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Mechanize Vehicle for Oxyacetylene Cutting

B.Sc. Project

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CHAPTER [1] INTRODUCTION

1.1 OXYGEN AND ACETYLENE

This chapter will deal with the two gases which, burned together, produce the oxy-acetylene flame. It will cover their properties, their production, their commercial distribution, the containers in which they are stored and distributed, and the precautions which should be observed when using the gases or handling and storing the containers. Oxygen, which makes up about 21 percent of the air we normally breathe, as well as about 90 percent by weight of all the water on earth, may be considered the most important element in the universe. Without it, there would be no life as we know it. Every living animal”burns” oxygen with carbon and hydrogen to produce the energy that it needs in order to live, grow, and move. Fortunately for the animal kingdom, all green plants produce more oxygen than they consume, so that the reservoir of oxygen in our atmosphere remains at a constant level from century to century. Oxygen not only combines with carbon and hydrogen to produce energy (heat), but combines with most of the other elements found in the universe, including all metals. Fortunately, its reaction with most elements and compounds takes place very slowly or not at all at normal temperatures. However, almost everything made up predominantly of carbon and hydrogen (coal, wood, petroleum products) has a”kindling temperature”. Once that temperature is reached, ”oxidation” suddenly becomes ”burning”, which then proceeds to produce enough heat to maintain the reaction until the supply of oxygen or fuel runs out, or until other influences produce enough cooling effect to quench the fire. It’s perhaps fortunate we have only 21 percent oxygen in our atmosphere, and that 78 percent is made up of nitrogen, which won’t combine with oxygen at any temperature normally reached by the burning of other materials. We don’t often think of it in that way, but the nitrogen acts as a cooling agent. A good part of the energy produced by the burning of carbon and hydrogen in air is used up in heating the nitrogen. In an atmosphere of 100 percent oxygen, burning takes place at a greatly accelerated rate. Given such an atmosphere, a wooden house that caught fire would probably burn flat in a matter of minutes, rather than hours. If there’s one thing you must remember about oxygen, it’s that things burn much faster in pure oxygen (or even in a mixture of half oxygen, half nitrogen) than they do in air. That’s why passing a lighted cigarette to a person in an oxygen tent is almost equivalent to signing his death warrant. The other thing you must remember is this: that when surrounded by pure oxygen, some oils and greases oxidize rapidly, fast enough to reach kindling temperature in a short time. That’s why you must always keep oxygen away from oils and grease, and keep oil and grease from getting into an oxygen regulator or hose. The only lubricants which can be used with oxy-acetylene apparatus – and then only on threads and O-rings – are special products approved for such use. Acetylene is a ”hydrocarbon”, just as are propane, methane, and virtually all the components which make up gasoline and fuel oils. However, it differs from those hydrocarbons in this respect: in the acetylene molecule, made up of two carbon atoms and two hydrogen atoms, the carbon atoms are joined by what chemists call a ”triple bond”. When acetylene reaches its kindling temperature (and under some other conditions as well, which we’ll cover shortly) the bond breaks and releases energy. In other hydrocarbons, the breaking of the bonds between the carbon atoms absorbs energy. The triple bond is the reason why the oxy-acetylene flame is hotter than the flame produced by burning any other hydrocarbon gas with oxygen. Acetylene is almost unknown in the natural world. There are ways to produce acetylene from natural gas, but they are economical only on a large scale. Virtually all the acetylene distributed for welding and cutting use is created by allowing calcium carbide, an electric furnace product, to react with water. As mentioned in Chapter 2, the discovery of the electric furnace method of producing calcium carbide was accidental. It turned out to be a lucky accident. The nice thing about the calcium carbide method of producing acetylene is that it can be done on almost any scale desired. In tightly-sealed cans, calcium carbide keeps indefinitely. For years, miners' lamps produced acetylene by adding water, a drop at a time, to lumps of carbide. Before acetylene in cylinders became available in almost every community of appreciable size, as it is today, many users of acetylene produced their own gas from calcium carbide, using acetylene generators which ranged in output from as little as 20 to as much as 1000 cubic feet per hour.

The triple bond which makes the oxy-acetylene flame the hottest of all gas flames is also responsible for two rather exceptional properties of acetylene gas which you should always remember. The first is this: that free gaseous acetylene, depending on confinement conditions, is potentially unstable at pressures above 15 psig (103kPa). If subject to severe shock, or a source of ignition, some of the triple bonds may break, releasing enough energy to cause all the other molecules in the enclosed volume to decompose into carbon and hydrogen with explosive force. The force of such an explosion is not so great as that released by the explosion of most mixtures of acetylene and oxygen, or acetylene and air, but it is substantial, and can be withstood only by extra-heavy-wall steel tubing. The maximum free acetylene pressure permitted by safety codes is 15 psig. All oxy-acetylene equipment is designed and manufactured to permit the use of acetylene at less than 15 psig. How it is possible to ship acetylene in cylinders at a pressure of 250 psi (1725 kPa) or more is something we'll get to a bit later in this chapter. The other property of acetylene which you must remember is this: that the flammability range of mixtures of air and acetylene is broader than that of any other fuel gas/air mixture. Let’s explain that more fully: Acetylene/air mixtures can be ignited when they contain anywhere from 2.5 percent acetylene to 80 percent acetylene. Mixtures of methane (the principal component of natural gas) and air are flammable when they contain as little as 5 percent methane and not more than 15 percent methane. The hazards resulting from acetylene leaks are therefore somewhat greater than the hazards involved in leaks of other fuel gases. Any leak in a fuel gas system is a hazard; acetylene is noticeably more hazardous than other gases only at the upper end of the flammability range. Except in an acetylene generator, the chances of creating a mixture which contains more acetylene than air are relatively small. Treat ALL fuel gases with respect and you’ll have no trouble. (In passing, we should note that flammability range is sometimes called explosive range. There’s really no difference.)

1.1.1 Oxygen Production

Virtually all the oxygen used commercially today is obtained from the atmosphere by air separation, or what is frequently termed the”liquid air” process. (It is also possible, but more expensive, to obtain oxygen by electrolysis – that is, by passing an electric current through water.) If you compress air, remove the heat created by the act of compression, and then cool it some more, you can liquefy it. (This is true of any gas, just as any liquid can be turned into a gas by heating it sufficiently.) The principal components of the resulting liquid air – liquid oxygen, liquid nitrogen, and liquid argon – all have different boiling points. That means that if you reduce the pressure, or put heat back into the mixture, the nitrogen will return to the gas state at a faster rate than the oxygen. Although the temperatures involved are much lower, the problem is basically the same as that involved in obtaining pure alcohol from a fermented mixture that contains no more than 9-10 percent alcohol. In each case, a rectification column is used. In the case of an alcohol-water mixture, the primary aim of the process is to recover, in as pure a state as possible, the lower-boiling- point component, alcohol, at the top of the column. During the first part of this century, the designers of liquid air columns were interested only in recovering the high-boiling-point component, oxygen, from the bottom of the column. Today, there are so many uses for pure nitrogen, either in gas or liquid for m, that almost all modern ”liquid-air” plants are designed to produce both high-purity oxygen and high-purity nitrogen. This normally requires a two-stage process: The liquid air is first partially rectified in one column. A nitrogen-rich liquid mixture form the top of this column, and an oxygen- rich liquid mixture from the bottom, are then passed on to a second column, operating at a lower pressure, where the final rectification takes place. A few words about the nature of a rectification column may be in order. Such a column houses a series of trays with slots or other perforations, each of which retains some liquid at all times, and is designed so that gas entering the tray from below must pass through that liquid. In an oxygen-plant column, the gas rising from each tray is slightly richer in nitrogen than the gas which entered the tray from below; the liquid which overflows from each tray is slightly richer in oxygen than the liquid which descended to that tray from the one above it.

Fig. 1-1 A major oxygen plant, from which both liquid oxygen and liquid nitrogen are shipped by tank trailers to use points and cylinder filling stations which may be hundreds of miles away.

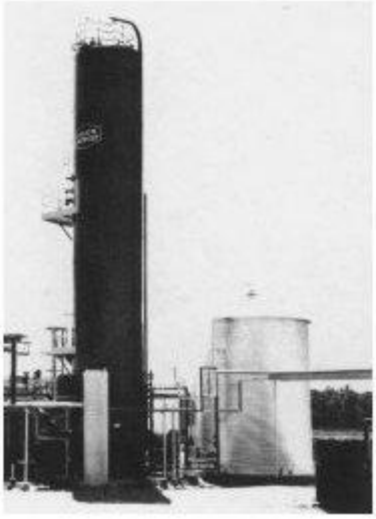


Fig. 1-2 A rather small on-site plant, showing rectification column and (right) back-up liquid storage tank.

1.1.2 EQUIPMENT FOR THE OXY-ACETYLENE PROCESS

As we said in the preceding chapter, the real ”tool” of the oxy-acetylene welding process is the flame, not the torch. When we come to oxygen cutting, we must consider the pure oxygen jet as a second ”tool”, working hand-in-hand with the flame. To produce only the flame, we use a welding torch, fitted with the appropriate size welding head or tip.* To produce both flames and the oxygen jet, we use a cutting torch or cutting attachment, equipped with the appropriate cutting nozzle or tip.* The equipment needed for oxy-acetylene welding and oxygen cutting is relatively simple and inexpensive. If the gases are to be supplied in cylinders, these are the minimum requirements: A cylinder of oxygen A cutting attachment, with one or more cutting nozzles A cylinder of acetylene A length of oxygen hose, with fittings A cylinder pressure regulator for oxygen A length of acetylene hose, with fittings A cylinder pressure regulator for acetylene Goggles and gloves for the operator A welding torch, with one or more welding heads A friction lighter for igniting the flame Mount the cylinders on a suitable truck, as shown in Fig1-3, and you have an outfit that will go almost anywhere and need no further power of any kind except a bit of muscle power.

Fig. 1-3 A portable welding outfit, with oxygen and acetylene cylinders chained to an easy-rolling cylinder truck. Cutting attachment, normally a part of such an outfit, is not shown

1.2 The Cutting Torch

The cutting torch must not only meter and mix oxygen and fuel gas to feed the flames required for oxygen cutting, but must also control the stream of oxygen required for the cutting jet. In almost all torches designed for hand cutting, all the oxygen is fed to the torch through one oxygen hose. Just inside the torch body, the stream of oxygen is split, with one part passing through the valve which provides ”on-off” control of the cutting oxygen jet, the other part passing through the throttle valve which controls oxygen flow to the mixer. Cutting torches for use in cutting machines usually are fitted with two oxygen inlet connections, with oxygen supplied through separate regulators. As in the case of welding torches, cutting torches are offered with two types of mixers: the injector type, and the medium-pressure type. The medium-pressure type is by far the more common. An injector is generally used in torches designed to operate with natural gas as the fuel, since natural gas piping systems are often operated at pressures of 5 psi or less. A few acetylene piping systems are still operated at low pressure (less than 1 psi) and require use of injector-type torches. In most cutting torches, a single mixer is used to cover the full range of nozzle sizes. This is feasible because the mixed-gas requirements for cutting steel 8 in. thick are only about four times the mixed-gas requirements for cutting 1/2 in. steel, while even a light-duty welding torch uses a range of tips whose requirements vary much more widely, as noted under ”Welding Torches”. Every hand cutting torch has some kind of a lever for opening and closing the cutting oxygen valve. Designers try to locate the lever so that it can be squeezed or pressed slowly to start the cut, and then easily held wide open while the cut is in progress. Latches for locking the lever in ”wide open” position are provided on some torches

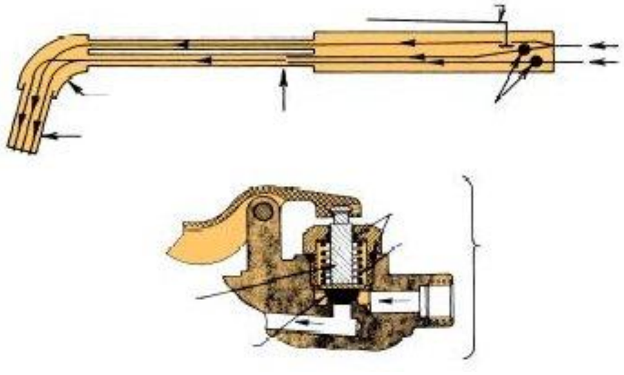


Fig. 1-4 Simplified sketch of a typical cutting torch, in which the preheat oxygen and acetylene are mixed at a point between torch head and handle. Detail shows construction of a cutting oxygen valve

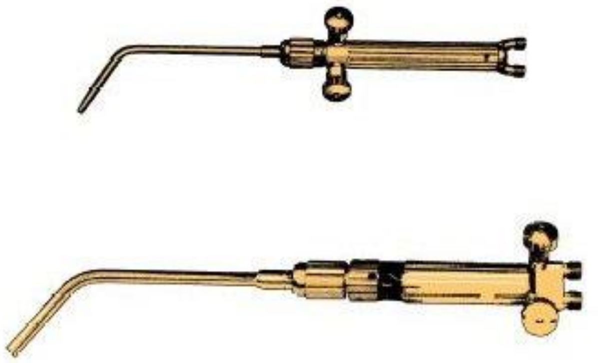


Fig. 1-5 Welding torches of this general design are by far the most widely used. They will handle any oxy- acetylene welding job, can be fitted with multiflame heads for heating applications, and accommodate cutting attachments that will cut steel 6 in. thick. Fig 1-5. Cutting attachment for use on the welding torch shown immediately above.

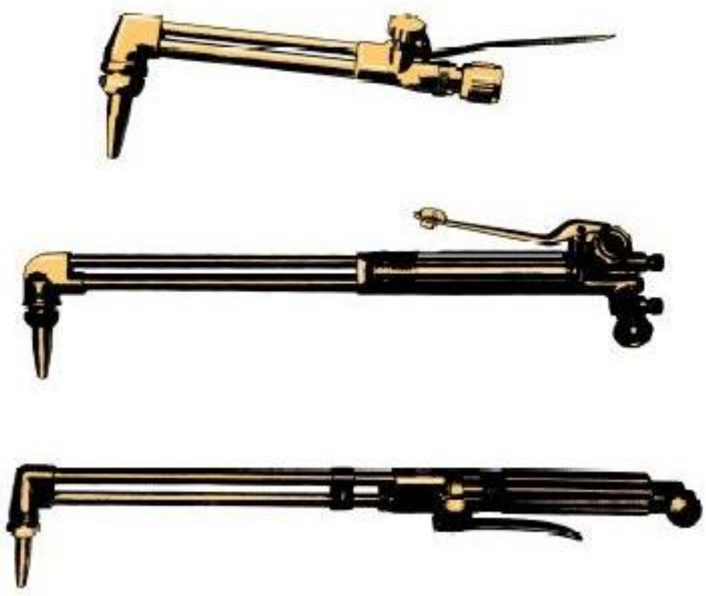


Fig. 1-6 A full-size oxygen cutting torch which has all valves located in its rear body. Fig. 1-7. Another style of cutting torch, with oxygen valves located at the front end of its handle.

1.3 Cutting Attachments

A cutting attachment is a scaled-down version of a cutting torch, for direct connection to a welding torch handle in place of a welding head. It’s a real convenience to the operator who wants to be able to switch back and forth from welding or heating to cutting, or vice versa. It takes only seconds to remove a welding head and install the cutting attachment, whereas it may take a couple of minutes to disconnect hoses from the welding torch handle and reconnect them to a full-sized cutting torch. Most cutting at attachments are capable of cutting 2-in. steel, or thicker, with ease. A cutting attachment does not need its own throttle valve for controlling acetylene flow, since the valve on the welding torch handle serves that purpose. It always has two valves for oxygen, however: a throttle valve to control flow of oxygen to the mixer, and a lever-operated valve to control the flow of cutting oxygen.

1.3.1 Regulators

The pressure in a full cylinder of oxygen is about 2200 psi at 70^0F (15200 kPa at 20^0C); in a full cylinder of acetylene, pressure is about 250 psi at 70^0F (1725 kPa at 20^0C). Oxygen must be supplied to welding and cutting torches at pressures ranging downward from about 100 psi to 5 psi (69 to 35 kPa) and acetylene at pressure of 15 psi (103 kPa) or less. To reduce cylinder pressures to desired working pressures, we use adjustable pressure- reducing regulators. They are designed so that they will maintain a steady working pressure as cylinder pressure drops. Fig. 1-9 presents the basic elements of a typical regulator. The high-pressure gas passes through a valve which is actuated by a flexible diaphragm. On one side of the diaphragm there is gas at the pressure to which it has been reduced by passing through the valve. On the other side, there is a spring. The loading on the spring can be varied by means of the pressure-adjusting screw. When demand for gas reduces the force applied by the gas against the diaphragm until it is less than the force applied by the spring, the diaphragm moves left and the valve opens wider. When gas pressure against the diaphragm increases, due to a decrease in demand, or the closing of a torch valve, the diaphragm moves to the right, and the valve opening is reduced, or the valve closes completely.

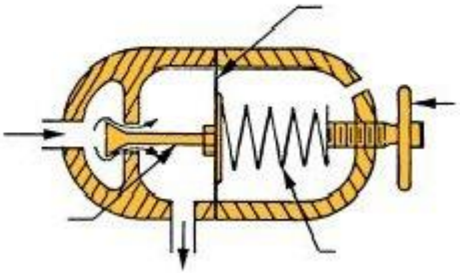


Fig. 1-7 Simplified sketch of a one-stage gas pressure regulator. FLEXIBLE DIAPHRAGM PRESSURE ADJUSTING SCREW PRESSURE ADJUSTING SPRING GAS OUT VALVE STEM (ATTACHED TO DIAPHRAGM) GAS IN

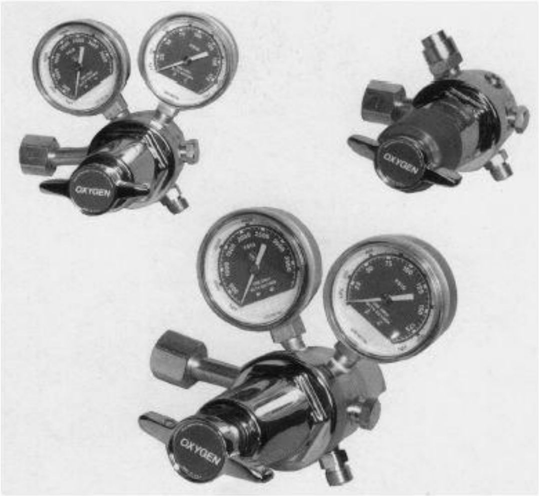


Fig. 1-8 Three regulators for use on oxygen cylinders: one-stage with gauges (upper left), gaugeless (upper right) and two-stage (lower).

To make a regulator that works well, and is truly useful for welding or cutting, we must add a few refinements to the basic design. Fig. 1-9 is a literal cross-sectional view of a type of regulator that has proved itself in service for nearly 50 years. All the parts are named. A valve spring on the high-pressure side of the diaphragm, and a valve stem guide which slides in the valve seat clamping screw, smooth out the movement of the valve stem so that the regulator won’t ”chatter” (due to rapid opening and closing of the valve). There’s a pressure gauge which shows how much pressure there is in the cylinder, and another (not shown) which registers the pressure of the gas on the delivery side of the regulator. The inlet nipple which makes up to the cylinder valve contains a porous-metal filter to remove particles or dirt which might otherwise enter the regulator and be harmful. Every regulator contains such a filter, and it is most important that the filter always be in place. Should it become clogged, do not merely remove it. Lack of a filter can lead to trouble. Always REPLACE it with a clean filter.

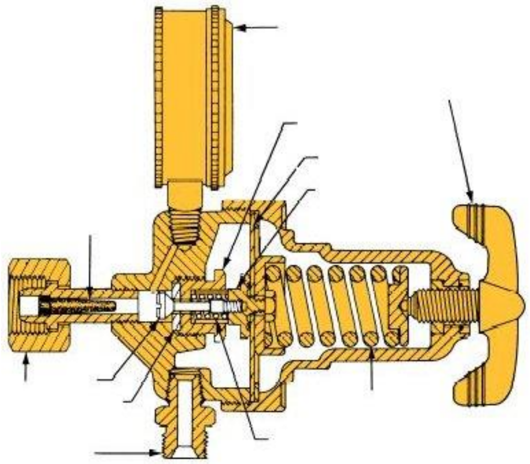


Fig. 1-9 Cross-section of a single-stage stem-type regulator. This basic design has been serving industry for a half-century

1.3.1.1 Two-Stage Regulators

It is impossible to build a one-stage regulator which will, without any readjustment of the pressure-adjusting screw, maintain absolutely constant delivery pressure as the gas in a cylinder is used up and the cylinder pressure falls. Why? Because the inlet pressure itself, acting against the valve parts, is a variable force. Depending upon the valve design, the delivery pressure may rise, or may fall, as the cylinder pressure decreases. In many types of operations, that rise or fall is not enough to be troublesome. It can be eliminated entirely by using a two-stage regulator. In such a regulator, the first stage reduces cylinder pressure to a fixed intermediate pressure (usually about 350 psi in an oxygen regulator) and the adjustable second stage reduces that intermediate pressure to the final working pressure. While the intermediate pressure may change as much as 20 psi as the cylinder pressure drops, that change in pressure supplied to the second stage is not enough to cause a measurable change in delivery pressure. After cylinder pressure has dropped below the level of the first-stage pressure setting, the first- stage valve remains open and the regulator acts like a single-stage regulator. The big advantage of the two-stage regulator is this: the materials used in each stage can be selected for their serviceability over a much narrower range of working conditions. For example, the second-stage valve seat can be a resilient material which seals much more readily than the harder materials which must be used to hold full oxygen cylinder pressure. (Full cylinder pressure will force its way right past any rubber seat.) The net result is this: Two- stage regulators will generally stand up better in heavy-duty, constant service, and require less maintenance than single-stage regulators.

Regulator Pressure Gauges The pressure gauges used on regulators are almost always of the”Bourdon-tube” type. Gas is admitted to a closed-end, bent tube made of phosphor bronze alloy. Internal pressure tends to straighten that tube. The end of the tube is connected to a curved rack which rotates a shaft upon which the gauge pin is mounted. Treated right, Bourdon tubes are tough, and will maintain their original properties for years. What do we mean by ”treated right”? The big thing is this: Avoid subjecting them to a rush of gas pressure which will make the tube jump from its static position to its fully-stretched position in ”nothing flat”. Always open cylinder valves slowly. Before opening a cylinder valve, always be sure that the pressure-adjusting screw on the regulator has been backed off so that there is no spring pressure against the regulator diaphragm and the regulator valve is therefore closed. By opening the cylinder valve slowly, you protect the cylinder pressure gauge. By making sure that the regulator valve is closed, you protect the delivery-pressure gauge against the sudden rush of pressure through an open valve. There’s another very good reason for opening cylinder valves, especially on full oxygen cylinders, as slowly as possible. The gas which is ”dead-ended” in the Bourdon tube is recompressed and heats up significantly if there is a sudden jump in pressure. This doesn’t do the tube any good, although it will not, in itself, cause the tube to rupture. However, if there has been any accumulation of combustible particles in the tube – and it is chiefly to prevent such particles from getting into the tube that it’s so essential to keep a filter in the regulator inlet – the heat may start a reaction between oxygen and those particles. And then you have a regulator ”burn-out”, which will at least ruin the regulator, and perhaps do even more damage or cause personal injury. Don’t think that oxygen regulator ”burnouts” are an everyday occurrence. They are not. There are hundreds of thousands of oxygen regulators in use on cylinders in the U.S., and only a few burn out every year. But evidence accumulated over the years shows that most of the burnouts have occurred in regulators from which the inlet filter was missing. While filters are necessary in all uses and all environments, clean filters are especially important in auto body shops, garages, foundries, coal mines and other environments where metal and hydrocarbon particles may be present. If you always check to make sure that the regulator has a filter (it is often mounted in the inlet nipple so that you can see it), and ”take it easy” when you open the oxygen cylinder valve, you should never experience a burnout.

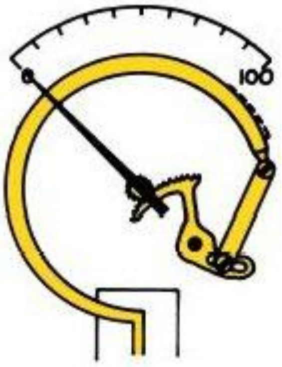


Fig. 1-10 A Bourdon tube gauge movement. Pressure in the semi- circular closed-end tube causes the free end of the tube to move (dashed line). This movement is transmitted through a fixed pivot point (black dot) to a curved rack which engages a pinion gear on the pointer shaft.

1.3.1.2 Gaugeless Regulators

In some locations, regulator gauges may be subject to frequent mechanical damage from external forces. Therefore, some people prefer ”gaugeless” regulators. In such regulators, cylinder pressure is roughly measured by a spring-loaded ”pop-up” indicator. When the cylinder is full, this indicator is fully extended; when pressure drops to the point where it’s about time to change cylinders, the pop-up indicator has retracted to the point where the color on its shaft (usually red) is no longer visible. A sliding indicator in the regulator front cap shows the setting of the regulator pressure-adjusting screw. Since delivery pressure is a function of that setting, the approximate pressure can be read on a scale mounted alongside the pointer

1.4 Oxy-fuel cutting

Oxy-fuel cutting uses a flammable gas, generally acetylene or propane. Burning the gas in oxygen, rather than just air, produces a flame with a high temperature. The flame first preheats the workpiece: when a sufficiently high temperature has been reached, a jet of oxygen produces the cut by actually burning the metal. This produces a metal oxide in the form of liquid slag, which is blown out of the joint by the jet of gas.

The flame also helps to maintain the upper surface of the plate above the ignition temperature of the metal while cutting is in progress, although most of the necessary heat required for the cutting comes from combustion of the actual material being cut. For example, when cutting 25 mm steel, about 85 % of the heat comes from combustion of the iron. In thinner materials, however, a greater proportion of the heat is applied by the flame.

1.5 Equipment for Oxyacetylene Welding

1.5.1 Torch

The torch is the part that the welder holds and manipulates to make the weld. It has a connection and valve for the fuel gas and a connection and valve for the oxygen, a handle for the welder to grasp, a mixing chamber (set at an angle) where the fuel gas and oxygen mix, with a tip where the flame forms.

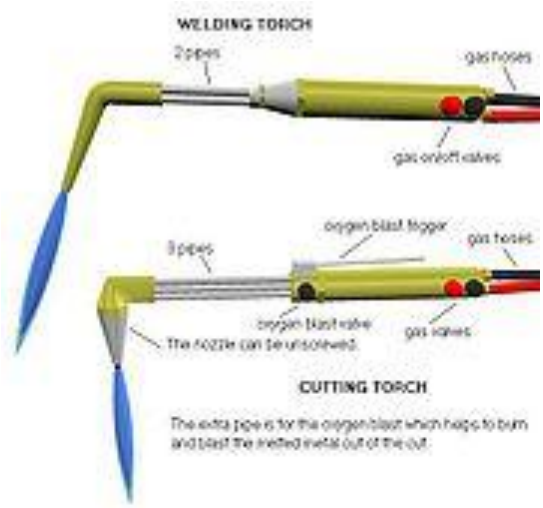


Fig. 1-11 Welding and cutting torches

1.5.1.1 Welding torch

A welding torch head is used to weld metals. It can be identified by having only one or two pipes running to the nozzle and no oxygen-blast trigger and two valve knobs at the bottom of the handle letting the operator adjust the oxygen flow and fuel flow.

1.5.1.2 Cutting torch

A cutting torch head is used to cut metal. It is similar to a welding torch. Oxygen is combined with the acetylene in the torch, which produces a high temperature flame. It can be identified by having three pipes that go to a 90 degree nozzle and by the oxygen-blast trigger.

The metal, (only iron and steel can be cut with this method) is heated until it is cherry red, once this temperature is attained, gently at first oxygen is applied by pressing the "oxygen-blast trigger" this oxygen reacts with the metal forming iron oxide and producing heat. It is this "heat" which continues the cutting process. The cutting torch only heats the metal to start the process, further heat is provided by the "burning metal".

The melting point of the iron oxide is around half of that of the metal, as the metal burns, it immediately turns to liquid Iron oxide and flows away from the cutting zone. However some of the Iron Oxide remains on the work piece forming a hard "slag" which can be removed by gentle tapping, and/or a grinder.

1.5.1.3 Rose-bud torch

A rose-bud torch is used to heat metals for bending, straightening, etc. where a large area needs to be heated. It is called as such because the flame at the end looks like a rose-bud. A welding torch can also be used to heat small area such as rusted nuts and bolts. In this case, no filler rod is used with the torch.

1.5.1.4 Injector torch

A typical Oxy-fuel torch, called an equal-pressure torch, merely mixes the two gasses. In an injector torch, high pressure oxygen comes out of a small nozzle inside the torch head so that it drags the fuel gas along with it, via venturi effect.

The basic oxyacetylene torch comprises:

- torch body (or handle)
- two separate gas tubes (through the handle connected to the hoses)
- separate control valves
- mixer chamber
- flame tube
- welding tip

NB The cutting torch requires two oxygen supplies to the nozzle, one mixed with fuel gas for preheating and a separate oxygen flow for cutting.

Torches are available for either welding or cutting. By placing the cutting torch attachment on the torch body it is used for manual flame cutting. Figure 1-12 shows a manual oxyacetylene flame-cutting torch. Various sizes of tips can be used for manual flame cutting. The numbering system for tips is not standardized. Most manufacturers use their own tip number system. Each system is, however, based on the size of the oxygen cutting orifice of the tip. These are related to drill sizes. Different tip sizes are required for cutting different thicknesses of carbon steel.

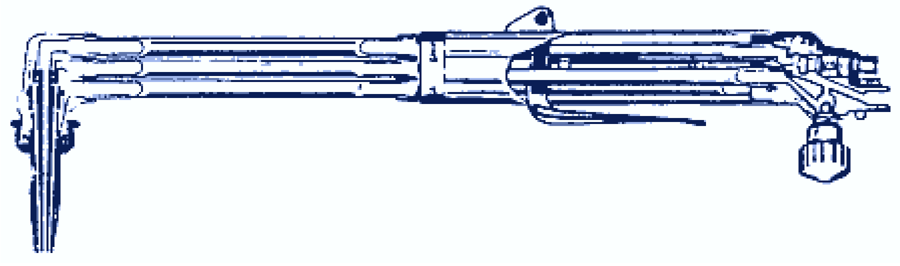


Fig. 1-12 Manual oxygen cutting torch

For automatic cutting with mechanized travel, the same types of tips can be used. High-speed type tips with a specially shaped oxygen orifice provide for higher-speed cutting and are normally used. The schedule shown in the table provides cutting speeds with normal tips; the speeds can be increased 25 to 50 percent when using high speed tips.

Automatic shape-cutting machines are widely used by the metalworking industry. These machines can carry several torches and cut a number of pieces simultaneously. Multi-torch cutting machines are directed by numerically-controlled equipment. Regardless of the tracing control system is used, the cutting operation is essentially the same.

One of the newer advances in the automatic flame cutting is the generation of bevel cuts on contour-shaped parts. This breakthrough has made the use of numerically controlled oxygen cutting equipment even more productive.

Many specialized automatic oxygen cutting machines are available for specific purposes. Special machines are available for cutting sprockets and other precise items. Oxygen-cutting machines are available for cutting pipe to fit other pipe at different angles and of different diameters. These are quite complex and have built-in contour templates to accommodate different cuts and bevels on the pipe. Other types of machines are designed for cutting holes in drum heads, test specimens, etc. Two or three torches can be used to prepare groove bevels for straight line cuts as shown by figure 1-13. Extremely smooth oxygen-cut surfaces can be produced when schedules are followed and all equipment is not in proper operating condition.

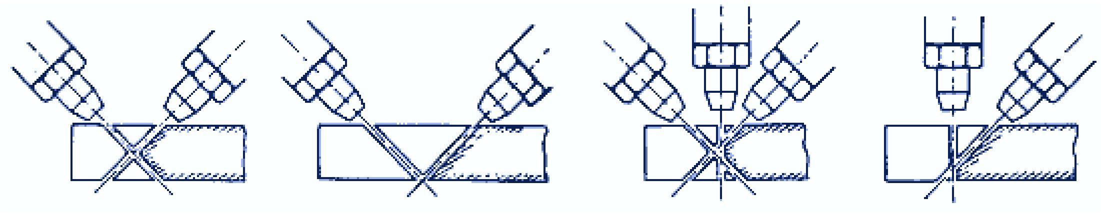


Fig. 1-13 Methods of preparing joints

1.5.2 Hoses

The hoses used are specifically designed for welding and cutting. The hose is usually a double-hose design, meaning that there are two hoses joined together. The oxygen hose is green and the fuel hose is red. The type of gas the hose will be carrying is important because the connections will have different threads for different types of gas. Fuel gases (red) will use left-hand threads and a groove cut into the nut, while the oxygen (green) will use right-hand threads. This is a safety precaution to prevent hoses from being hooked up the wrong way.

There are basically two types of connections that can be used. The first is using a jubilee clip. The second option is using a crimped connector. The second option is probably safer as it is harder for this type of connection to come loose. The hoses should also be clipped together at intervals approximately 3 feet apart.

1.5.3 Regulator

The regulator is used to control pressure from the tanks by reducing pressure and regulating flow rate. Oxy-gas regulators usually have two stages: The first stage of the regulator releases the gas at a constant rate from the cylinder despite the pressure in the cylinder becoming less as the gas in the cylinder is used, as in the first stage of a scuba-diving regulator. The second stage of the regulator controls the pressure reduction from the intermediate pressure to low pressure. It is constant flow. The valve assembly has two pressure gauges, one indicating cylinder pressure, the other indicating hose pressure.

Some oxy-gas regulators only have one stage, and one pressure gauge. With those the gas flow gets less as the cylinder pressure drops.

Note Acetylene is supplied in cylinders under a pressure of about 15 bars psi but welding is carried out with torch gas pressures typically up to 2 bars.

1.5.4 Check valve

A check valve lets gas flow in one direction only. Not to be confused with a flashback arrestor, a check valve is not designed to block a shock wave. The pressure wave could occur while the ball is so far from the inlet that the pressure wave gets past before the ball reaches its off position. A check valve is usually a chamber containing a ball that is pressed against one end by a spring: gas flow one way pushes the ball out of the way, and no flow or flow the other way lets the spring push the ball into the inlet, blocking it.

1.5.5 Flame traps

Flame traps (also called flashback arresters) must be fitted into both oxygen and acetylene gas lines to prevent a flashback flame from reaching the regulators. Non-return spring-loaded valves can be fitted in the hoses to detect/stop reverse gas flow. Thus, the valves can be used to prevent conditions leading to flashback, but should always be used in conjunction with flashback arresters.

A flashback is where the flame burns in the torch body, accompanied by a whistling sound. It will occur when flame speed exceeds gas flow rate and the flame can pass back through the mixing chamber into the hoses. Most likely causes are: incorrect gas pressures giving too low a gas velocity, hose leaks, loose connections, or welder techniques which disturb gas flow.

1.6 Flame Hardening

The oxyacetylene flame can be used to harden the surface of hardenable steel, including stainless steels, to provide better wearing qualities. The carbon content of the steel should be 0.35 percent or higher for appreciable hardening. The best range for the hardening process is 0.40 to 0.50 percent. In this process, the steel is heated to its critical temperature and then quenched, usually with water. Steels containing 0.70 percent carbon or higher can be treated in the same manner, except that compressed air or water sprayed by compressed air, is used to quench the parts less rapidly to prevent surface checking. Oil is used for quenching some steel compositions.

The oxyacetylene flame is used merely as a heat source and involves no change in the composition of the steels as in case hardening where carbon or nitrogen is introduced into the surface. In case hardening, the thickness of the hardened area ranges from 0 to 0.020 in. (0 to 0.508 mm).

Ordinary welding torches are used for small work, but for most flame hardening work, water-cooled torches are necessary. Tips or burners are of the multiflame type. They are water cooled since they must operate for extended periods without backfiring. Where limited areas are to be hardened, the torch is moved back and forth over the part until the area is heated above the critical temperature. Then the area is quenched. The hardening of extended areas is accomplished by steel hardening devices. These consist of a row of flames followed by a row of quenching jets. A means of moving these elements over the surface of the work, or moving the work at the required speed under the flames and jets, is also required.

CHAPTER [2]

DESIGN OF THE CUTTING VEHICLE

2.1 Introduction

The cutting vehicle is intended to move with m/s and this is achieved by using a reduction unit as mentioned in the next sections.

2.1.1 Description the motor :

The motor has 1/2 HP and rotate at 1000 rpm, motor is convert electric power to mechanical power .

Fig 2-1 motor

2.1.2 Description the reduction unit :

The motor transmits power (torque) to the first shaft on which a worm (1) is mounted. The worm (1) transmit movement to gear (2) which is mounted on the second shaft which contains warm (2) which transmits the motion to the output shaft through gear (2) .

Therefore, the gear train is a two stages worm –worm gear.

2.1.3 Description of shaft:

Fig 2-2 shaft

Length	**50cm**
Diameter	**16mm**
Material	**St 37**

2.1.4 Description gear :

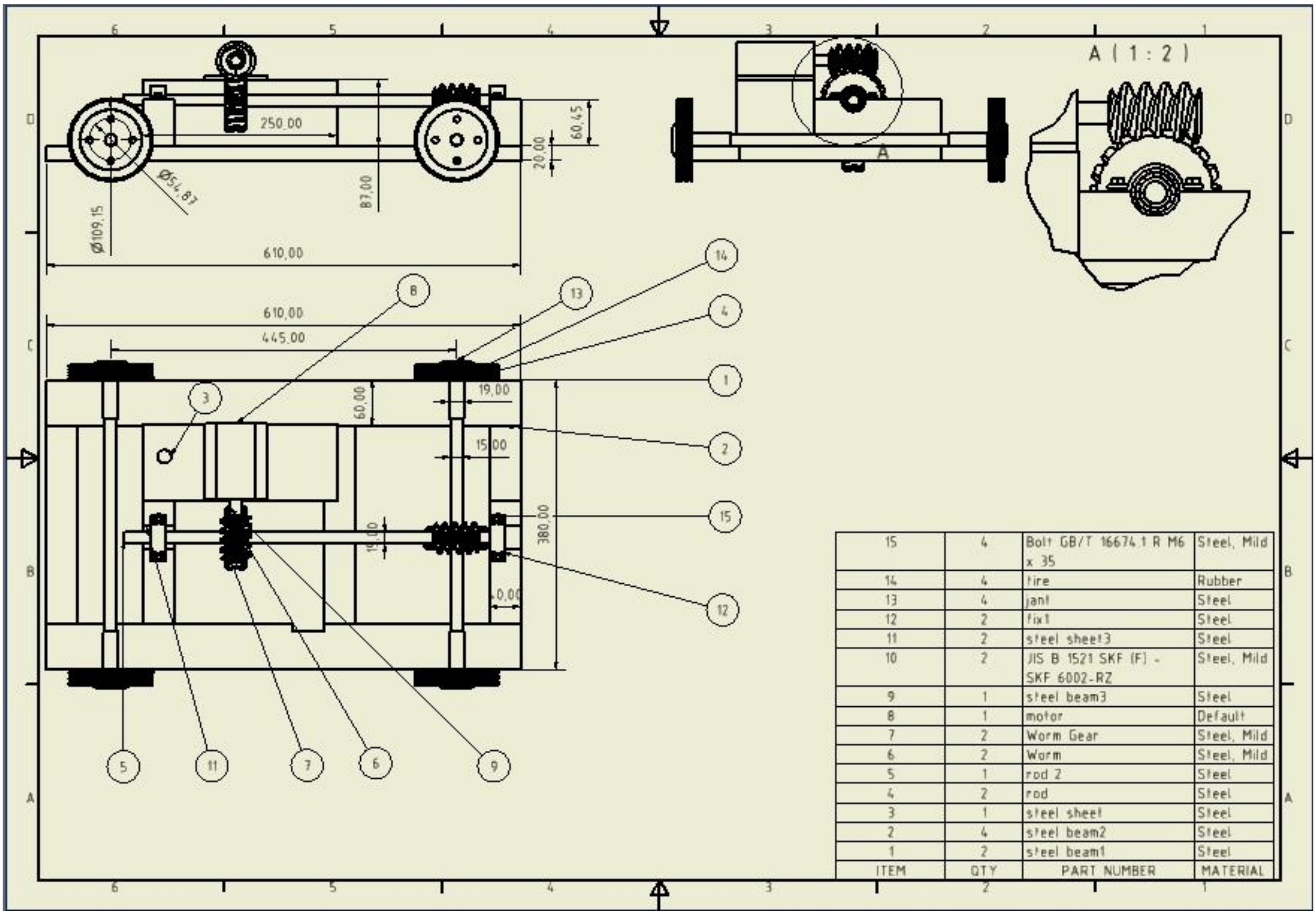
Fig 2-3 Gear

Number of teeth	**18**
Material	**St 37**

CHAPTER [3]

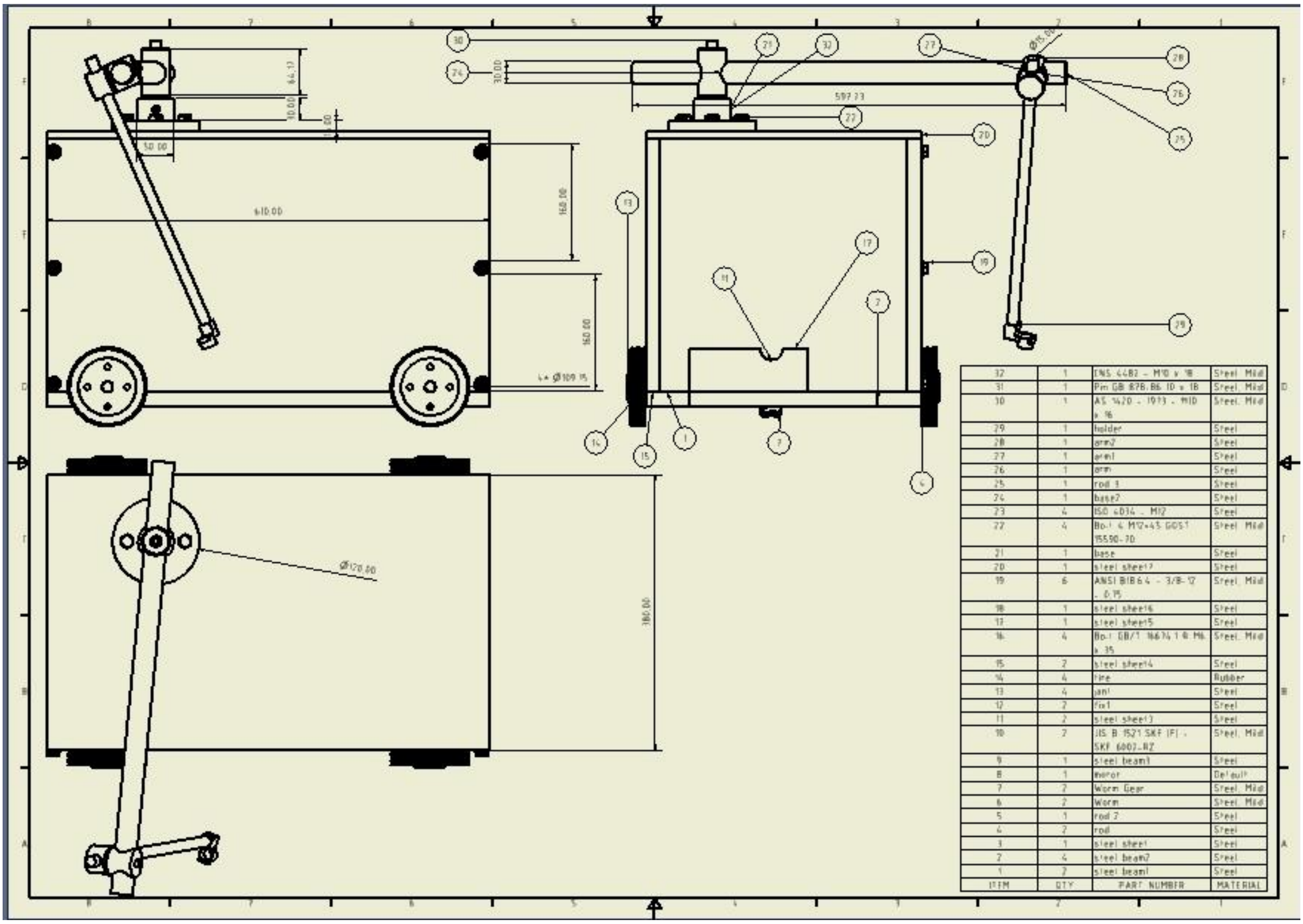
DESIGN DETAILS

The following figures show the design details of the mechanized vehicle.



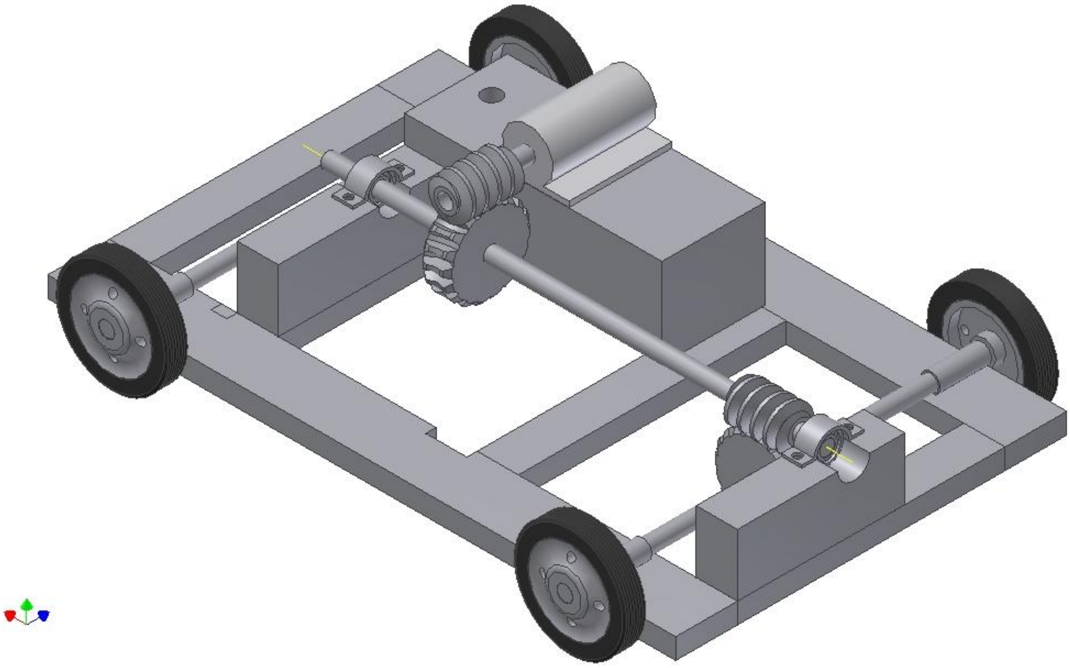
ITEM	QTY	PART NUMBER	MATERIAL
15	4	Bolt GB/T 16674.1 R M6 x 35	Steel, Mild
14	4	tire	Rubber
13	4	jant	Steel
12	2	fix1	Steel
11	2	steel sheet3	Steel
10	2	JIS B 1521 SKF (F) - SKF 6002-RZ	Steel, Mild
9	1	steel beam3	Steel
8	1	motor	Default
7	2	Worm Gear	Steel, Mild
6	2	Worm	Steel, Mild
5	1	rod 2	Steel
4	2	rod	Steel
3	1	steel sheet	Steel
2	4	steel beam2	Steel
1	2	steel beam1	Steel

Figure 3-1 Design of the mechanized vehicle (internal view)



ITEM	QTY	PART NUMBER	MATERIAL
32	1	DIN S 6482 - M10 x 18	Steel, Mild
31	1	Pin GB 878.86 10 x 18	Steel, Mild
30	1	AS 1420 - 1973 - M10 x 96	Steel, Mild
29	1	holder	Steel
28	1	arm2	Steel
27	1	arm1	Steel
26	1	arm	Steel
25	1	rod 3	Steel
24	1	base2	Steel
23	4	ISO 4034 - M12	Steel
22	4	Bolt 4 M12x45 GOST 15590-70	Steel, Mild
21	1	base	Steel
20	1	steel sheet7	Steel
19	6	ANSI B18.6.4 - 3/8-12 - 0.75	Steel, Mild
18	1	steel sheet6	Steel
17	1	steel sheet5	Steel
16	4	Bolt GB/T 16674.1 M6 x 35	Steel, Mild
15	2	steel sheet4	Steel
14	4	tire	Rubber
13	4	jant	Steel
12	2	fix1	Steel
11	2	steel sheet3	Steel
10	2	JIS B 1521 SKF (F) - SKF 6002-RZ	Steel, Mild
9	1	steel beam3	Steel
8	1	motor	Default
7	2	Worm Gear	Steel, Mild
6	2	Worm	Steel, Mild
5	1	rod 2	Steel
4	2	rod	Steel
3	1	steel sheet	Steel
2	4	steel beam2	Steel
1	2	steel beam1	Steel

Figure 3-2 Design of the mechanized vehicle (outer view)



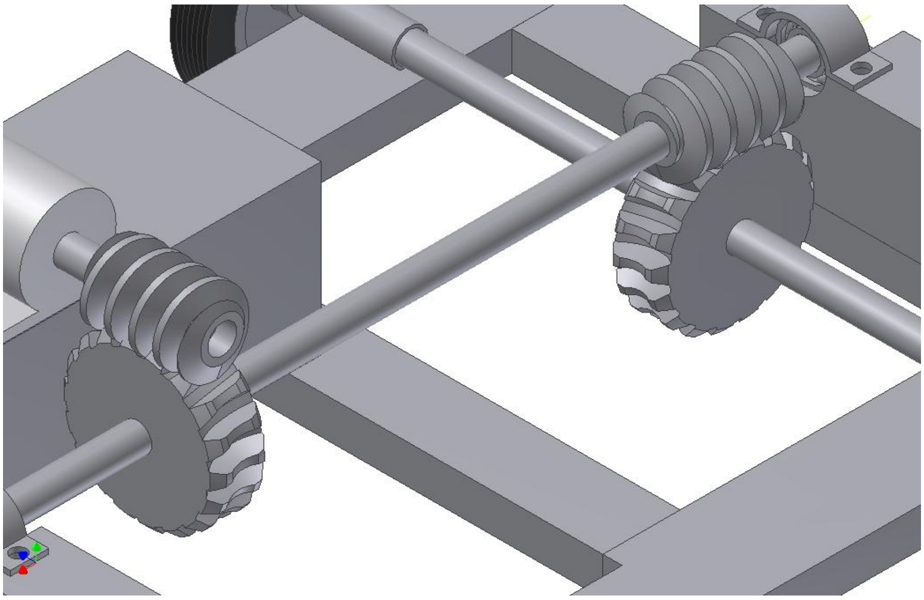


Figure 3-3 Isometric views of the reduction unit

of the mechanized vehicle

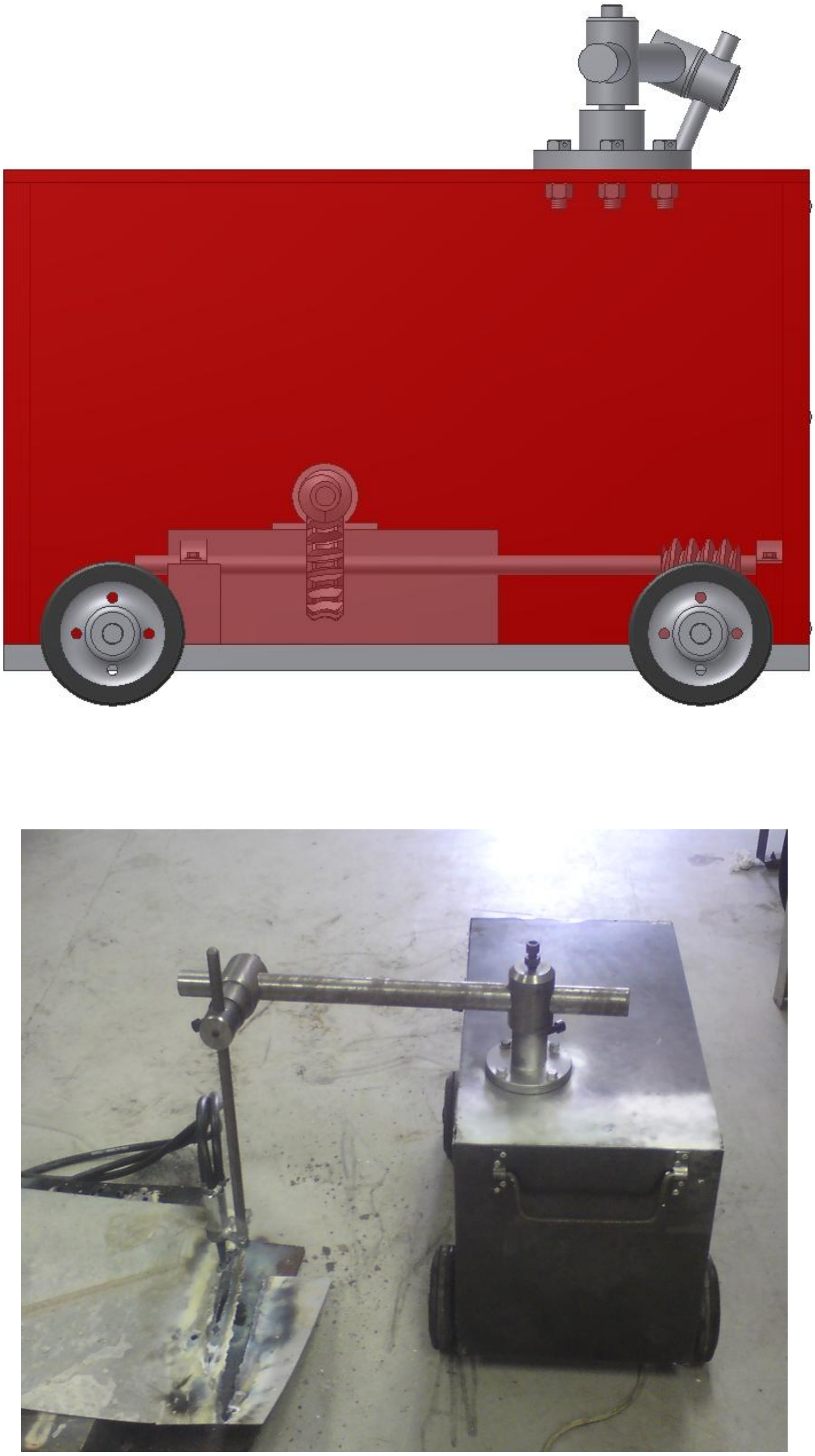


Figure 3-4 External view of the mechanize vehicle