

Semi Automation of Tig Welding Process For Pump Impeller Bush (FOR CHANSUBA PUMPS)



Project Work 1998 - '99

Submitted by

SURESH KUMAR A.

ASHOK KARTHIKEYAN K. V.

GANDHI K.

Guided by

Mr. V. GUNARAJ M E.,

Submitted in partial fulfilment of the requirements
for the award of the degree of
BACHELOR OF ENGINEERING
in Mechanical Engineering
Branch of the Bharathiar University, Coimbatore

Department of Mechanical Engineering

Kumaraguru College of Technology

COIMBATORE - 641 006



CHANSUBA PUMPS PRIVATE LIMITED

OFFICE : 125, Rajaji Road, Ramnagar, Coimbatore - 641 009, Tamilnadu, INDIA.

Phone : +91-(0) 422 - 235544 Fax : +91 - (0) 422 - 236438 Grams : HICHANSUBA

E.MAIL : RAJU.MOULI @ SMI.SPRINTRPG.EMS.VSNL.NET.IN

PROJECT COMPLETION CERTIFICATE

This is to inform that the following students of Kumaraguru College of Technology

Have successfully completed the project (SEMI AUTOMATION OF TIG WELDING

PROCESS FOR PUMP IMPELLER BUSH) in our factory.

- 1) A. SURESH KUMAR
- 2) K.V.ASHOK KARTHIKEYAN
- 3) K.GANDHI

We wish them all a Bright future

For Chansuba Pumps Pvt Limited.

T.C. VIDYASANKAR
DIRECTOR - ENGINEERING

COIMBATORE
10.03.1999



In Collaboration with STA -RITE Industries, Inc., USA

Works: 366/5-B, Thudiyalur Road, Chinnavedampatti, Coimbatore-641 006.
TAMILNADU, INDIA. PHONE : + 91 - (0) 422 - 868467, 868468, 867107

ACKNOWLEDGEMENT

We are very grateful and indebted to our principal **Dr.K.K.PADMANABHAN** and to **Dr.T.L.SITHARAMA RAO**, Prof and H.O.D of Mechanical Engineering Department for allowing us to do the project and providing the necessary facilities.

We take the privilege to express our deep gratitude to our guide **Prof.V.GUNARAJ** who gave us valuable guidance and help based on his knowledge and experience.

We also express our thanks to all the staff members of Mechanical Engineering Department for the help rendered during the project.

We express our sincere and heartfelt thanks to **Mr.T.C.VIDYA SANKAR**, Managing Director, Chansuba Pumps for giving us the permission to do the project in his esteemed company.

We express our deepest gratitude and are highly indebted to our company guide **Mr.RAJESH**, Manager for his help and guidance right from the inception to the completion of the project. His motivation and constructive criticism also have a key role in the success of this project.

We also thank all the supervisors and workers of the production department for their kind co-operation in making this project a successful one.

SYNOPSIS

This project has been sponsored by **M/s.CHANSUBA PUMPS (P) LTD., COIMBATORE**. The company produces S.S.Pumps with stages ranging from 5 to 37, which requires large no. of impellers. The production of the impeller bush involves machining and spot welding of different parts of the impeller bush. This spot welding process is a time consuming one because (i) It is done manually (ii) As the weld is a weaker one, no. of welds done are more. (iii) The holding of w/p is difficult.

The company wants to increase the productivity of the impeller bush by reducing the time of the welding process. We made a study on the present welding method and found a new solution to it. Our solution involves.

1. Slight modification in the design of impeller bush
2. Replacement of spot welding process by TIG welding process.
3. Design of fixture for holding impeller bush during welding.
4. Design of pneumatic package for clamping and lifting the w/p.

The achievements made by implementing this new method are

1. No. of welds made is reduced by 60%.
2. 50% reduction in production time of impeller bush
3. A sound and efficient weld is produced
4. Labour fatigue in less.

CONTENTS

1. INTRODUCTION	
1.1. ABOUT THE COMPANY	1
1.2. CONCEPTS OF AUTOMATION	5
1.3. ABOUT THE WORK PIECE	7
1.4. EXISTING METHOD	8
2. PROPOSED SYSTEM	9
3. INTRODUCTION TO PNEUMATICS	10
4. INTRODUCTION TO TIG WELDING	17
5. CIRCUITS	
5.1. PNEUMATIC CIRCUIT	28
5.2. WELDING CIRCUIT	29
6. DESIGN ANALYSIS	
6.1. WELDING COMPONENT DESIGN	30
6.2. PNEUMATIC COMPONENT DESIGN	37
6.3. MECHANICAL COMPONENT DESIGN	40
7. FABRICATION	42
8. COST ANALYSIS	
9. INSTRUCTIONS FOR USE	46
10. TROUBLE SHOOTING	48
10.1. PNEUMATIC CIRCUIT	50
10.2. WELDING PROCESS	51
11. DRAWINGS	52
12. CONCLUSION	71
13. BIBLIOGRAPHY	72
14. APPENDIX	73
15. PHOTOGRAPHY	106

1. INTRODUCTION

1.1 ABOUT THE COMPANY

Chansuba Pumps was established in collaboration with the sta-rite company, U.S.A. The company today emerged as one among the leading manufacturers in the submersible motor and pumps.

The company has been conceived and developed over the years for supplying high quality pumps and motors for various parts of the world.

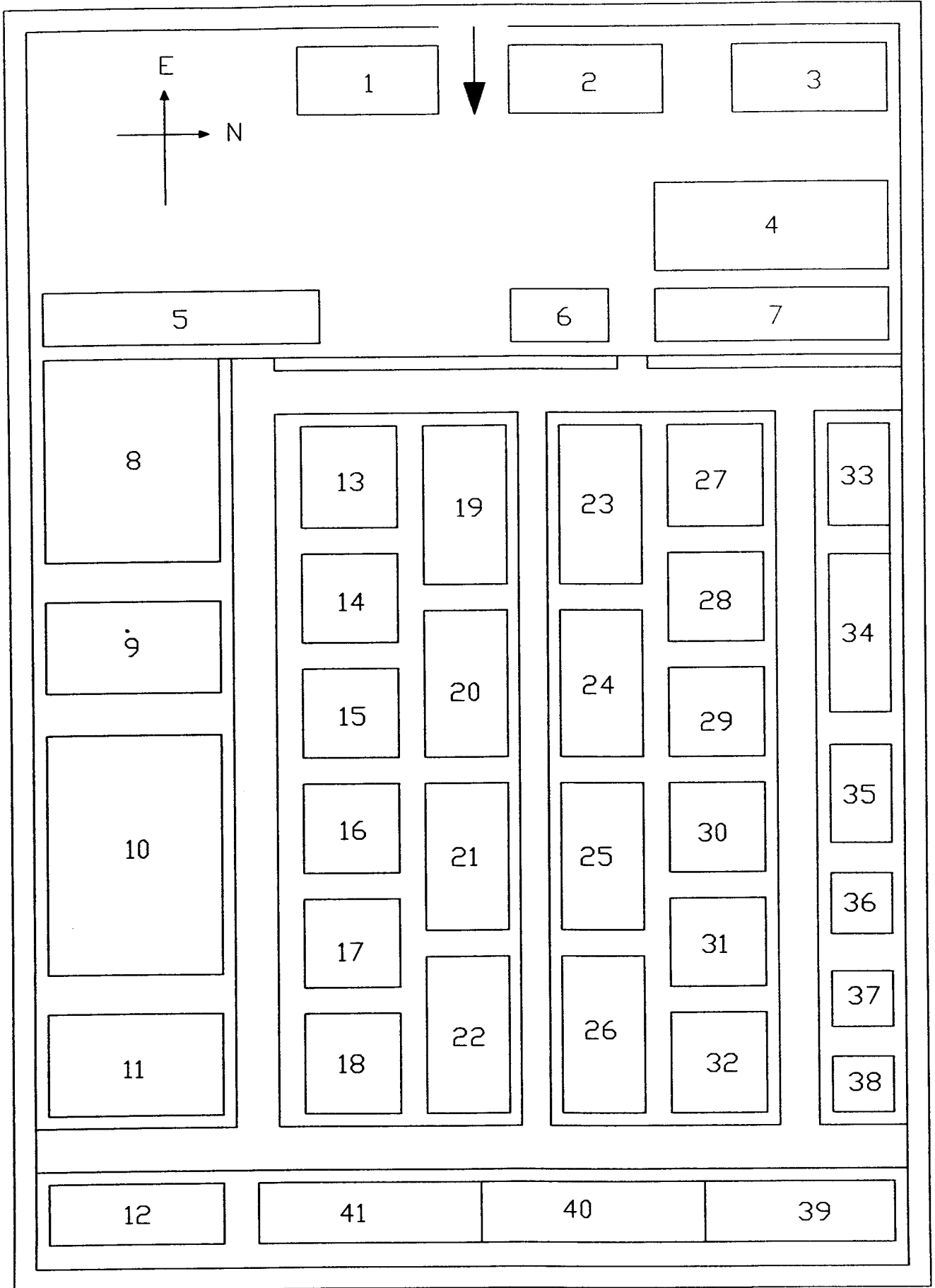
RANGE OF PRODUCTS

1. Casting Pump
2. Stainless Steel Pump
3. Submersible Motor

Manufacturing of stainless steel pump constitute their main product and the clients are from various parts of the world like USA, Kuwait, Iran, German, etc.,

The company employs a total of about 70 employees. The employees are highly skilled and trained in various departments like winding, pump assembly in order to meet the exacting specifications and accuracy of the products manufactured.

COMPANY LAYOUT



1	Security	21	Enterprise Lathe
2	Parking	22	Kirloskar Lathe
3	Canteen	23	Leadwell CNC
4	Generator Room	24	Batliboi Universal Drilling M/c.
5	Reception	25	Batliboi Grinding M/c.
6	Store	26	Kirloskar Turret Lathe
7	Office	27	Coil Winding M/c.
8	Manager Room	28	Pake Manual Hydraylic Press
9	Shaft Balancing M/c	29	Vidyut Spot Welding M/c.
10	Storage of Pump Components	30	Rolex Spot Welding M/c.
11	Buffing M/c.	31	Sew Power Press
12	Assembly of Pumps & Motors	32	Compressor
13	Power Matic Radial Drilling M/c	33	Sheet Cutter
14	Universal Radial Drilling M/c	34	Winding Section
15	Shaft Storage	35	Sheet Bending M/c.
16	Max India Drilling M/c.	36	TIG Welding
17	Field Slotting M/s.	37	MIG Welding
18	Max India Bench Grinder	38	Tech'n MEG Hydraulic Press
19	Smithson Grinding M/c	39	Pump Storage
20	Lathe	40	Testing Section
		41	Administrative Cabin

1.2 CONCEPTS OF AUTOMATION

1.2.1 AUTOMATION

Automation is a trend in the development of production that calls for the use of machines and mechanisms in the process of production instead of muscular power of the workers. It is an intricate process in which many of the engineering, social, economical and other aspects are closely interrelated making them a sort of union where the opposites combine with expediency called for by the development of the process.

In mass and large-scale production where the equipment is intended to perform the same recurrent operations without changing the setup, the paths of automation are quite definite and the problem mainly boils down to a wider use of automation devices. Automation proves most effective in the production stages requiring much labour work.

1.2.2 SEMI AUTOMATION

Semi automation is a concept of automation in which the power of the compressed air is used for clamping, transportation, etc., but the operator operates the actuator and other devices by controlling the valve in between the operations that are performed on the component. Here each operation is

controlled by the operator and only clamping, transportation, etc are pneumatically performed.

Automation, like in other, improves in welding too, increase production, improves quality and lowers cost. Automatic welding employs various automatic power devices, gas controls, coolant fluid, controls, sequence controls, gauges, timers and limit switches, etc.,

1.3 ABOUT THE WORK PIECE

Our project concerned with the particular component, impeller bush which is used for the manufacture of pump impeller. The impeller bush consists of 3 parts

- 1) Bush
- 2) Washer
- 3) Impeller top plate.

The bush is an mild steel material which is machined using the conventional machines. The washer and the impeller top plate are of stainless steel sheets which are producing by punching to the required dimensions in the punching press.

After the production of these 3 parts, the three parts are sent to the hydraulic pressing machine. In the hydraulic pressing machine, first the impeller top plate is placed over the table. Over the impeller top plate the washer is placed and over these two parts the bush is placed and these three parts are pressed together to form the impeller bush.

The impeller bush is used for the manufacture of the pump impeller. The impeller consists of these parts. The impeller bush, vane and the bottom plate. The vane is placed below the top plate of the impeller bush and below which the bottom plate is placed and these are spot welded to make the impeller.

1.4 PRESENT PRACTICE

At present in the company, the spot welding process is applied to weld the parts in the impeller bush. The welding done in the impeller bush parts are (1) The top plate is welded with the bush. (2) The top plate is welded with the washer. Since the spot weld is done, first the weld between the top plate and the washer is performed. Randomly 5 spots on the edge of the washer is selected and the spot weld is made.

While welding, the worker holds the workpiece over the stationary electrode and presses the pedal to do the weld. While the pedal is pressed the movable electrode comes into contact with the work piece and the circuit closes and the weld is performed. In the similar way all the 5 welds are performed.

Now the stationary electrode is changed for performing the weld between the top plate and the bush. Now the stationary electrode will be in the horizontal position where the bush can be inserted into it and can be held in the weld spot. The 6 spots are selected at the edge of the top plate and the weld is performed as mentioned above.

While during the welding, first the weld between the top plate and washer is performed for all the components and then the stationary electrode is changed for the welding between the top plate and the bush for the same components.

2. PROPOSED SYSTEM

The main objective of our project is to eliminate all the problems that are currently faced in the industry and to reduce the cost of production. In our project the two hands of the operator are replaced by pneumatic system that consists of two pneumatically controlled cylinders along with the control valves and devices. One cylinder is used for clamping the work piece rigidly while it is welded and the other cylinder is used for lifting the clamped work piece to the required weld position. The pneumatic components and the required mechanical components are assembled over the base plate. The whole assembly is fitted on the table. Tubes from the main compressor for the circuits functioning connects all pneumatic components.

The TIG welding air cooled torch is fitted on the torch holder which is fitted to the vertical shaft. The torch is positioned in such a way that when the clamped work piece is lifted there will be a spark gap of 3mm between the torch tip and the work piece.

Once the work piece is kept over the table, the first cylinder is actuated so that the work piece is clamped. Now the second cylinder is actuated so that the clamped workpiece is lifted to the weld position. Now the switch in the TIG welding torch is pressed and thus the weld is made. After the weld is made the top bracket is manually indexed to the next position and the switch in the TIG welding torch is pressed and the weld is made. Similarly the other two welds are made by indexing the top bracket.

After completing the welding operation the second cylinder is actuated to lift down the clamped work piece and then the first cylinder is actuated to unclamp the work piece and is removed.

3. INTRODUCTIN TO PNEUMATICS

3.1 PNEUMATICS

Pneumatics is a powerful tool in production now-a-days. It provides the industry with a valuable and economic medium of power for production and control. Pneumatics deals with the application of air as a working medium in industry, especially the driving and controlling of machines and equipment. Pneumatics is used in mechanical stops, gear reduction units driven by air motors, clamping purposes, operating the actuators, etc. In manufacturing air is used to power high clamping, grinding and assembly using pneumatic wrenches and riveting machines.

3.2 ADVANTAGES OF PNEUMATIC SYSTEM

Pneumatics has various features and advantages that make it suitable for low and medium pressure operation of various equipments, they are:

- ❖ Output power of pneumatic system can be controlled easily.
- ❖ Pneumatic system is faster and more accurate than hydraulic system.
- ❖ High reversibility than the conventional system.
- ❖ It is easy to position the work piece accurately using the pneumatics systems.
- ❖ Transportation of compressed air is easy and it is possible over large distance.

- ❖ Compressed air can be easily stored in a reservoir and used as required.
- ❖ Operating components are of simple construction and therefore relatively inexpensive.
- ❖ Compared with a hydraulic system the friction losses in air pipes and fittings are low.
- ❖ The temperature of the medium has little effect on the operation of a pneumatic system.
- ❖ Low cost of compressed air and maintenance free service.
- ❖ Pneumatic components are smaller, lighter, and cheaper than those of hydraulic system and electrical system.

3.3 COMPRESSORS

A compressor is a machine that takes in air, gas or vapour at a certain pressure and delivers the air at a higher pressure.

Compressors may be classified into two general type namely positive displacement compressors and turbo compressors. Positive displacement compressors are most frequently employed for compressed air plant to supply the air successfully.

Positive displacement compressors are of two types reciprocating and rotary types. A single piston compressor can provide pressure upto 15 bar. The normal operating pressure may be in the range of 5 to 7 bar in case of pneumatic components.

3.4 DISTRIBUTION SYSTEM

The system for distribution of compressed air from the production point to the consumption point is the distribution system. The volume of air needed by the actuators and other components are provided from the air receiver via the pipe lines. They are usually flexible and made of rubber. The diameter is selected according to the following requirements.

- ❖ Flow Volume
- ❖ Pipe length
- ❖ Pressure drop
- ❖ Working pressure
- ❖ Number of restrictions in the line.

3.5 AIR RECEIVERS

Air receivers are installed directly downstream of the compressor to receive the compressed air delivered by the latter, thereby balancing out pulsation in the airflow. Mostly they are also intended to serve as storage reservoirs for the overall air mains, thus additionally helping to cool the compressed air and separate condensate before it is distributed further. A certain storage capacity is essential to ensure that the pneumatic control devices connected to the system will be able to reach neutral or standstill position in the event of any disruption such as a power failure.

3.6 ACTUATORS

Fluid power can be transmitted through either linear or rotary actuators called cylinders or motors. Actuators used in pneumatic system are similar to that of hydraulic system. Pneumatic actuators are of lighter construction. Air cylinder construction makes extensive use of Aluminium to reduce weight and corrosive effects.

There are several types of cylinders that are used for linear actuation according to the purpose, they are

- ❖ Single acting cylinder
- ❖ Double acting cylinder
- ❖ Double rod end type
- ❖ Three position cylinder
- ❖ Tandem cylinder
- ❖ Telescopic cylinder
- ❖ Rod less cylinder

3.7 CONTROL VALVES

Fluid power is controlled primarily through the use of control devices called valves. They are three basic types of control devices.

- ❖ Direction control valves
- ❖ Pressure control valves
- ❖ Flow control valves

Pneumatic control valves are used to regulate pressure and velocity of flow and to manage the direction of air. Pressure relief valve protects the compressor and components by setting system pressure within the safe working limits. To control the direction of airflow through the tube, directional control valves are used.

DC valves determine the path through which air traverse within a given circuit. Pressure control valves protect the system against over pressure. Flow control valves achieve the control of speed of actuator. Check valve permits free flow in one direction and prevents any flow in the opposite direction.

3.8 FLUID CONDITIONERS

The purpose of fluid conditioners is to make air a more acceptable medium for pneumatic system. Fluid conditioners include filters, regulators, lubricators, mufflers and air dryers. The function of a filter is to remove contaminants from the air.

Controlling of air pressure in compressor is accomplished with pressure switch and relief valve. Pressure regulator is used to regulate and maintain constant pressure. Lubricator ensures proper lubrication of internal moving parts of pneumatic components. The conditioning function is usually carried out by the components of the FLR unit. FLR unit consists of:

- 1) Filter
- 2) Regulator
- 3) Lubricator

3.8.1 FILTER

The purpose of filter is to clean the impurities present in compressed air and any condensate if present. Air entering the filter chamber is set in rotation by the guide slots whereby its flow velocity is increased. Flow velocity action taking place the residual water vapour is separated from the air stream, condensate together with the removed impurities collected in the bottom of the chamber and must be drained off not later than when it raises to the maximum level mark. If condensate accumulates at a high rate, it is advisable to provide automatic drain.

3.8.2 REGULATOR

The inlet pressure must always be higher than the outlet pressure. Regulator controls outlet pressure. Regulator consists of diaphragm, one side of which is loaded by the outlet pressure while the other side is loaded by spring. Any increase in outlet pressure causes the diaphragm to be moved against the force of the spring thereby restriction flow across the valve seat until it may be completely closed. Outlet pressure is therefore regulated as set by repeated opening and throttling of the valve seat. A gauge connected to the downstream system indicates outlet pressure available.

3.8.3 LUBRICATOR

A lubricator is required to ensure an adequate supply of lubricant to the pneumatic equipment. The oil injected into the air stream should be dispersed as sufficiently fine vapour to make sure that it will not be precipitated at the first lubrication. Points or reductions of low area in an extensive pneumatic system.

Nozzle is provided for oil flow. This air becomes enriched with oil, which is forced out of the reservoir due to pressure inside reservoir. Adjustments can be made by set screw to regulate the oil flow. Refilling the lubricator with oil is possible only when air stream is shut off on some types, but more recent lubricators are designed for refilling while air is passing through.

4. INTRODUCTION TO TIG WELDING

TUNGSTEN ELECTRODE, INERT GAS SHIELDED (TIG) WELDING

4.1 TECHNOLOGY & EQUIPMENT

The welding of aluminium, magnesium and ferrous alloys by the oxyacetylene and manual metal arc processes is limited by the necessity to use a corrosive flux. The gas shielded tungsten arc process enables these metals to be welded without the use of flux. The choice of either a.c. or d.c. depends upon the metal to be welded. For metals having refractory surface oxides such as aluminium and its alloys, magnesium alloys and aluminium bronze, a.c. is used whilst d.c. is used for carbon and alloy steels, heat-resistant and stainless steels, copper and its alloys, nickel and its alloys, titanium, zirconium and silver.

The arc burns between a tungsten electrode and the work piece within a shield of the inert gas argon, which excludes the atmosphere and prevents contamination of electrode and molten metal. The hot tungsten arc ionizes argon atoms within the shield to form a gas plasma consisting of almost equal no. of free electrons and positive ions. Unlike the electrode in the manual metal arc process, the tungsten is not transferred to the work and evaporates very slowly, being classed as "non-consumable". Small amounts of other elements are added to the tungsten to improve electron emission. It is however, a relatively slow method of welding.

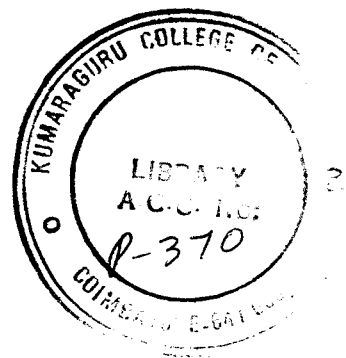
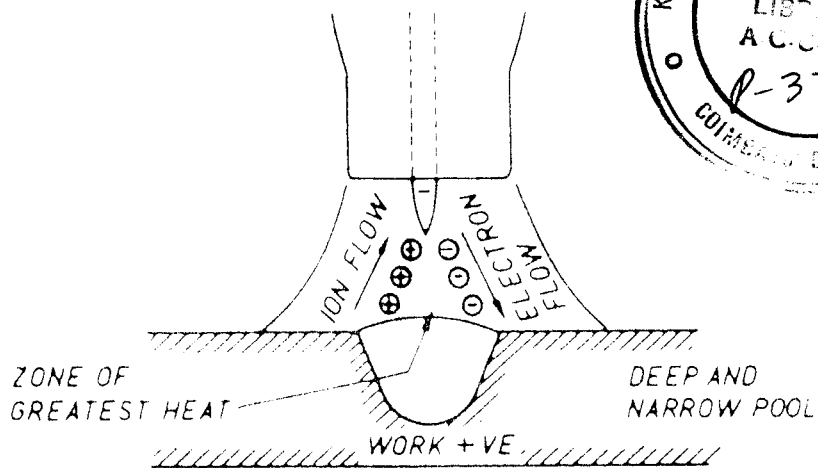
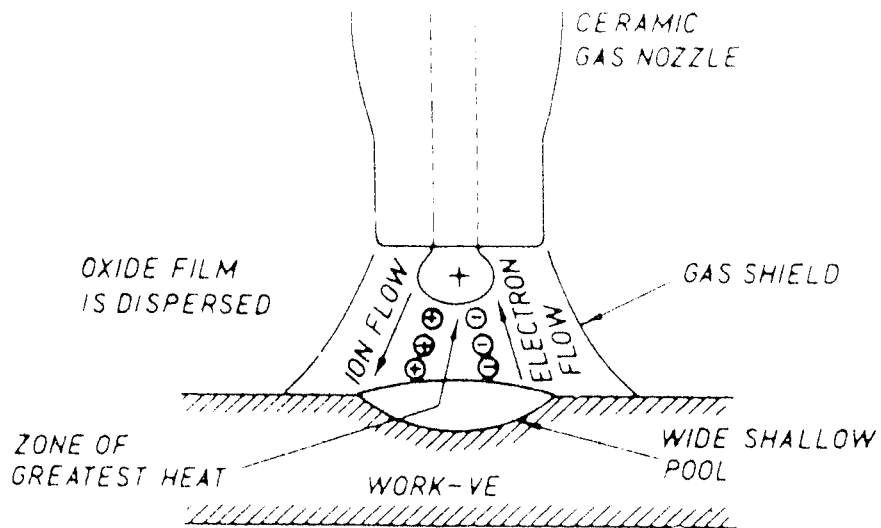
4.2 GASES

Argon in its commercial purity state (99.996%) is used for metals named above but for titanium extreme purity is required. Argon with 5% hydrogen gives increased welding speed and / or penetration in the welding of stainless steel and nickel alloys; nitrogen can be used for copper welding on deoxidised coppers only. Helium may be used for aluminium and its alloys and copper, but it is more expensive than argon and, due to its lower density, a greater volume is required than with argon to ensure adequate shielding, and small variations in arc length cause greater changes in weld conditions.

The characteristics of the arc are changed considerably with change of direction of flow of current, that is with arc polarity.

4.3 ELECTRODE POSITIVE

The electron stream is from work to electrode while the heavier positive ions travel from electrode to work piece. The positive ions in the TIG arc bombard this oxide and, together with the electrode generate great heat, so its diameter must be relatively large and it forms a bulbous end. It is this overheating with consequent vaporization of the tungsten and the possibility of tungsten being transferred to the molten pool and contaminating it that is the drawback to the use of to the use of the process with electrode positive. Very much less heat is generated at the molten pool and this is therefore wide and shallow.



4.4 ELECTRODE NEGATIVE

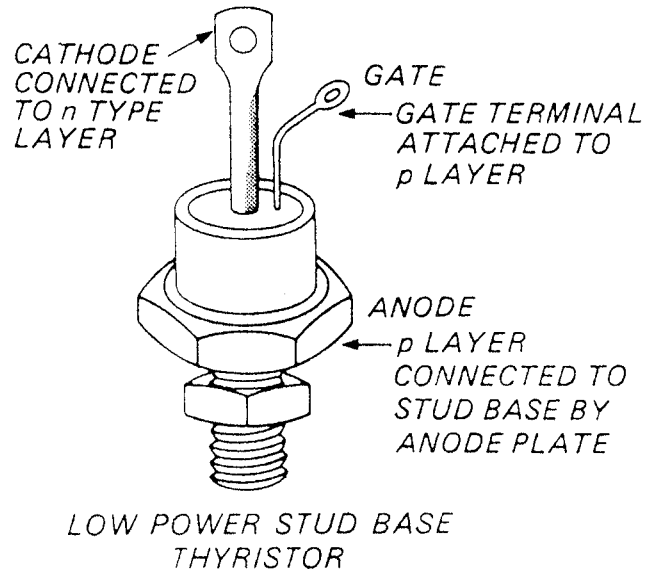
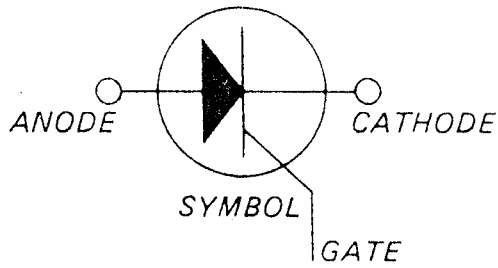
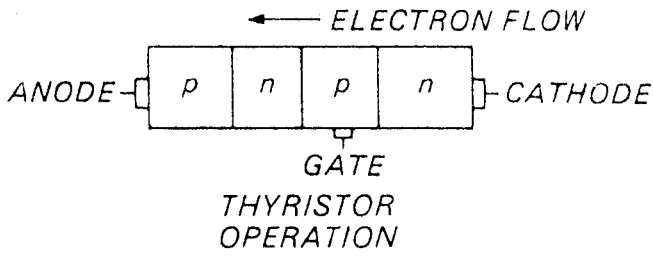
The electrode stream is now from electrode to work with the zone of greatest heat concentrated in the work piece so that penetration is deep and the pool is narrower. The ion flow is from work to electrode so that there is no dispersal of oxide film and this polarity cannot be used for welding the light alloys. The electrode is now near the zone of lesser heat and needs be of reduced diameter compared with that with positive polarity. For a given diameter the electrode, when negative, will carry from four to eight times the current than when it is positive and twice as much as when a.c. is used.

4.5 POWER SOURCES A.C. AND D.C.

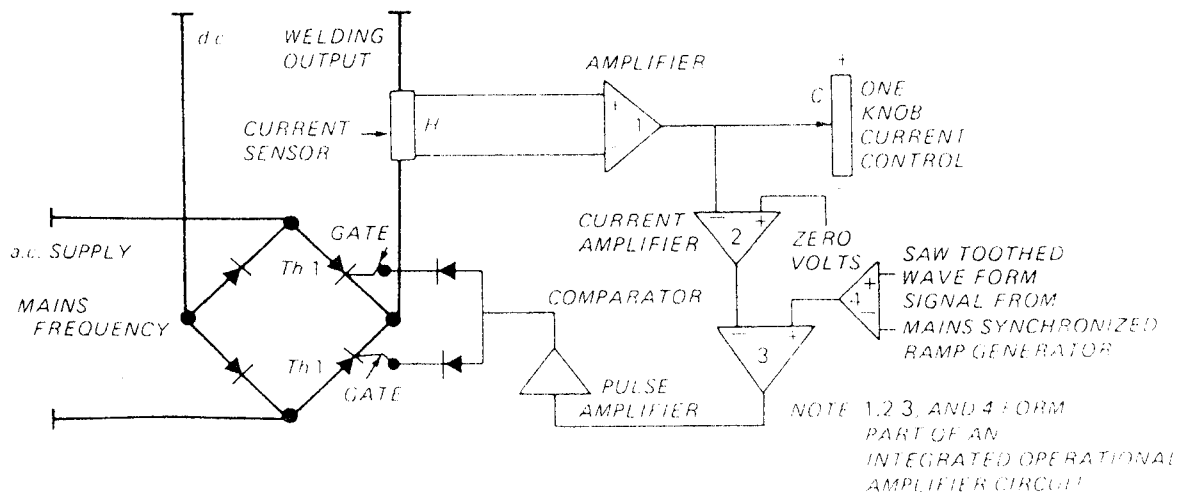
Equipment can be chosen to give a.c. or d.c. or both a.c. & d.c. from one unit and may even be designed for specific industries. (1) d.c. output for the fabrication of a variety of steels and special steels such as stainless, heat resistant and 9% Ni, etc., (2) a.c. output for fabrication aluminium and its alloys (3) a.c. and d.c., which includes the fabrication of both the above ferrous and non-ferrous metals and it is this type that covers most types of fabrication.

4.6 POWER UNIT A.C.

For the light alloys of aluminium and magnesium a transformer can be used. Cooling can be by forced draught or oil, usually the former, and primary tapings are provided on the input side for single – or three phase 60Hz



Simplified schematic diagram for one knob control of welding current by thyristor (SCR).



The thyristor (sometimes called the silicon controlled rectifier) has four elements with three junctions and a further terminal called the 'gate' which is connected to the 'P' layer adjacent to cathode. If the gate is connected directly to the cathode, the device blocks the flow of current in either direction. However, if, while the anode is positive with respect to the cathode, the gate is also made positive (typically by two or three volts), current will flow from anode to cathode. The current required in the gate is usually between 1/100 and 1/1000 of the maximum anode current. Once conduction has been so initiated, the gate has no further effect and can be de-energized. Conduction will continue until the external circuit causes the current to fall to zero, when the device will revert to its blocking state. Like a diode, it will not permit reverse (cathode to anode) current flow under any conditions.

4.10 TORCH

There is a variety of torches available varying from light weight air cooled to heavy duty water cooled types. The main factors to be considered in choosing a torch are:

- ❖ Current-carrying capacity for the work in hand
- ❖ Weight, balance and accessibility of the torch head to the work in hand.

The torch body holds a top-loading compression-type collect assembly which accommodates electrodes of various diameters. They are securely gripped yet the collect is easily slackened for removal or reposition of the

electrode. As the thickness of plate to be welded increases, size of torch and electrode diameter must increase to deal with the larger welding currents required.

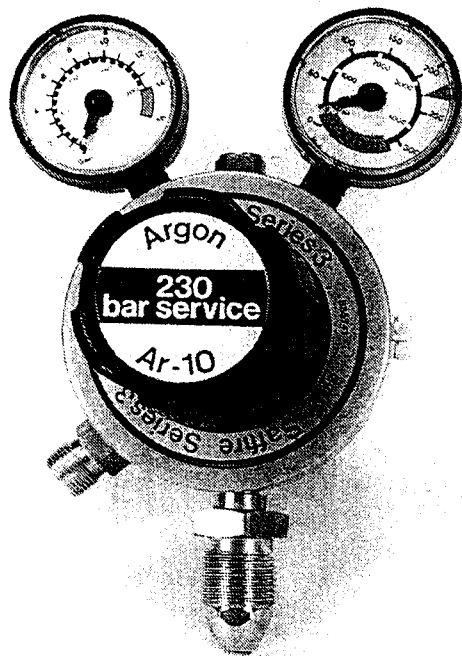
Normally, because of turbulence in the flow of gas from the nozzle, the electrode is adjusted to project upto a maximum of 4-9 mm beyond the nozzle. The ceramic nozzles, which direct the flow of gas, screw on to the torch head and are easily removable for cleaning and replacement. Nozzle orifices range from 9.5 to 15.9 mm in diameter and they are available in a variety of patterns for various applications. Ceramic nozzles are generally used upto 200A a.c. or d.c. but above this water cooled nozzles or shields are recommended because they avoid constant replacement.

4.11 GAS REGULATOR

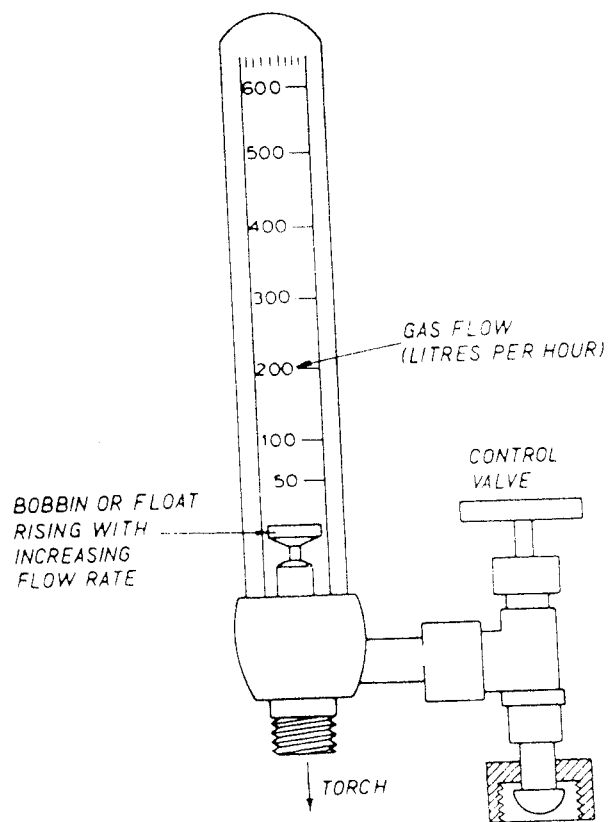
The gas regulator reduces the pressure in the argon cylinder from 175 or 200 bar down to 0-35 bar for supply to the torch to the desired working pressure and holds that pressure, without fluctuation of readjustment, until the cylinder is almost exhausted.

In most welding operations, the arc is maintained for only short periods, and there are many starts and stops during a day's operation. Thus, it should be made very convenient for the operator to turn off the gas at the proper time. Mainly regulators are constructed with two gauges. One gauge indicates the pressure of the gas in the cylinder and the other indicates the working pressure of the gas being delivered to the torch.

Two-stage argon regulator.



Argon flowmeter.



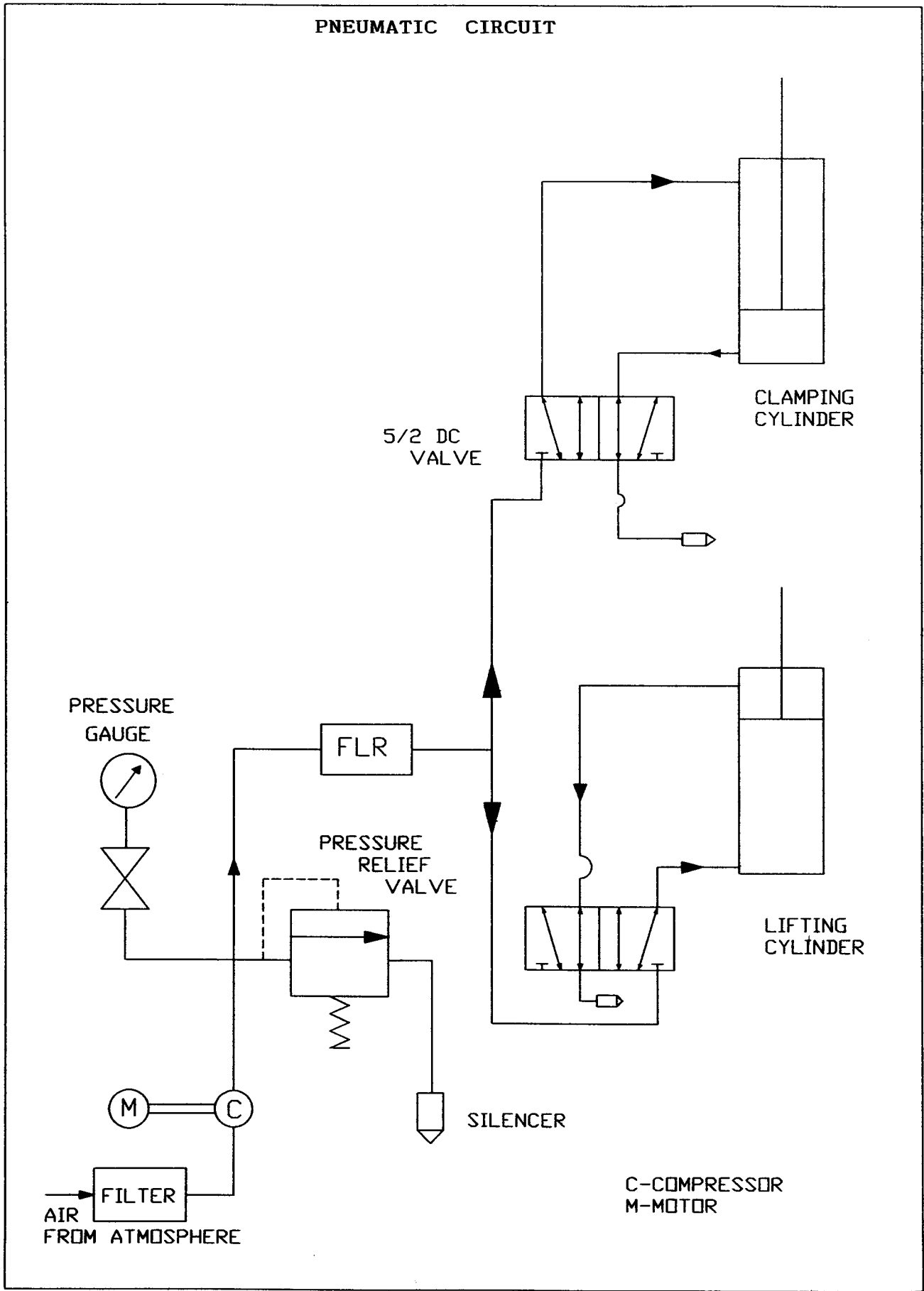
4.12 FLOW METER

The flowmeter is a device calibrated to measure how many cubic feet per hour are flowing through a certain point. The scale is indexed on a glass tube and the cubic-feet-per-hour rate is indicated by reading to the top of a float ball in the glass tube. The ball in the flow meter gauge indicates the flow of gas to the TIG torch. Weld protection in inert-gas metal-arc welding is effected by displacing the air physically with the flowing inert gas. Thus the required rate of inert-gas flow for the welding operation is that rate which will give effective shielding.

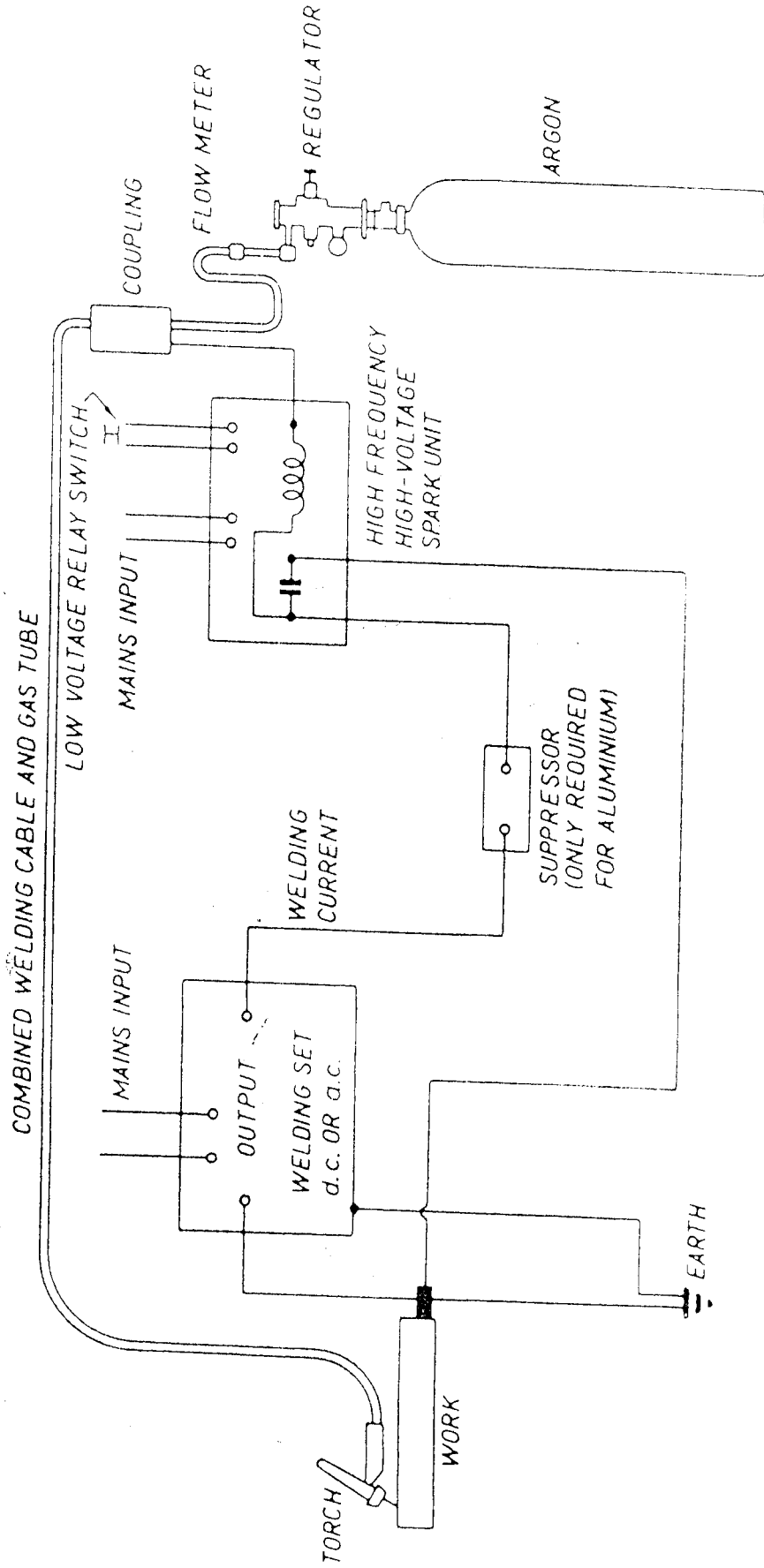
Gas-flow requirements depend upon the following factors.

- ❖ Type of metal being welded
- ❖ Type of inert gas employed
- ❖ Design and location of the joint
- ❖ Amount that the electrode extends beyond the gas nozzle.
- ❖ Exposure to drafts
- ❖ Position of welding.

PNEUMATIC CIRCUIT



Connections for inert gas welding using air-cooled torch.



5.1 DESIGN OF TIG WELDING COMPONENTS

5.1.1 POWER SOURCE

Equipment can be chosen to give a.c. or d.c. or both a.c. and d.c. from one unit and may even be designed for specific purposes (1) d.c. output for the fabrication of a variety of steels and special steels such as stainless, heat resistant, etc., (2) a.c. output for fabrication aluminium and its alloys. (3) a.c. and d.c. which includes the fabrication of both the above ferrous and non—ferrous metals and it is this type that covers most types of fabrication.

Hence the power unit a.c. and d.c., which supply either a.c. or d.c., are connected to single or 3-phase mains, fed into a step-down transformer and then into a thyristor which may also act as a contactor so that there are no mechanical parts to open and close when welding is begun and ended.

The thyristors, which can be switched under load and current can be supplied for TIG and output can be for electrode +ve or –ve or a.c. by means of the controlling printed circuit and hence a stepless control is achieved by using a thyristor control.

SPECIFICATON: WELDTRONIC LST 300

5.1.2 POLARITY

When the electrode is kept as positive, then the electron stream is from work to electrode and the electrons streaming to the tungsten electrode generate great heat, so its diameter must be relatively large and it forms a bulbous end. Due to this over heating there is a possibility of tungsten being transferred to the molten pool and contaminating it that is the drawback to the use of the process with electrode +ve.

When the electrode is kept negative the electron stream is now from electrode to work with the zone of greatest heat concentrated in the work piece so that penetration is deep and the pool is narrower. The electrode is now near the zone of lesser heat and needs be of reduced diameter compared with that with +ve polarity.

WORK PIECE : POSITIVE POLARITY

ELECTRODE : NEGATIVE POLARITY

5.1.3 TORCH

There is a variety of torches available varying from light weight aircooled to heavy duty water cooled. The selection of the torch depends on (1) The current used during the welding process (2) The duration of the welding process whether it is a continuous weld or an intermittent weld.

As in our case the current used is medium of about 125A and also the welding process is not a continuous one. Hence an air cooled torch will be sufficient for the welding process.

TORCH: Air cooled Torch

5.1.4 ELECTRODE

Though pure tungsten electrodes may be used, thoriated tungsten electrodes gives easier starting on d.c. with a more stable and little possibility of tungsten contamination in the weld and they have a greater current carrying capacity for a given diameter than pure tungsten.

ELECTRODE: Thoriated Tungsten

Melting point : 3380°C

Boiling point : 5950°C

5.1.5 ELECTRODE SIZE

Selection of electrode size is usually made by choosing one near the maximum range for electrode and work. Too small an electrode will result in overheating and thus contamination of the work with tungsten.

Thickness of the sheet to be welded = 2 mm

From Table 1

For stainless steel material with DCSP and for material thickness upto 3 mm,

The Diameter of the electrode is 2.5 mm.

Electrode diameter = **2.5 mm.**

Table – 1

TIG, Mild steel, Low alloy steel and Stainless steel, DCSP

Metal Thickness (mm)	Current (Amps)	Tungsten size (mm)	Nozzle Size (mm)	Argon m ³ /hr.
1.5	80-120	1.5	6-10	0.4
3	100-120	1.5-2.5	6-10	0.4
6	200-350	3	12	0.45
12	300-450	3-4.5	12	0.5

Table – 2

CURRENT RANGES FOR TUNGSTEN ELECTRODES

Diameter of Tungsten Electrode (mm)	Operating D.C. (Amp)				Size of Gas Nozzle (mm) Inside Diameter	Gas Flow (m ³ /hr)
	Straight Polarity		Reverse Polarity			
			Argon	Helium		
1.0	Upto 65	Upto 55		Upto 10	10	0.25-0.5
1.5	65-180	50-140	Not	10-20	10	0.4-0.6
2.5	125-280	100-225	Recom-	15-35	10-11.5	0.5-0.0.66
3.0	250-475	200-300	Mended	20-50	10-11.5	0.67-1.0
4.0	280-450	225-350		25-60	11.5-12	0.85-1.33
4.5	300-600	250-400		30-80	12-16	1.00-1.67
6.0	375-800	300-475		40-125	16	1.33-2.0

5.1.6 CURRENT

The current setting is determined by the thickness of the weld joint and the type of the metal to be joined. Metals with the high thermal conductivity like copper and aluminium require more heat than metals such as stainless steel. Thicker sections also require more heat than thinner sections of the same metal.

Thickness of the metal to be welded = 2 mm.

Diameter of the tungsten electrode = 2.5 mm

Power Source : DC Straight Polarity (DCSP)

For the above details from **Table 2**.

For tungsten electrode diameter = 2.5 mm.

The value of current is 125 amps.

Current = **125 Amps**.

5.1.7 SHIELDING GAS

The inert monatomic gases argon and helium are used as shielding gas for welding operations. Inert shielding gases are extremely dry and pure. Argon is the most commonly used shielding gas. It provides a lower arc voltage than helium at any given current and arc length. Argon also provides a quieter, smoother-running arc, and arc starting in argon is easier than in

helium. Since argon is a heavy gas, lower flow rates are required to provide good shielding in the down hand position.

GAS: Argon

5.1.8 NOZZLE

All TIG holders have gas nozzles protect the tungsten electrode and also direct the flow of shielding gas at the weld metal most TIG nozzles are made of fairly tough ceramic materials. The ceramic material is usually an aluminium – oxide ceramic which is both heat resistant and an electrical insulator. These qualities are necessary because of tremendous heat of this end of the holder and because the nozzle contains both an electrical tungsten and also hot, ionized shielding gases.

Electrode diameter = 2.5 mm

From Table: 2

For the electrode diameter = 2.5 mm,

Diameter of the nozzle is 10 mm.

Nozzle diameter = 10 mm

5.1.9 GAS FLOW

The gas flow from the argon cylinder should effectively shield the welding area in order to produce a good weld. The gas flow is suitably selected so that a smooth even gas stream is obtained which envelops the electrode.

Electrode diameter = 2.5 mm

From the **table 2**,

For electrode diameter = 2.5 mm

Flow rate = 0.6 m³ / hr.

$$\text{Therefore Flow rate} = \frac{0.6 \times 1000}{60}$$

FLOW RATE = 10 lit / min.

6.2 PNEUMATIC COMPONENTS

6.2.1 DESIGN OF CYLINDERS

The system utilizes two pneumatic cylinders for clamping and lifting purposes. Their diameter and the required stroke length are calculated and other parameters are determined from the catalogue of pneumatic cylinders.

The pressure available for usage for the pneumatic components can be set using the pressure regulator in the FLR unit. The optimum pressure that would suit various pneumatic components is 3 bar.

CYLINDER I

The first cylinder or the clamping cylinder has to clamp the work piece on the table. The following characteristics are considered in selecting the cylinder

- ❖ Double acting short stroke cylinder
- ❖ Rapid response when pressure is applied
- ❖ Larger clamping force in relation to their size.

For the above characteristics the specification of the clamping cylinder according to the standards from the standard pneumatic catalogue and the type of mounting preferable to be used in the circuit are determined as

SPECIFICATON: ADU 20-10

MOUNTING: Flange Mount

CYLINDER – II

For the design of the lifting cylinder the various forces acting on the piston are considered. The pressure available for the component is taken as 3 bar. We have to give a factor of loss, to overcome the frictional losses, pressure drop, etc.

F1 – Total force acting on the piston

Total force acting on the piston = force acting on the piston x loss factor

Total weight acting on the piston = weight of work piece + weight of the assembly or fixture

$$= 0.3 + 4$$

$$= 4.3 \text{ Kg.}$$

F1 = Force acting on the piston

$$= 4.3 \times 10$$

$$= 43 \text{ N}$$

Assume a loss factor of 3

= > Total force acting on the piston = $F_1 \times 3$

$$F_1 = 43 \times 3$$

$$F_1 = 129 \text{ N}$$

Force acting on the piston = Pressure x Area of the piston.

$$F = P \times A$$

$$129 = 3 \times 10^6 \times A$$

$$A = 4.3 \times 10^{-5}$$

$$\pi/4 d^2 = 4.3 \times 10^{-5}$$

$$d^2 = 5.475 \times 10^{-5}$$

$$d = 7.4 \text{ mm}$$

Diameter of the lifting cylinder = 7.4 mm

Assume a factor of safety of 3

The new diameter will be

$$d = 7.4 \times 3$$

$$d = 22.2 \text{ mm}$$

The diameter of the lifting cylinder is corrected to $d=22.2$ mm.

The next standard diameter of cylinder from pneumatic catalogue is **25 mm**.

Now we shall find out the stroke length

$L = \text{Height of the work piece} + \text{clearance}$

$$= 40 + 10$$

$L = 50 \text{ mm}$

Therefore Stroke length of the cylinder = **50 mm**.

Thus the specifications of the lifting cylinder according to the standards from the standard pneumatic catalogue and the type of mounting preferable to be used in the circuit are determined as

SPECIFICATION: DGS – 25 – 50 – PPV

MOUNTING: Flange type

6.3 DESIGN OF MECHANICAL COMPONENTS

6.3.1 INDEXING TOP BRACKET

The indexing top bracket is used to hold the work piece while clamping and carry the work piece to the weld location when lifted.

Max. outer diameter of work piece = 100 mm.

Height of the work piece = 40 mm

$$\begin{aligned} \text{Diameter of indexing top bracket} &= \left\{ \begin{array}{l} \text{max. outer diameter} \\ \text{of work piece} \end{array} \right\} + \left\{ \begin{array}{l} \text{clearance for} \\ \text{fixing over} \\ \text{bottom bracket} \end{array} \right\} \\ &= 100 + 45 \\ &= 145 \text{ mm} \end{aligned}$$

Thickness of the indexing top bracket = 19 mm

(A taper of 7° is provided from PCD 100 mm towards the center of the indexing top bracket).

6.3.2 BOTTOM BRACKET

Base table is the one, which holds the indexing top bracket, the plate should be rigid so it is designed for rigidity.

The outer diameter of the base table

= max outer diameter of the index bottom bracket + clearance.

= 145 + 5

= 150 mm

Thickness of the bottom bracket = 18 mm.

7. FABRICATION

Every component that has to be finished to the required shape, size, and accuracy specifications to suit our project requirements should be taken through various processes like machining, etc. This is collectively known as fabrication. It is quite essential that this should be economical.

In our project the fabrication of machine components was done as per conventional methods involving standard machining process like turning, shaping, milling, slotting, grinding, drilling, welding, gas cutting, etc. The process sheet for the fabrication of the machine components used in our project are shown below.

Sl. No.	Component	OPN No	Operations Involved	Machine Tools & Gauges
1	INDEXING TOP BRACKET	1	Outside diameter turning of $\phi 145$	Lathe
		2	Taper turning of $\phi 100$	Lathe
		3	Drilling of $\phi 25$ hole	Drilling Machine
		4	Drilling of $\phi 10$ hole	Drilling Machine
		5	Drilling of $\phi 10$ hole on PCD 104, 47	Drilling Machine
		6	Grinding	Surface Grinder
		8	Inspection	Vernier Caliper, Depth gauge, steel ruler.
2	BOTTOM BRACKET	1	Outside diameter turning of $\phi 150$	Lathe
		2	Facing on both sides.	Lathe
		3	Drilling of $\phi 18$ hole	Lathe
		4	Drilling of $\phi 25$ hole	Drilling Machine
		5	Drilling of $\phi 50$ hole	Drilling Machine
		6	Drilling of $\phi 15$ hole on PCD 104 & PCD 47	Drilling Machine
		7	Inspection	Vernier Caliper, Depth gauge, steel ruler.

Sl. No.	Component	OPN No	Operations Involved	Machine Tools & Gauges
6	SUPPORTING PIN	1	Facing	Lathe
		2	OD Turning of ϕ 20	Lathe
		3	OD Turning of ϕ 15	Lathe
		4	Facing	Lathe
		5	OD Turning of ϕ 15	Lathe
		6	Inspection	Vernier Caliper
7	ADJUSTING BAR	1	Pre-machining	Shaping Machine
		2	OD Turning of ϕ 47	Lathe
		3	Shaping of ϕ 47 Boring of ϕ 8	Shaping Machine Boring Machine
		4	Drilling of ϕ 20 hole	Drilling Machine
		5	Drilling ϕ 4 hole	Drilling Machine
		6	Inspection	Vernier Caliper
8	TOP CLAMP	1	Pre-machining	Shaping Machine
		2	Drilling of ϕ 5 hole	Drilling Machine
		3	Drilling of ϕ 18 hole	Drilling Machine
		4	CSK Drilling of ϕ 10 hole	Drilling Machine
		5	Inspection	Vernier Caliper
9	BOTTOM CLAMP	1	Pre-machining	Shaping Machine
		2	Drilling of ϕ 5 hole	Drilling Machine
		3	Drilling of ϕ 18 hole	Drilling Machine
		4	Threading of ϕ 5 hole	Tap set
		5	Inspection	Vernier Caliper

COST ANALYSIS

LIST AND COST OF EQUIPMENTS REQUIRED

		Unit Price	Qty	Total
1.	Double acting cylinder DGS-25-50-PPV	1900	1	1900
2.	Double acting cylinder ADU 20-10	1500	1	1500
3.	5/2 DC Valve	1260	2	2520
4.	Silencer U ¼	85	2	170
5.	OD 6 mm tubes for connection	40	10M	400
6.	FLR Unit	2200	1	2200
7.	Foot Mountings ADU	185	1	185
	DGS	125	1	125
8.	TIG Torch Unit	8000	1	8000
9.	Female Connector ACK for DGS	20	2	40
	for ADU	15	2	30
10.	Push-in sleeve QSH	15	4	60
	Total			<u>17100</u>
	Tax at 14%			<u>2394</u>
			Rs.	19494

LIST AND COST OF MATERIALS REQUIRED

1. Raw materials (Aluminium, Mild Steel, Stailess Steel)	400.00
2. Machining cost	100.00
3. Cutting tools used	50.00 -----
TOTAL	550.00

Total Budget Amount : 19494 + 550

= Rs. 20044.

(Rupees Twenty thousand and forty four only)

9. INSTRUCTIONS FOR USE

The following procedure is to be adopted before the welding process,

- ❖ Select the electrode size most suited for the type of metal, joint design and current being used.
- ❖ Insert the electrode in the collet of torch. Make certain that it is firmly held and extends the required distance beyond the end of the nozzle.
- ❖ Move the polarity switch to the correct setting.
- ❖ Make the current adjustments recommended for the size electrode being used.
- ❖ Make all other necessary adjustments on the machine. These will depend, of course, on the type of current being used.
- ❖ Turn on the gas.
- ❖ Adjust the flowmeter for the desired rate of flow
- ❖ Turn the power switch on.
- ❖ Adjust the pressure of the compressed air in the FLR unit.
- ❖ Keep the work piece on the top brakcet.
- ❖ Actuate the clamping cylinder to clamp the work piece.

- ❖ Actuate the lifting cylinder so that the work piece welding spot is at the right position with required spark gap between the welding spot and torch electrode tip.
- ❖ Switch on the torch so that weld is made.
- ❖ Index the top bracket for the next weld position and similarly also for the next two welds.
- ❖ Actuate the lifting cylinder so as to retain to the initial position.
- ❖ Actuate the clamping cylinder so that the work piece is unclamped.
- ❖ Remove the work piece.

10. MAINTENANCE AND TROUBLE SHOOTING

10.1 IN PNEUMATIC CIRCUIT

TROUBLES	CAUSES	REMEDIES
Low or erratic pressure	Pressure regulator set to low Leakage in tubes Defective or worn actuator	Adjust pressure regulator Correct it. Replace it
No Pressure	No Pressure in Compressor Regulator does not work Leakage in compressor line	Test and correct it Replace it. Change the tube connection
Actuator Fails to move	No sufficient pressure Faulty check valve D.C. valve fails to shift check Valve in backward.	Increase the pressure Correct it Correct the D.C. Valve Change the direction
Slow or erratic motion of actuator	Actuator load is excessive Faulty check valve Lack of compressed air Defective pressure regulator	Correct the load. Replace it. Air should be filled in compressor Replace it.

10.2 WELDING PROCESS

Check points for abnormal operation during welding

NO ARC OCCURS:

No high frequency current is generated

- * Power Fuse Blown
- * Spark-gap spacing too large or short circuited.
- * Torch cable disconnected.
- * Welding method selector switch is set to manual

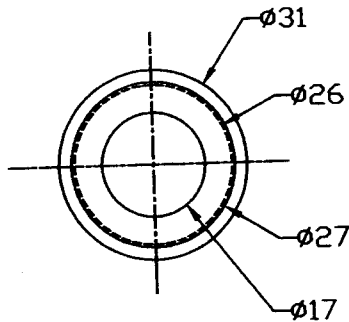
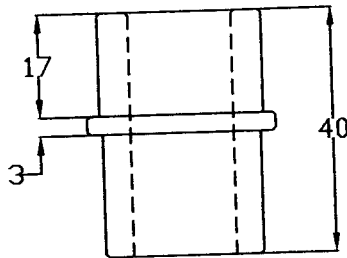
High-frequency current is generated, while no arc occurs.

- * Failure in connecting base metal side cable or poor connection.

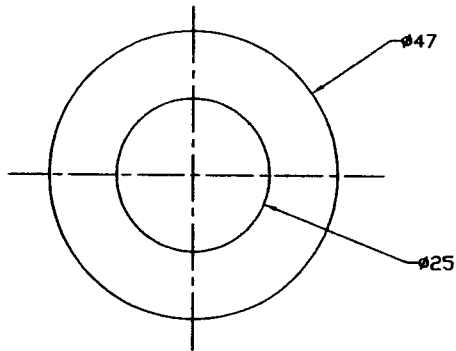
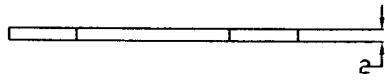
UNSTABLE ARC

Arc is hard to start. Arc is intermittently cut off

- * Tungsten electrode is too thick for the current value.
- * Shielding gas flow rate is too excessive.
- * Shielding gas other than pure Argon gas is used.
- * Poor connection of base metal side cable.



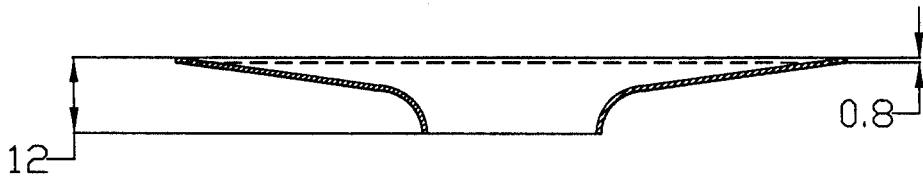
TOLERANCE UNLESS SPECIFIED	NO OFF	MODEL	TYPE	SS	WEIGHT	HARDNESS	REF. DRG.NO	
	ALTERNATIONS							
0. ±0.50	S.NO.	MODIFICATION	NAME	SIGN				
0.0 ±0.20	TITLE				SCALE	DRN BY	NAME	DATE
0.00 ±0.10	BUSH				NTS	CHD BY		
<u>ANGULAR</u>					DRAWING NO:			
DEG MIN					CHANSUBA PUMPS PVT.LTD.			
0 30'	COIMBATORE-641006				ALL DIMENSIONS ARE IN MM			



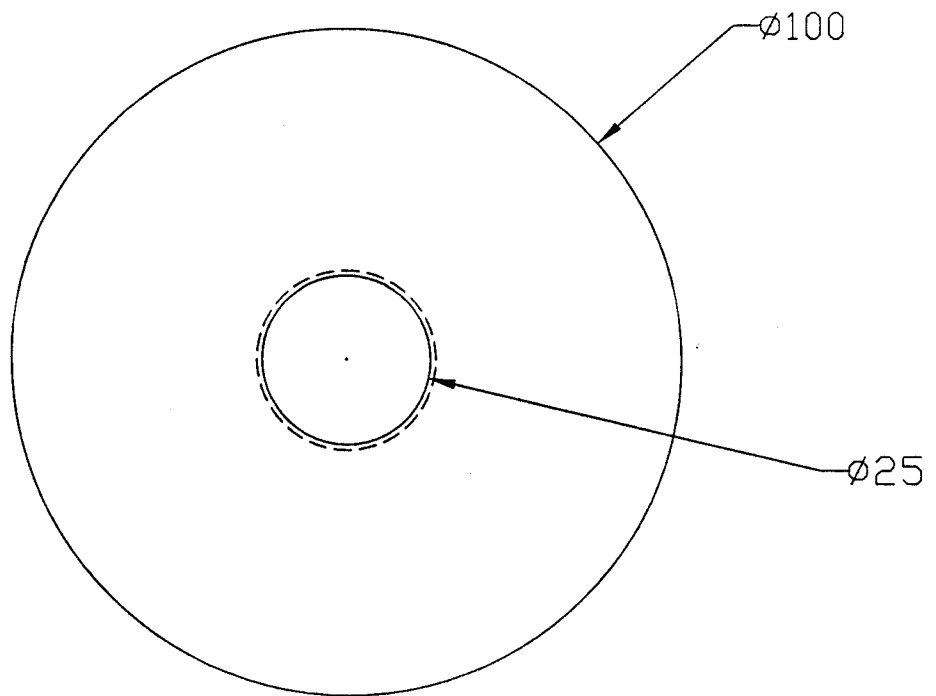
TOLERANCE UNLESS SPECIFIED 0. ±0.50 0.0 ±0.20 0.00 ±0.10 ANGULAR DEG MIN 0 30'	NO OFF	MODEL	TYPE	SS	WEIGHT	HARDNESS	REF. DRG.NO	
	ALTERATIONS							
	S.NO.	MODIFICATION	NAME	SIGN	NAME		DATE	
	TITLE				SCALE	DRN BY		
WASHER				NTS	CHD BY			
CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 ALL DIMENSIONS ARE IN MM				DRAWING NO:				
				SHEET		OF		

Any modification in the drawing should first be incorporated in cad file

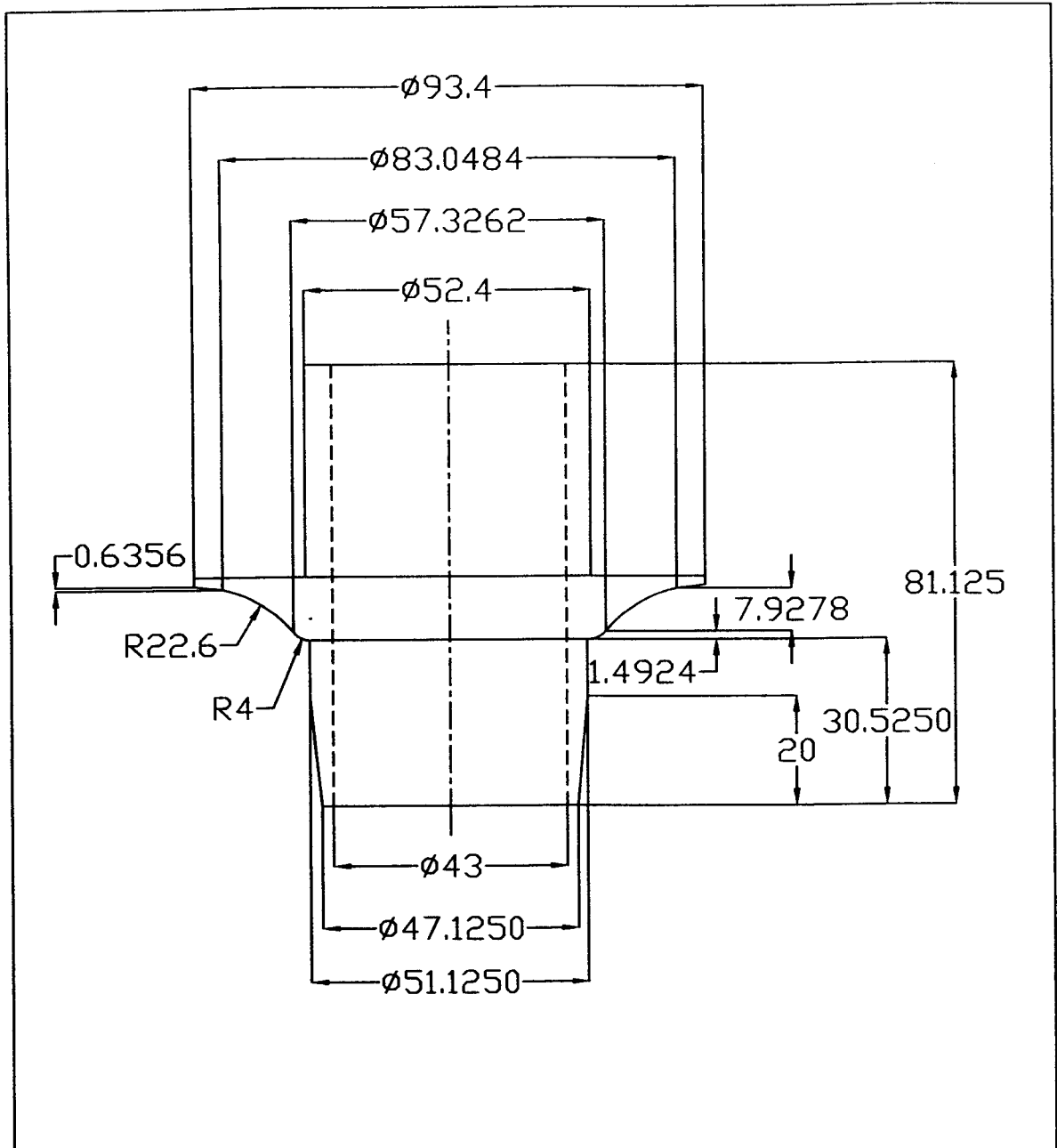
SECTIONAL VIEW



PLAN

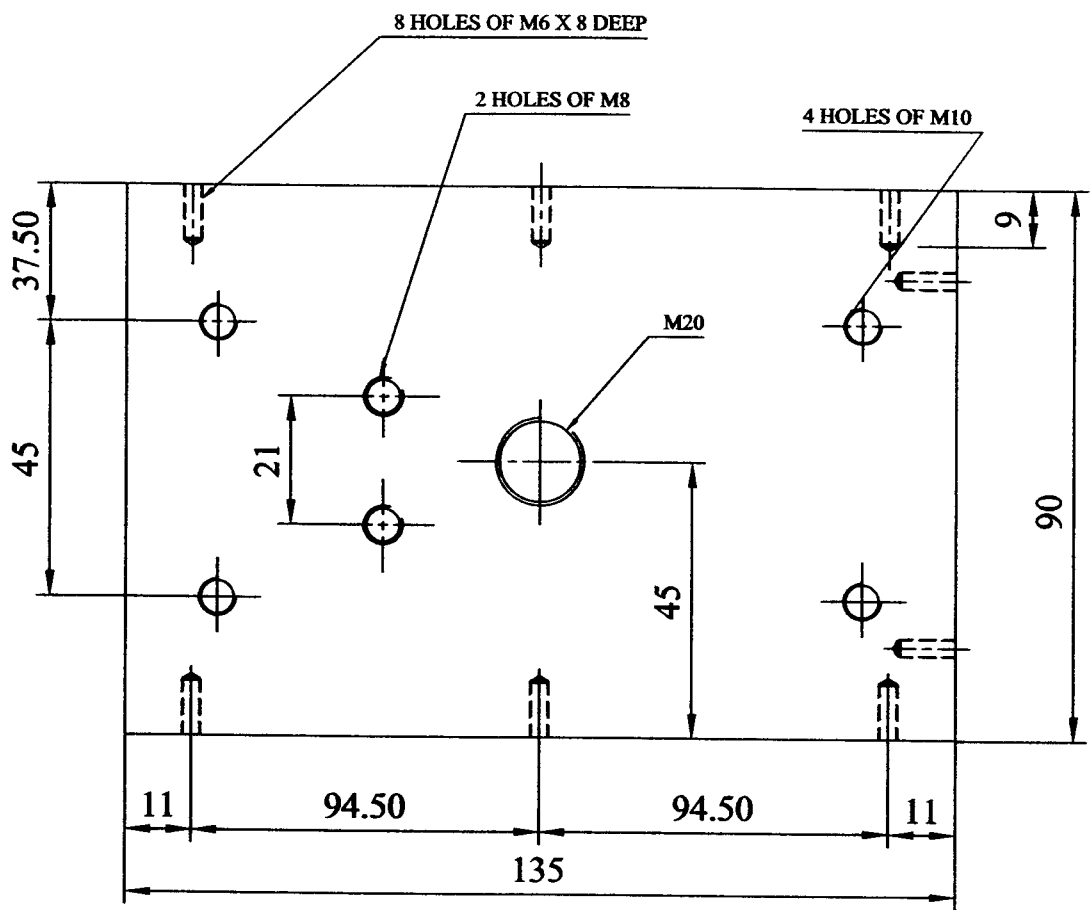
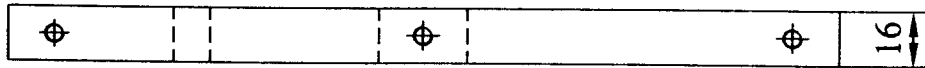


TOLERANCE UNLESS SPECIFIED	SS							
	NO OFF	MODEL	PART NO	MATERIAL	WEIGHT	HARDNESS	REF.DRG.NO	
0 + 0.50								
0 + 0.20								
0 + 0.10								
ANGULAR	TITLE : IMPELLER TOP				SCALE	DRN BY	NAME	DATE
DEG MIN					NTS	CHD BY		
0 30'	CHANSUBA PUMPS PVT.LTD COIMBATORE-641006					APPD BY		
	ALL DIMENSIONS ARE IN MM						DRAWING NO :	
							SHEET	OF



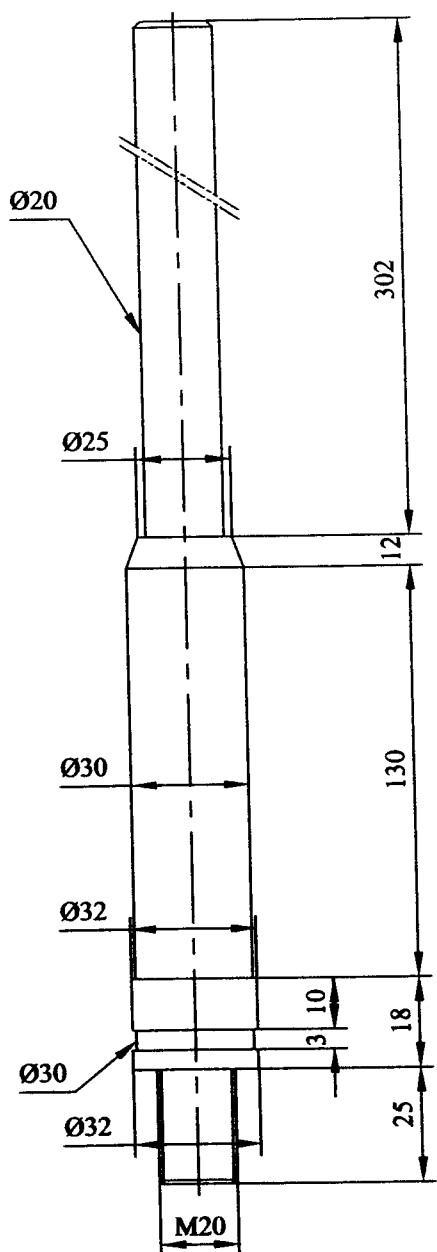
TOLERANCE UNLESS SPECIFIED	NO OFF	MODEL	TYPE	SS	WEIGHT	HARDNESS	REF. DRG.NO	
	ALTERATIONS				SCALE NTS	DRN BY	NAME	DATE
0. ± 0.50	S.NO.	MODIFICATION	NAME	SIGN				
0.0 ± 0.20	TITLE				CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006	SHEET OF		
0.00 ± 0.10	IMPELLER BUSH					ALL DIMENSIONS ARE IN MM		
ANGULAR	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006				SHEET OF			
DEG MIN	ALL DIMENSIONS ARE IN MM				SHEET OF			
0 30'	ALL DIMENSIONS ARE IN MM				SHEET OF			




Any modification in the drawing should first be incorporated in cad file



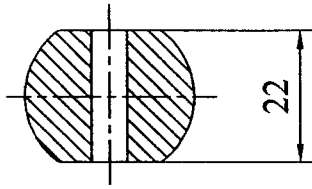
TOLERANCE UNLESS SPECIFIED	1			M.S.					
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO		
	ALTERATIONS								
	S.NO.	MODIFICATION	NAME	SIGN					
0. ±0.50									
0.0 ±0.20									
0.00 ±0.10									
ANGULAR									
DEG MIN									
0 30'									
					CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 ALL DIMENSIONS ARE IN MM		DRAWING NO: SHEET OF		

Any modification in the drawing should first be incorporated in cad file

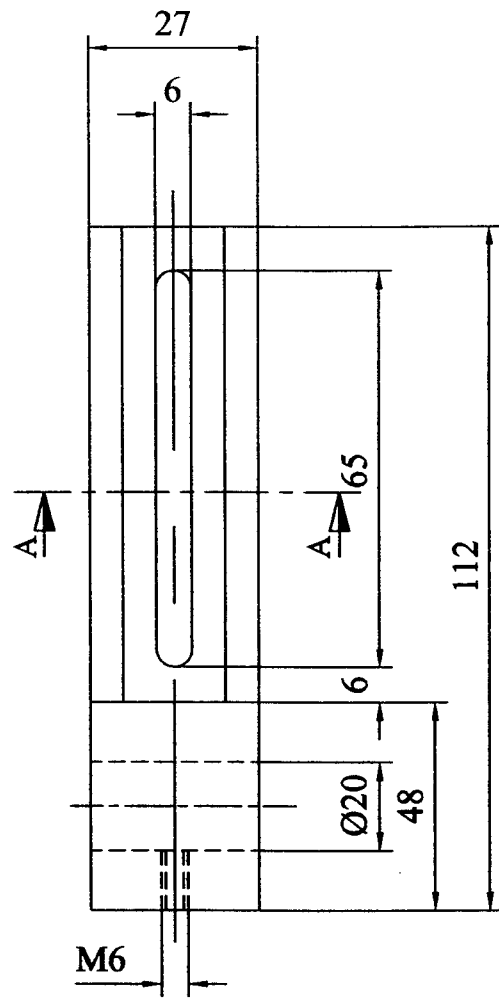



TOLERANCE UNLESS SPECIFIED	01			SS 304				
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ± 0.50 0.0 ± 0.20 0.00 ± 0.10	ALTERATIONS				SCALE NTS	 	NAME	DATE
	S.NO.	MODIFICATION	NAME	SIGN				
ANGULAR	TITLE				DRN BY			
DEG MIN	SHAFT				CHD BY			
0 30'	 CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 ALL DIMENSIONS ARE IN MM				APPD BY			
					DRAWING NO:			
					SHEET	OF		

Any modification in the drawing should first be incorporated in cad file

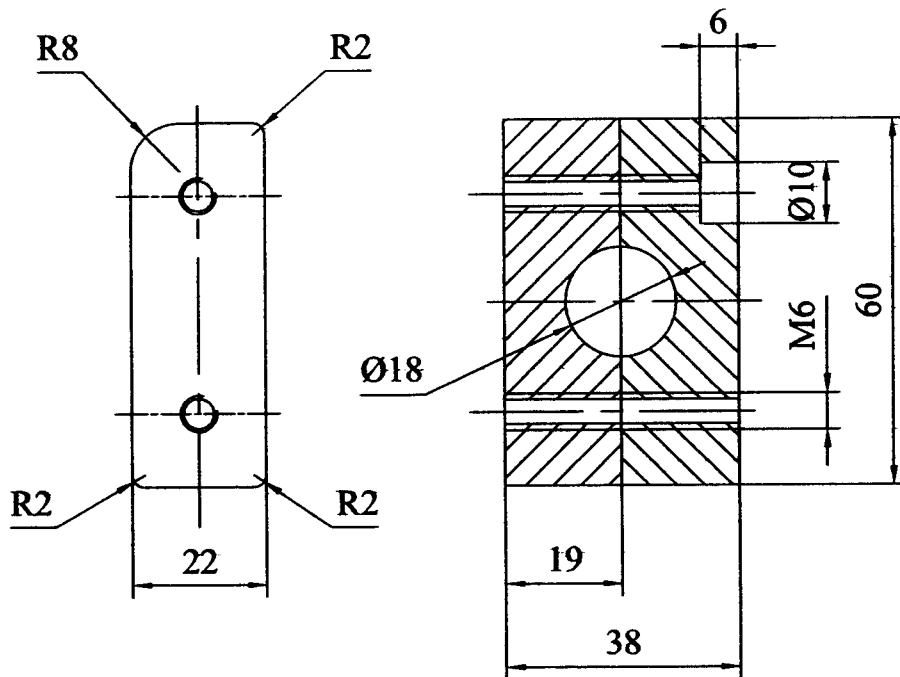


SECTION AT A-A



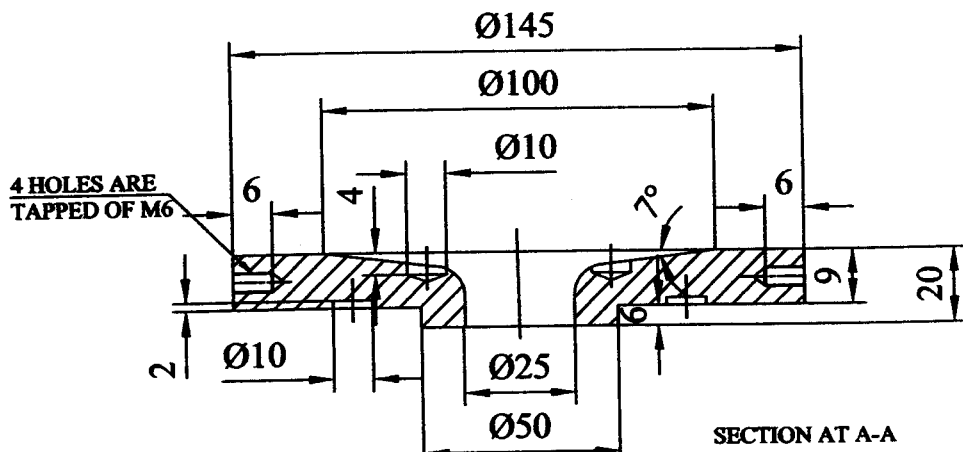
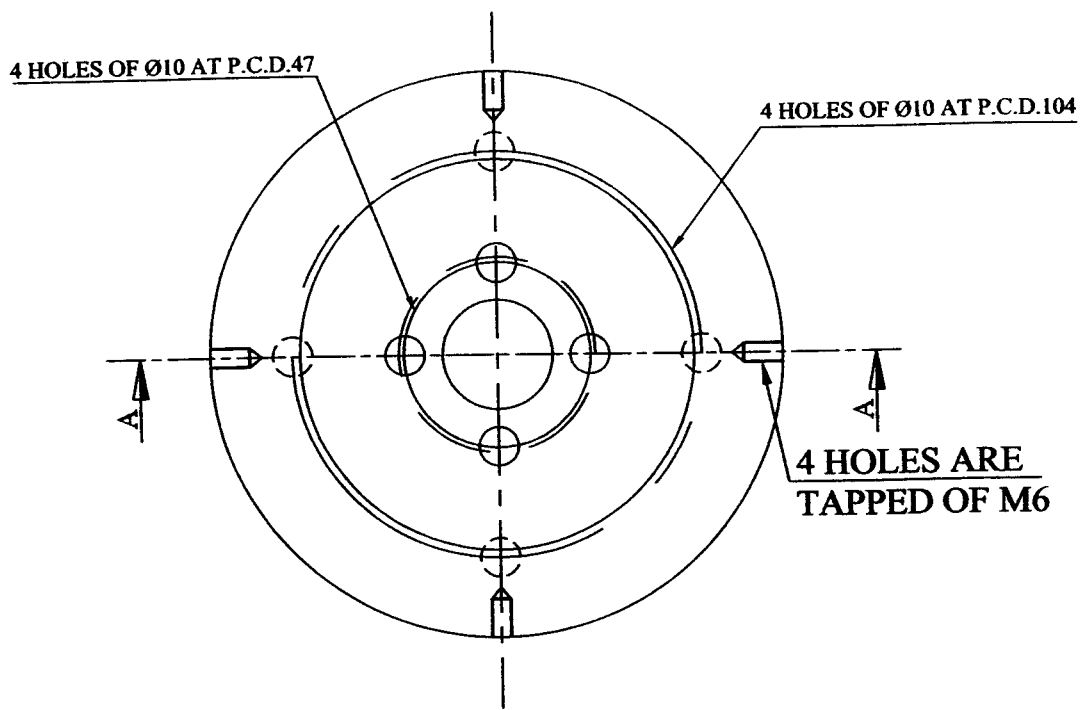
TOLERANCE UNLESS SPECIFIED	1			Al			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS				SCALE NTS	DRAWING NO:	SHEET OF
	S.NO.	MODIFICATION	NAME	SIGN			
ANGULAR DEG MIN 0 30'	TITLE ADJUSTING BAR				DRN BY	NAME	DATE
	 CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 ALL DIMENSIONS ARE IN MM				CHD BY		
					APPD BY		

Any modification in the drawing should first be incorporated in cad file



TOLERANCE UNLESS SPECIFIED	1			Al															
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO												
	ALTERATIONS																		
	S.NO.	MODIFICATION	NAME	SIGN															
0. ±0.50					<table border="1"> <tr> <td></td> <td>NAME</td> <td>DATE</td> </tr> <tr> <td>DRN BY</td> <td></td> <td></td> </tr> <tr> <td>CHD BY</td> <td></td> <td></td> </tr> <tr> <td>APPD BY</td> <td></td> <td></td> </tr> </table>				NAME	DATE	DRN BY			CHD BY			APPD BY		
	NAME	DATE																	
DRN BY																			
CHD BY																			
APPD BY																			
0.0 ±0.20	TITLE				SCALE														
0.00 ±0.10	TORCH HOLDER				NTS														
ANGULAR	CHANSUBA PUMPS PVT.LTD.				DRAWING NO:														
DEG MIN	COIMBATORE-641006																		
0 30'	ALL DIMENSIONS ARE IN MM				SHEET OF														

Any modification in the drawing should first be incorporated in cad file

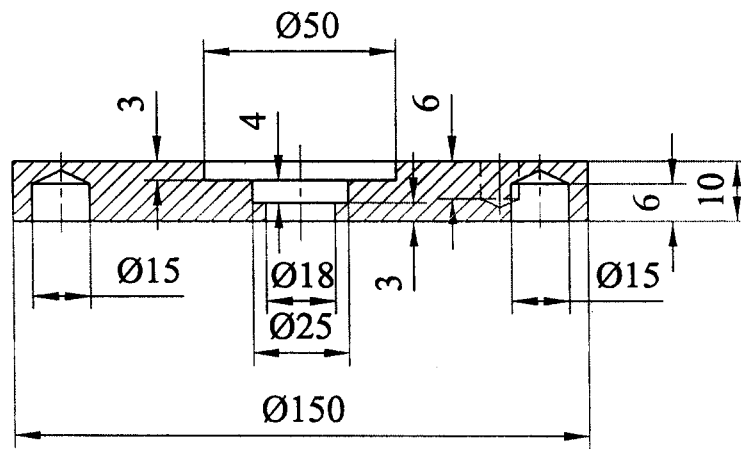
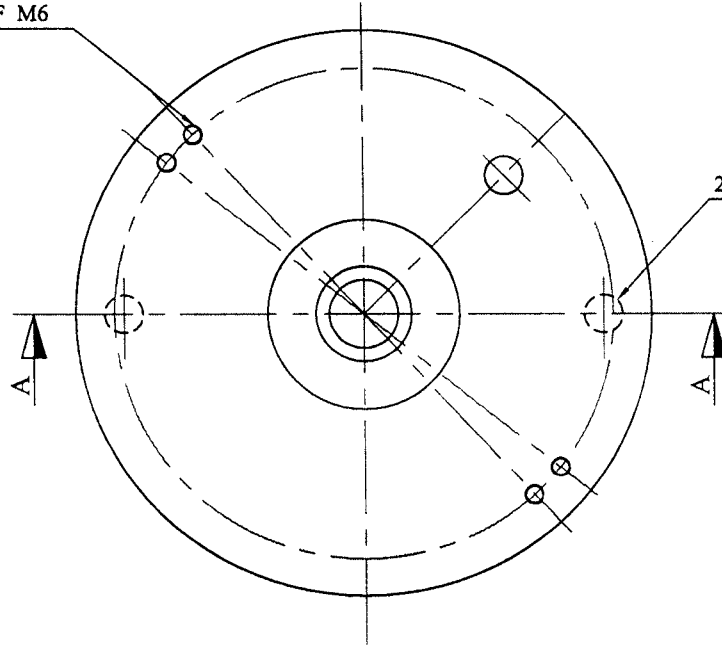


TOLERANCE UNLESS SPECIFIED	1				M.S.			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS				SCALE NTS			
	S.NO.	MODIFICATION	NAME	SIGN		NAME	DATE	
ANGULAR	TITLE				DRN BY			
DEG MIN	TOP BRACKET				CHD BY			
0 30'	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006				APPD BY			
	ALL DIMENSIONS ARE IN MM				DRAWING NO:			
					SHEET	OF		

Any modification in the drawing should first be incorporated in cad file

4 HOLES OF M6

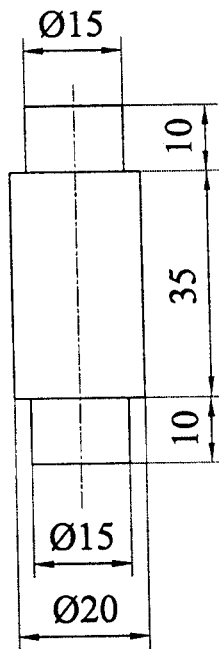
2 HOLES OF Ø10 X DEEP



SECTION AT A-A

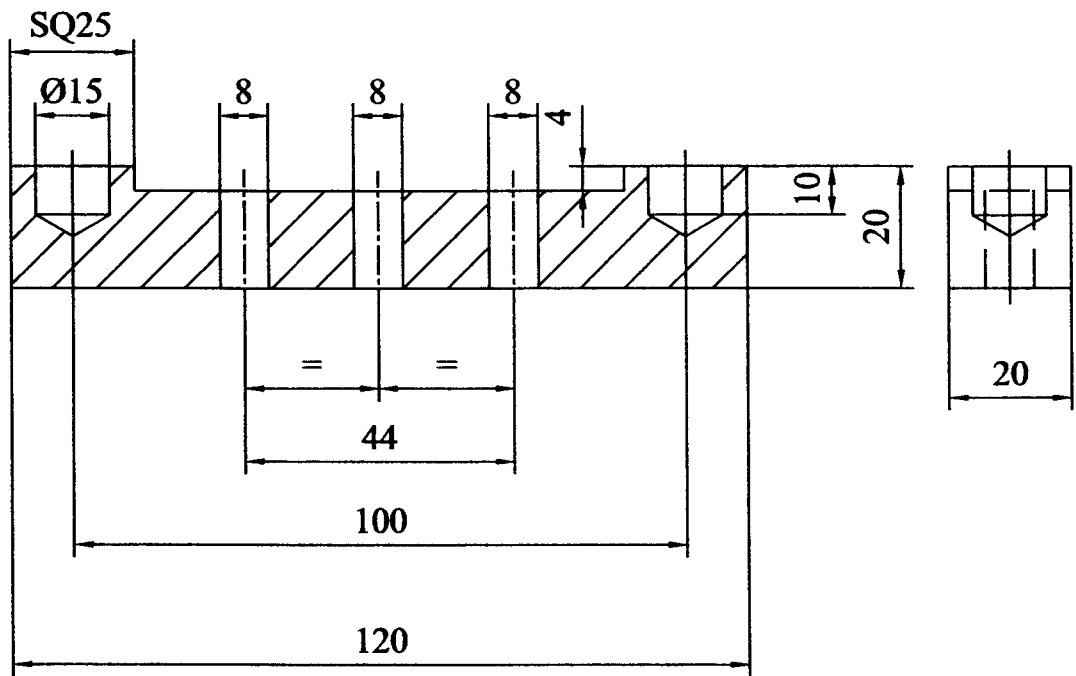
TOLERANCE UNLESS SPECIFIED	1			M.S.				
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
	ALTERATIONS							
	S.NO.	MODIFICATION		NAME	SIGN	NAME	DATE	
0. ±0.50	TITLE				SCALE	DRN BY		
0.0 ±0.20	BOTTOM BRACKET				NTS	CHD BY		
0.00 ±0.10						CHANSUBA PUMPS PVT.LTD.		APPD BY
ANGULAR	COIMBATORE-641006				DRAWING NO:			
DEG MIN	ALL DIMENSIONS ARE IN MM				SHEET OF			
0 30'								

Any modification in the drawing should first be incorporated in cad file



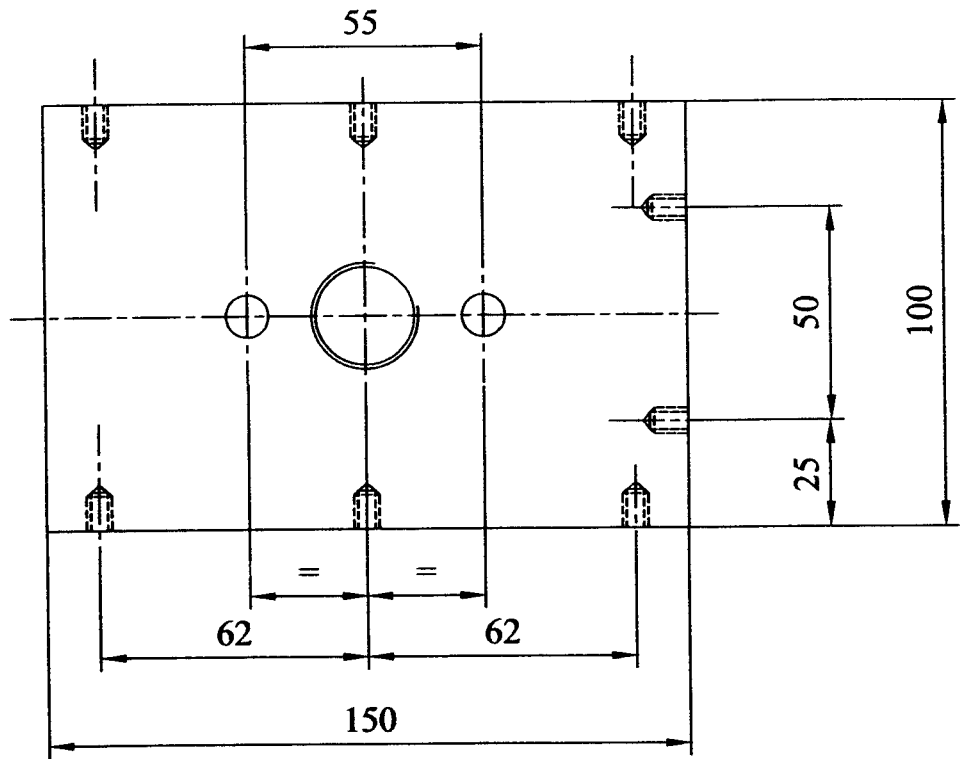
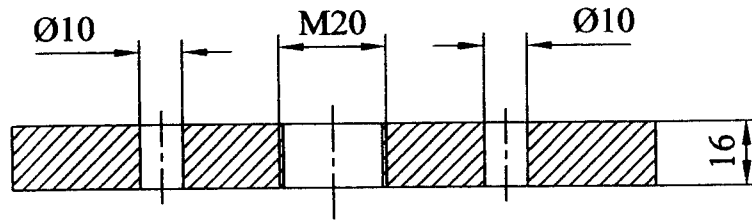
TOLERANCE UNLESS SPECIFIED	2			M.S.				
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS				SCALE NTS			
	S.NO.	MODIFICATION	NAME	SIGN			NAME	DATE
ANGULAR	TITLE				DRN BY			
DEG MIN	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006				CHD BY			
0 30'					ALL DIMENSIONS ARE IN MM			
					DRAWING NO:			
					SHEET	OF		

Any modification in the drawing should first be incorporated in cad file



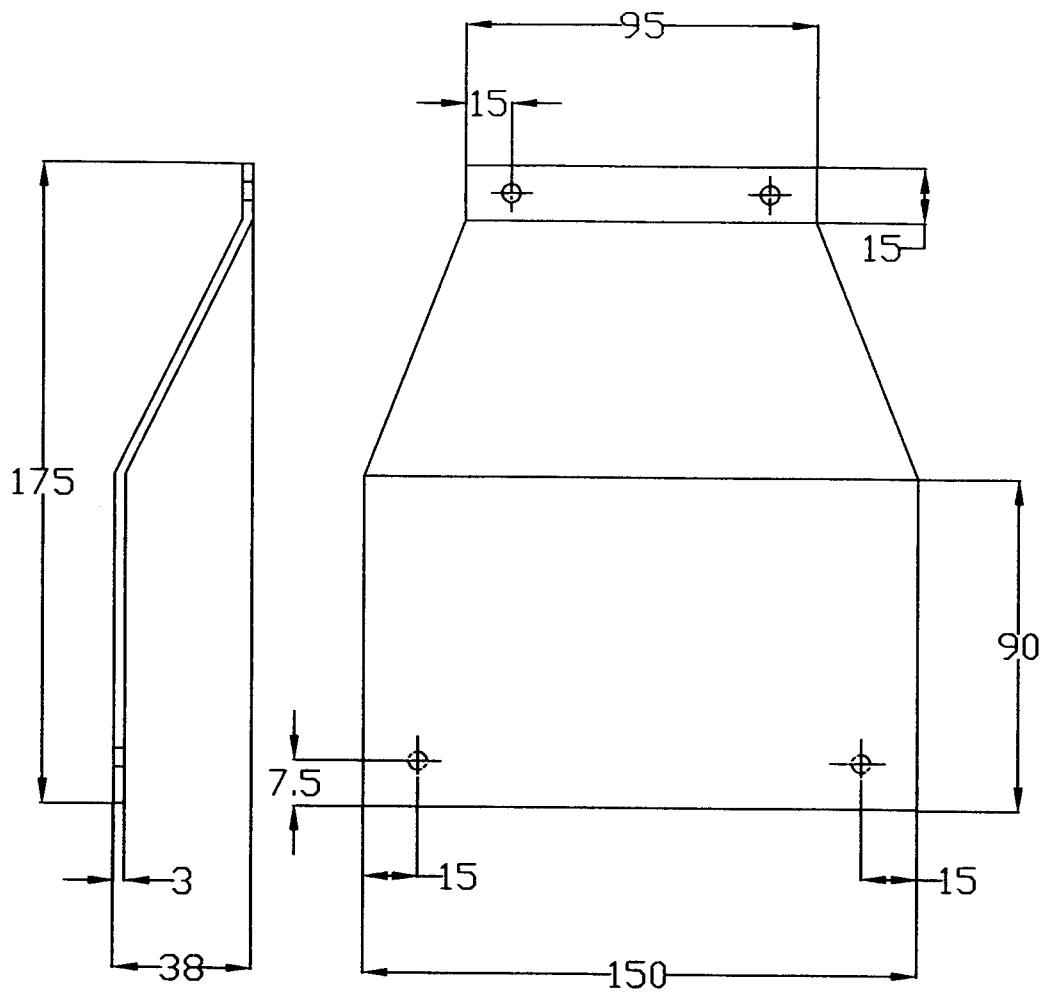
TOLERANCE UNLESS SPECIFIED	1			Al				
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ±0.50 0.0 ±0.20 0.00 ±0.10 <u>ANGULAR</u> DEG MIN 0 30'	ALTERATIONS							
	S.NO.	MODIFICATION	NAME	SIGN				
	TITLE				SCALE	DRN BY	NAME	DATE
	SUPPORTING RIB				NTS	CHD BY		
				DRAWING NO:				
CHANSUBA PUMPS PVT.LTD.				SHEET				
COIMBATORE-641006				OF				
ALL DIMENSIONS ARE IN MM								

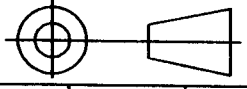
Any modification in the drawing should first be incorporated in cad file



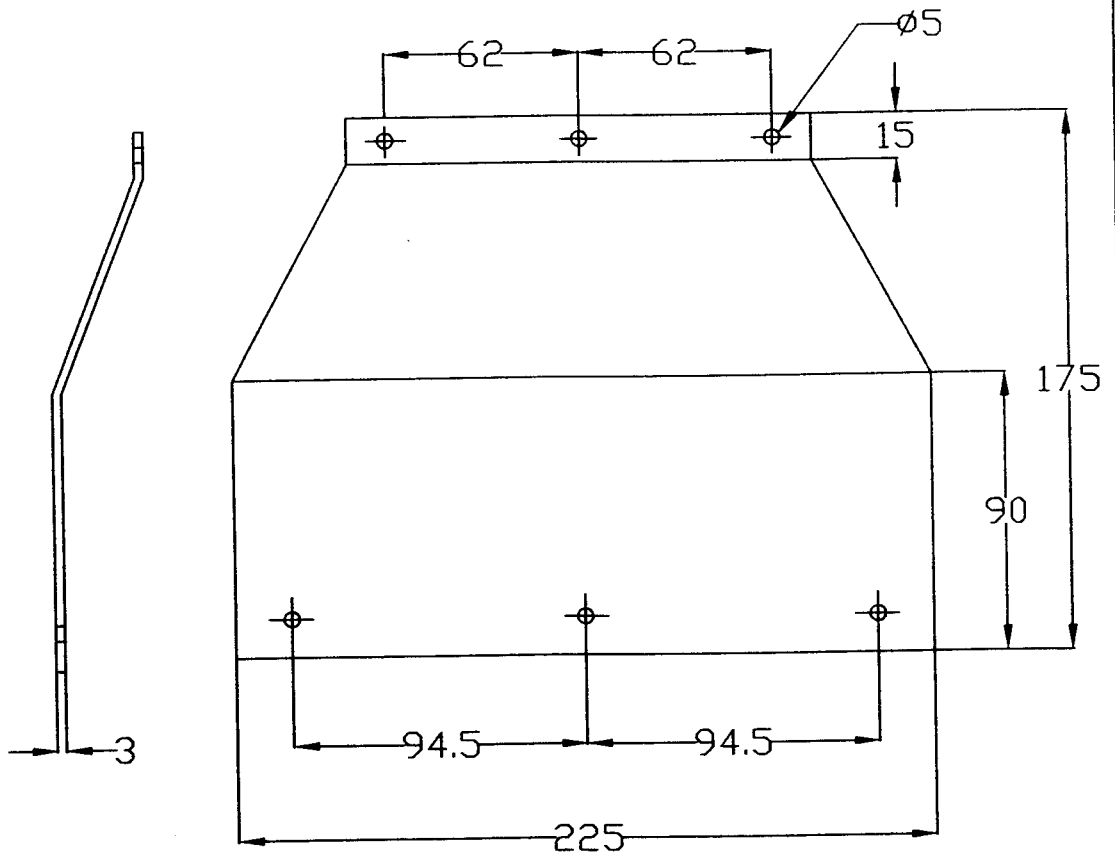
TOLERANCE UNLESS SPECIFIED 0. ±0.50 0.0 ±0.20 0.00 ±0.10 ANGULAR DEG MIN 0 30°	1			M.S.				
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
	ALTERATIONS							
	S.NO.	MODIFICATION		NAME	SIGN	NAME		
TITLE				SCALE	DRN BY			
PLATE				NTS	CHD BY			
CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006				DRAWING NO:				
ALL DIMENSIONS ARE IN MM				SHEET OF				

Any modification in the drawing should first be incorporated in cad file



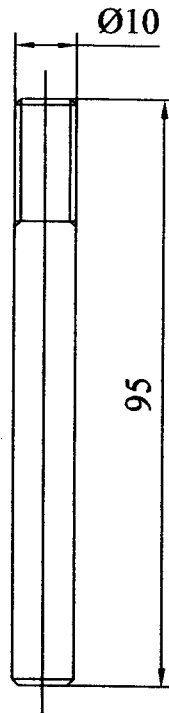
TOLERANCE UNLESS SPECIFIED	1			SS SHEET			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS						
	S.NO.	MODIFICATION	NAME	SIGN			
	ANGULAR	TITLE				SCALE	NAME
DEG MIN 0 30'	SIDE COVER				NTS	DRN BY	
	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006					CHD BY	
	ALL DIMENSIONS ARE IN MM					APPD BY	
						DRAWING NO:	
						SHEET	OF

Any modification in the drawing should first be incorporated in cad file



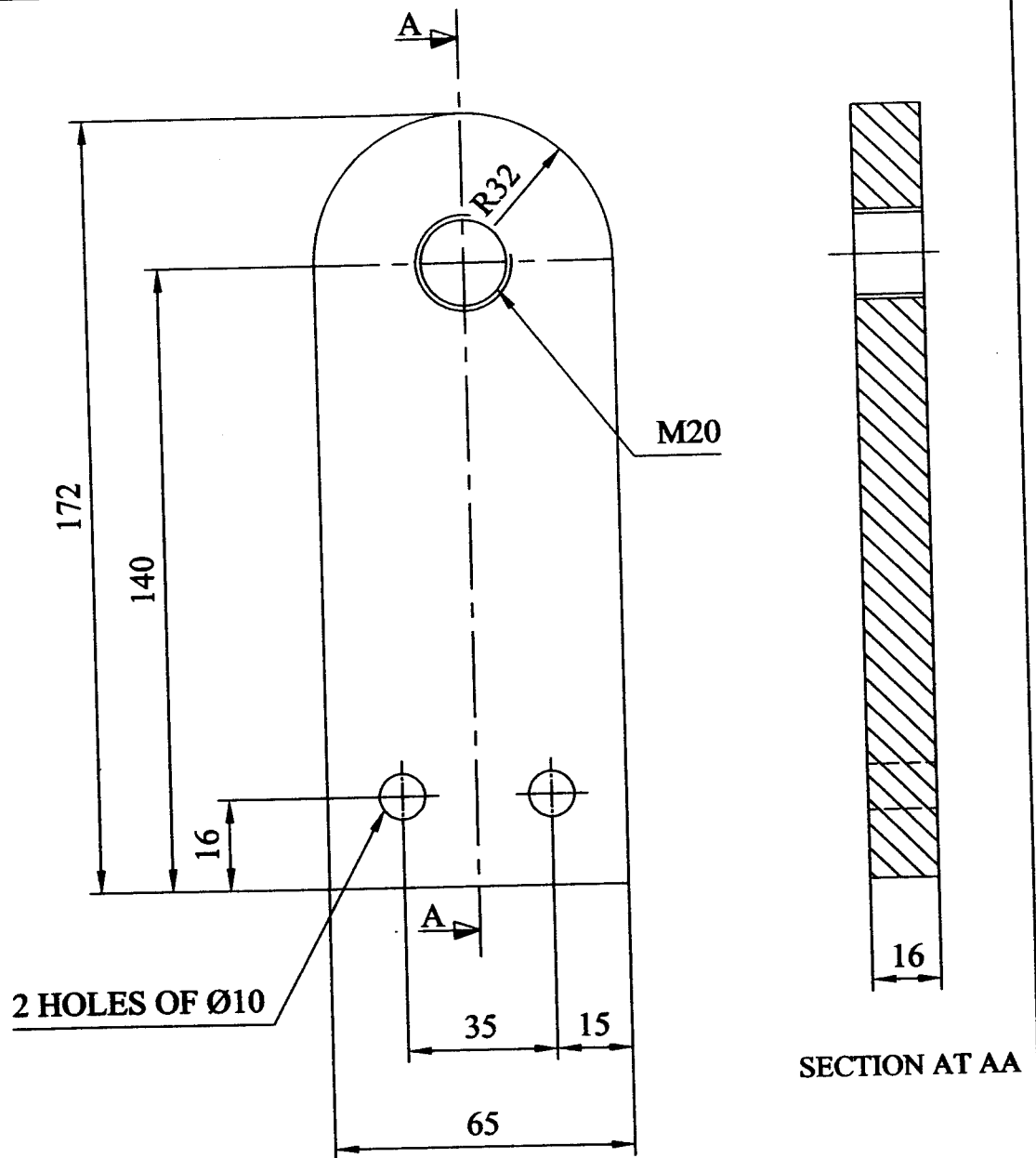
TOLERANCE UNLESS SPECIFIED								
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS							
	S.NO.	MODIFICATION	NAME	SIGN				
ANGULAR	TITLE				SCALE	DRN BY	NAME	DATE
DEG MIN 0 30'	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 ALL DIMENSIONS ARE IN MM				NTS	CHD BY		
					DRAWING NO:		APPD BY	
					SHEET	OF		

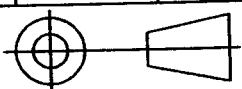
Any modification in the drawing should first be incorporated in cad file



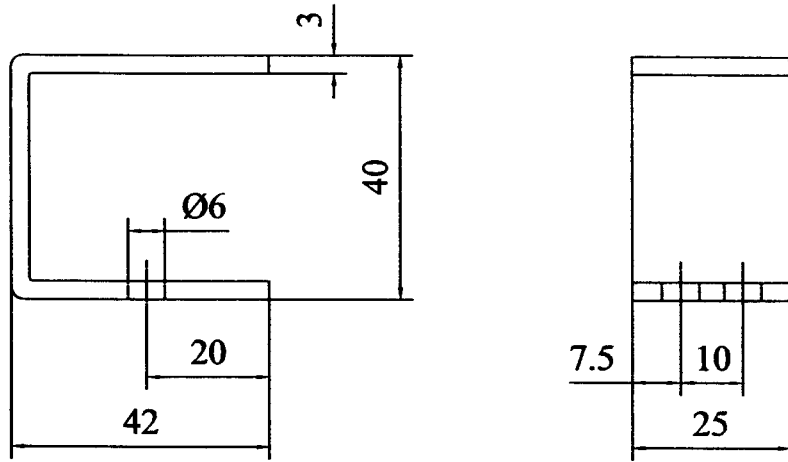
TOLERANCE	2				M.S.			
	UNLESS SPECIFIED	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO
	ALTERATIONS							
	S.NO.	MODIFICATION		NAME	SIGN			
0. ±0.50								
0.0 ±0.20	TITLE					SCALE	DRN BY	NAME
0.00 ±0.10	STEM					NTS	CHD BY	DATE
ANGULAR						DRAWING NO:		
DEG MIN	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006					SHEET		
0 30'						OF		
	ALL DIMENSIONS ARE IN MM							

Any modification in the drawing should first be incorporated in cad file



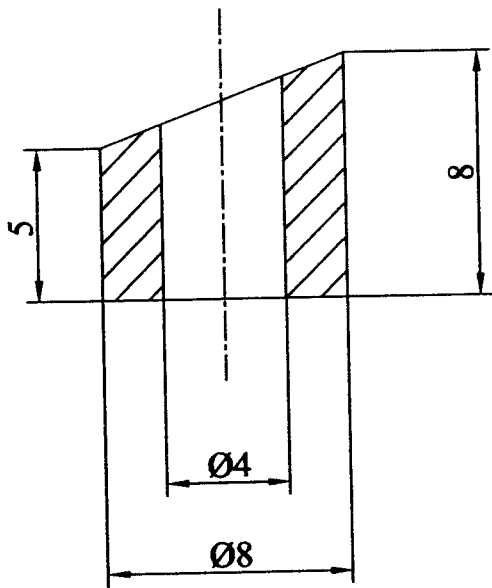
TOLERANCE UNLESS SPECIFIED	1			M.S.			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO
	ALTERATIONS					NAME	DATE
	S.NO.	MODIFICATION	NAME	SIGN			
0. ±0.50	TITLE			SCALE	DRN BY		
0.0 ±0.20	SHAFT BASE PLATE			NTS	CHD BY		
0.00 ±0.10					APPD BY		
<u>ANGULAR</u>	CHANSUBA PUMPS PVT.LTD.				DRAWING NO:		
DEG MIN	COIMBATORE-641006						
0 30'	ALL DIMENSIONS ARE IN MM				SHEET	OF	

Any modification in the drawing should first be incorporated in cad file



TOLERANCE UNLESS SPECIFIED	2			SS 304			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS				SCALE NTS		
	S.NO.	MODIFICATION	NAME	SGN		NAME	DATE
ANGULAR	TITLE				DRAWING NO:		
DEG MIN 0 30'	CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006					SHEET	OF
	ALL DIMENSIONS ARE IN MM						

Any modification in the drawing should first be incorporated in cad file



TOLERANCE UNLESS SPECIFIED	1				M.S.			
	NO OFF	MODEL	TYPE	MATERIAL	WEIGHT	HARDNESS	REF. DRG.NO	
0. ±0.50 0.0 ±0.20 0.00 ±0.10	ALTERATIONS							
	S.NO.	MODIFICATION	NAME	SIGN			NAME	DATE
ANGULAR	TITLE					SCALE	DRN BY	
DEG MIN	INDEXING PIN CHANSUBA PUMPS PVT.LTD. COIMBATORE-641006 <small>ALL DIMENSIONS ARE IN MM</small>					NTS	CHD BY	
0 30'							DRAWING NO:	
		SHEET	OF					

Any modification in the drawing should first be incorporated in cad file

12. CONCLUSION

The aim of our project to implement the concept of semi-automation on TIG welding process for the Company's advantage has been achieved successfully. We hope that the project serve its purpose in the company useful to them as a production tool.

We are very happy that the problem faced by the company in welding the impeller bush that has been identified by us during the study is solved and the productivity has been increased by the use of semi-automation. We hope this project serves as a typical example of simplification and we expect this project to be a small stepping stone in the road to creating a revolution in manufacturing processes involving simple, easy, safe and economical methods.

The TIG welding setup having the following features has been designed, fabricated and the trial production is taken.

1. Work piece clamping fixture – reduces the man power
2. Compact and portable fixture.
3. Selection of weld position in easier due to indexing arrangement.

The equipment and fixture has been completed in collaboration with and under the guidance from CHAN SUBA PUMPS PVT. LTD., Saravanampatty and is now at use with them.

13. BIBLIOGRAPHY

TITLE	AUTHOR	PUBLISHER
The Science and Practice of Welding	A.C.Davies	Cambridge University Press, Cambridge.
Welding Skills and Technology	Dave Smith	McGraw-Hill International Editions
Welders Guide and Hand Book	James E.Brum baugh	D.B.Tara porevala Sons & Co. Pvt. Ltd.
Welding and Welding Technology	Richard L.Little	Tata-McGraw-Hill Publishing Co. Ltd.
Welding Engineering	R.L.Agarwal Tahil Manghnani	Khanna Publishers.
Pneumatic Catalogue		Festo
Fluid Power with Applications	Anthony Esposito	Mc-Graw-Hill International Editions.
Design Data Book		P S G

Rating

Item	Model	Weldtronic LST 300
Rated input voltage	V	415 ± 10%
No. of phase		3-Phase
Rated frequency	Hz	50
Rated input	KVA	16.1
	Kw	13.5
Rated duty cycle	%	60
Start up voltage (DC)	V	105
Output current (DC)	A	5 ~ 300
Output Load voltage (TIG)	V	16 ~ 20
Output Load voltage (Manual)	V	20 ~ 32
Gas pre-flow	Sec	0.3
Gas post-flow	Sec	2 ~ 23
Adjustable Arc spot time	Sec	0.5 ~ 5
Up-slop time range	Sec	0.2 ~ 10
Down-slop time range	Sec	0.2 ~ 10
Pulse frequency (Adjustable)	Sec	0.5 ~ 15
Pulse width	%	50
Initial current adjustment		With Crater "ON" & "Repeat" only for TIG WELDING.
Weight	Kgs.	119

Accessories

Glass fuse 1

Optional Accessories (Required for GTA Welding)

GTA Welding Torch with Accessories (Water Cooled or Air cooled) 1

Gas Regulator with flow meter 1

Optional Accessories (Required for SMA Welding)

400 Amps Electro Holder with Copper Cable 1

Preliminary Arrangements for Operation

Please check the following :

(1) Power equipment capacity and connecting cable

Weldtronic LST 300		
Supply Voltage	3-phase, 415 V \pm 10%, 50 Hz Ac	
Equipment capacity (Minimum)	20 KVA	
Switch box Capacity	For fuse	32A
	No-fuse breaker	32A
Input Cable (Copper)	14 mm ² min.	
Output Cable (Copper)	50 mm ² min.	

Note : Since a sudden inflow of current to the welding machine may trip the no-fuse breaker, the use of a breaker suitable for welding machine or motor of rated capacity.

(2) TIG welding torch :

It is recommended to use either gas cooled or water cooled TIG Torch, preferably the one marked by *Electro Equipment Services*.

(3) Argon gas :

Welding grade argon gas with purity 99.9% minimum should be used.

(4) Gas Regulator & flow meter :

Use gas regulator & flow meter , preferably the one marked by *Electro Equipment Services*.

(5) Cooling water equipment :

While using a water-cooled TIG welding torch, ensure the adequate flow of clean water. The equipment can be connected with Aquapac Unit with separate 220 V, 1 PH, 50 Hz AC line.

- Installation place :**

The machine should be installed at a place in accordance with the following guidelines :

- Indoor, free from moisture and dust
- Place under ambient temperature 0° to + 45° C.
- Place not subjected to abnormal vibration or shock.
- Place not exposed to direct sunlight or rainfall
- Place 20 cm. or more apart from the wall surface.

Place free from oil stream or detrimental corrosive gas.

Connections

The standard configuration of the welding machine will be as below. Follow the connection diagram below, before switch 'ON' the equipment.

- **TIG Welding**

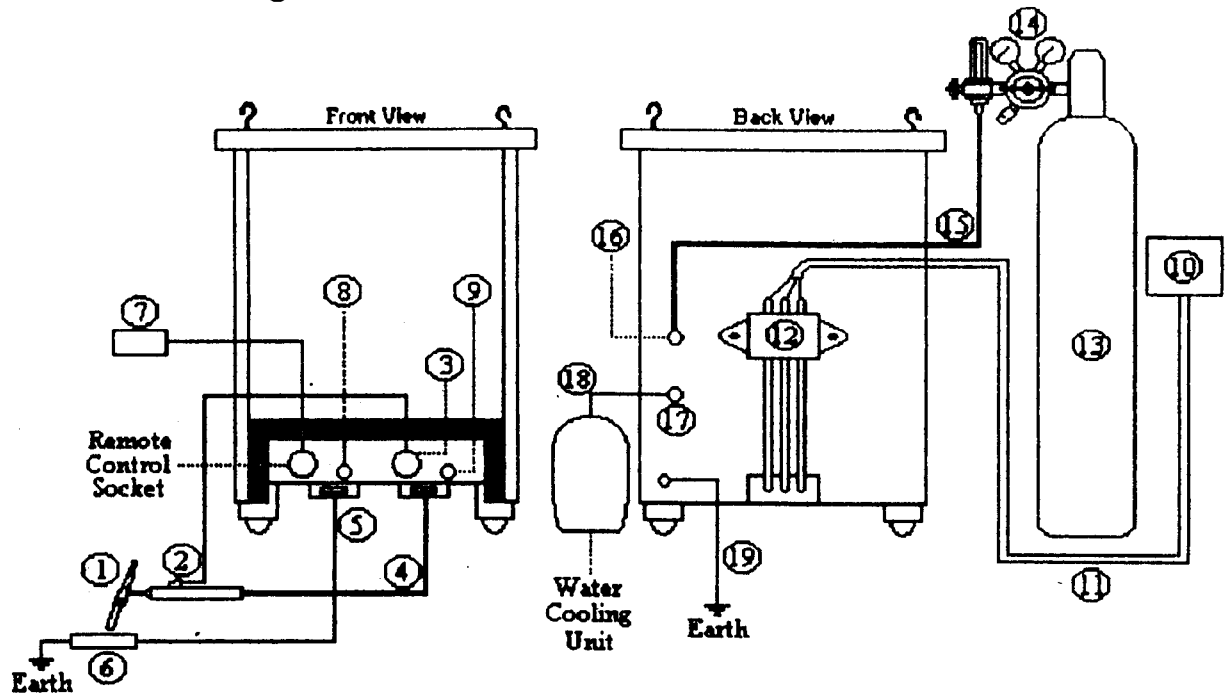


Fig. 1

- Always connect only TIG torch and base metal side cable to the output terminal.
- Be sure to apply insulated tape to the conductive part in such a manner that it is not exposed after connections.

Illustrated No.	Description	Illustrated No.	Description
1	* TIG Torch	11	* Input Cable
2	* Torch Switch	12	Terminal Input Cover
3	Torch Switch Socket	13	* Gas Cylinder
4	Output Terminal (TIG Torch)	14	* Gas Regulator
5	* Base Metal Side Cable	15	Gas Hose
6	* Base Metal	16	Gas Inlet Connection
7	* Remote Controller (Note #1)	17	Water Inlet Connection
8	Gas Outlet Metal	18	* Feed Water Hose
9	Water Outlet Connection	19	* Earth Cable (14 mm Sq.min.)
10	* Switch Box		

Asterisked (*) Items are optional

* **Note 1) This machine can be used even without a remote controller. When using an optional remote controller, always connect it to the remote controller socket showed above.**

• **Manual Welding**

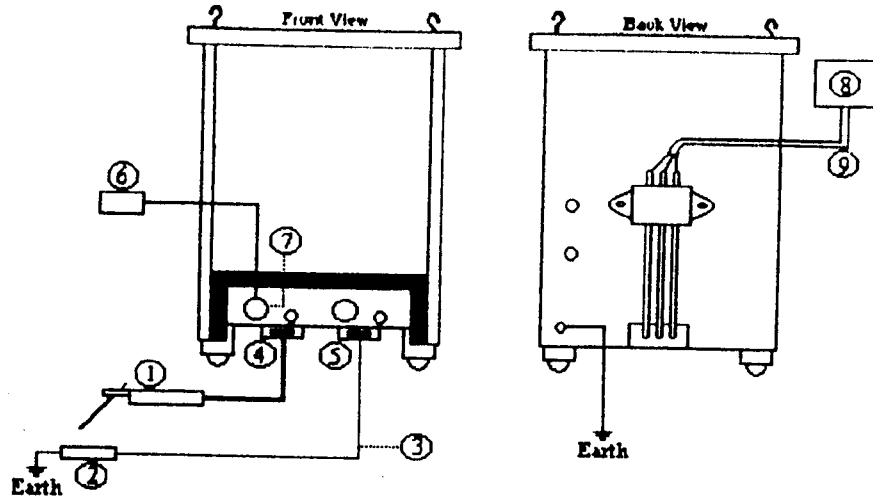


Fig.2

- Connect a holder and base metal side cable according to the proper polarity of manual welding electrode to be used.

Illust No.	Description
* 1	Holder
* 2	Base metal
* 3	Base metal side cable
4	Output terminal (Base metal side)
5	Output terminal (TIG torch side)
* 6	Remote controller
* 7	Socket for remote controller
8	Power distribution box
* 9	Input cable

Asterisked (*) Items are optional

OPERATION

Power Panel

The Welding conditions are pre-set on the operational panel of the front power source.

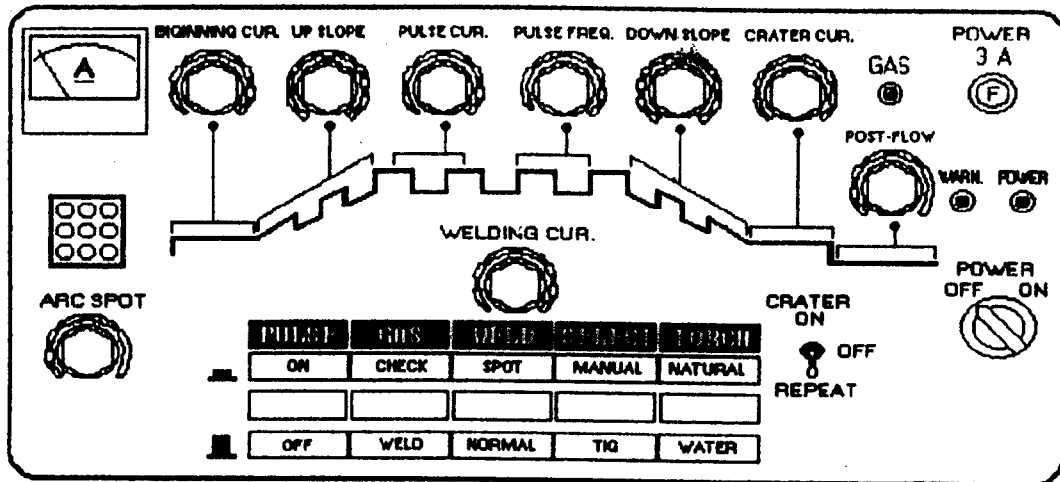


Fig. 3

Welding operation

Power source : With power 'ON', the power lamp lights up and the cooling fan rotates.

Torch : When using an air-cooled torch, set the switch to 'NATURAL', and set it to 'WATER' when using a water-cooled one

When the switch set to 'WATER', the 'WARN' lamp lights up if the water flow is below the specified level, thereby the machine operation will be stopped.

Select : Set the switch to 'TIG' or 'MANUAL' according to the welding method. When the switch is set to 'MANUAL' voltage always remains applied to the output terminal. Using the welding current regulator to adjust welding current.

Weld : Set the switch 'NORMAL' when performing normal welding GTA/SMA operation, and set it to 'SPOT' for arc spot welding. The arc spot time can be pre-set, using the arc spot timer potentiometer.

Gas : Set the switch to 'CHECK' to optimise the gas flow rate.

WARNING * Do not press the torch switch for checking the gas flow. The torch switch operates the machine; therefore, avoid pressing the torch switch and do not touch the electrode tip.

- Pulse** : For normal welding, set the switch to 'OFF', and set it to 'ON' for pulse TIG welding.
- Crater** : Set the switch to 'ON' or 'REPEAT' when crater control is required in TIG welding.
- Post-flow** : Set the post-flow time limit for shielded gas according to welding and tungsten electrode diameter.

Note : When using a remote controller :-

- * A remote controller can be automatically used by connecting it to the remote controller socket.
- * It becomes possible to adjust welding current and crater current, using a remote controller.

OPERATION CONDITION

Prior to operation, refer to the following :-
For tungsten electrode, see table below.

Electrode rod (dia.) (mm)	1.0	1.6	2.4	3.2	4.0
Welding current (A) (DC positive polarity)	5-50	30-150	150-250	250-400	400-500

- **Shielding gas for TIG welding**

For shielding for TIG welding, use welding argon gas. Presence of impurities such as oxygen, moisture and nitrogen in argon gas may deteriorate shielding performance and the quality of the weld zone will be severely effected.

For the filler wire, the material is determined by the base metal, and thickness is determined by the welding current value. In general, the same quality material as base metal is used, and in special cases such the different types of metal is welded, it is important to select a proper material according to applications.

Hints on Filler Wire Diameter Selection

Welding Current (A)	Filler Wire Dia. (mm)
10 - 20	1.0
20 - 50	1.6
50 - 100	1.0 - 2.4
100 - 200	1.6 - 3.0
200 - 300	2.4 - 4.5
300 - 500	4.5 - 6.0

CHECK POINTS FOR ABNORMAL OPERATION**• No arc occurs**

No high-frequency current is generated

Power fuse (3A) blown

Spark-gap spacing too large or short circuited

Torch cable disconnected

Welding method selector switch is set to 'MANUAL'

High-frequency current is generated, while no arc occurs

Failure in connecting base metal side cable or poor connection

• Unstable arc

Arc is hard to start. Arc is intermittently cut off

Tungsten electrode is too thick for the current value.

Shielding gas flow rate is too excessive.

Shielding gas other than pure argon gas is used.

Poor connection of base metal side cable (Connect one base metal side cable to one machine securely).

MAINTENANCE AND INSPECTION

Due attention should be paid on periodical maintenance and inspection for safe operation of the welding machine. Before checking interior and exterior terminals of the welding machine, be sure to turn the switch box at the primary side.

• Daily precautions

- (1) Check for abnormal vibration, beat or smell.
- (2) Check of abnormal heating at the cable connections.
- (3) Ensure that in the welding machine, cooling fan rotates smoothly with power ON.
- (4) Check the switch for abnormal operation.
- (5) Check for poor cable connection and insulation.
- (6) Check the cable for any possible disconnection.

- **3 to 6 month inspection**

- (1) **Checking electrical connections sections :**

Ensure that tightening screws at the input and output side cable connections of welding machine are not loose, rust may worsen the electric contact, and check for any problem in insulation.

- (2) **Grounding line :**

Ensure that the welding machine case is completely grounded.

- (3) **Removing dust inside the welding machine:**

Dust deposited on the thyristor cooling plate reduces heat dissipation effect, which in turn adversely affects the thyristor.

If dust is accumulated between windings of the transformer, insulation may deteriorate accordingly; therefore, remove the side and top plates of the welding machine at least once in 6 months.

- (4) **Checking flow rate switch ;**

Deposited fur and contaminants in the flow rate switch may cause insufficient water flow; therefore, check this switch periodically.

- **Adjusting high-frequency current**

Do not touch the spark gap in normal cases. (The distance between spark gap is adjusted for 0.8 mm.)

When the electrode is significantly non-uniform and contaminated on the surface, always clean the surface, and then adjust the interelectrode gap for 0.7 to 0.9 mm. (To do this, use a thickness gauge.)

- **Operating precautions**

- (1) **Power switch operation :**

If power switch is turned OFF immediately after the welding work is completed, the cooling fan will stop, and the temperature of transformer, etc., will remain high. This may deteriorate the life span of the transformer, etc., therefore, remember to turn power switch OFF, 2 or 3 minutes after completion of the operation, not immediately.

- (2) **Service factor :**

Be sure to use the machine so that the pre-set duty cycle is not exceeded. Over-due cycle may cause burning the welding machine in the worst case, and even if it does not lead to burning trouble, the reduced service life may result. Therefore, be sure to follow the duty cycle appropriate with respect to the welding current.

The rated service factor 60% means that if the welding machine works for 6 minutes at the rated output (for example, 300A output current with the 300A machine) in a cycle of 10 minutes, it must not be operated for next 4 minutes.

(3) Precautions after maintenance and inspection ;

After removing a top board, side board and rear board for maintenance and inspection, do not fail to reinstall them just as they were.

• Precautions for flow switch

Water Pressure : This machine uses a flow rate switch to prevent the water-cooled torch from burning. For the flow rate switch, if the water amount becomes small in a low water pressure 'WARN' indicator lamp lights up, and it ceases to operate. In this case, be sure to take water from a high water pressure place or locate a Aqua-Pac. Also, always keep the water pressure at 1.2 kfg/cm² min. and water quantity at 0.7 l/min. or more.

* **When using the water tank :** Replace cooling water with a new one 1 or 2 times per 6 months. Deposited fur may cause the pump motor cease to rotate, and the water line or torch and flow rate switch may become clogged accordingly.

When using non-freezing fluid : For non-freezing fluid, always use glycol. If this antifreeze mixing ratio is increased, cooling water viscosity becomes higher, thus making it hard to let cooling water flow, and the flow rate switch may become inoperative. Therefore, it is recommended that this antifreeze mixing ratio should not exceed 20%.

Maintenance for flow rate switch : If the flow rate switch is not cleaned over long period of time, fur and rust may stick to the flow rate switch shaft and float, whereby the float may cease to operate; therefore, periodically clean the flow rate switch. To do this, follow the steps given below :

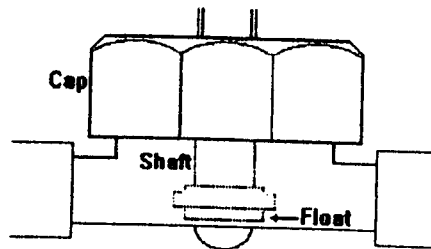


Fig.4 Flow Rate Switch

- (1) Remove the right-side plate (right, as viewed from the front power supply).
- (2) Remove the nut of water inlet hardware.
- (3) Remove the flow rate switch.
- (4) Detach the cap at the upper part of flow switch from main unit.
- (5) Remove fur and rust from the shaft, float and insert flow rate flow rate switch.
- (6) Reinstall the cap to main body. (Manually tighten it.)
- (7) Reinstall the flow rate switch. The flow rate switch may break down due to freezing in winter when the ambient temperature falls below 2° C, under such condition connect an Air-cooled Torch in place of water cooled one.

1	Arc spot time regulator	15	Power switch
2	Beginning regulator	16	Crater selector switch
3	Up slope time regulator	17	Gas indicator lamp
4	Pulse current regulator	18	Push switch
5	Pulse frequency regulator	19	Gas outlet
6	Down slope time regulator	20	Water outlet
7	Crater current regulator	21	Torch switch socket
8	Post-flow time regulator	22	Remote controller socket
9	Welding current regulator	23	Output terminal
10	Spark gap	24	Input terminal
11	Ammeter	25	Gas inlet
12	Power fuse	26	Water inlet
13	Warning	27	Case (chassis) grounding
14	Power indicator lamp		

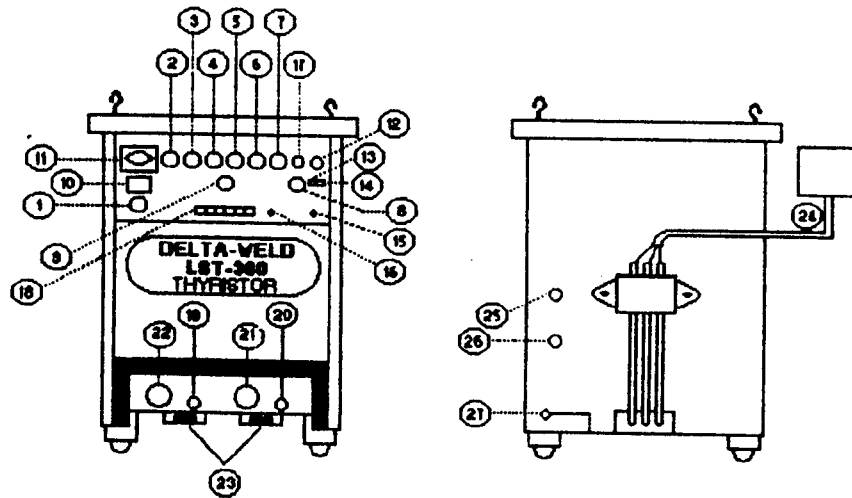
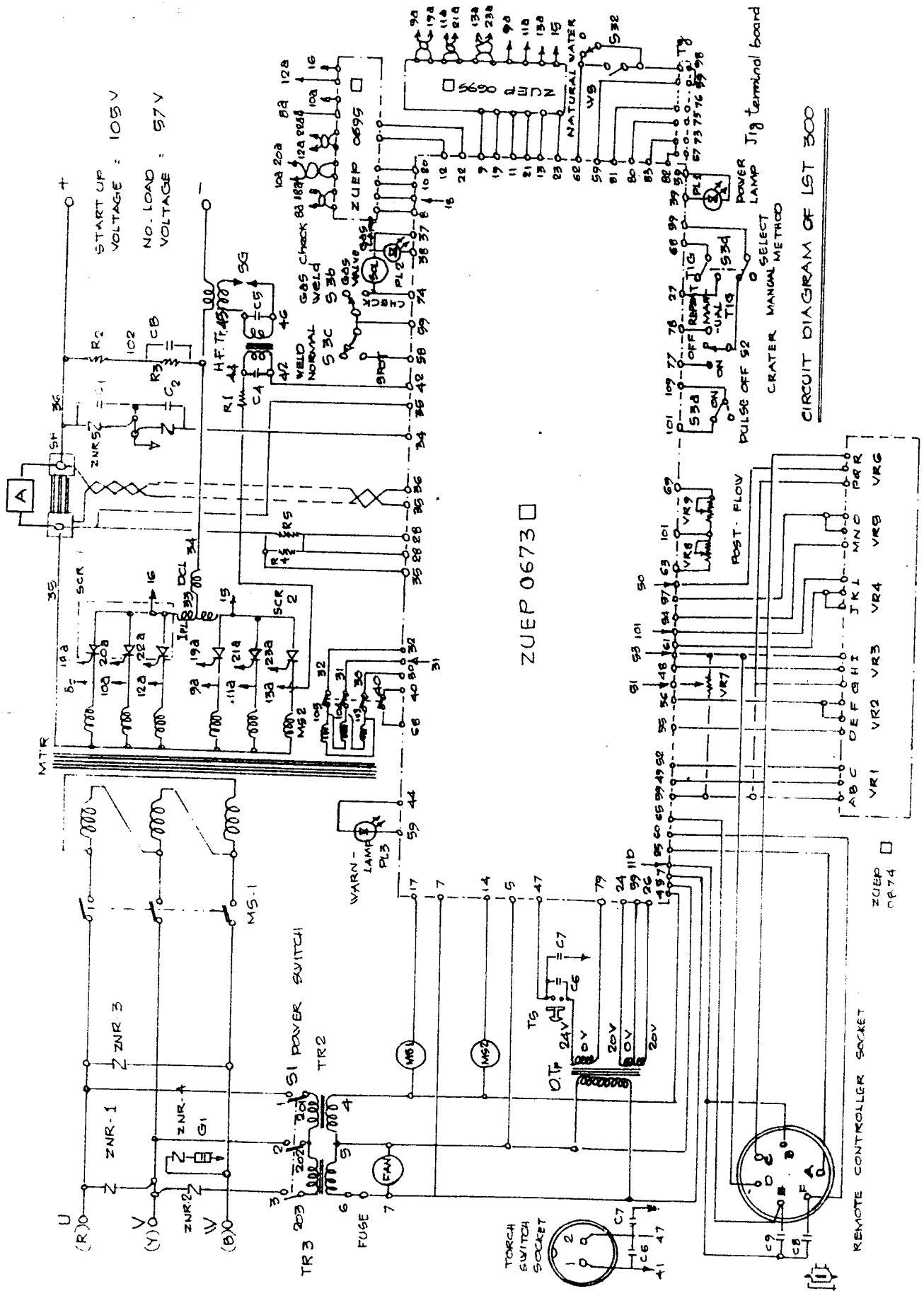


Fig.5

OUTSIDE DIAGRAM OF DELTA - WELD LST 300

**RECOMMENDED SPARE PART LIST
FOR
WELDTRONIC LST 300**

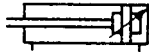
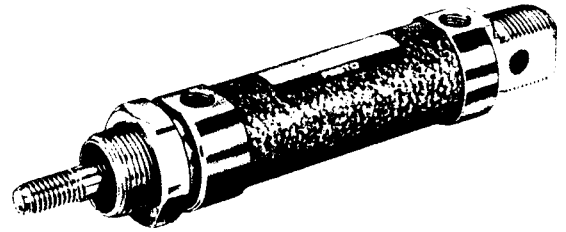
SL. NO.	PART NO.	DESCRIPTION	RECOMMENDED HOLDING
1.	SCR1.2	THYRISTOR	2
2.	SH	SHUNT	1
3.	SOL	GAS VALVE	1
4.	Ful	POWER FUSE	2
5.	S 1	POWER SWITCH	1
6.	PL1	POWER INDICATOR LAMP	2
7.	PL2	GAS INDICATOR LAMP	2
8.	PL3	LOW WATER LEVEL INDICATOR	2
9.	A	AMMETER	1
10.	R1	RESISTER	1
11.	R2	RESISTER	1
12.	R3	RESISTER	1
13.	R4.R5	RESISTER	1
14.	G1	SPARK GAP	1



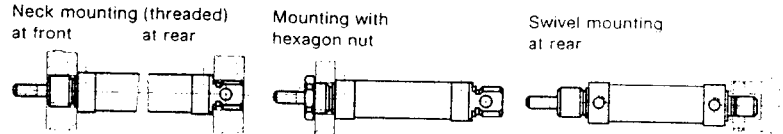
Double acting cylinder

with end position cushioning adjustable at both ends

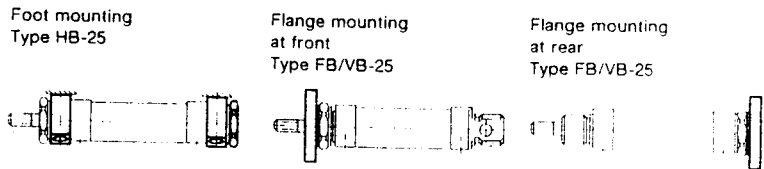
Type DGS-25-...-PPV




Installation of basic cylinder without mounting attachments



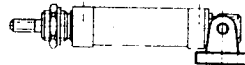
Additional types of mounting attachments



Additional components (sheets 3.8/10-1)

 Rod clevis, Type SG

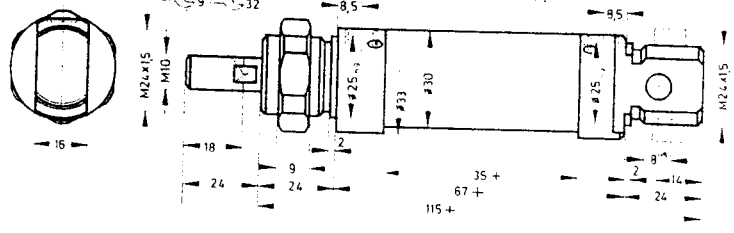
Clevis foot mounting Type LB-25



Example: Type DGS-25-...



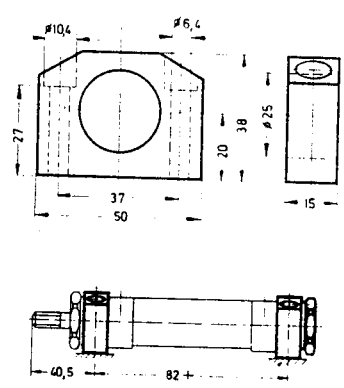
Order code [see sheet 3.2 / 105-3		Part No. + DGS + piston dia. + stroke length + end position cushioning <i>Example: piston dia. 25 mm, stroke length 140 mm, adjustable end position cushioning = 9836 DGS-25-140-PPV</i>				
Medium		Compressed air, filtered (lubricated or unlubricated)				
Design		Piston cylinder				
Max. permissible operating pressure		12 bar				
Temperature range		-20 to +80° C				
Materials		Bearing cap and cover cap: galvanized steel; cylinder barrel: precision steel painted; piston rod: X 20 Cr 13, rolled thread; seals: perbunan				
Weights		See overleaf				
Piston dia. mm	Standard stroke lengths mm	Stroke length min. — max. mm	Thrust at 6 bar N (kp)	Return force at 6 bar N (kp)	Connection	Cushioning length mm
25	25, 40, 50, 80, 100, 140, 200, 300	1 to 500	250 (25)	200 (20)	G 1/8	16



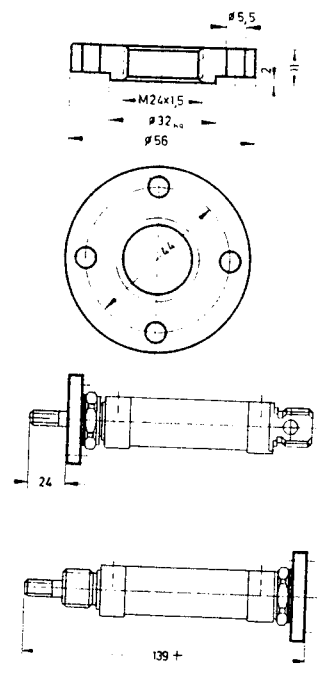
(C) = Adjustable end positioning
 (D) = Plus stroke length

Additional mounting attachments

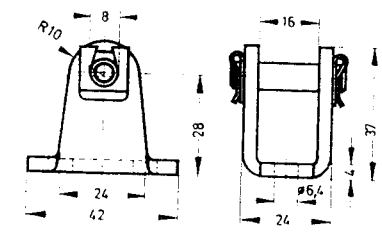
Foot mounting, Type HB-25
(2 feet and 1 mounting nut)



Flange mounting, Type FB/VB-25
(1 flange)



Clevis foot mounting, Type LB-25
with king pin



Weights

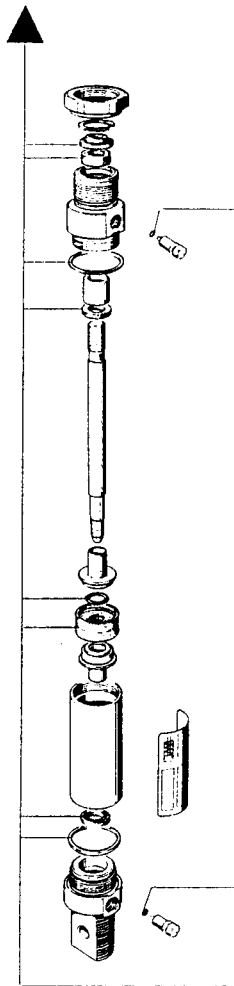
Basic cylinder in kg				Mounting attachments: Material/wt in kg			
Piston dia. mm			DGS.....PPV		Steel	FB/VB-25 Galvanized steel	LB-25 Galvanized steel
			Basic weight	Weight per 10 mm of stroke			
25			0.500	0.023	0.230	0.140	0.180

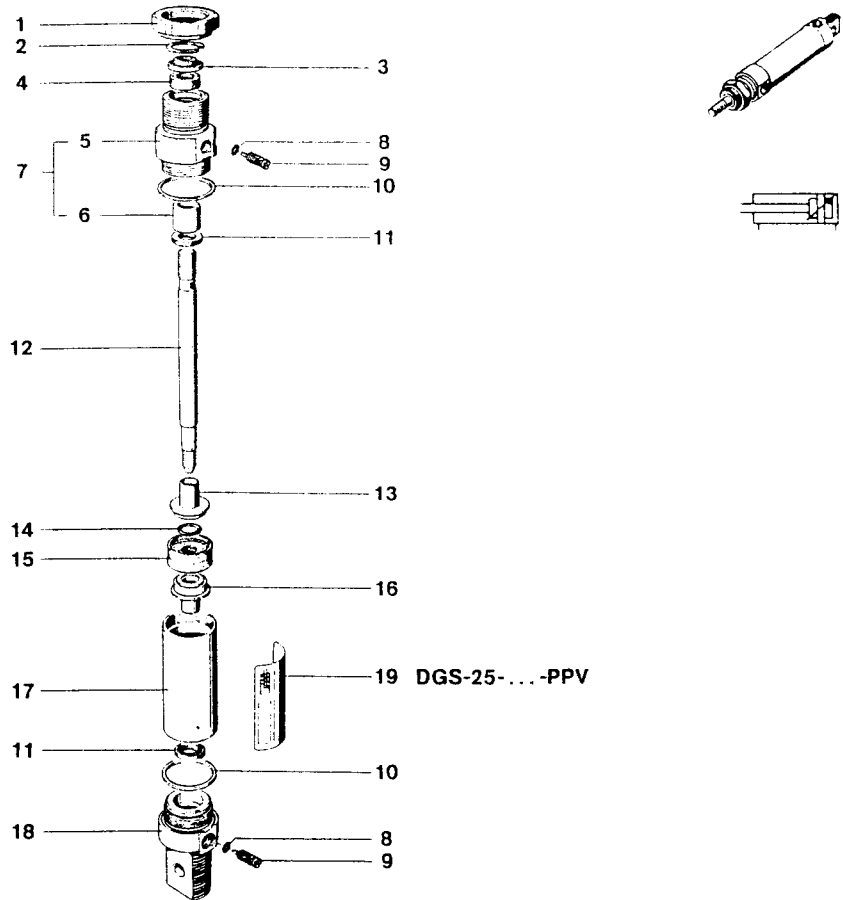
3.2/105-2

Oder code						Oder code					
Part No.	Type	Piston dia.	Stroke	End position cushioning	Special design	Part No.	Type	Piston dia.	Stroke	End position cushioning	Special design
11252	DGS-	25-	25-	PPV		Mounting attachments					
9832	DGS-	25-	40-	PPV		2683	HB	-25			
9833	DGS-	25-	50-	PPV		2685	FB/VB	-25			
9834	DGS-	25-	80-	PPV		2689	LB	-25			
9835	DGS-	25-	100-	PPV							
9836	DGS-	25-	140-	PPV							
9837	DGS-	25-	200-	PPV							
9838	DGS-	25-	300-	PPV							
9831	DGS-	25-	...-	PPV							

Wearing parts kits

for Type	DGS-25-...-PPV
Order code	104 147





DGS-25-...-PPV																	
Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can	Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can	Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can	Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can	Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can	Pos. Item	Best.-Nr./Symbol Order/Symbols	St. Qty. Can
Pos. No./Symboles		Nbr.	Pos. No./Symboles		Nbr.	Pos. No./Symboles		Nbr.	Pos. No./Symboles		Nbr.	Pos. No./Symboles		Nbr.	Pos. No./Symboles		Nbr.
1	201847	1	14	200916	1												
2	200627	1	15	208028	1												
3	100244	1	16	208030	1												
4	200885	1	17	202990+X	1												
5+		-	18	102499	1												
6	201076	1															
7	102498	1		103635	1												
8	200901	2															
9	216844	2															
	222063	2															
10	200812	2															
11	208077	2															
12	202989+X	1															
13	208029	1		104147	1												

Bestellbeispiel beachten

Zeichenerklärungen, Bestellbeispiel siehe Klappe

Please note the example of order

Legend and example of order: see back flap

Atender el ejemplo de pedido

Para explicaciones de simbolos, ejemplo de pedido, véase la solapa en la contraportada

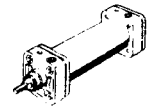
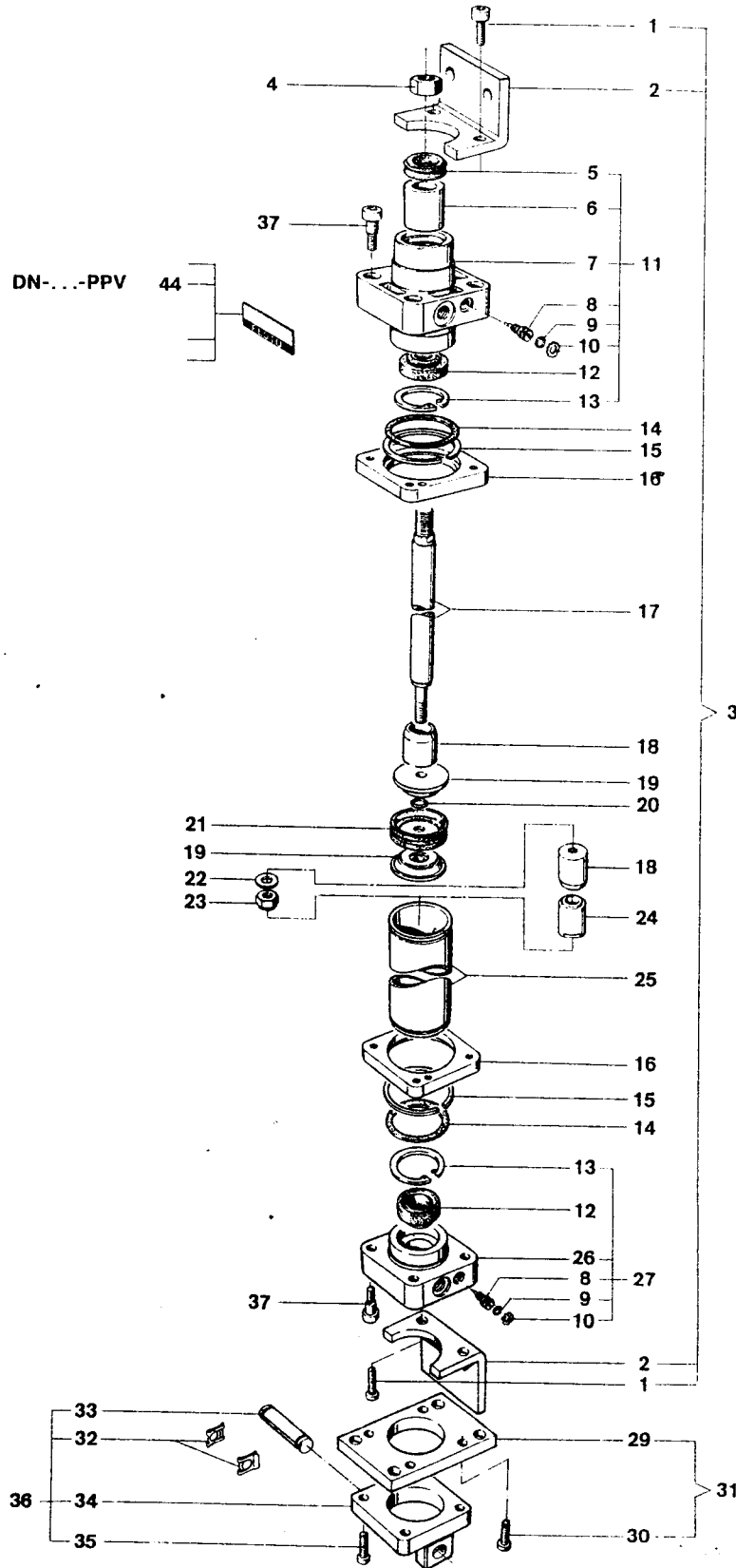
Veuillez noter l'exemple de commande

Légende et l'exemple de commande Voir volet la couverture

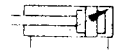
DN-32-...-PPV
 DN-40-...-PPV
 DN-50-...-PPV

Doppeltwirkender Zylinder
 Double acting cylinder
 Cilindro de doble efecto
 Vérin à double effet

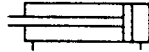
Katalogblatt 1.270
 Catalogue page
 Pág. catálogo
 Page catalogue



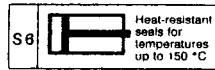
DN-...-PPV



Double acting short stroke
cylinder
Type ADV-...



Special design

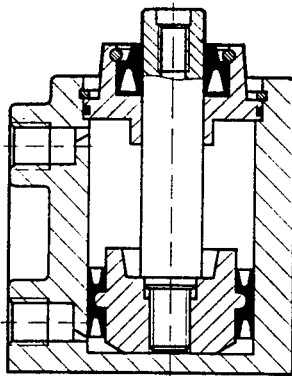
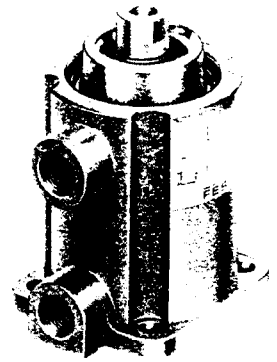


These short stroke piston cylinders are particularly suitable for clamping work requiring short movements e.g. in fixtures.

They are characterised by:

- rapid response when pressure is applied
- large clamping forces in relation to their size.

As a general rule, these cylinders should be run against an external stop.

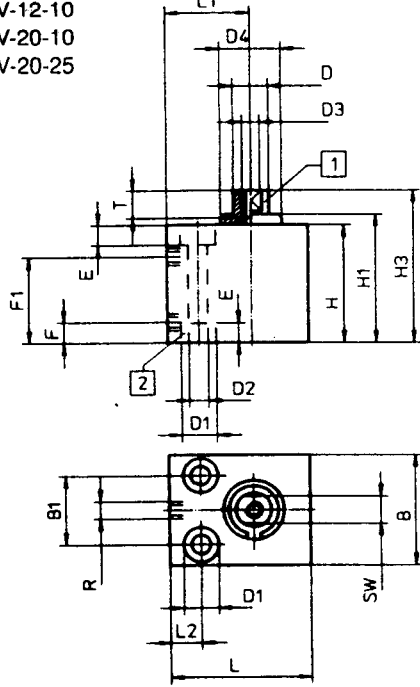


Permissible weight acting on piston rod

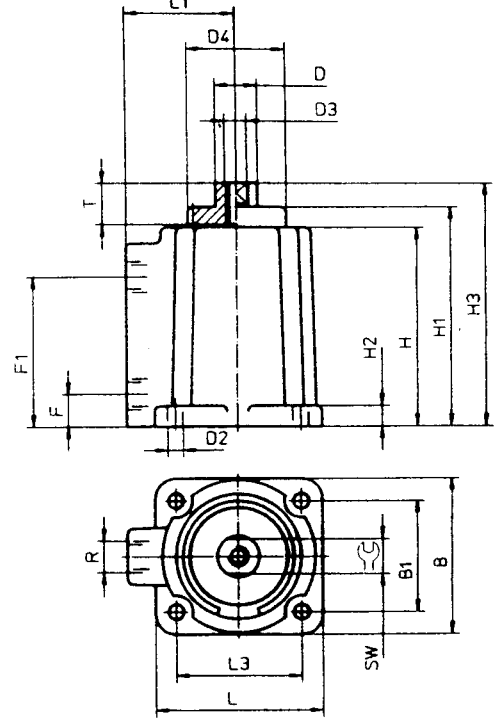
If the piston runs against a stop at full stroke, the weight acting on the piston rod must not exceed the values opposite.	Type	Weight
	ADV- 12-10	max. 25 g
ADV- 20-10	max. 75 g	
ADV- 20-25	max. 75 g	
ADV- 32-25	max. 100 g	
ADV- 50-25	max. 200 g	
ADV- 63-25	max. 250 g	
ADV- 80-25	max. 300 g	
ADV-100-25	max. 600 g	

Order code	Part No. + ADV + piston dia. + stroke length								
Medium	Compressed air, filtered (lubricated or unlubricated)								
Design	Piston cylinder								
Max. permissible operating pressure	8 bar								
Temperature range	- 20 to + 80 °C								
Materials	Housing: anodized aluminium (dia. 12 and 20); die-cast aluminium; brass (dia. 32 to 68); piston rod: stainless steel; seals: perbunan								
Order code				Piston dia. mm	Stroke length mm	Clamping force at 6 bar N (≈ kp)	Return force at 6 bar N (≈ kp)	Con- nection	Weight kg
Standard design		Special design S 6							
Part No.	Type	Part No.	Type						
9699	ADV-12-10	14774	ADV-12-10-S6	12	10	64 (6.4)	52 (5.2)	M 5	0.045
9701	ADV-20-10	14778	ADV-20-10-S6	20	10	175 (17.5)	128 (12.8)	M 5	0.140
13795	ADV-20-25	14779	ADV-20-25-S6	20	25	175 (17.5)	128 (12.8)	M 5	0.170
9703	ADV-32-25	14783	ADV-32-25-S6	32	25	460 (46)	390 (39)	G 1/8	0.245
9773	ADV-50-25	14787	ADV-50-25-S6	50	25	1100 (110)	980 (98)	G 1/8	0.400
9781	ADV-63-25	14791	ADV-63-25-S6	63	25	1760 (176)	1640 (164)	G 1/8	0.580
10053	ADV-80-25	14793	ADV-80-25-S6	80	25	2970 (297)	2780 (278)	G 1/4	0.955
10054	ADV-100-25	14795	ADV-100-25-S6	100	25	4630 (463)	4350 (435)	G 1/4	1.635

Type ADV-12-10
 ADV-20-10
 ADV-20-25



ADV- 32-25
 ADV- 50-25
 ADV- 63-25
 ADV- 80-25
 ADV-100-25



- 1 Male thread M 5 x 8 only on ADV-12-10
- 2 Lower counterbore only on ADV-20-25

Type	B	B ₁	D ∅	D ₁ ∅	D ₂ ∅	D ₃	D ₄	E	F	F ₁	H	H ₁	H ₂	H ₃	L	L ₁	L ₂	L ₃	R	T	
ADV-12-10	20	13	M 5	6	3.4	-	10.5	3.4	7	22.5	31	32	-	41	25	16	7	-	M 5	-	8
ADV-20-10	32	20	10	10	5.5	M 5	17.5	5.7	6	25	34	37	-	44	40	24	9	-	M 5	8	8
ADV-20-25	32	20	10	10	5.5	M 5	-	5.7	6	40	57	-	-	64	40	24	9	-	M 5	8	11
ADV-32-25	45	32	12	-	5.5	M 6	28.5	-	9.5	43.5	57.5	63.5	6	70.5	48	32	-	36	G 1/8	10	12
ADV-50-25	65	50	16	-	6.6	M 8	34	-	9	43.5	57.5	67	7.5	74.5	65	41	-	50	G 1/8	13	12
ADV-63-25	80	62	16	-	9	M 8	38.5	-	9.5	44.5	60.5	70	7.5	77.5	80	47	-	62	G 1/8	13	14
ADV-80-25	100	82	20	-	9	M 10	44	-	11	46	67	77	10	85	100	60	-	82	G 1/4	17	16
ADV-100-25	124	103	25	-	10.5	M 12	56	-	12	51	74.5	85	12	95	124	70	-	103	G 1/4	22	20

5/2-way basic valve with valve actuators for panel mounting

Valve actuators with standard dia. 22.5 or 30.5 mm can be mounted on this valve.

A reliable quick coupling system permits rapid assembly and disassembly of the actuators.

The valve actuators can also be mounted on 3/2-way valves (see sheet 4.4/20-1)

Accessories:

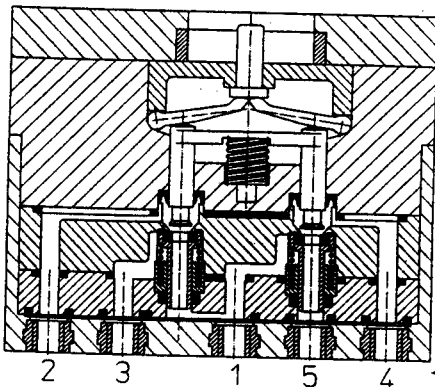
Inscription labels, Type BZ
(DIN 1451)



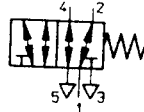
Design: anodized aluminium,
height of letters 6 mm

See sheet 6.315 for order code

Basic valve: Type SV-5-M5-B

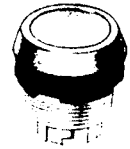


Basic valve for panel
mounting
Type SV-5-M5-B



Pushbutton actuator

Type T-22-S T-30-S
T-22-G T-30-G
T-22-R T-30-R



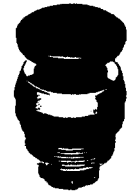
Mushroom pushbutton
actuator

Type P-22-S P-30-S



Impact head with detent

Type PR-22-R PR-30-R
*disengage by turning the head.



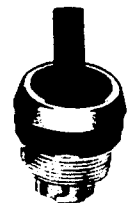
Selector actuator

Type N-22-S N-30-S



Toggle actuator

Type H-22-S H-30-S



Impact head with detent,
key return,

Type PRS-22-R PRS-30-R
*the key can be withdrawn in both switch
positions



Lock key actuator

Type Q-22 Q-30



Order code	Basic valve	11914 SV-5-M 5-B
Part No./Type	Valve actuators	see table overleaf
Medium		Compressed air (filtered, lubricated and unlubricated) non-over lapping
Design		Spool valve, directly actuated in one direction, with return spring
Mounting		Panel mounting (installation dia. 22.5 and 30.5 mm), also 2 through-holes
Connection		M 5
Nominal size		2.3 mm
Standard nominal flow rate (P → A)		95 l/min
Pressure range		0 to 8 bar
Actuating force at 6 bar operating pressure		17 N (with actuators see reverse side.)
Temperature range		- 10 to +60 °C
Materials		Housing: aluminium, plastic; valve piston: aluminium; seals: perbunan
Weight		0.053 kg

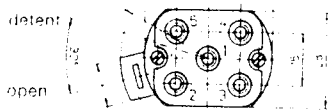
* Vacuum connected to R and S

Subject to change

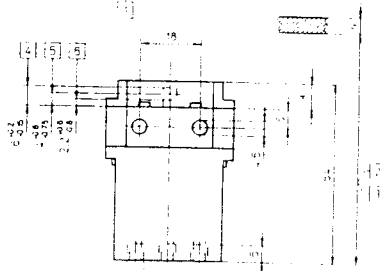
Type SV-5-M 5

- 1 Quick latching coupler for valve actuators
- 2 Installation dimension for dia. 22.5 : 75
- 3 Installation dimension for dia. 30.5 : 81
- 4 max. stroke
- 5 Start of opening
- 6 max. opening
- s = Thickness of panel

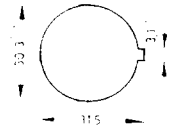
- 1 (P) = Supply port
- 4, 2 (A, B) = Working or outlet line
- 5, 3 (R, S) = Exhaust (or vacuum)



Installation dia. 22.5



Installation dia. 30.5



Valve actuators

Type T-22

P-22

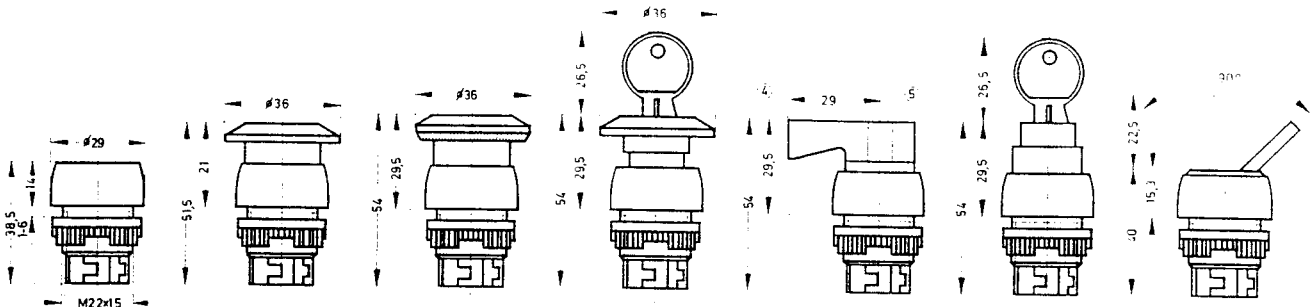
PR-22

PRS-22

N-22

Q-22

H-22



Type T-30

P-30

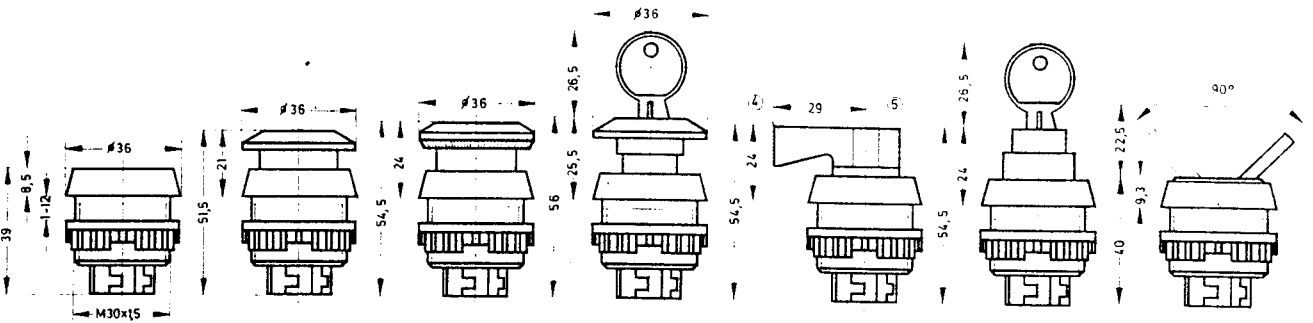
PR-30

PRS-30

N-30

Q-30

H-30



Type PR: The actuator is unlatched by turning the mushroom pushbutton.

Type N: ④ off; ⑤ on

Type PRS: After it has been pressed, the actuator remains locked and can only be unlocked with the key. The key can be withdrawn in both switch positions.

Type Q: the key actuator can only be operated with the key. The key can be withdrawn in both switch positions.

Valve actuators

Order code		Colour	Actuating force at 6 bar operating pressure	Weight kg
Part No.	Type			
9289	T-22-S	Black	7 N (≈ 0.7 kp)	0.016
9290	T-22-G	Yellow		
9997	T-22-R	Red		
9293	P-22-S	Black	7 N (≈ 0.7 kp)	0.020
9297	PR-22-R	Red	21 N (≈ 2.1 kp)	0.026
9299	PRS-22-R	Red	16 N (≈ 1.6 kp)	0.083
9301	N-22-S	Black	25 Ncm (≈ 2.5 kpcm)	0.021
9303	Q-22		16 N (≈ 1.6 kp)	0.080
9305	H-22-S	Black	10 Ncm (≈ 1 kpcm)	0.019
9291	T-30-S	Black	7 N (≈ 0.7 kp)	0.022
9292	T-30-G	Yellow		
10014	T-30-R	Red		
9295	P-30-S	Black	7 N (≈ 0.7 kp)	0.028
9298	PR-30-R	Red	21 N (≈ 2.1 kp)	0.037
9300	PRS-30-R	Red	16 N (≈ 1.6 kp)	0.091
9302	N-30-S	Black	25 Ncm (≈ 2.5 kpcm)	0.030
9304	Q-30		16 N (≈ 1.6 kp)	0.088
9306	H-30-S	Black	10 Ncm (≈ 1.0 kpcm)	0.027

3/2-way basic valve Type SV-3-M 5 (spring return) with actuators for panel mounting

Valve actuators with standard dia. 22.5 or 30.5 mm can be mounted on this valve.

A reliable quick coupling system permits rapid assembly and disassembly of the actuator.

The valve actuators can also be mounted on 5/2-way valves (see sheet 4.4/20-1)

Accessories:

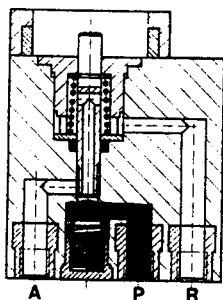
Inscription labels, Type BZ
(DIN 1451)



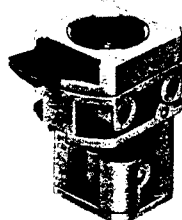
Design: anodized aluminium,
height of letters 6 mm

See sheet 6.315 for order code

Basic valve: Type SV-3-M 5



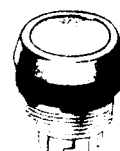
Basic valve for panel mounting
Type SV-3-M 5



Pushbutton actuator



Type T-22-S T-30-S
T-22-G T-30-G
T-22-R T-30-R



Mushroom push-button actuator
Type P-22-S



Impact head with detent.

Type PR-22-R PR-30-R
* disengage by turning the head



Selector actuator
Type N-22-S



Toggle actuator
Type H-22-S



Impact head with detent, key return
Type PRS-22-R PRS-30-R



Look and key actuator for
Type Q-22



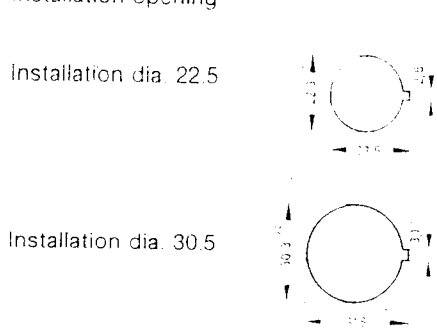
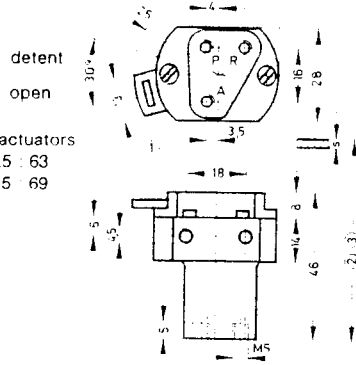
* the key can be withdrawn in both switch positions.



Order code	Basic valve	6817 SV-3-M 5
Part. No./Type	Valve actuators	See table overleaf
Medium		Compressed air (filtered, lubricated or unlubricated) can be used for vacuum*
Design		Poppet valve, directly actuated in one direction, with return spring
Mounting		Panel mounting (installation dia. 22.5 and 30.5 mm), also 2 through-holes
Connection		M 5
Nominal size		2 mm
Standard nominal flow rate (P→A)		65 l/min
Pressure range		-0.95 to 8 bar
Actuating force at 6 bar operating pressure		12 N (≈ 1.2 kp), with valve actuators—see overleaf
Temperature range		-10 to +60 °C
Materials		Housing: plastic; valve stem: brass; seals: perbunan
Weight		0.040 kg

*Vacuum connected to P

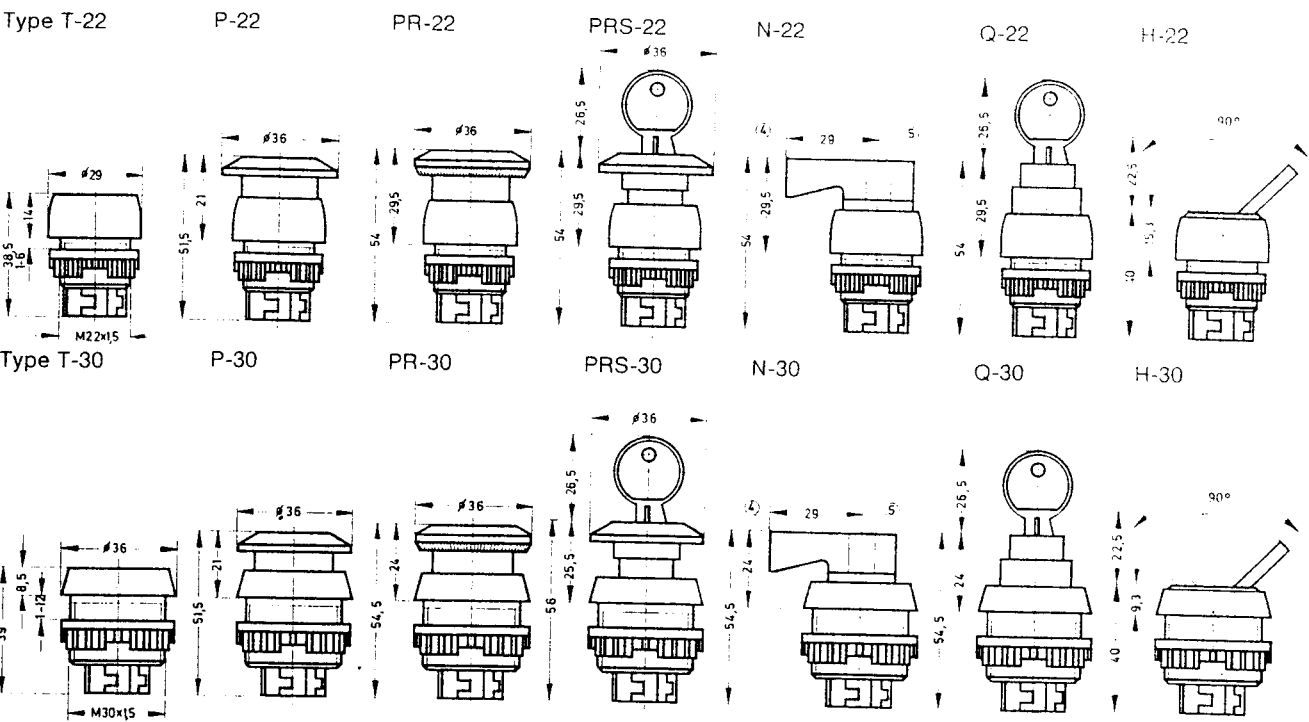
Subject to change



- ① Quick latching coupler for valve actuators
- ② Installation dimension for dia. 22.5 : 63
- ③ Installation dimension for dia. 30.5 : 69
- s = Thickness of panel

P = Supply port (or vacuum)
 A = Working or outlet line
 R = Exhaust

Valve actuators



Type PR: The actuator is unlatched by turning the mushroom pushbutton.

Type N: ④ Off, ⑤ On

Type PRS: After it has been pressed, the actuator remains locked and can only be unlocked with the key. The key can be withdrawn in both switch positions.

Type Q: The key actuator can only be operated with the key. The key can be withdrawn in both switch positions.

Valve actuators

Order code	Colour	Actuating force at 6 bar operating pressure	Weight kg
Part No. Type			
9289 T-22-S	Black	14 N (≈ 1.4 kp)	0.016
9290 T-22-G	Yellow		
9997 T-22-R	Red		
9293 P-22-S	Black	14 N (≈ 1.4 kp)	0.020
9297 PR-22-R	Red	25 N (≈ 2.5 kp)	0.026
9299 PRS-22-R	Red	23 N (≈ 2.3 kp)	0.083
9301 N-22-S	Black	40 Ncm (≈ 4.0 kpcm)	0.021
9303 Q-22		23 N (≈ 2.3 kp)	0.080
9305 H-22-S	Black	14 Ncm (≈ 1.4 kpcm)	0.019
9291 T-30-S	Black	14 N (≈ 1.4 kp)	0.022
9292 T-30-G	Yellow		
10014 T-30-R	Red		
9295 P-30-S	Black	14 N (≈ 1.4 kp)	0.028
9298 PR-30-R	Red	25 N (≈ 2.5 kp)	0.037
9300 PRS-30-R	Red	23 N (≈ 2.3 kp)	0.091
9302 N-30-S	Black	40 Ncm (≈ 4.0 kpcm)	0.030
9304 Q-30		23 N (≈ 2.3 kp)	0.088
9306 H-30-S	Black	14 Ncm (≈ 1.4 kpcm)	0.027

95

Service unit

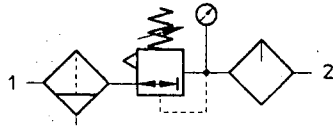
with metal bowl guard, pressure gauge and latching regulating knob

with manual condensate drain

Type FRC-...-D-...

with integrated automatic condensate drain

Type FRC-...-D-...-A



Accessories:

Mounting bracket type HFOE-...

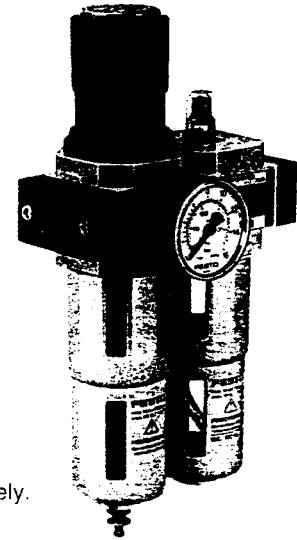
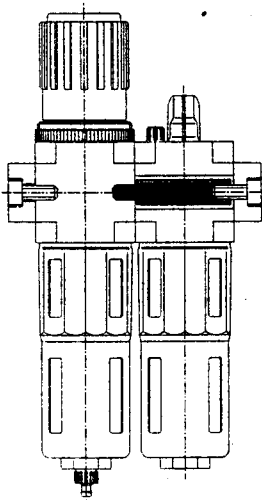
(kit with two brackets, see dimensional drawing, item 3) see sheet 8/34-3

Distributor type FRZ-... see sheet 8/30-3

Threaded pins type FRB-... (2 pieces) to combine individual units of series D into service modules see sheet 8/34-1.

Example:

Type FRC-...-D-... with threaded pins



Note:

The service unit type FRC-... consists of a filter, a regulator type LFR-... and a lubricator type LOE-...

These components are also available separately.

The components are in detail as follows:

The sintered filter with water separator removes dirt, pipe scale, rust and condensate from the compressed air.

The standard 40 µm cartridge can easily be replaced by a 5 µm cartridge for special applications.

The pressure regulator with secondary relief keeps the working pressure (secondary side) largely constant, irrespective of pressure fluctuations on the supply (primary side) and the level of air consumption.

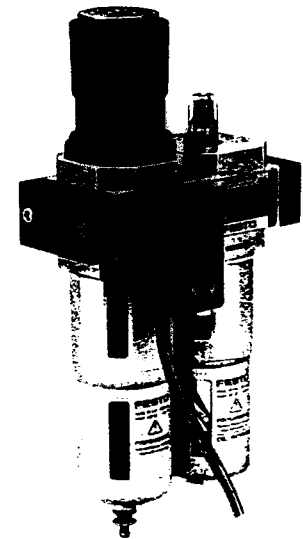
There are two working pressure ranges
(pressure regulation ranges): Up to 7 bar
Up to 12 bar

The proportional lubricator adds oil mist to the filtered air supply. The amount of oil atomised is proportional to the air flow. Refilling with oil can be carried out with the unit under pressure.

The drip rate is regulated via an adjusting screw. For general use, 1 to 12 drops per 1000 litres of air are sufficient.

Note:

The PE signal converter type PENV-A-... can be used as a digital pressure measuring device, for example with service units. See sheet 5.4/60-1.



The following oils are recommended for use with Festo service units:

Suitable types of oil	Viscosity range
Festo special oil	32 mm ² /s
Aral Vitam GF 32	(= cSt) at 40 °C
BP Energol HLP 32	ISO class VG 32
Esso Nuto H 32	as per ISO 3448
Mobil DTE 24	
Shell Hydrol DO 32	

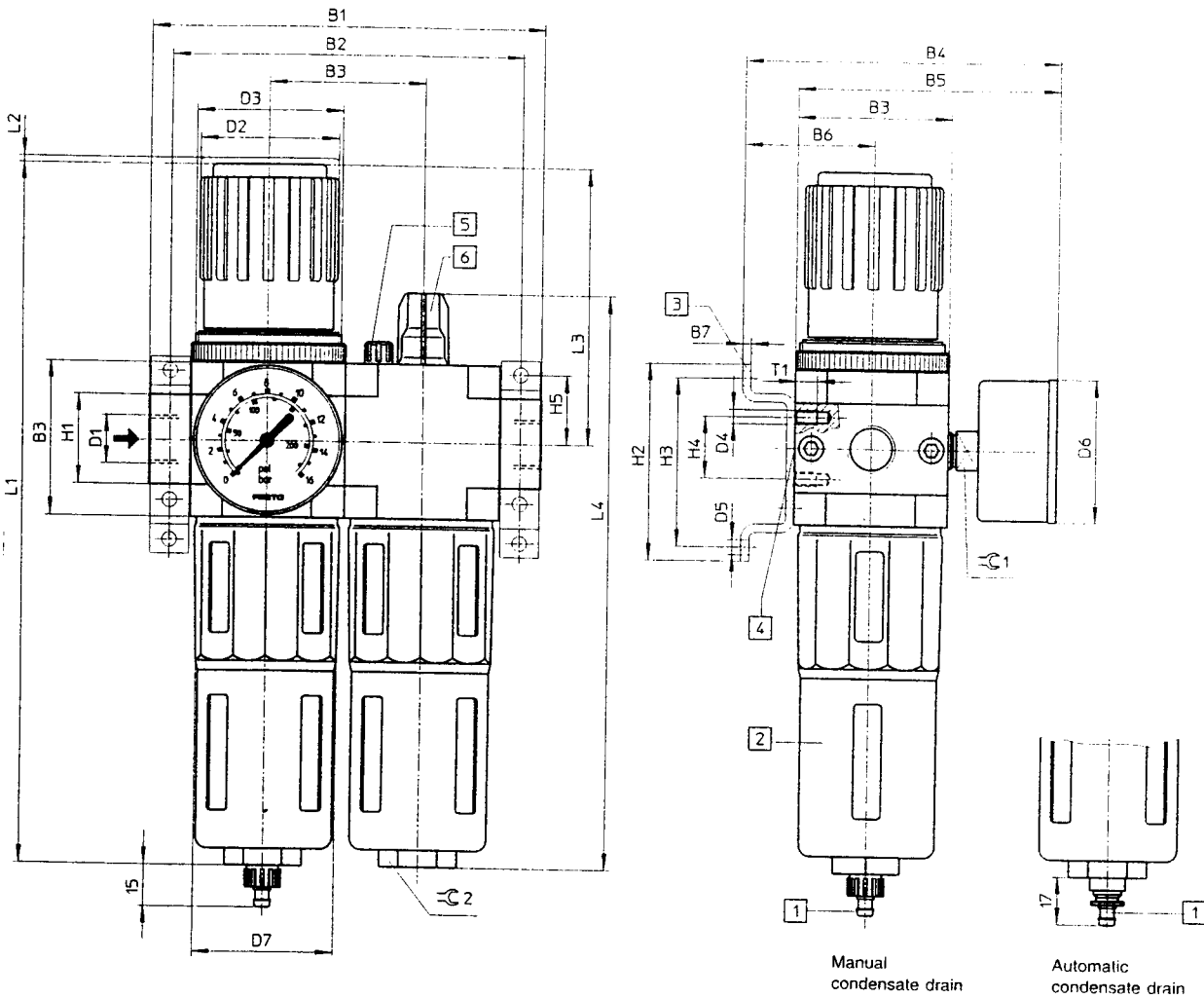
Festo special oil in 1 litre container: Order code 152 811 OFSW-32

Order code	Part No./Type	MINI size			MIDI size			MAXI size	
Service unit Working pressure 12 bar 40 µm filter cartridge	Manual condensate drain	159 604 FRC-1/8-D-MINI	159 605 FRC-1/4-D-MINI	162 734 FRC-3/8-D-MINI	159 588 FRC-3/8-D-MIDI	159 590 FRC-1/2-D-MIDI	162 735 FRC-3/4-D-MIDI	159 606 FRC-3/4-D-MAXI	159 607 FRC-1-D-MAXI
	Automatic condensate drain	159 608 FRC-1/8-D-MINI-A	159 609 FRC-1/4-D-MINI-A	162 736 FRC-3/8-D-MINI-A	159 589 FRC-3/8-D-MIDI-A	159 591 FRC-1/2-D-MIDI-A	162 737 FRC-3/4-D-MIDI-A	159 610 FRC-3/4-D-MAXI-A	159 611 FRC-1-D-MAXI-A
Working pressure 7 bar 40 µm filter cartridge	Manual condensate drain	162 754 FRC-1/8-D-7-MINI	162 755 FRC-1/4-D-7-MINI	162 756 FRC-3/8-D-7-MINI	162 757 FRC-3/8-D-7-MIDI	162 758 FRC-1/2-D-7-MIDI	162 759 FRC-3/4-D-7-MIDI	162 760 FRC-3/4-D-7-MAXI	162 761 FRC-1-D-7-MAXI
	Automatic condensate drain	162 762 FRC-1/8-D-7-MINI-A	162 763 FRC-1/4-D-7-MINI-A	162 764 FRC-3/8-D-7-MINI-A	162 765 FRC-3/8-D-7-MIDI-A	162 766 FRC-1/2-D-7-MIDI-A	162 767 FRC-3/4-D-7-MIDI-A	162 768 FRC-3/4-D-7-MAXI-A	162 769 FRC-1-D-7-MAXI-A
Working pressure 12 bar 5 µm filter cartridge	Manual condensate drain	162 770 FRC-1/8-D-5M-MINI	162 771 FRC-1/4-D-5M-MINI	162 772 FRC-3/8-D-5M-MINI	162 773 FRC-3/8-D-5M-MIDI	162 774 FRC-1/2-D-5M-MIDI	162 775 FRC-3/4-D-5M-MIDI	162 776 FRC-3/4-D-5M-MAXI	162 777 FRC-1-D-5M-MAXI
	Automatic condensate drain	162 778 FRC-1/8-D-5M-MINI-A	162 779 FRC-1/4-D-5M-MINI-A	162 780 FRC-3/8-D-5M-MINI-A	162 781 FRC-3/8-D-5M-MIDI-A	162 782 FRC-1/2-D-5M-MIDI-A	162 783 FRC-3/4-D-5M-MIDI-A	162 784 FRC-3/4-D-5M-MAXI-A	162 785 FRC-1-D-5M-MAXI-A
Mounting bracket		159 638 HFOE-D-MINI			159 593 HFOE-D-MIDI/MAXI				
Bracket for PE converter		161 207 PENV-A-H-1/8-D			161 208 PENV-A-H-3/8-D				
Threaded pin		159 642 FRB-D-MINI			159 595 FRB-D-MIDI			159 643 FRB-D-MAXI	
Filter cartridge 40 µm		352 811 LFP-D-MINI-40M			349 611 LFP-D-MIDI-40M			352 812 LFP-D-MAXI-40M	
Filter cartridge 5 µm		159 640 LFP-D-MINI-5M			159 594 LFP-D-MIDI-5M			159 641 LFP-D-MAXI-5M	
Replacement pressure gauge	for 12 bar unit	345 395 MA-40-16-1/8			356 759 MA-50-16-1/4				
	for 7 bar unit	359 874 MA-40-10-1/8			359 873 MA-50-10-1/4				
Medium		Compressed air							
Design		Sintered filter with water separator; MINI/MIDI: diaphragm regulator; MAXI: piston regulator; directly proportional lubricator							
Mounting		Line mounting or mounting bracket							
Installation position		Vertical ±5°							
Connection		G 1/8	G 1/4	G 3/8	G 3/8	G 1/2	G 3/4	G 3/4	G 1
Standard nominal flow rate*	FRC-...-D-...(-A)	700	1000	1200	2000	2600	2600	7000	8000
	FRC-...-D-7...(-A)	800	1300	1500	2500	2800	2800	8500	8700
	FRC-...-D-5M...(-A)	600	850	1050	1700	1800	2100	6500	7200
Primary pressure range	Manual condensate drain	1 to 16 bar							
	Automatic condensate drain**	1.5 to 12 bar							
Working pressure range		0.5 to 12 bar/0.5 to 7 bar							
Range of lubricator operation		From 3 l/min			From 6 l/min			From 10 l/min	
Filter rating		40 µm/5 µm							
Condensate capacity, max.		22 ml			43 ml			80 ml	
Temperature range		-10 to +60 °C							
Material		Housing: die-cast zinc; filter and lubricator bowl: polycarbonate; metal bowl guard: Al; seals: Perbunan; adjusting knob: PA 6							
Weight		0.700 kg	0.700 kg	0.700 kg	1.400 kg	1.400 kg	1.400 kg	2.400 kg	2.500 kg

* With 10 bar primary pressure, working pressure 6 bar and Δp = 1 bar..

** For correct operation, a minimum flow rate of 125 l/min. is required.

Type FRC-...-D-...



- 1 Barbed fitting for plastic tubing (order code 7134 PCN-4)
- 2 Metal bowl guard
- 3 Mounting bracket type HFOE (not included in scope of delivery)
- 4 Additional pressure gauge connection
- 5 Vent screw for oil reservoir
- 6 Oil adjusting screw

→ Direction of flow

Type	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	D ₁	D ₂ dia.	D ₃	D ₄	D ₅ dia.	D ₆ dia.	D ₇ dia.	H ₁	H ₂	H ₃	H ₄	H ₅	L ₁	L ₂	L ₃	L ₄	T ₁	∅ ₁	∅ ₂
FRC-1/8-D-MINI	104	92	40	96	77	39	2	G 1/8	31	M36×1.5	M4	4.3	39	38	20	43	35	11	17.5	194	1	70	169	7	14	22
FRC-1/4-D-MINI	104	92	40	96	77	39	2	G 1/4	31	M36×1.5	M4	4.3	39	38	20	43	35	11	17.5	194	1	70	169	7	14	22
FRC-3/8-D-MINI	104	92	40	96	77	39	2	G 3/8	31	M36×1.5	M4	4.3	39	38	20	43	35	11	17.5	194	1	70	169	7	14	22
FRC-3/8-D-MIDI	110	125	55	113	94	47	3	G 3/8	50	M52×1.5	M5	5.3	51	52	32	70	60	22	24.5	250	2	98	206	8	14	24
FRC-1/2-D-MIDI	140	125	55	113	94	47	3	G 1/2	50	M52×1.5	M5	5.3	51	52	32	70	60	22	24.5	250	2	98	206	8	14	24
FRC-3/4-D-MIDI	140	125	55	113	94	47	3	G 3/4	50	M52×1.5	M5	5.3	51	52	32	70	60	22	24.5	250	2	98	206	8	14	24
FRC-3/4-D-MAXI	162	146	66	125	105	53	3	G 3/4	31	M36×1.5	M5	5.3	51	65	32	70	60	22	24.5	252	2	82	223	8	14	24
FRC-1-D-MAXI	182	157	66	125	105	53	3	G 1	31	M36×1.5	M5	5.3	51	65	40	70	60	22	24.5	252	2	82	223	8	14	24

Subject to change

Not approved for use in food production.

Plastic tubing

with outer dia. to CETOP RP 54 P

Type PUN-...

This tubing is especially kink-resistant and flexible.



Pressure range			-0.95 to max. pressure (see table)				
Temperature range			-35 to +60 °C				
Part. No.	Type	Outer dia. mm	inner dia. mm	Material	Min. bending radius mm	Weight kg/m	Tubing colour
152 583	PUN- 3 × 0.5	3.0	2.1	Polyurethane	12.5	0.004	Silver metallic
159 660	PUN- 3 × 0.5-BL						Blue
159 661	PUN- 3 × 0.5-SW						Black
178 416	PUN- 3 × 0.5-GE						Yellow
178 423	PUN- 3 × 0.5-GN						Green
178 409	PUN- 3 × 0.5-RT						Red
152 584	PUN- 4 × 0.75	4.0	2.8		17.0	0.009	Silver metallic
159 662	PUN- 4 × 0.75-BL						Blue
159 663	PUN- 4 × 0.75-SW						Black
178 417	PUN- 4 × 0.75-GE						Yellow
178 424	PUN- 4 × 0.75-GN						Green
178 410	PUN- 4 × 0.75-RT						Red
152 586	PUN- 6 × 1	6.0	4.0		26.5	0.019	Silver metallic
159 664	PUN- 6 × 1-BL						Blue
159 665	PUN- 6 × 1-SW						Black
178 418	PUN- 6 × 1-GE						Yellow
178 425	PUN- 6 × 1-GN						Green
178 411	PUN- 6 × 1-RT						Red
152 587	PUN- 8 × 1.25	8.0	5.7		37.0	0.030	Silver metallic
159 666	PUN- 8 × 1.25-BL						Blue
159 667	PUN- 8 × 1.25-SW						Black
178 419	PUN- 8 × 1.25-GE						Yellow
178 426	PUN- 8 × 1.25-GN						Green
178 412	PUN- 8 × 1.25-RT						Red
152 588	PUN-10 × 1.5	10.0	7.0		54.0	0.049	Silver metallic
159 668	PUN-10 × 1.5-BL						Blue
159 669	PUN-10 × 1.5-SW						Black
178 420	PUN-10 × 1.5-GE						Yellow
178 427	PUN-10 × 1.5-GN						Green
178 413	PUN-10 × 1.5-RT						Red
152 589	PUN-12 × 2	12.0	8.0		62.0	0.077	Silver metallic
159 670	PUN-12 × 2-BL						Blue
159 671	PUN-12 × 2-SW						Black
178 421	PUN-12 × 2-GE						Yellow
178 428	PUN-12 × 2-GN						Green
178 414	PUN-12 × 2-RT						Red
152 590	PUN-16 × 2.5	16.0	11.0		88.0	0.129	Silver metallic
159 672	PUN-16 × 2.5-BL						Blue
159 673	PUN-16 × 2.5-SW						Black
178 422	PUN-16 × 2.5-GE						Yellow
178 429	PUN-16 × 2.5-GN						Green
178 415	PUN-16 × 2.5-RT						Red

Max. operating pressure in relation to temperature with Type PUN-...

Temperature	PUN-3 × 0.5	PUN-4 × 0.75	PAN-6 × 1	PAN-8 × 1.25	PAN-10 × 1.5	PAN-12 × 2	PAN-16 × 2.5
-35 to +30 °C	10 bar	10 bar	10 bar	10 bar	10 bar	10 bar	10 bar
-30 to +40 °C	9 bar	9 bar	9 bar	9 bar	9 bar	9 bar	9 bar
-40 to +60 °C	7 bar	7 bar	7 bar	7 bar	7 bar	7 bar	7 bar

Subject to change

Plastic tubing Type PL-... (previously Type PK)

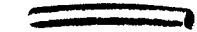
PL-3, 4 and 6 tubing is approved in accordance with the German Foodstuffs Protection Act § 2 for the production of foodstuffs and cosmetic articles.



Pressure range*		- 0.95 to + 7 bar (PL-9, PL-13; 0 to 7 bar)					
Temperature range		- 10 to + 35 °C					
Order code		Inside dia. mm	Outside dia. mm	Material	Min. bending radius mm	Weight kg/m	Colour of tubing
Part No.	Type						
3856	PL-3	3	4.3	Polyethylene	18	0.007	Neutral
3453	PL-3						Blue
4640	PL-3						Black
2236	PL-4	4	6.2		22.5	0.016	Neutral
3861	PL-4						Blue
4641	PL-4						Black
2237	PL-6	6	8.4	39	0.025	Neutral	
3862	PL-6					Blue	
4642	PL-6					Black	
2238	PL-9	9	11.6	PVC with fabric	85	0.049	Blue
4103	PL-13	13	17.6		100	0.135	Blue

Plastic tubing Type PU-...

This tubing is particularly flexible, will not kink and is suitable for connection to barbed fittings.



Pressure range*		- 0.95 to + 7 bar (PU-9, PU-13 max. 10 bar)					
Temperature range		- 35 to + 60 °C					
Order code		Inside dia. mm	Outside dia. mm	Material	Min. bending radius mm	Weight kg/m	Colour of tubing
Part No.	Type						
13365	PU-2	2.2	3.2	Polyurethane	13	0.005	Blue
13366	PU-2						Black
5732	PU-3	2.9	4.3		14	0.009	Blue
5731	PU-3						Black
6204	PU-4	3.9	6.1		20	0.021	Blue
5733	PU-4						Black
9159	PU-6	5.9	8.3	36	0.033	Blue	
6731	PU-6					Black	
8976	PU-8	8	11	84	0.055	Blue	
11255	PU-8					Black	
12134	PU-9	9	11.6	Polyurethane with fabric	76	0.051	Black
12133	PU-13	13	17.6		83	0.14	Black

Plastic tubing Type PU-...-DUO

This tubing is particularly flexible, will not kink and is suitable for connection to barbed fittings.

Two tubing sections, blue and black, are welded together to form twin tubing. For installation, the twin tubing should be trimmed at both ends to the required length.



Pressure range*		- 0.95 to + 7 bar					
Temperature range		- 35 to + 60 °C					
Order code		Inside dia. mm	Outside dia. mm	Material	Min. bending radius mm	Weight kg/m	Colour of tubing
Part No.	Type						
19581	PU-2-DUO	2.2	3.2	Polyurethane	13	0.010	Blue/black
11958	PU-3-DUO						
11959	PU-4-DUO	3.9	6.1		20	0.042	
11960	PU-6-DUO						
13295	PU-8-DUO	8	11		84	0.110	

* The maximum pressure is permissible at the maximum temperature

Plastic tubing Type PP-...

This tubing is suitable for higher pressures and temperatures.

Pressure range*		- 0.95 bar to max. pressure (see table below)					
Temperature range		- 30 to + 80 °C					
Order code		Inside dia. mm	Outside dia. mm	Material	Min. bending radius mm	Weight kg/m	Colour of tubing
Part No.	Type						
4572	PP-3	3	4.3	Polyamide	19	0.007	Neutral
4231	PP-4	4	5		27	0.016	Neutral
4191	PP-6	6	8.2		50	0.025	Neutral

Max. operating pressure as a function of temperature

Temperature	Type PP-3	Type PP-4	Type PP-6 *
- 30 °C	17.5 bar	21 bar	17.5 bar
+ 20 °C	17.5 bar	21 bar	17.5 bar
+ 40 °C	12.5 bar	15 bar	12.5 bar
+ 60 °C	10 bar	12 bar	10 bar
+ 80 °C	8 bar	10 bar	8 bar

* The maximum pressure is permissible at the maximum temperature.

Heavy-duty tubing Type PR-...

This tubing has an additional outer sheath which provides long-term protection for the fabric against damage, even under tough operating conditions.

Pressure range*		- 0.95 to + 10 bar					
Temperature range		- 30 to + 60 °C					
Order code		Inside dia. mm	Outside dia. mm	Material	Minimum bending radius mm	Weight kg/mm	Colour of tubing
Part No.	Type						
13294	PR-3	2.9	6.5	Polyurethane with polyester fabric	21	0.031	Blue
12973	PR-4	3.9	7.7		34	0.041	
12974	PR-6	5.9	9.7		37	0.054	

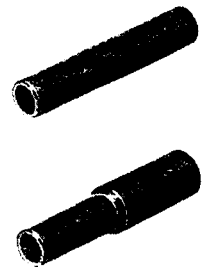
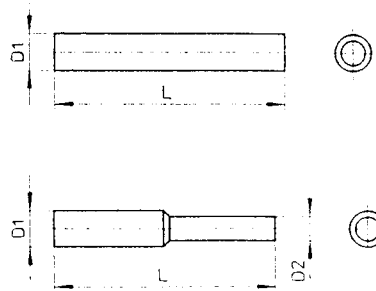
* The maximum pressure is permissible at the maximum temperature.

Flexible metal conduit Type MK-...

For tube cutter Type ZRS,
see sheet 6.107.

Order code		For tubing	Material	Weight kg/m
Part No.	Type			
2203	MK-4	PL-4, PP-4, PU-4	Steel	0.082
2204	MK-6	PL-6, PP-6, PU-6		

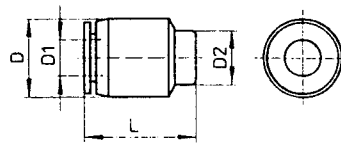
Push-in sleeve
Type QSH-...
for QS connections



Technical Data see sheet 9/21-1

Order code		Nominal size mm	For QS push-in fittings		Weight kg	Dimensions	
Part No.	Type		D ₁	D ₂		L	
153 251	QSH-4	2.5	4	-	0.001	35	
153 252	QSH-6	4	6	-	0.001	38	
153 253	QSH-8	6	8	-	0.001	41.5	
153 254	QSH-10	7.5	10	-	0.002	46	
153 255	QSH-12	9	12	-	0.003	53	
153 256	QSH-16	11	16	-	0.004	55.5	
153 257	QSH-6-4	2.5	6	4	0.001	36.5	
153 258	QSH-8-6	4	8	6	0.001	40.5	
153 259	QSH-10-8	6	10	8	0.002	44	
153 260	QSH-12-10	7.5	12	10	0.002	49.5	
153 261	QSH-16-12	9	16	12	0.005	54.5	

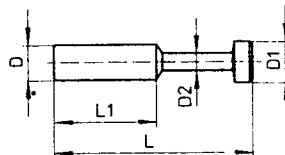
Push-in connector
Type QSC-...
to seal unused lines



Technical Data see sheet 9/21-1

Order code		For tubing outside diameter D ₁	Weight kg	Dimensions		
Part No.	Type			D dia.	D ₂ dia.	L
153 262	QSC-4	4	0.003	10	7	16.5
153 263	QSC-6	6	0.004	13	9	18.5
153 264	QSC-8	8	0.005	15	11	20
153 265	QSC-10	10	0.008	18	13	22.5
153 266	QSC-12	12	0.012	21.5	16	23

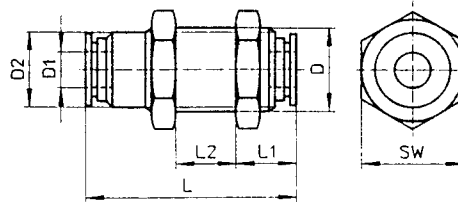
Plug
Type QSC-...
to seal unused
QS connections



Technical Data see sheet 9/21-1

Order code		For QS push-in fittings D	Weight kg	Dimensions			
Part No.	Type			D ₁ dia.	D ₂ dia.	L	L ₁
153 267	QSC-4H	4	0.001	5	3	28	15
153 268	QSC-6H	6	0.001	7	3	33	17
153 269	QSC-8H	8	0.001	9	4	37	18
153 270	QSC-10H	10	0.002	11	5	42	20.5
153 271	QSC-12H	12	0.003	13	6	44	23
153 272	QSC-16H	16	0.004	17	8	46	24

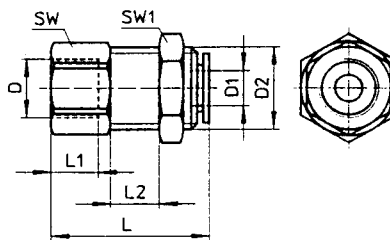
Push-in/threaded bulkhead fitting
Type QSS-...



Technical Data see sheet 9/21-1

Order code		Nominal size mm	For tubing outside dia. D ₁	Weight kg	Dimensions					
Part No.	Type				D	D ₂ dia.	L	L ₁	L ₂	⊕
153 157	QSS-4	3	4	0.011	M12 × 1	11	31	9.5	7	14
153 158	QSS-6	4.6	6	0.016	M14 × 1	12.5	35	10	10	17
153 159	QSS-8	6	8	0.020	M16 × 1	14.5	37.5	10.5	9	19
153 160	QSS-10	8	10	0.038	M20 × 1	18.5	43	11.5	13	24
153 161	QSS-12	11	12	0.056	M22 × 1	20.5	47	12.5	18	27

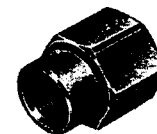
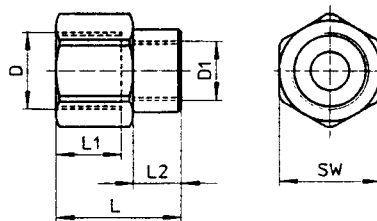
Push-in/threaded bulkhead fitting
Type QSSF-...-B
with female thread



Cf. caractéristiques techniques feuille 9/21-1

Order code		Connection D	Nom. size mm	For tubing outside dia. D ₁	Weight kg	Dimensions					
Part No.	Type					D ₂ dia.	L	L ₁	L ₂	⊕	⊕ ₁
153 162	QSSF-1/8-4-B	G 1/8	3	4	0.019	M12 × 1	25	8	5.5	14	14
153 163	QSSF-1/8-6-B	G 1/8	6	6	0.030	M14 × 1	27.5	8	7.5	17	17
153 165	QSSF-1/8-8-B	G 1/8	8	8	0.039	M16 × 1	29	8	11	19	19
153 164	QSSF-1/4-6-B	G 1/4	6	6	0.030	M14 × 1	30.5	11	7.5	17	17
153 166	QSSF-1/4-8-B	G 1/4	8	8	0.041	M16 × 1	32	11	11	19	19
153 168	QSSF-1/4-10-B	G 1/4	10	10	0.078	M20 × 1	35	11	9.5	24	24
153 167	QSSF-3/8-8-B	G 3/8	8	8	0.034	M16 × 1	33	12	11	19	19
153 169	QSSF-3/8-10-B	G 3/8	10	10	0.073	M20 × 1	36	12	9.5	24	24
153 170	QSSF-3/8-12-B	G 3/8	12	12	0.085	M22 × 1	39	12	11.5	24	27
153 171	QSSF-1/2-12-B	G 1/2	12	12	0.080	M22 × 1	42	15	11.5	24	27

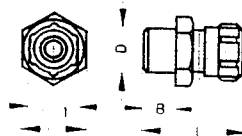
Reducing sleeve
Type QMR-...B



Technical Data see sheet 9/21-1

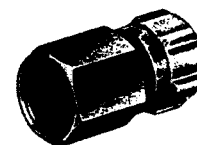
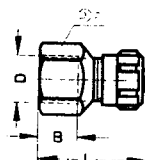
Order code		Connection		Nominal size mm	Weight kg	Dimensions			
Part No.	Type	D	D ₁			L	L ₁	L ₂	⊕
153 281	QMR-1/8-M5-B	G 1/8	M5	3	0.012	17	8	5	14
153 282	QMR-1/4-1/8-B	G 1/4	G 1/8	6.5	0.023	21	11	8	17
153 283	QMR-3/8-1/4-B	G 3/8	G 1/4	9	0.036	25	12	11	21
153 284	QMR-1/2-3/8-B	G 1/2	G 3/8	12	0.059	33	15	12	24

Male connector
Type CK-...



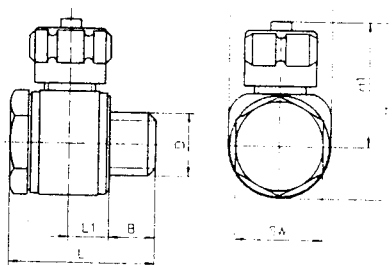
Order code		For tubing inside dia.	Connection D	Nominal size mm	Material	Weight kg	Dimensions				
Part No.	Type						B	L	Ø	Ø ₁	
3561	CK-M 5-PK-3	3	M 5	2.4	Steel/ aluminium with seal- ing ring	0.002	4.5	17.5	8	8	
3562	CK-M 5-PK-4	4	M 5	2.4		0.003	4.5	19.3	10	—	
3563	CK- ¹ / ₈ -PK-3	3	G ¹ / ₈	2.4	Blue anodized alumi- nium with sealing ring	0.003	6.5	21.6	14	8	
2027	CK- ¹ / ₈ -PK-4	4	G ¹ / ₈	3.4		0.005	6.5	24.7	14	12	
2028	CK- ¹ / ₈ -PK-6	6	G ¹ / ₈	5.3		0.008	6.5	24.8	14	14	
2029	CK- ¹ / ₄ -PK-4	4	G ¹ / ₄	3.4		0.009	8.5	26.5	17	12	
2030	CK- ¹ / ₄ -PK-6	6	G ¹ / ₄	5.4		0.009	8.5	26.8	17	14	
2031	CK- ¹ / ₄ -PK-9	9	G ¹ / ₄	8		0.015	8.5	30	17	19	
2032	CK- ³ / ₈ -PK-6	6	G ³ / ₈	5.4		0.013	10.5	29	19	14	
2033	CK- ³ / ₈ -PK-9	9	G ³ / ₈	8		0.018	10.5	32	19	19	
4097	CK- ³ / ₈ -PK-13	13	G ³ / ₈	12		0.025	10.5	33.5	24	24	
4098	CK- ¹ / ₂ -PK-13	13	G ¹ / ₂	12		0.028	13.5	36.5	24	24	
Order code		For tubing inside dia.	Connection D	Nominal size mm		Material	Weight kg	Dimensions			
Part No.	Type							B	L	Ø	Ø ₁
6253	CK- ¹ / ₈ -PK-3-KU	3	G ¹ / ₈	2.4		Plastic with moulded- on sealing rim	0.002	6.5	22	13	8
6254	CK- ¹ / ₈ -PK-4-KU	4	G ¹ / ₈	3.4			0.003	6.5	22.5	13	12
6255	CK- ¹ / ₈ -PK-6-KU	6	G ¹ / ₈	4.4	0.003		6.5	25.5	13	14	
6256	CK- ¹ / ₄ -PK-4-KU	4	G ¹ / ₄	3.4	0.005		8.5	28.5	17	12	
6257	CK- ¹ / ₄ -PK-6-KU	6	G ¹ / ₄	5.3	0.005		8.5	28.5	17	14	
6258	CK- ¹ / ₄ -PK-9-KU	9	G ¹ / ₄	7.3	0.007		8.5	32	17	19	
6460	CK- ³ / ₈ -PK-6-KU	6	G ³ / ₈	5.3	0.007		10.5	31	19	14	
6468	CK- ³ / ₈ -PK-9-KU	9	G ³ / ₈	8	0.009		10.5	34.5	19	19	

Female connector
Type ACK-...
with female thread and sealing ring



Order code		For tubing inside dia.	Connection D	Nominal size mm	Material	Weight kg	Dimensions		
Part No.	Type						B	L	Ø
5664	ACK- ¹ / ₈ -PK-3	3	G ¹ / ₈	2.4	Blue anodized aluminium	0.005	9	24	13
3714	ACK- ¹ / ₈ -PK-4	4	G ¹ / ₈	3.4		0.007	9	27	13
7842	ACK- ¹ / ₈ -PK-6	6	G ¹ / ₈	5.3		0.009	9	27	13
3713	ACK- ¹ / ₄ -PK-4	4	G ¹ / ₄	3.4		0.010	12	30	17
3712	ACK- ¹ / ₄ -PK-6	6	G ¹ / ₄	5.3		0.011	12	30	17
3711	ACK- ³ / ₈ -PK-6	6	G ³ / ₈	5.3		0.011	12	31	19
3710	ACK- ³ / ₈ -PK-9	9	G ³ / ₈	8		0.015	15	37.5	19
4099	ACK- ¹ / ₂ -PK-13	13	G ¹ / ₂	12		0.034	15	39	27

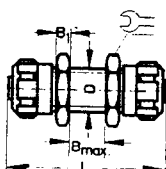
L-Swivel elbow
Type LCK-...



Order code		For tubing inside dia.	Connection D	Nominal size mm	Material	Weight kg	Dimensions						
Part No.	Type						B	C	H	H ₁	L	L ₁	SW
4468	LCK-M 5-PK-3	3	M 5	2	Aluminium with 2 sealing rings	0.006	5	10	21.1	16.1	19.5	5.7	8
4562	LCK-M 5-PK-4	4	M 5	2.9		0.008	4.2	11	25.2	19.7	19.5	6.1	8
4136	LCK-1/8-PK-3	3	G 1/8	2		0.010	6.4	16	27.1	19.1	22	6	13
4469	LCK-1/8-PK-4	4	G 1/8	2.9		0.017	6	16	30.2	22.2	27.5	9	13
4470	LCK-1/8-PK-6	6	G 1/8	4.9		0.017	6	16	30.3	22.3	27.5	9	13
4471	LCK-1/4-PK-4	4	G 1/4	2.9		0.020	7	20	34.2	24.2	28.5	9	17
4472	LCK-1/4-PK-6	6	G 1/4	4.9		0.021	6.8	20	34.3	24.3	28.5	9.1	17
11452	LCK-1/4-PK-9	9	G 1/4	8		0.320	7.3	20	37.6	27.6	33.7	11.6	17
4473	LCK-3/8-PK-6	6	G 3/8	4.9		0.026	8.6	25	39.3	26.8	31	9.1	22
4474	LCK-3/8-PK-9	9	G 3/8	8		0.043	9.1	25	42.6	30.1	36.5	11.6	22
4100	LCK-1/2-PK-13	13	G 1/2	11.7		0.085	12.7	30	49.2	34.2	50	16.5	27

Order code		For tubing inside dia.	Connection D	Nominal size mm	Material	Weight kg	Dimensions						
Part No.	Type						B	C	H	H ₁	L	L ₁	SW
6259	LCK-1/8-PK-4-KU	4	G 1/8	3.4	Plastic with moulded on sealing rim 0 to 10 bar -10 to +60 °C	0.015	8.5	16	30	22	27.5	7	13
6260	LCK-1/8-PK-6-KU	6	G 1/8	5.3		0.013	8.5	16	30	22	27.5	7	13
6261	LCK-1/4-PK-4-KU	4	G 1/4	3.4		0.012	10	20	34	23.5	28.5	6.5	17
6262	LCK-1/4-PK-6-KU	6	G 1/4	5.3		0.017	10	20	34	23.5	28.5	6.5	17

Bulkhead connector
Type SCK-...



Order code		For tubing inside dia.	Nominal size mm	Material	Weight kg	Dimensions				
Part No.	Type					B max.	B ₁	D	L	SW
9420	SCK-PK-3	3	2.4	Blue anodized aluminium/ steel nut	0.005	8	3	M 6 × 0.75	34	10
9421	SCK-PK-4	4	3.4		0.014	10	3.5	M 10 × 1	43	13
9422	SCK-PK-6	6	5.3		0.022	10	4	M 12 × 1	44	17