gas. Acetylene cylinders therefore should not be agitated unduly. A fusible plug is fitted to acetylene cylinders, this plug, melting at 212°F (100°C) should never be interfered with.

REGULATORS.

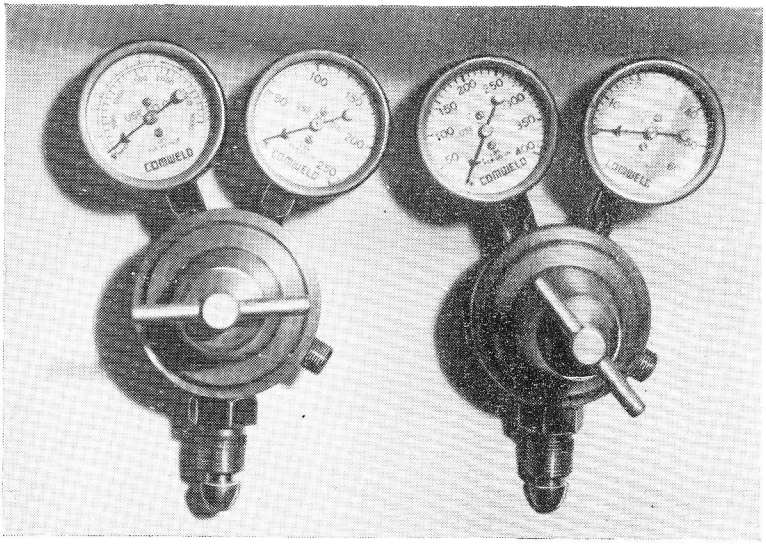


Fig. 4 (a)—Oxygen Regulator, right hand thread.

Fig. 4 (b)—Acetylene Regulator, left hand thread.

In the case of oxygen and where high pressure dissolved acetylene is used it is readily apparent that the gas must be delivered to the torches at appropriately reduced and constant pressures. This is achieved by applying to each cylinder a regulator each of which is equipped with two pressure gauges, one to inform the operator of the pressure of gas in the cylinder and one to show the reduced pressure at which the gas is being delivered through the rubber tubing to the operating torch. Essentially the regulators complete with gauges are the same both for oxygen and acetylene except that in the case of those intended for oxygen the connections to the cylinder are right hand male and are coloured black, whilst those for acetylene have the connections to the cylinder left hand male and are painted maroon. See Figs. 4 (a) and 4 (b), page 10.

RUBBER TUBE CONNECTIONS.

The flexible connections between regulators and torches are of rubber tubing specially made for this purpose and none other must be used. The inside of the tubing is dusted with french chalk and this must be blown out before using. The actual connection between the tubing and the regulator or torch nipples must only be made by the use of correct size of approved connector. No white lead, oil, grease, pipe fitting compound or any other substance whatever should be used to assist in making the joint. After the connection is made test for leaks with soapy water. The hose couplings to oxygen cylinders are marked with black and those for acetylene maroon and under no circumstances must they be interchanged.

Tubing at all times must be protected from molten slag and heat and never allowed to come in contact with oil or grease. It should be frequently examined for leaks, worn sections and loose connections.

TORCHES.

When using acetylene supplied in cylinders the acetylene is delivered from the regulator to the torch at working pressures of up to 15 lbs. per square inch but in the case of acetylene generated by the Department at some workshops the pressure is less than one pound per square inch i.e. low pressure generated acetylene.

It is necessary in the case of this low pressure acetylene that the torch incorporate an injector so that the inflow of oxygen induces a flow of acetylene into the mixing chamber but this is not required where high pressure acetylene only is used. These injectors should never be interfered with.

Comweld High Pressure Cutting Torch T.195 (See Fig. 5, page 12.)

This is the only cutting torch that may be used at locomotive depots. It is suitable only for high pressure dissolved acetylene. It is equipped with appropriate thumb screws to independently control the flow of both oxygen and acetylene and a lever to release the oxygen jet for cutting after preheating has been achieved. It is equipped with roller guides to assist the operator in controlling the cut but these are readily removable to give access to the torch in cramped positions. Interchangeable tips are provided to suit different thicknesses of material. To select the correct size of tip and the gas pressure refer to Table 1, page 24.

TYPICAL TORCHES.

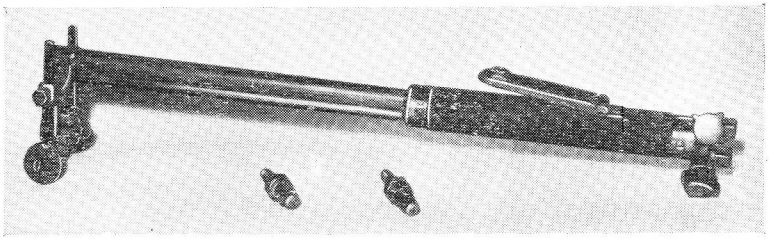


Fig. 5.

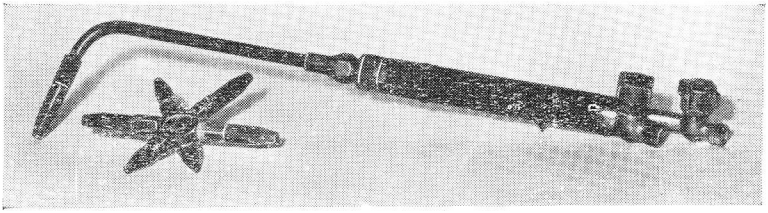


Fig. 6.

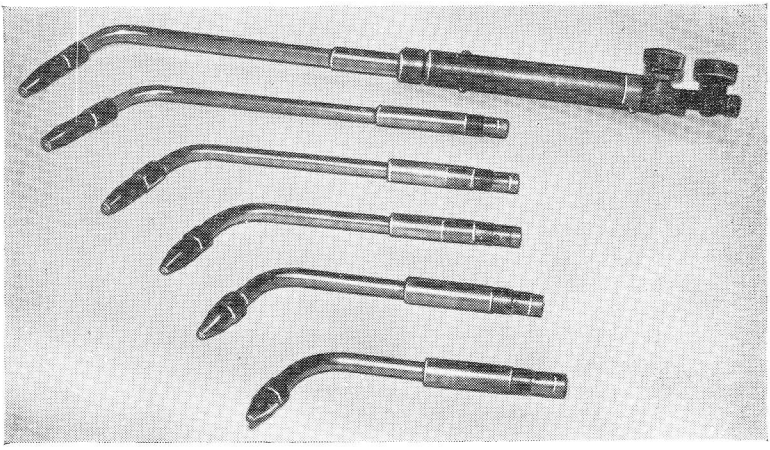


Fig. 7

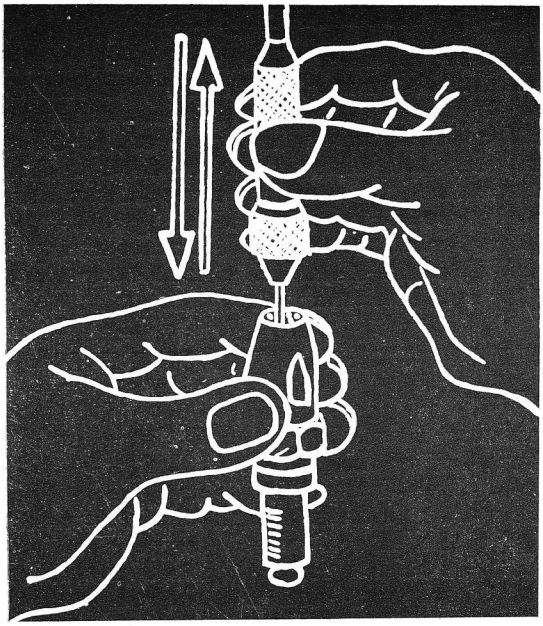


Fig. 8—Application of drill to cutting tip.

Comweld All Pressure Cutting Torch T.546 :

This torch is suitable when either high pressure dissolved acetylene or low pressure acetylene supplied from workshops generators is being used. The oxygen pressure delivered from the regulator to the torch should be adjusted to suit the thickness of cut being made in accordance with Table 1, page 24. When high pressure dissolved acetylene is being used the regulator should be set at 9 lbs/sq. in. for all plate thicknesses, but when low pressure generated acetylene is being used, the pressure should be not less than 6 inches of water. When using low pressure acetylene use low pressure cutting nozzles.

Comweld Equal Pressure Welding Torch T.171 (See Fig. 6, page 12.)

This torch is only suitable for use when high pressure dissolved acetylene is being used and great care should be taken to see that both the oxygen and acetylene pressures delivered from the regulators to the torch are equal at 9 lbs./sq. in.

Comweld All Pressure Welding Torch T.107 (See Fig. 7, page 12.)

This torch is suitable for both high and low pressure acetylene systems and its operation is the same in principle as that for the All Pressure Cutting Torch T.546.

CARE OF TORCHES.

It is essential that the orifices of the tips be kept clean and free from obstructions, and for this purpose, only soft copper wire of suitable size should be used. The size of these holes is critical and under no circumstances must odd pieces of wire or the like be used to clean them as this will cause them to lose their shape or increase in size. Another method is to insert a standard size drill to suit each size of tip as shown on Fig. 8, page 13. The sizes are laid down in Table 3, page 25.

No unauthorised person must meddle with or attempt any repair to defective torches whatever. These should be returned to the central authority for proper skilled attention.

PROCEDURE FOR SETTING UP EQUIPMENT.

Applying the Regulators :

Before connecting the regulators to cylinders either of acetylene or oxygen the cylinder valves should be opened slightly and quickly shut two or three times. This blows out any dirt or grit that has accumulated in or around the outlet and ensures that the valves are operating freely. The regulator spigot seatings should be inspected and then carefully connected to their respective cylinders by means of a spanner and a gas tight joint effected. Take care to see that this is done properly and that threads are not crossed. Open cylinder valve slowly with regulator tee screw free and note pressure on high pressure gauge. Close cylinder valve and if the pressure drops it is evident that there is a leak and further attention must be given before using the equipment. The gland nut of the valve should be examined and if necessary the packing gland tightened. Care is necessary however as if too tight the gland will cause the spindle to stick. If the leaks cannot be stopped, screw down the cylinder valve, disconnect the regulator and return the cylinder to the store with an explanatory tag attached. (See Figs. 4 (a) and 4 (b), page 10).

Blowing out the Regulators :

Having attached the regulator as above, see that the tee screw on the regulator is quite free and then slowly open the cylinder valve. (If opened suddenly, the inrush of gas, at high pressure, into the regulator may be attended with disastrous results.) Turn tee screw clockwise to allow gas to escape to atmosphere for a few seconds, then again turn the tee screw free whereupon the outlet of gas will cease.

Blowing out the Rubber Tubing :

It is essential that no grit or dust be allowed to enter the torch. Before being attached to their respective cylinders by the approved connection, the hoses should be blown through. After attachment a small amount of gas is blown through each hose. This gas should be directed away from any flame or inflammable material.

Attachment of Torch :

The torch should then be applied to the rubber tubing and secured with the approved connection. Care must be taken that the correct tubing from the oxygen regulator is applied to the oxygen inlet of the

torch marked O and that from the acetylene regulator to the acetylene inlet marked A.

The equipment is now ready for use.

CUTTING.

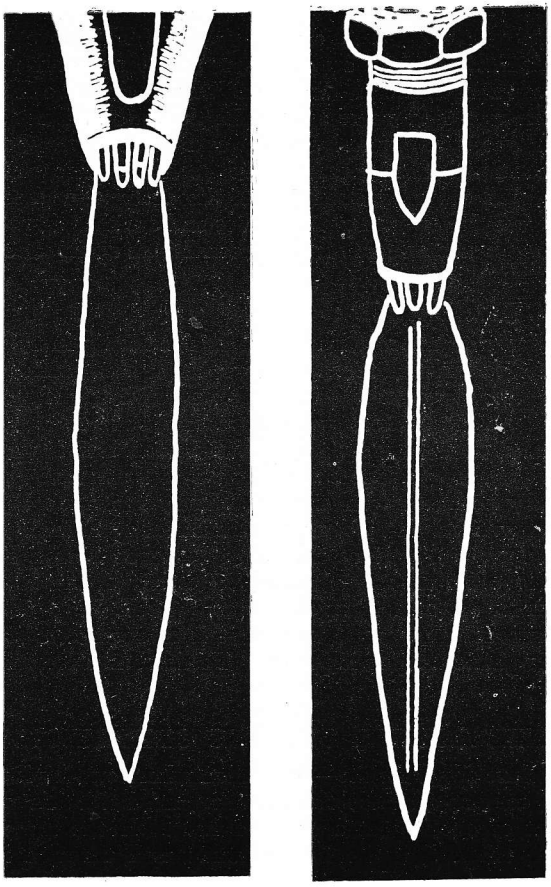


Fig. 9

Cutting with the oxy-acetylene flame is in general only practicable in the case of iron and steel (not including stainless steel). Cast Iron can only be cut with difficulty and then not very well.

Cutting consists of two distinct operations :—

1. The material must be preheated by a mixture of the two gases.
2. After sufficient heat has been attained, a jet of pure oxygen is impinged on the metal at the point of heating. This starts a chemical reaction and the metal is consumed and blown away as magnetic iron oxide (Fe3 04.)

The cutting torch therefore has a ring of heating flames surrounding a central opening through which comes the cutting jet of pure oxygen. The heating flames are intended only to heat the steel to a red heat immediately prior to starting the cut and then to provide supplementary heat during the cut. (See Fig. 9, page 15.)

LIGHTING THE TORCH FOR CUTTING.

High Pressure Torch (T.195) :

Having selected the correct size tip (see Table 1, page 24) adjust the regulator pressures of both oxygen and acetylene with the respective torch valves open separately. When adjusted, close both torch valves. Open the torch acetylene valve and ignite the gas. Adjust the acetylene gas until the flame is about to leave the end of the tip. Open the torch oxygen valve and the flame will resolve itself into two visible sections. Adjust the oxygen valve gradually until the inner cone becomes clearly defined. Operate the oxygen cutting lever and see that there is a free flow from the cutting orifice and under these conditions again check the heating flames.

All Pressure Torch (T.546) :

Set the oxygen to the required pressure for the tip in use by adjusting the regulator tee screw with torch valves open. When using low pressure generated acetylene, open the torch oxygen valve slightly and then the acetylene valve and ignite the gas. It is necessary to open the oxygen valve to ensure a flow of acetylene. If the acetylene is ignited without the oxygen valve being opened the flame may burn back and cause an explosion. Adjust the oxygen and acetylene valves to give the correct flame. Try oxygen cutting jet and recheck heating flames. When using dissolved acetylene, proceed as for High Pressure Torch shown above.

The cutting guide may now be fitted, if required, and adjusted to keep the tip the correct distance from the work (Table 1, page 24).

NOTE :—Never set the oxygen or acetylene regulators to a pressure higher than the particular job requires. To do so is wasteful and dangerous.

THE ACTUAL CUTTING OPERATION.

Apply torch to edge of plate—or portion where cutting is to commence—keeping tip correct distance from work, and hold this position until commencement of cut is just above red heat. If the material is thick, care should be taken that the heat extends well through its thickness. Then open the oxygen cutting valve fully and after making sure that the cut is penetrating right through the section being cut advance the torch in the direction of the cut. Cutting is easier to perform if the cut is so made that the torch is drawn toward the operator.

Hints on Cutting :

The figures for regulator pressures given in the table are correct for sizes of plates shown and if radically departed from good cutting is impossible.

Given reasonably clean material, good equipment and clean cutting tips of the correct size, the only other factor in good cutting is the speed of cutting which should be maintained as near as possible to that laid

down in the table for each thickness of plate. If these speeds are maintained, the cut will proceed at a speed just sufficient to allow combustion to take place clear through the section as the torch progresses. If the speed is excessive, the lower portion of the cut will lag behind until eventually the torch will cease to cut. If on the other hand, the speed is too slow the metal at each side of the cut will burn away. See chart, Fig. 10, pages 18 and 20, for typical faults.

When cutting out rivets with the oxy-acetylene torch, it is generally found advisable to use a No. 3 size tip with an oxygen pressure between 30–40 lbs/sq. in. and an acetylene pressure of 9–10 lbs.

It is essential that the plate, from which the rivet is being cut, be not damaged. Care should be taken to give a general heat to the whole rivet head until it glows to a cherry red colour and then to concentrate at one point on the periphery of the rivet head which should be further heated before the oxygen cutting jet is impinged on the work. The head should then be blown away in a regular sweeping motion taking care that the flame is directed parallel to the plate. The rivet should then be driven out with the aid of a punch and flogging hammer.

When cutting heavily scaled or rusted material, it is advisable to descale along the line of the cut particularly at the edge where it is desired to start the cut. This operation can often be assisted by quickly heating the surface with the torch and knocking the scale away.

Cast iron cannot be cut in the ordinary way with the oxy-acetylene torch because the process is interfered with by the presence of carbon in the form of graphite. The cutting action is therefore slower and must take place at temperatures approaching the melting point. The reaction when it starts is violent and greater precautions are necessary to protect the operator from erupting metal and reflected heat.

Generally speaking cast iron should not be cut with the oxy-acetylene flame but in the case of clearing of wreckage it may be sometimes necessary to do so. In these cases the heating flame should be set with a considerable excess of acetylene and the edge of the cut should be raised nearly to melting point in order to start the cut. The torch should be oscillated from side to side in semi-circles. The kerf or slot is therefore much wider and rougher than that made in iron or steel. Usually a larger size tip should be used than would be the case for mild steel.

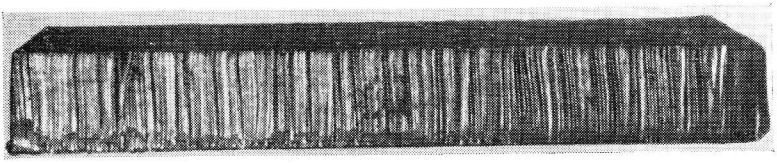
Shutting Down :

After completion of cut, shut off acetylene and oxygen valves on torch. If the torch will not again be used for any length of time, the cylinder valve should be closed down and the gear disconnected.

Re-commencing :

When starting work again at any subsequent time, the whole of the foregoing instructions are to be complied with. If the torch is connected to the regulators when they are fitted to cylinders, the respective gas valves on the torch must be opened to give free access to the atmosphere whilst the working pressures are being adjusted at the regulator tee screw as previously described.

Fig. 10



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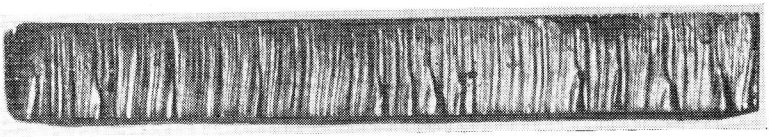

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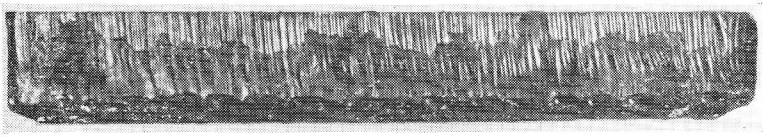

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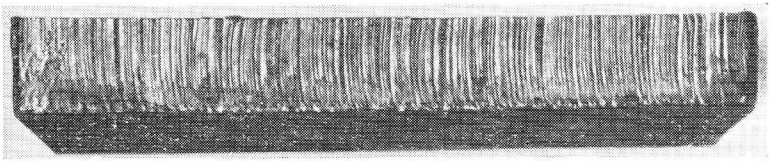

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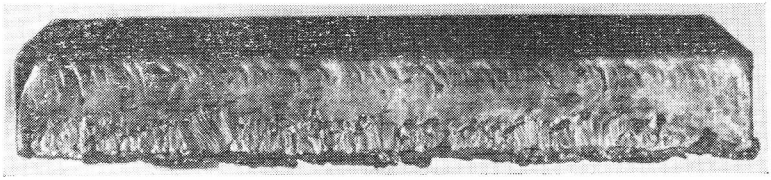

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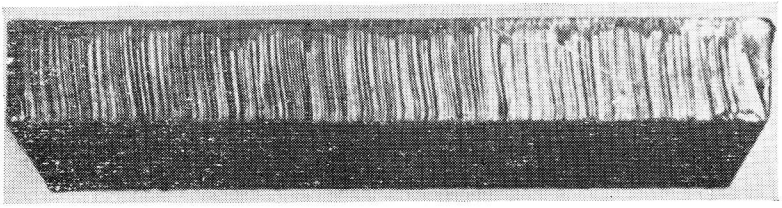

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1. Correct Procedure

Compare this correctly made cut in 1-in. plate with those shown below. The edge is square and the drag lines are vertical and not too pronounced.

2. Preheat Flames Too Small

Fault : preheat flames too small—only about $\frac{1}{8}$ in. long. Result : cutting speed was too slow, causing bad gouging effect at bottom.

3. Preheat Flames Too Long

Fault : preheat flames too long—about $\frac{1}{2}$ inch. Result : top surface has melted over, the cut edge is irregular, and there is too much adhering slag.

4. Oxygen Pressure Too Low

Fault : oxygen pressure too low. Result : top edge has melted over because of too slow cutting speed.

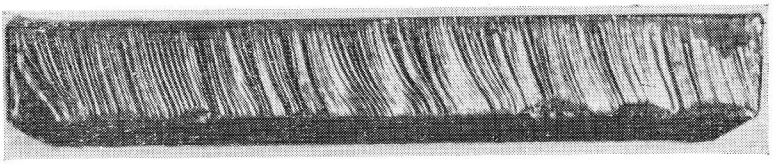
5. Oxygen Pressure Too High

Fault : oxygen pressure too high and nozzle size too small. Result : entire control of the cut has been lost.

6. Cutting Speed Too Slow

Fault : cutting speed too slow. Result : irregularities of drag lines are emphasized.

Fig. 10—continued.



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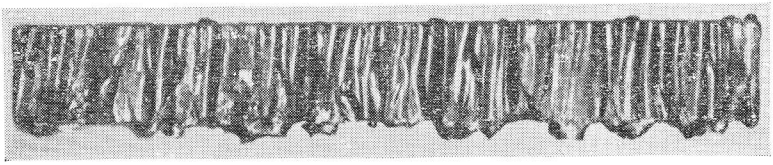

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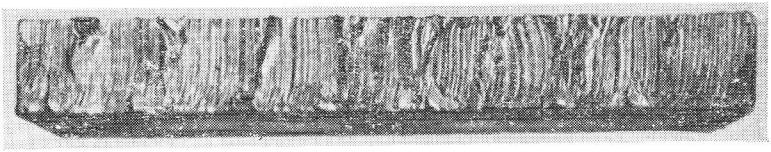

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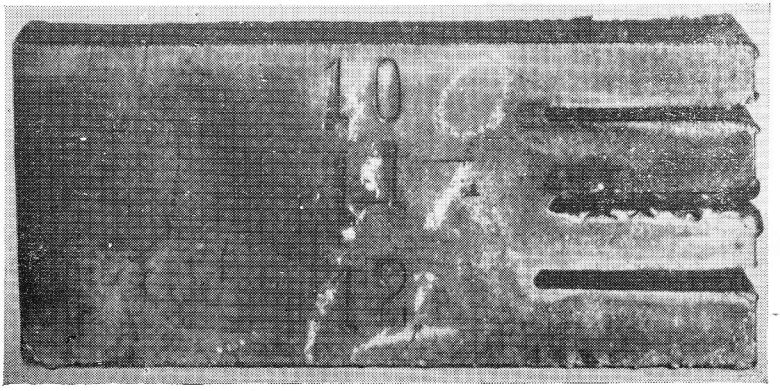

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7. **Cutting Speed Too High**

Fault : cutting speed too high. Result : there is a pronounced rake to the drag lines and the cut edge is irregular.

8. **Blowpipe Travel Unsteady**

Fault : blowpipe travel unsteady. Result : the cut edge is wavy and irregular.

9. **Lost Cut Not Properly Restarted**

Fault : cut lost and not carefully restarted. Result : bad gouges were caused where cut was restarted.

10. **Good Kerf**

Compare this view (from the top of the plate) of a good kerf with those below. This cut was made by using correct procedures.

11. **Too Much Preheat**

Fault : too much preheat and nozzle too close to plate. Result : bad melting over the top edge occurred.

12. **Too Little Preheat**

Fault : too little preheat and flames too far from plate. Result : heat spread has opened up kerf at top. Kerf is too wide and is tapered.

Precautions during Cutting Operations :

A bucket of water should always be within reach of the operator. If particles of material adhere to the tip it should be cleaned, as a back-fire is likely to occur through this cause. If the operator allows the tip to touch the surface of the plate, a back-fire will also occur. In the event of a back-fire, at once close the oxygen valve on torch, then the acetylene valve, and plunge the torch in a bucket of cold water.

WELDING

When pure oxygen and acetylene are mixed and ignited a remarkable flame is produced. The luminous cone has a temperature of 6300°F. but combustion is not complete and this gives rise to an envelope of surrounding flame the temperature of which varies from 3800°F. to 2300°F. at the tip. This envelope is entirely of non-oxidizing gases which surround the weld metal and prevent it absorbing oxygen and nitrogen from the air. It will be readily understood that proper control of the gases through the torch to the flame is essential and that the torch must be in good condition and the tip orifices clean.

TO LIGHT THE TORCH FOR WELDING.

1. Select tip according to thickness of metal (Table 2, page 24).
2. Set the oxygen and acetylene cylinder regulators at the appropriate pressures (See Table 2, page 24) with respective torch valves open.
   (a) When using Equal Pressure Torch T.171 or All Pressure Torch T.107 with high pressure dissolved acetylene, open the acetylene valve on the torch, light up and adjust valve until the flame attaches itself to the end of the tip. It is important that this be done before the oxygen valve is opened.
   (b) When using All Pressure Torch T.107 and low pressure acetylene open the torch oxygen valve first to ensure a flow of acetylene.
3. Gradually open the oxygen valve until a well defined white cone appears at the orifice of the tip. This varies in length from $\frac{1}{4}$" to $\frac{3}{4}$" according to the size of tip being used. Great care should be taken that the flame is truly neutral that is to say that it has neither an excess of oxygen nor of acetylene.

Excess oxygen causes the whole flame to shorten and the inner cone to become less luminous. It causes excessive foaming and sparking of the metal. If in doubt readjust flame.

Excess acetylene can be recognised by a light coloured halo round the inner cone, which is bearded by a green flame, the flame envelope is streaky in appearance. It tends to make a sooty deposit round the weld area and the metal boils and is not clear.

Instructions during Welding :

Keep a bucket of water at hand in case of emergency and to cool the torch should it become overheated. The hole in the tip should be kept clear but a soft copper wire is all that should be used to clear it. The end of the tip should be kept clean by fine emery cloth lightly applied (See

Fig. 11, page 23). Occasionally during welding, the flame should be checked by further opening the acetylene valve on the torch and then closing it until the halo round the inner cone of flame just disappears. Closing it beyond this point gives an oxidising flame.

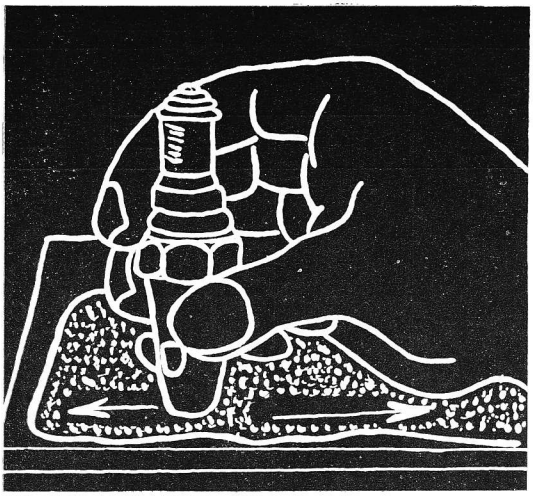

Fig. 11.—Dressing Cutting Tip.

BACK-FIRE.

Back-fires are caused by touching the tip against the work, overheating of the tip or operating at other than the correct gas pressures. When a back-fire occurs, the oxygen valve on the torch should be closed immediately and the torch may then be relit and the flame again adjusted. Back-fires are sometimes caused by a loose tip or dirt under the seat. When this is the cause, the fault should be rectified before relighting the torch.

FLASH-BACKS.

Flash-backs are more serious than back-fires and may be distinguished from back-fires by the fact that the flame flashes right back into the torch and burns therein and perhaps may run right back into the rubber tubing. Flash-backs are due to gross maladjustment of pressure, extremely bad manipulation of the torch or by defects in the welding or cutting equipment.

As soon as a flash-back occurs, close both the acetylene and oxygen valves on the torch or if the flash has gone beyond the torch close both the acetylene and oxygen cylinder valves. Always close the acetylene valve first. If there has been burning in the rubber tubing it should be discarded. Should a flash-back again occur, there is something radically wrong with the equipment and it should be sent forward to the Repair Authority for attention.

HAND FLAME CUTTING AND STEEL WELDING PRESSURE CHARTS.

TABLE 1.

Hand Flame Cutting Table.

High Pressure Torch T.195 or All Pressure Torch T.546.

Steel Thickness in Ins.	Cutting Tip No.	Regulator Pressures Lbs. per Sq. In.		Speed of Cutting (Approx.) Lin. Ft. per Hr.
		Oxygen	Acetylene	
$\frac{1}{8}$	1	10		100—130
$\frac{1}{4}$	1	20		90—125
$\frac{3}{8}$	2	25		80—120
$\frac{1}{2}$	2	25	Medium	70—110
$\frac{3}{4}$	2	25	Pressure 9 lbs	60—100
1	2	25	and Low	50— 90
$1\frac{1}{2}$	3	35	Pressure not	45— 80
2	3	45	less than 6 in.	40— 60
3	3	55	for all tip	25— 50
4	4	50	sizes.	20— 40
5	4	60		17— 30
6	5	60		15— 25

The lower speeds will be found easier for inexperienced operators and more suitable for short cuts or on dirty steel.

TABLE 2.

Steel Welding Table.

Material Thickness In Ins.	Tip No.	Regulator Pressures. Lbs. per Sq. In.			
		Equal Pressure Torch T.171		All Pressure Torch T.107	
		Oxygen	Acetylene	Oxygen	Acetylene
$\frac{1}{16}$	1	15	15	10	Medium
$\frac{1}{8}$	2	15	15	15	Pressure
	3	15	15	20	9 lbs. and
$\frac{3}{16}$	4	15	15	25	Low Pressure
	5	15	15	25	not less
$\frac{1}{4}$	6	15	15	25	than 6 in.
$\frac{5}{16}$	6	15	15	25	for all
	7	15	15	35	tip sizes.
$\frac{3}{8}$	7	15	15	35	

Equal Pressure Torch: Oxygen and Acetylene pressures must be kept exactly equal. 15 lbs. per sq. in. of each gas is a most suitable pressure, although a minimum equal pressure of 9 lbs. per sq. in. of each gas will satisfactorily operate this torch up to a No. 7 size tip.

TABLE 3.

Tip Sizes Related to Drill Numbers.

Tip Size	Drill Size
No. 1 cutting tip, heating hole	No. 73
No. 1 „ „ cutting hole	No. 67
No. 2 „ „ heating hole	No. 70
No. 2 „ „ cutting hole	No. 57
No. 3 „ „ heating hole	No. 66
No. 3 „ „ cutting hole	No. 53
No. 1 welding tip	No. 70
No. 2 „ „	No. 61
No. 3 „ „	No. 56
No. 4 „ „	No. 53
No. 5 „ „	No. 51
No. 6 „ „	No. 45
No. 7 „ „	No. 38

RETICULATED OXYGEN AND ACETYLENE.

In Workshops where the demand on gasses is great enough (notably the Newport Workshops) oxygen may be supplied in the liquid form and be piped to the operating points through an evaporator as gas at pressures of 120 to 150 lbs. per sq. inch. The operator then connects his oxygen regulator to the take off points and adjusts his pressure to suit the torch and work involved as laid down in pressure charts, Tables 1 and 2, page 24.

Similarly, acetylene may be delivered to the operation points by pipe-line from a bank of cylinders connected together by a manifold. In this case the line pressure is set at 10–12 lbs. per sq. inch and the operator merely attaches his tubing or hose to the outlet point without the use of an acetylene regulator.

The operation and management of the torches in connection with reticulated oxygen and acetylene is exactly the same as when the gasses are drawn direct from cylinders.

SAFETY IS A GOCD HABIT—
CULTIVATE IT.