

Furnace Monitoring Systems

A Major Project Report

*Submitted to the Rajasthan Technical University
in partial fulfillment of requirements for the award of
degree*

Bachelor of Technology

in

Mechanical Engineering

by

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**DEPARTMENT OF MECHANICAL
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2022- 23**



CERTIFICATE

This is to certify that the report entitled submitted by **Deepak Prajapat (19etcme003)** and **Shalini Sharma (19etcme009)**, to Department of **Mechanical Engineering** in partial fulfillment of the B.Tech. degree in Mechanical Engineering is a bonafide record of the seminar work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

I hereby declare that the major project report Furnace Monitoring System, submitted for partial fulfillment of the requirements for the award of the degree of Bachelor of Technology of the Rajasthan Technical University, Kota, Rajasthan is a bonafide work done by me under the supervision of Mr. Abhishek Sharma.

This submission represents my ideas in my own words and where ideas or words of others have been included, I have adequately and accurately cited and referenced the original sources.

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Abstract

The high-temperature Furnace monitoring systems provide plant engineers and operators in the control room with views of burner flames, material alignment and movement, and other process conditions in the furnace, kiln, boiler, cooler, reheating furnace, or another combustion chamber.

We use a special high-definition CCD color camera above 650 lines, a pinhole lens, and a stainless-steel camera housing with an air & water cooling system, enabling the system to work in harsh environments.

It can be inserted into the furnace with 400 mm-600 mm with a working temperature of up to 2000°C.

The system has an auto-retraction function. The camera will exit out of the furnace when the temperature of the inner camera housing is higher than the setting value or the pressure of compressed air is lower than the setting value or the power failures or the water flow pressure is low than the set value.

The camera is inserted through the gravitational shutter which opens the force of the camera probe & shut the furnace opening when the probe was removed.

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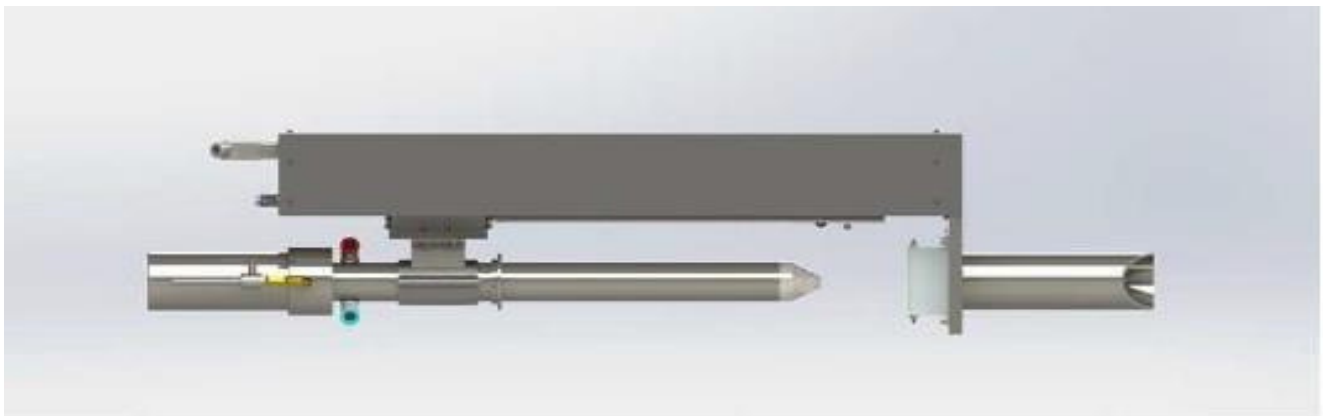
CHAPTER-1

Introduction

Our high-temperature CCTV camera monitoring systems provide plant engineers and operators in the control room with views of burner flames, material alignment and movement, and other process conditions in the furnace, kiln, boiler, cooler, reheating furnace, or other combustion chamber. We use a special high-definition CCD color camera above 650 lines, a pinhole lens, and stainless-steel camera housing with air & water cooling system, enabling the system working in harsh environment. TFV series can be inserted into the furnace with 400mm-600mm with working temperature up to 2000°C.

The system has auto-retraction function. The camera will exit out of the furnace, when the temperature of the inner camera housing is higher than the setting value or the pressure of compressed air is lower than the setting value or the power failures or the water flow pressure is low than set value.

The camera inserted through the gravitational shutter which open the force of camera probe & shut the furnace opening when the probe removed.



(Fig 1 : Furnace Monitoring Camera)

CHAPTER-2

Technical Specification

Technical data	
Environment up to	2000°C
Cooling system	Vortex cooling(only air cooled) and water cooling
Transmission device	Pneumatic Cylinder
Furnace wall thickness	400-600mm
Power	AC 220V ;100W/120W
Requirement of compressed air for control panel	
Pressure	2-7 kg/cm ²
Volume flow	5m ³ /H
Temperature	<35°C
Quality clean	Dust, moisture and oil free
Requirement of water flow for cooling jacket	
Pressure	2.5 - 8 Bar
Water flow	20L/Min.
Inlet Temperature	15°C - 30°C
Outlet temperature	Max. 45°C
pH value	6-8
Quality	Drinking water quality
Power supply for control panel	
Supply Voltage	230V AC,50Hz
Supply Voltage	110V AC,50 Hz(optional)
Condition	UPS Power Supply

CHAPTER-3

Data Sheet

Probe	Pneumatic & Electronic Panel	Retraction System
Camera CCD	Panel	Limit Switch
Straight View	PLC & HMI	Pneumatic Cylinder
Pin Hole Lens Tube 750	Relay Card	Gravity Shutter Attachment
Camera Holding Clamp	T/C to Volt Converter	Base Plate
Hood & Cover Plate	Power Supply (12V & 24V)	Wall Sleeve
Water & Air Cooling Jacket 750	Pressure Gauge	Retraction Stand
Camera Housing	Air Filter Regulator with Digital	Hood Cover
Support Ring	Pressure Switch	Back Plate
Thermocouple 'K' Type	Mist Separator	Clamp
Vortex Tube	Quick Release Valve	10 Pin Connector
Cable Connector 6 Pin	Speed Controller	Other
	Solenoid Valve	PU-Pipe
	Non Return Valve	12 Core Si Cable
	Ball Valve	Coaxial Cable
	Air Tank 5 liter	Camera Remote
	Pressure Pipe SS1/2"BSPT	Water Flow Switch
		SS Braided Hoses

3.1 Furnace Probe System

Furnace probe camera consists of CCD color camera, furnace probe lens and probe camera housing.

Probe Housing

Probe Camera housing in 2 standard and long designs.

Housing made of Cr-Ni-steel or SS304.

Double walled housing for cooling water; with forced ventilation, temperature monitoring at the probe tip. Probe with Straight View.

Housing and viewing aperture air-purged for cooling purpose and keeping the viewing aperture clean.

CCD – Camera

CCD camera solid by high temperature, color to black, HLC, BLC, remote menu control, unique appearance, zoom lenses. It is very easy for installation.

CCD sensor	Color SONY 1/3 " Super HAD CCD
Image	Manual adjustable
Scanning system	2:1 Interface
OSD menu	5 buttons remote menu adjustable
Lens	5 times manual/electric zoom lens
Video output	Composite 1 [Vp-p] 75(Ω)
White balance	Auto/manual adjustable
Color to black	Manual adjustable
Gain control	Auto/manual adjustable
Power	DC12V ($\pm 10\%$)
Power consumption	Less than 120mA
Electric shutter	Electric shutter EI(1/50~1/100, 000sec)
Gamma coefficient	$\gamma = 0.45$
SNR	More than 48dB
Voice frequency	Adjustable
TV Line	Black and white 650 lines
Illumination	0.005Lux @ F2.0
Synchronization	Inner synchronization
Scanning frequency (H)	PAL : 15.625 KHz / NTSC : 15.734KHz
Scanning frequency (V)	PAL : 50Hz / NTSC : 59.94Hz
Working temperature	-10°C ~ +70°C (Humidity: 10%RH ~ 60%RH)
Storage temperature	-20°C ~ +60°C (Humidity: 10%RH ~ 60%RH)
Dimension	Diameter 20mm x Length 350mm

Camera Field View

View of Camera:

Calculation of field of view (FOV)

$$H = \frac{h \times L}{F}$$

$$W = \frac{w \times L}{F}$$

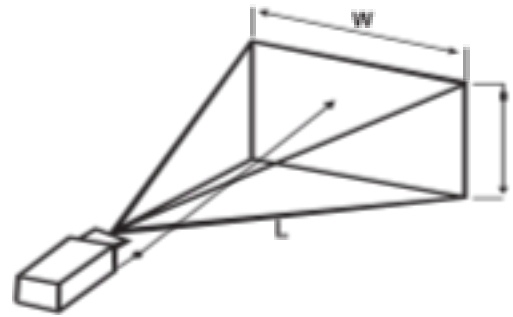


Fig 2 : Field of view

Where,

- F = (focal length of pinhole lens) = 3.3 mm
- H = (height of field of view) (m)
- W = (width of field of view) (m)
- L = (the distance between the lens and target)
- h = (1/3" height of camera sensor) = 3.6 mm
- w = (1/3" width of camera sensor) = 4.8 mm

PIN HOLE LENS

The pin hole is made of stainless steel in the diameter of 25mm. the observation hole in the front is only 1mm to applicable in the high temperature furnace. The pinhole is uneasy to be damaged and has good high temperature properties.

Focal Length	f = 3.3 mm
Image plane format	1/3" sensor
Diagonal FOV	85°
Lens mount	C/CS
Dimension	Approximately ø25.4 x
View Angle	820 mm 0° (Straight)

VORTEX TUBE

Vortex tube is device that works on standard compress air supply. Air entered in vortex tube literally split in two part-cold air at one end, hot air at other without moving any part. vortex tube have adjustable valve at the "Hot" end which control the volume of air flow, and the temperature exiting at the cool end. By adjusting the valve control the "cold fraction" which is the percentage of total input compressed air that exits the cold end of vortex tube. Vortex tube may also be supplied with a fixed preset ^{1,8°} cold fraction instead of adjustable valve.



Fig 3 : Vortex tube

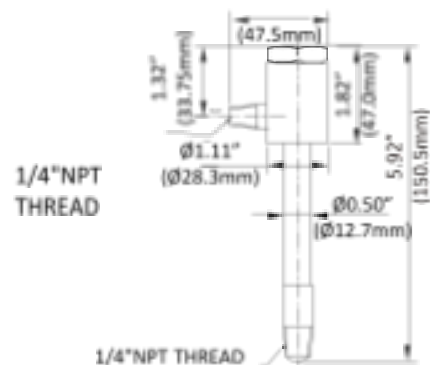


Fig 4 : Dimensions of vortex tube

Vortex Tube

SCFM	SLPM	BTU/HR.	WATT
15	425	1100	322

NOTE:

1. SCFM and SLPM at 100PSIG or 6.9 BAR inlet pressure.
2. BTU/HR and WATT is cooling capacity at 100 PSIG or 6.9 BAR inlet pressure with optimal cold fraction setting.

PSIG (BAR)	20	30	40	50	60	70	80
20 (1.4)	62 (34)	60 (33)	56 (31)	51 (28)	44 (24)	36 (20)	28 (16)
	15 (8)	25 (14)	36 (20)	50 (28)	64 (26)	83 (46)	107 (59)
40 (2.8)	88 (48)	85 (46)	80 (42)	73 (39)	63 (34)	52 (28)	38 (20)
	21 (11)	35 (18)	52 (28)	71 (38)	92 (50)	117 (62)	147 (80)
60 (4.1)	104 (57)	100 (55)	93 (51)	84 (46)	73 (40)	60 (33)	46 (25)
	24 (14)	40 (22)	59 (33)	80 (44)	104 (57)	132 (73)	166 (92)
80 (5.5)	115 (63)	110 (62)	102 (56)	92 (51)	80 (45)	66 (36)	50 (28)
	25 (14)	43 (24)	63 (35)	86 (47)	113 (63)	143 (80)	180 (100)

Temperature drop of cold air,
°F (°C) in blue

Temperature rise of hot air,
°F (°C)

THERMOCOUPLE

The type 'K' thermocouple has a Chromel (90% nickel&10% copper) positive leg and an Alumel (95%nickel & 5% manganese, aluminum and silicon) negative leg. The temperature range for type 'K' alloys is -200°C to 1250°C (- 328 to 2282°F). Type 'K' sensors are recommended for use in oxidizing or completely inert environments. Type 'K' should not be used in sulfurous environments, its main area of usage is at temperatures above 600°C but vacuum and low oxygen conditions should be avoided. Length of thermocouple is 800mm.

3.2 CONTROL SYSTEM

The control unit is a single box that provides the necessary services required by the system. It measures 800mm x 800mm x 300mm approx. It is broken down into 2 sections -Electronics and Pneumatic. The power supply provides the required voltages used by the system from the 110/240VAC site supply. The electronics control transmits the video signal to the control room via Co- axial cable. It also houses the Mist separator, air filters and associated valves and pipe work to supply the air cooling and insertion and retraction mechanism.

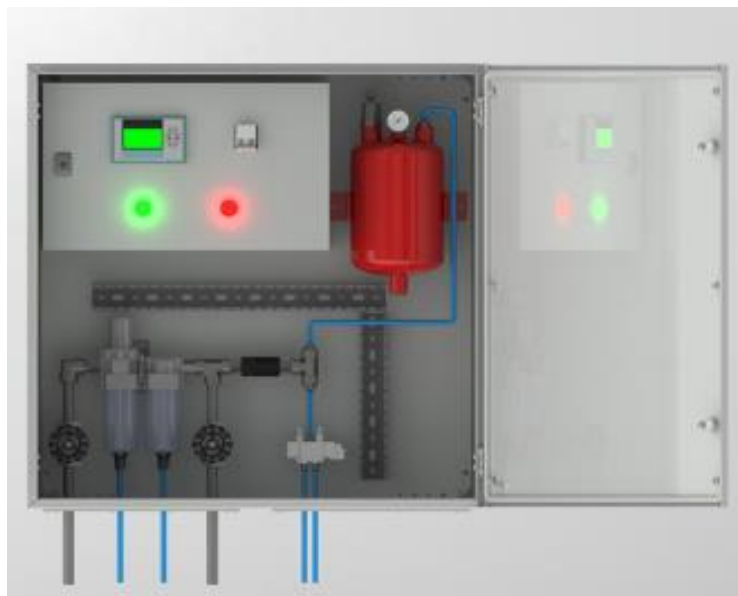
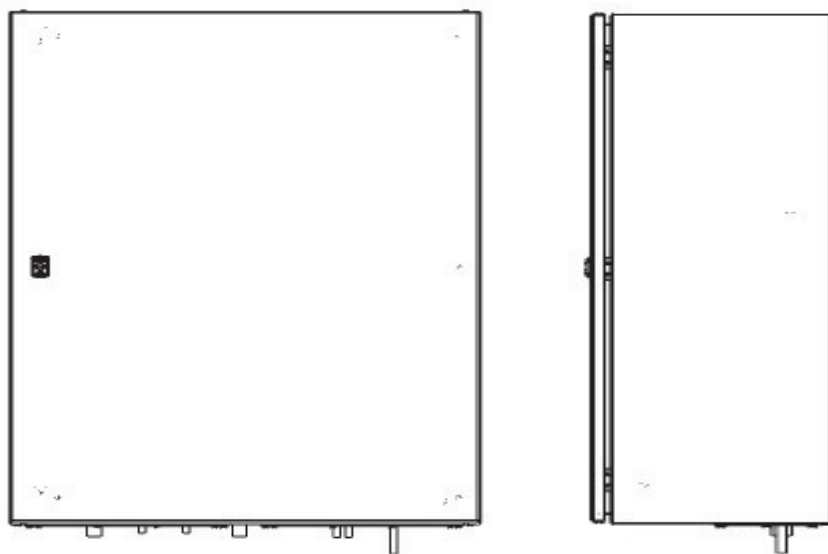


Fig 5 : Control panel



POWER SUPPLY

Features



Fig 6 : Power Supply

- Ultra slim design with 17.5mm (1SU) width
- Universal input 85~264 VAC (277VAC operational)
- No load power consumption < 0.3W
- Isolation Class II
- Pass LPS (Limited Power Source)
- DC output voltage adjustable
- Protections: Short circuit/Overload/Over Voltage
- Cooling by free air convection (Working temp:-30~+70°C) DIN Rail TS-35/7.5 or 15 mountable
- Over voltage category III
- LED indicator for power on

PLC



Fig 7 : PLC

Display	
With Display	Yes
Installation type/mounting	
Mounting	on 35 mm DIN rail, 4 spacing units wide
Supply Voltage	
Rated Value (DC)	
12 V DC	Yes
24 V DC	Yes
permissible range, lower limit (DC)	10.8 V
permissible range, upper limit (DC)	28.8 V
Time of day	
Time switching clocks	
12 V DC	Yes
24 V DC	Yes
Digital inputs	
Number of digital inputs	8; of which 4 can be used in Analog mode (0 to 10 V)
Digital outputs	
Number of digital outputs	4; Relays
Short-circuit protection	No; external fusing necessary
Output current	10 A
For signal "1" permissible range for 0 to 55 °C, max. Relay outputs	
Switching capacity of contacts	
– With inductive load, max.	3 A
– With resistive load, max.	10 A

EMC

Emission of radio interference acc. to EN 55 011 Limit class B, for use in residential areas	Yes
Degree and class of protection	Max. 55 °C
Degree of protection acc. to EN 60529	Dimensions
IP20 Yes	Width 71.5 mm
Ambient conditions	Height 90 mm
Ambient temperature during operation	Depth 60 mm
Min. 0 °C; LOGO! 8 FS 04 and higher: -20 °C	

HMI



Fig 8 : HMI

General information	
Product type Designation	LOGO! TDE
Suitability for use	Can be used with LOGO! 8 and higher
Display	
Design of display	FSTN
Line display	
Number of lines	6
Number of characters per line	20
Backlighting	
Type of backlighting	LED
Control elements	
Keyboard fonts	
System keys	Yes
Number of configurable system keys	0
alphanumeric keyboard	No

Installation type/mounting	
Wall mounting/direct mounting	No
Supply voltage	
Type of supply voltage	AC/DC
Rated value (DC)	12 V; 12/24 V DC, 24 V AC
Power loss	
Power loss, typ.	1.8 W; At 24 V DC
Interrupts/diagnostics/status	
Diagnostics function	No
Degree and class of protection	
IP (at the front)	IP65
Standards, approvals, certificates	
CE mark	YES
UL approval	YES
FM approval	YES
KC approval	YES
Marine approval	YES
American Bureau of Shipping (ABS)	YES
Ambient conditions	
Ambient temperature during operation	Min. -20 °C; No condensation Max. 55 °C
Ambient temperature during storage/transportation	Min. -40 °C Max. 70 °C
Altitude during operation relating to sea level	Ambient air temperature-barometric Tmin ... Tmax at 1 080 hPa ... 795 hPa (-1 000 m ... pressure- altitude +2 000 m)
Configuration	
Configuration software	Configuration tool LOGO! Soft Comfort V8

Accessories	LOGO!
Mechanics/material	Plastic
Width	128.2 mm
Height	86 mm
Depth	38.7 mm
Overall depth	38.7 mm

3.3 PNEUMATIC COMPONENTS

1. a) Air Filter - Mist Separator with Regulator and Digital Pressure Switch

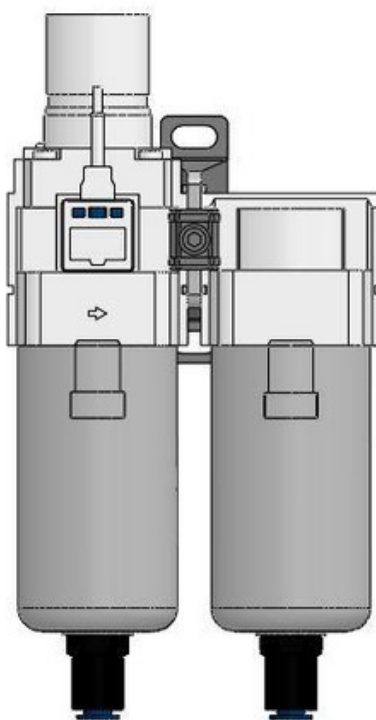


Fig 9 : Air Filter- Mist Separator

Parameter	Specification
Pipe Thread	1/2"
Body Material	Aluminum Alloy die cast
Drain	Automatic
Filter Element	5µm Sintered Drowns
Pressure Range	0.05 to 0.7MPa
Mounting	Wall Bracket Fitted

b). Mist Separator

Specification

Port size	1/2"
Fluid	Air
Ambient and Fluid	-5°C to 60°C
Temperature Proof Pressure	1.5MPa
Max. Operating Pressure	1MPa
Min. Operating Pressure	0.05MPa
Nominal Filtration Rating	.01µm (95% filtered particle size)
Outlet Side Oil Mist Concentration	MAX. 0.1 MG/ M ' (ANR) (Before Saturated With Oil: 0.01MG/M3 (ANR) Or Less,
Rated Flow (L/Min)	600
Bowl Material	Polycarbonate
Bowl Guard	Standard
Mass	0.44Kg

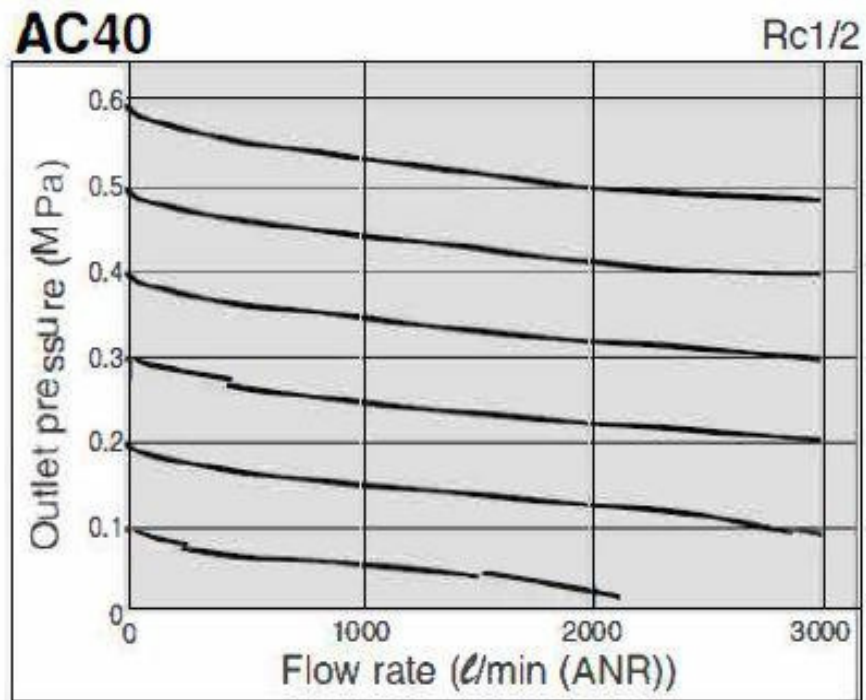


Fig 10 : Flow Rate Graph

c).Digital Pressure Switch



Fig 11 : Digital Pressure Switch

Specification

■ Specifications

Model No.	ISE35	
Rated pressure range	0 to 1 MPa	
Set pressure range	-0.1 to 1 MPa	
Proof pressure	1.5 MPa	
Setting and display resolution	0.01 MPa	
Applicable fluids	Air, inert gases, and incombustible gases	
Power supply voltage	12 to 24 VDC, ripple (p-p) 10% or less (Protected against inverse connection)	
Current consumption	55 mA or less (With no load)	
Switch output	NPN or PNP open collector output	
	Max. load current	80 mA
	Max. applied voltage	30 V (During NPN output)
	Residual voltage	1 V or less (80 mA load current)
	Response time Chattering-proof function	1 s (0.25, 0.5, 2, 3 selectable)
	Short circuit protection	Provided
Repeatability	±1%F.S.	
Hysteresis	Hysteresis mode	Variable (from 0)
	Window comparator mode	
Display method	3-digits 7-segment display, dual-color display (Red/Green), A switch can be operated simultaneously.	
Indication accuracy	±2%F.S. ±1 digit (25±3 °C reference)	
Indicator light	OUT: LIT When ON (Green)	
Environment	Enclosure	IP40
	Ambient temperature	-5 to 50 °C (No freezing)
Lead wire with connector (for option "L")	Oil resistance vinyl cabtyre cable 3 cores φ3.4, 2 m Sectional area of conductor: 0.2 mm ² (AWG25) Outside diameter of insulator: 1.12 mm	
Standard	CE, UL/CSA, RoHS	

2. Non Return Valve

Model

Model	AK4000-04
Port size	1/2"
Sonic Conductance dm ³ /(s.bar)	19
Critical pressure ration	0.25
Weight(g)	140



Fig 12: Non Return Valve

Specification

Fluid	Air
Proof Pressure	1.5MPa
Maximum Operating Pressure	1MPa
Minimum Operating Pressure	0.02MPa
Ambient And Fluid Temperature	-5°C to 60°C

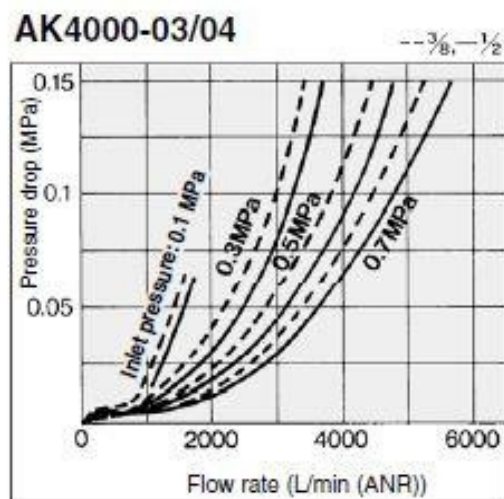


Fig 13: Flow Rate Characteristics

3. Solenoid Valve with Speed Controller



Fig 14: Solenoid Valve with Speed Controllers

Series	SY3000	SY5000	SY7000	SY9000
Fluid	Air			
Internal pilot operating	0.15 to 0.7			
	0.10 to 0.7			
	0.20 to 0.7			
Manual Override	Non-locking push type Push turn locking slotted type			
Pilot exhaust method	Common exhaust for main and pilot valves			
Lubrication	Not Required			
Mounting Orientation	Unrestricted			
Impact resistance/Vibration resistance (m/s ²)	150/30			
Enclosure	Dust proof(IP65 for DIN terminal)			

4. Air Tank

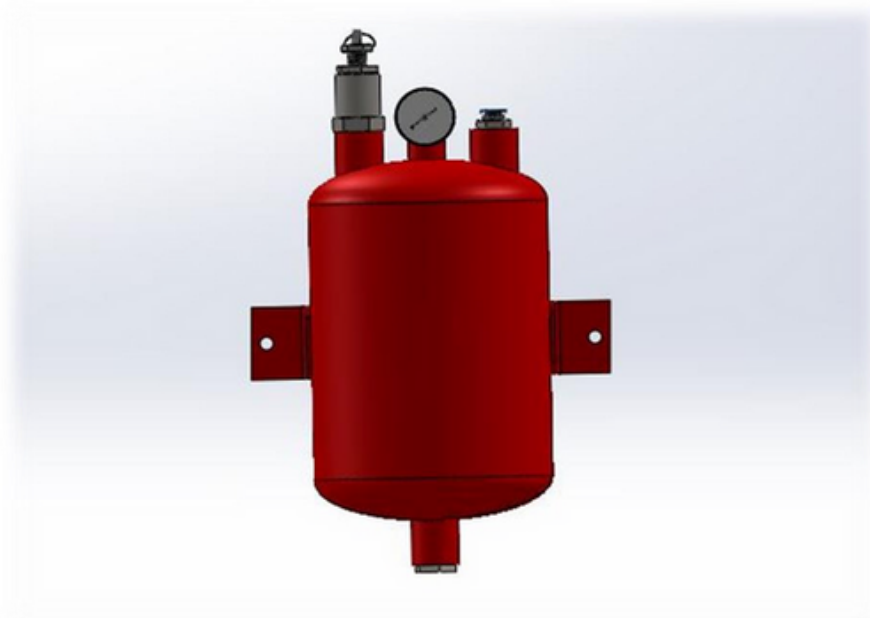


Fig 15: Air Tank

Specification

Description	Main Shell
Dimension	250X160(HXW)
Bottom Clearance	3 MM
Working Pressure	15 Kg/cm ²
Hydro Test Pressure Kg/cm ²	18 Kg/cm ²
Coating	Red Met Powder

3.4 RETRACTION SYSTEM

Features

Maximum speed < 1 m/s.

Adjustable plastic slide element.

Composite sealing system with plastic and felt wiper elements to remove dirt and lubricate the slide ways. Length of stroke 600mm.

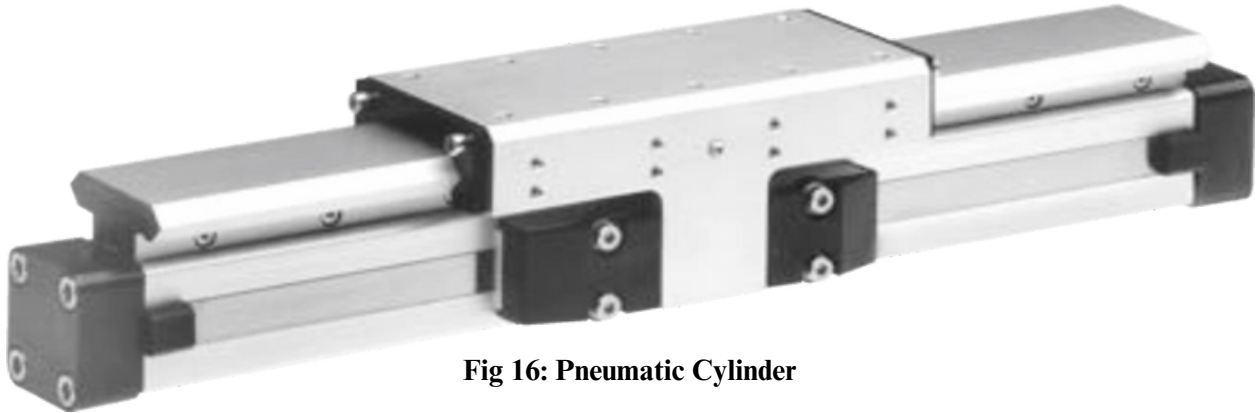


Fig 16: Pneumatic Cylinder

Auto Retraction Function

This device will exit when any one of the following condition appears: The Air and Water pressure is low; the temperature over high and the power is cut-off. The action collecting points of protective function are: pressure controller which is fixed at the output of fine filter, temperature probe which is fixed in the inner layer of camera housing, and electromagnetic valve (solenoid valve) in control box.

Low-Pressure Auto Retraction System:

The setting standard reference value is 2Kg/cm^2 when pressure controller detecting the pressure of compressed air from precise filter is lower than 2kg/cm^2 , the inner switch cut-off the signal and sends feedback to PLC in control panel through control line. PLC disposes the signal and control the camera housing exiting. The time delay of this action is less than 100ms.

High-Temperature Auto Retraction System:

The setting standard reference value is 65°C . The thermocouple temperature probe, fixed at the head of camera housing sense the temperature reference value, then send the data to PLC display in the control box through sensing line. It will be converted to the digital signal and display on panel. When the temperature on the head of camera housing is less than 65°C , the switch relay in display will be cut-off this signal and feedback to PLC in control Box through control line. PLC disposes the signal and control the camera housing exiting. The time delay of this action is less than 10ms.

Power Failure Auto Retraction Function:

When the power is cut, the solenoid valve in control box will lose power. Thus, the air pipe is automatically changed to exit direction and the probe is driven out of furnace.

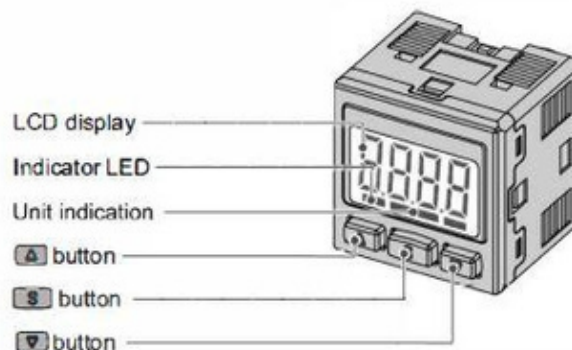
Setting Of Auto Retraction in HMI

Setting of Temperature



By Pressing key on HMI user go in the temperature Coefficient setting menu. Press F2 button to increase the temperature Co-efficient & Press F3 button to decrease the temperature Co-efficient. The camera system will retract if inner temperature goes beyond the temp co-efficient.

Setting of Air Pressure



LCD display: Displays the current status of pressure, setting mode, and selected indication unit

Indicator LED: (Green OUT 1 and Red OUT 2): Displays the switch output condition and error

code. Four display modes can be selected: display always in red or green, or display changing from green to red or red to green, according to the output status.

Button:-Selects the mode or increases the ON/OFF set value.

Press this button to change to the peak display mode.

Button:-Selects the mode or decreases the ON/OFF set value.

Press this button to change to the bottom display mode.

Button:-Press this button to change to another mode and to set a value.

Unit indication:-Displays the unit currently selected.(Only for KPa and MPa unit indication).

Limit Switch



Fig 17: Limit Switch

Characteristics

Contact Type/Material	SPDT, Silver Alloy
Actuators	See selection guide
Operating Speed	0.05mm ~ 2m/s
Operating Frequency	Mechanically : 120 ops/min, Electrically : 30 ops/min
Rated Current/Voltage	10A/250VAC (EN60947-5-1)
Contact Resistance	<25mΩ (initial)
Insulation Resistance	>100MΩ@500V DC
Dielectric Strength	1000VAC for 1 min between current carrying parts 2500VAC for 1 min between non-current carrying parts
Service Life	Mechanically : 5,000,000 ops Electrically : 500,000 ops at maximum rating
Shock	Free position:<10G, Maximum position : <30G
Vibration	10 to 55 Hz, 1.5 mm double amplitude
Operating Temperature	-20 to 60°C
Humidity	Max. 95%RH
Certification	CE, UL file# E312336 CCC file # 2007010305227223,
Degree of Protection	IP64

CHAPTER-4

System Operation

VIDEO SYSTEM

Furnace camera video system consists the CCD camera, pin hole lens, connector, monitor. The lens tube and CCD camera placed in the welded probe and housing which extends into the furnace. The output of CCD camera is connected to connector which forwards the signal to monitor screen in the observation room.

COOLING SYSTEM

Cooling system consists of air and water cooling. In the furnace camera cooling are done in the probe. The inner and outer layer is cooled by air and water.

PROBE CAMERA HOUSING, AIR WITH WATER COOLING

Function: - Remove heat from inside the camera assembly. The compressed air (Pressure more than $2\text{Kg}/\text{cm}^2$) will be separated two parts. One will be sent to furnace gate system through gravity shutter and converted to air curtain at the end of wall sleeve tube. It can avoid the fire spout out which is caused by the positive pressure of furnace and thus reduce the heat radiation on camera housing. The other part of compressed air will be filtrated through Mist separator (Dust and Moisture) and then send to pressure switch in control box. The pressure of compressed air is more than $2\text{Kg}/\text{cm}^2$, which protect the camera from heat radiation. The airflow from an air curtain prevents the bounce-back of furnace fire and clear up the erosion of lens from the high temperature powder. As the camera and lens are fixed in camera housing, the precision demand of inner compressed air is comparatively higher. The compressor air is adjusted by a precise filtering pressure regulator (pressure more than $2\text{Kg}/\text{cm}^2$), and then sent it to vortex refrigerating tube for cooling. Then the compressed air will be sent to the inner of camera housing after being refrigerated, which will flow through the whole housing and cool the camera and lens directly and water circulate into the outer shell of cooling jacket and cool down the temperature of cooling jacket. Air will move out at the front side of cooling jacket to make system fully protect.

AUTO RETRACTION SYSTEM

The main component of the auto retract system is the pneumatic cylinder. A solenoid (direction control valve) inside pneumatic control box controls the air direction to extend or withdraw the piston rod of cylinder. The piston rod is connected directly with the lens and camera assembly. This motion brings the camera lens in and out of the furnace.

CHAPTER-5

System Installation

In order to get the best angle of view, you should choose the ideal installing angle and position. In order to keep the equipment working properly, you should choose suitable compressed air and ideal installation place.

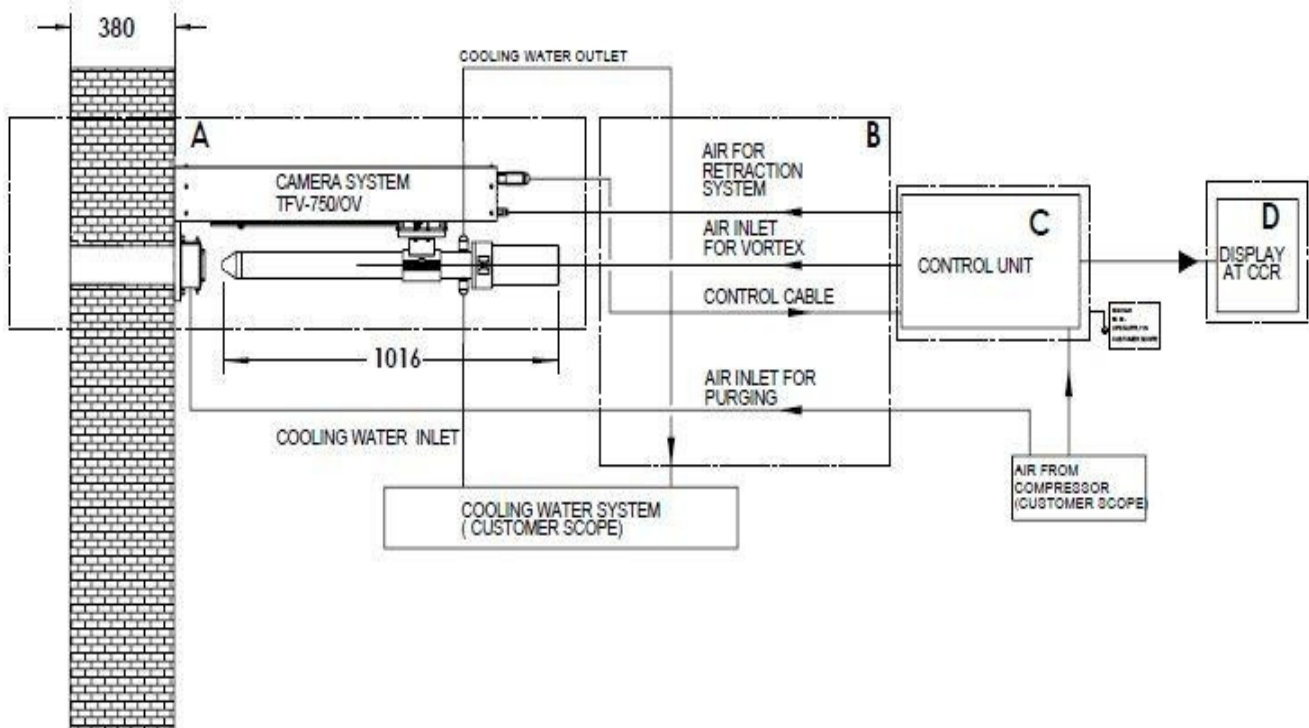


Fig 18: Schematic Diagram of System Installation

MOUNTING BASE PLATE

The user must open an installing hole on the wall of heating furnace according to the camera housing and dimensional drawing of hole. Choose the best observing position. To ensure the reasonable installation of equipment, the range of R500mm of center must not be used and there is no other object. Furnace monitoring camera mounted on the hole position by welding the bolts on the furnace wall according to base plate position and the hole position given in the drawing. Furnace camera mounted on the outside furnace wall with M16 bolts are welded on wall according to dimension drawing shown in figure.

Attention:- The diameter of the hole in the furnace wall is 110mm.

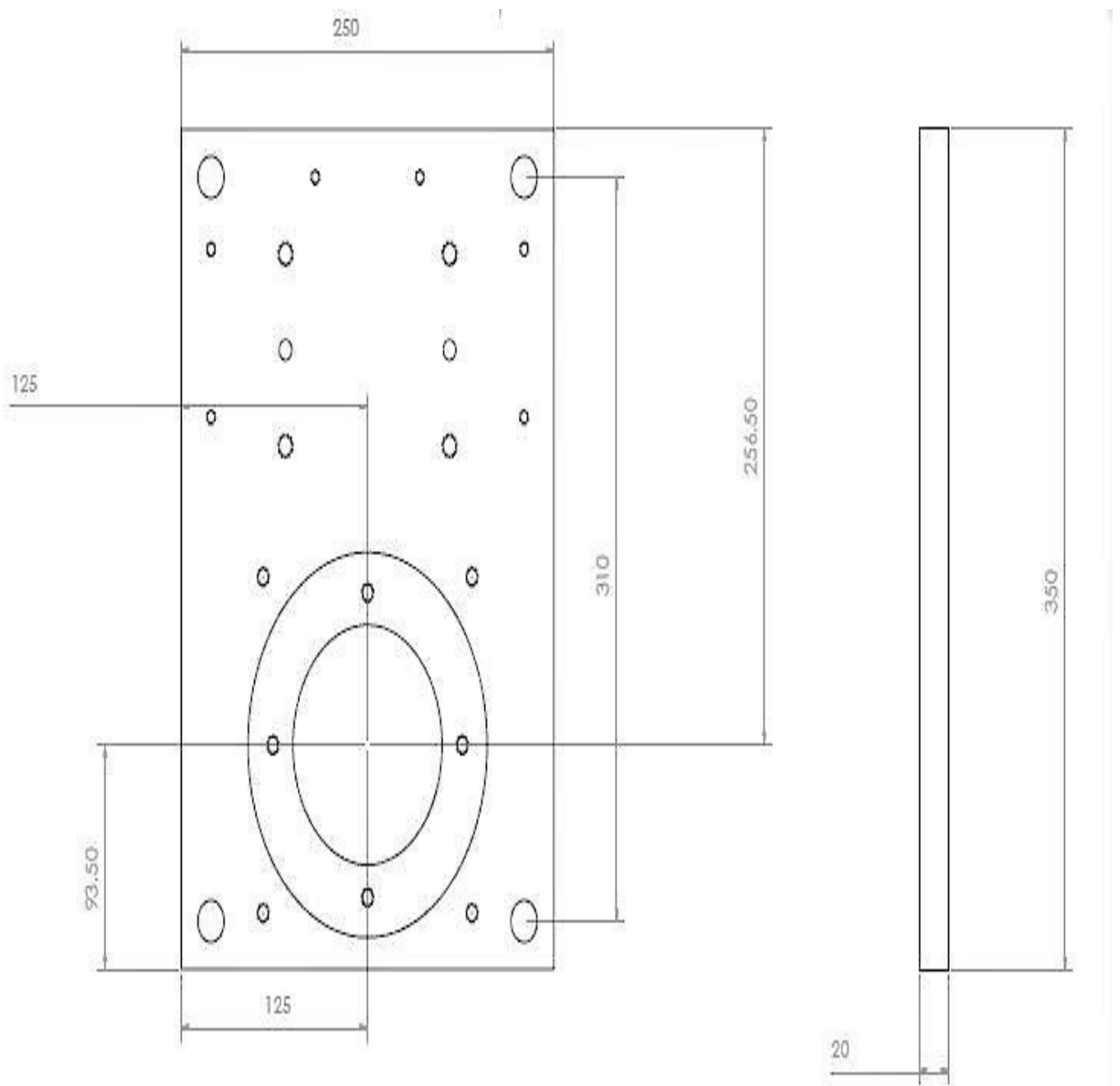


Fig 19: Base Plate

General Installation

Pick out the auto exit device and fix it with hexangular nut on the base plate. The front fitting surface should close to the surface of base plate. If the position of auto-exit device is too high (more than 2m), we commend user mount a platform to repair and maintain conveniently Fix the control box near the auto-exit device less than 2meters. Basing on the local condition you can choose fixing the screw or electric welding. Weld the filter near the control case less than 1 meter.

Air Pipe Connection

The General air inlet pipe is 1/2" tube with a cut-off valve. Near the device put a container with a cock for periodically water drain. Then the compressed air is divided into two 1/2" ways by a 1/2" three-way pipe. One pipe is a cut-off valve at the end is connected to oil-water separator and has a "GO" external interface at the distance away from the separator 1.5m. Other 1/2" pipe is connect to air purge in shutter attachment. Filtered air out from panel through drain valve is supplied to vortex tube. The air connection of pneumatic fittings shown in panel pneumatic fitting drawing.

Attention: Before connecting the separator and pipe with metal tube, you should open the cut- off valve of Compressed air for one minute to blow away the art in pipe.

Attention: All the air pipes should be avoided from any heat objects, or wrapped with heat protect material.

CABLE CONNECTION

Cable Connection includes fiber optics cable, power cable and control cable Selection: As for fiber optics cable, user should select suitable specification according to the distance between camera and terminal unit .If the distance is less than 1000meters, we commend. In case environment temperature up to 100°C, the user should use high temperature fiber optics cable. As for power cable, user should select suitable size according to the distance between power supply device and CCTV system.

CHAPTER-6

Functionality

Imaging

As main part of the system, the camera head contains the imager providing image information. The camera head comprises the long probe optics, reaching into the furnace, while the camera body, containing the imager themselves is kept outside. The optics front window is made from Sapphire, being very resistant to heat and particle impacts. Length of probe optics and field of view can be chosen according to the specific needs.

Cooling and Purging

The camera head is cooled by clean compressed air. The same air is used to purge the tip of the probe, thus keeping it free of deposits and damages from particles. Additionally, the shutter has a fixed protection tube, which is also air-cooled (pressured air or optionally turbine blower). Different types of corrosion resistant stainless steel are available for this tube. In extremely hot environments, the camera head cooling can be intensified by a vortex cooler. Water cooling is in general not necessary.

Automatic Retraction

To protect the camera head from extreme operating conditions, it will be retracted from the furnace if any problem occurs (air pressure drop, cutoff of electrical power, over temperature and low water pressure). This is realized by a pneumatic system with its own air reservoir. A shutter flap automatically closes the protection tube, when the camera head is pulled out.

Chapter-7

Regulation and Maintenance

Connection and Regulation of Electrical Appliance

As for a single device, all the connection has been fixed before leaving the factory. The connections in the spot are mainly between the devices. The connections between control the control cable, power, and temperature control cable are according to the color of the wiring diagram. Input the power line and remote control box, and connect it to the corresponding wiring terminal in the control box. Connect the external video line to the control box, and connect it to the internal video line with "Straight through". Check up the connections of every part; open the switch of compressed air. Wait for 5 minutes, and then turn on the power. Observe the LED on the panel and the temperature digital display regulation device.

Maintenance

This Equipment is a special device used in high temperature environment. It is necessary to carry through some maintenance for longtime reliable working. The maintenance work includes the air pipes maintenance and the electric equipment maintenance.

- **Air Pipe Maintenance**

As the air supply contains water and oil, you need to do some water draining and oil draining work periodically to the filter after using for some time.

- **Cleaning and Draining of Mist Separator**

The filter regulator system is equipped with manual draining. Thus, there is Periodical cleaning & draining needed.

- **Cleaning and Draining of Filter**

After working for some time, the filtering efficiency of separator will be reduced because of the accumulation of water and oil. You should do the oil draining work when the amount of oil is more than a quarter of a cup. You only need to boost up the drain outlet at the bottom of fine filter and the water and oil will be out of control box. You should clean the core of filter when draining. The dismantling.

- **Maintenance of Vortex Tube**

The inside of vortex refrigerating pipe will be walled up by draffy after long-time using. You need to do some clearing work by alcohol.

- **Water Pipe Maintenance**

As the Water supply contains Particles, you need to clean inlet and outlet pipes periodically with water cooling jacket.

- **Cleaning and Draining of Water flow Switch**

Periodically clean diaphragm of water flow switch for smooth work of system.

- **Maintain of Electric Equipment**

The Camera and lens are cooled and protected from dust by compressed air. There will be oil aggradations after working for long time as the air includes oil. You need to remove the camera and lens, and then clean the oil. You must use some special material to scrub of lens, like lens clearing paper, deerskin and etc.

- **Cleaning of Pneumatic Cylinder**

Remove the dust accumulated on rail guide of pneumatic system for smooth insertion and retraction.

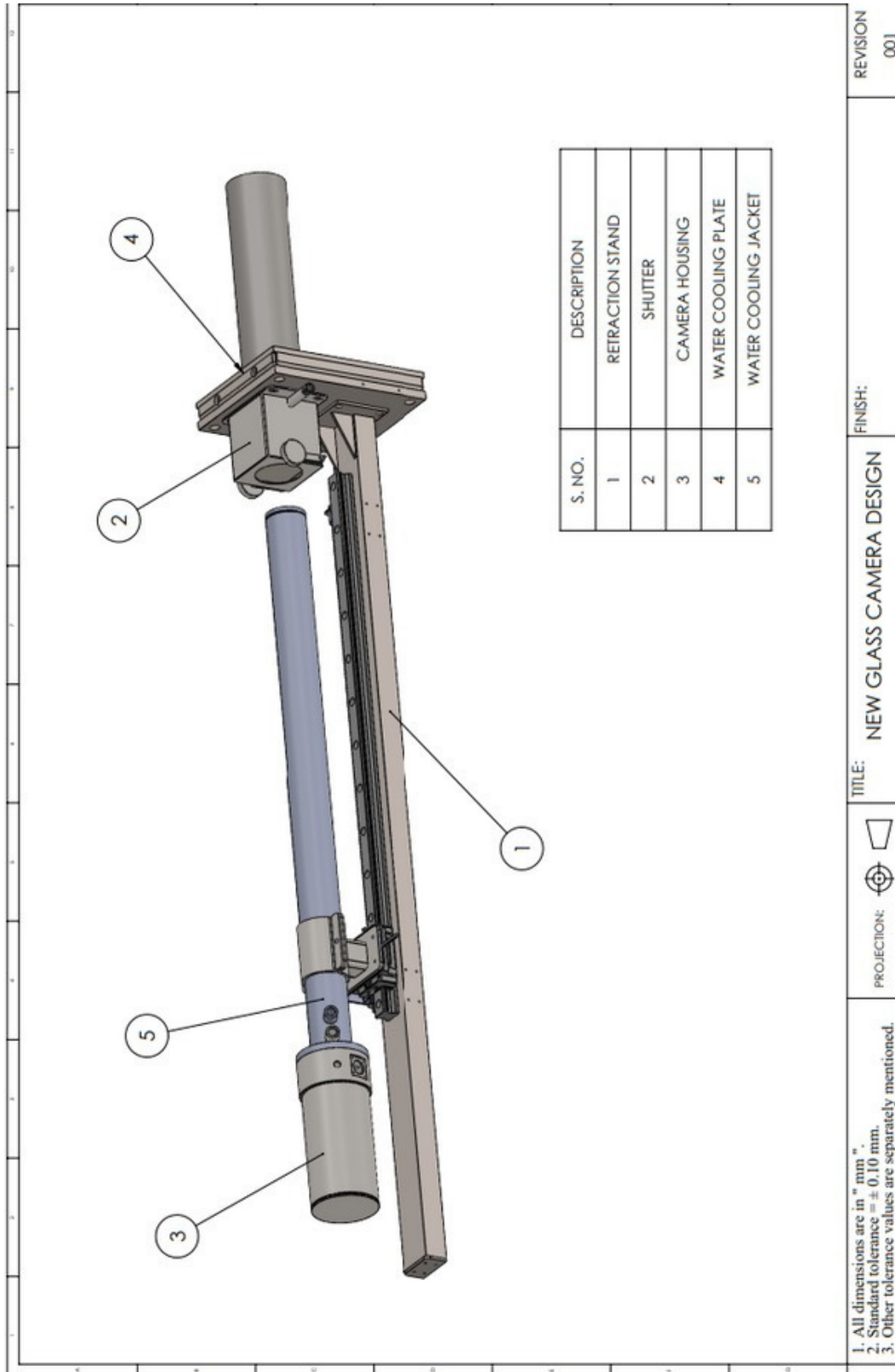
CHAPTER-8

APPLICATION

- Steel- Blast, Melt and Reheat Furnaces. Cement-Clinker Cooler, Rotary Kiln.
- Power Generation-Combustion Monitoring.
- Glass- Float Glass Line, Furnace.
- Waste Combustion-Grate Firing.
- Clay and Ceramics-Kiln Monitoring.

CHAPTER-9

Design of FMS



1. All dimensions are in "mm".
 2. Standard tolerance = ± 0.10 mm.
 3. Other tolerance values are separately mentioned.

PROJECTION:

TITLE: NEW GLASS CAMERA DESIGN

FINISH:

REVISION 001

Fig 20: Design of FMS

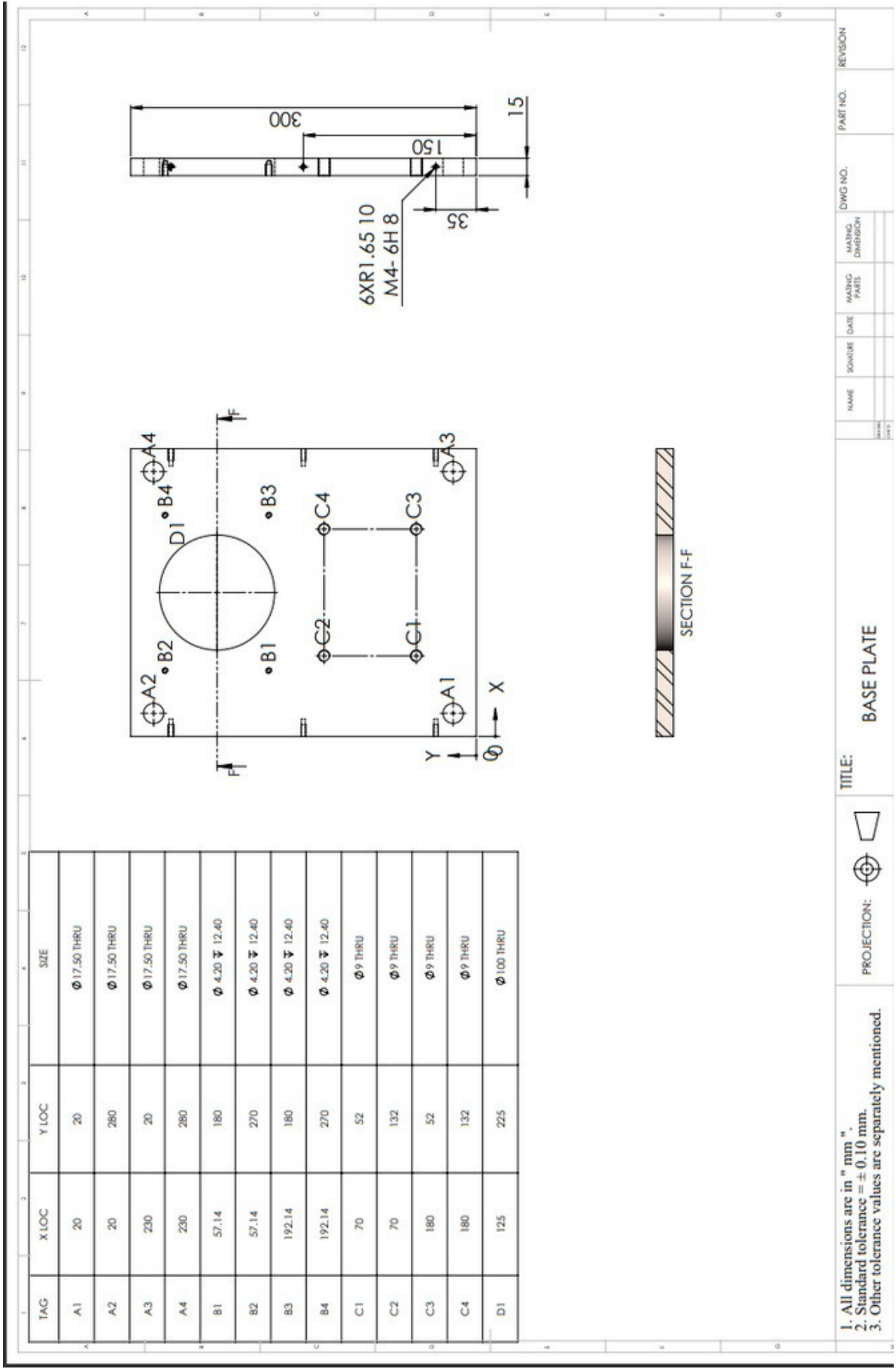


Fig 21: 2D Drawing of Base Plate

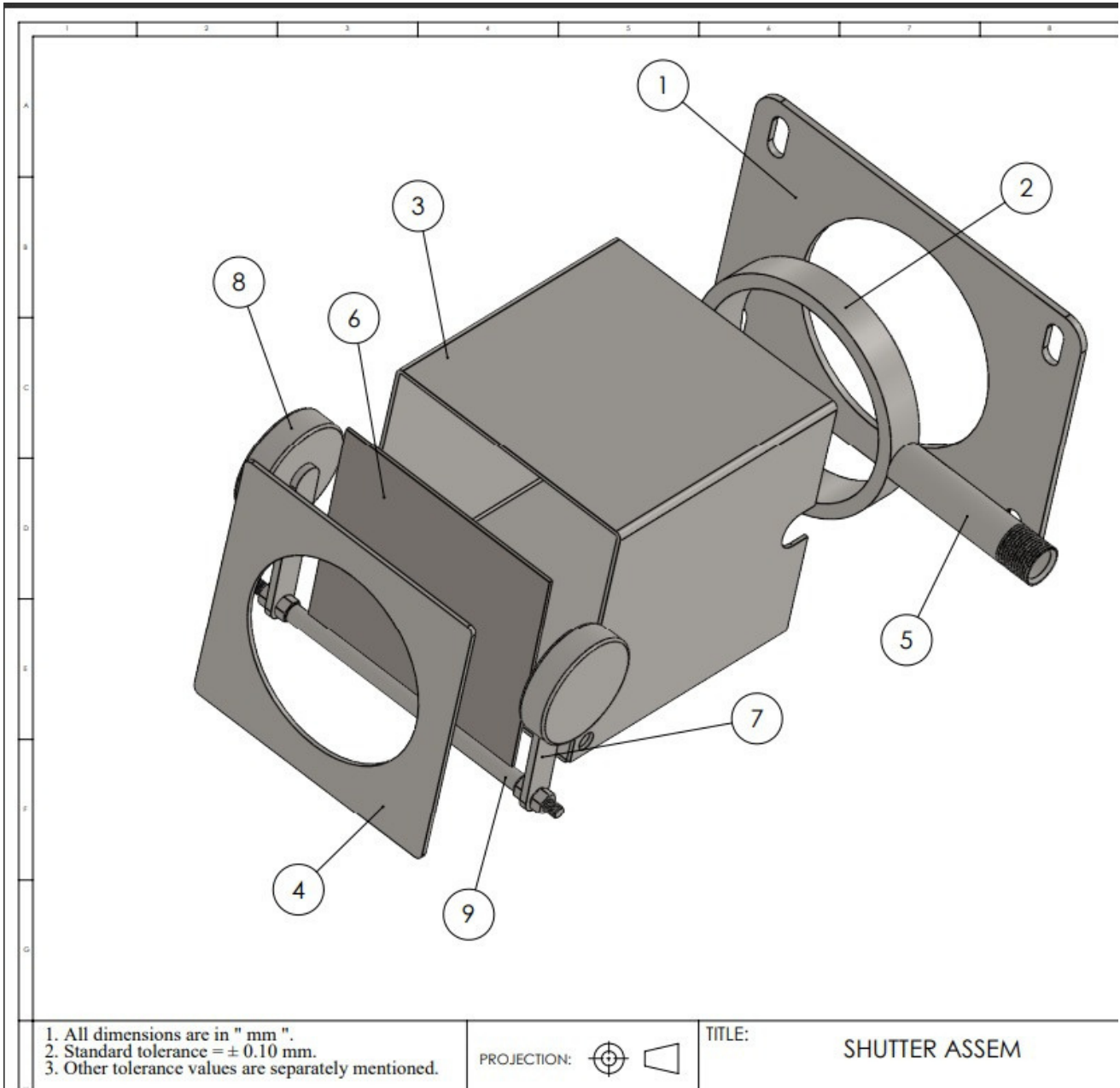


Fig 22: 3D Shutter Assembly

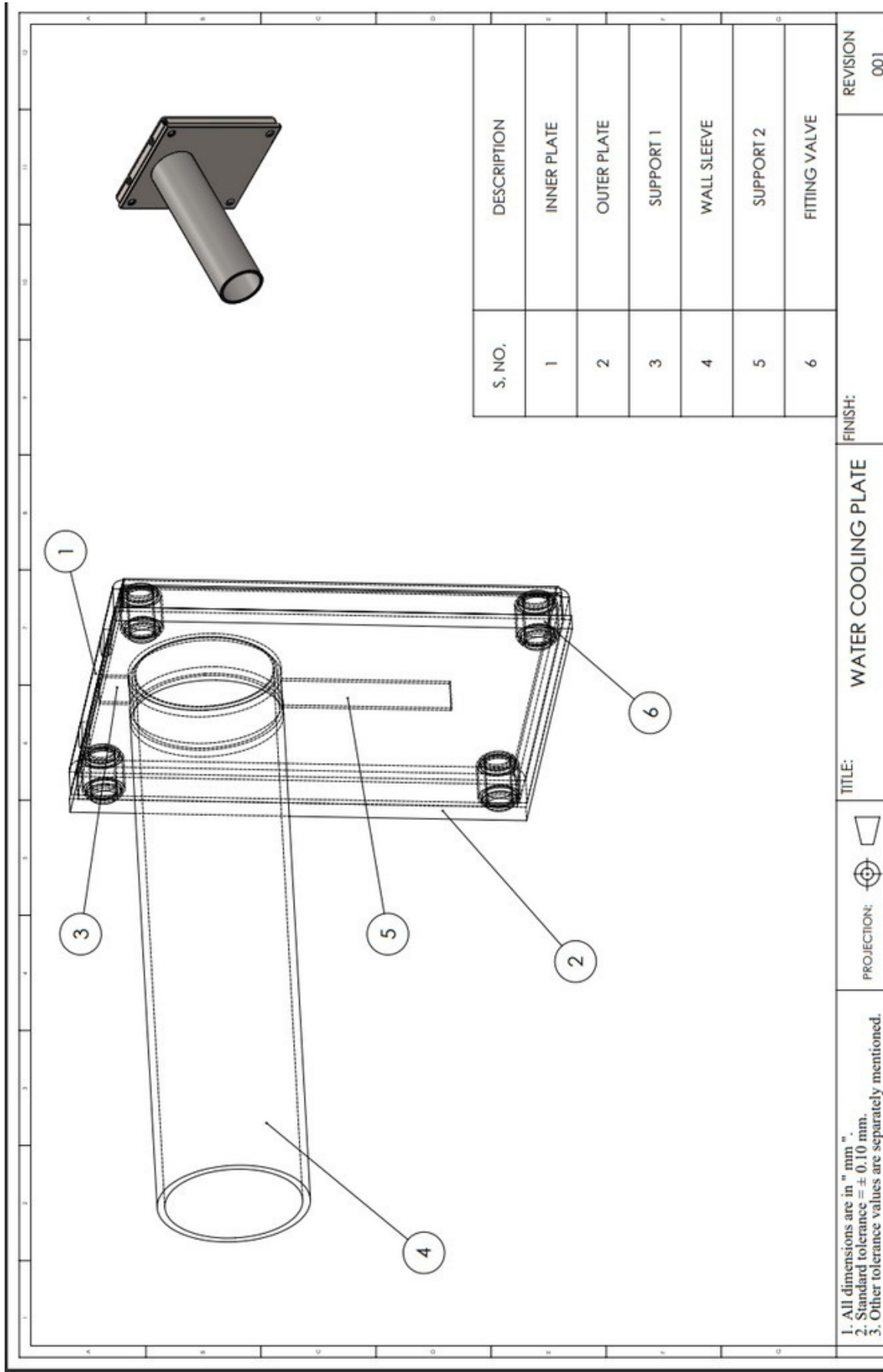


Fig 23: 2D Drawing of Water Cooling Plate

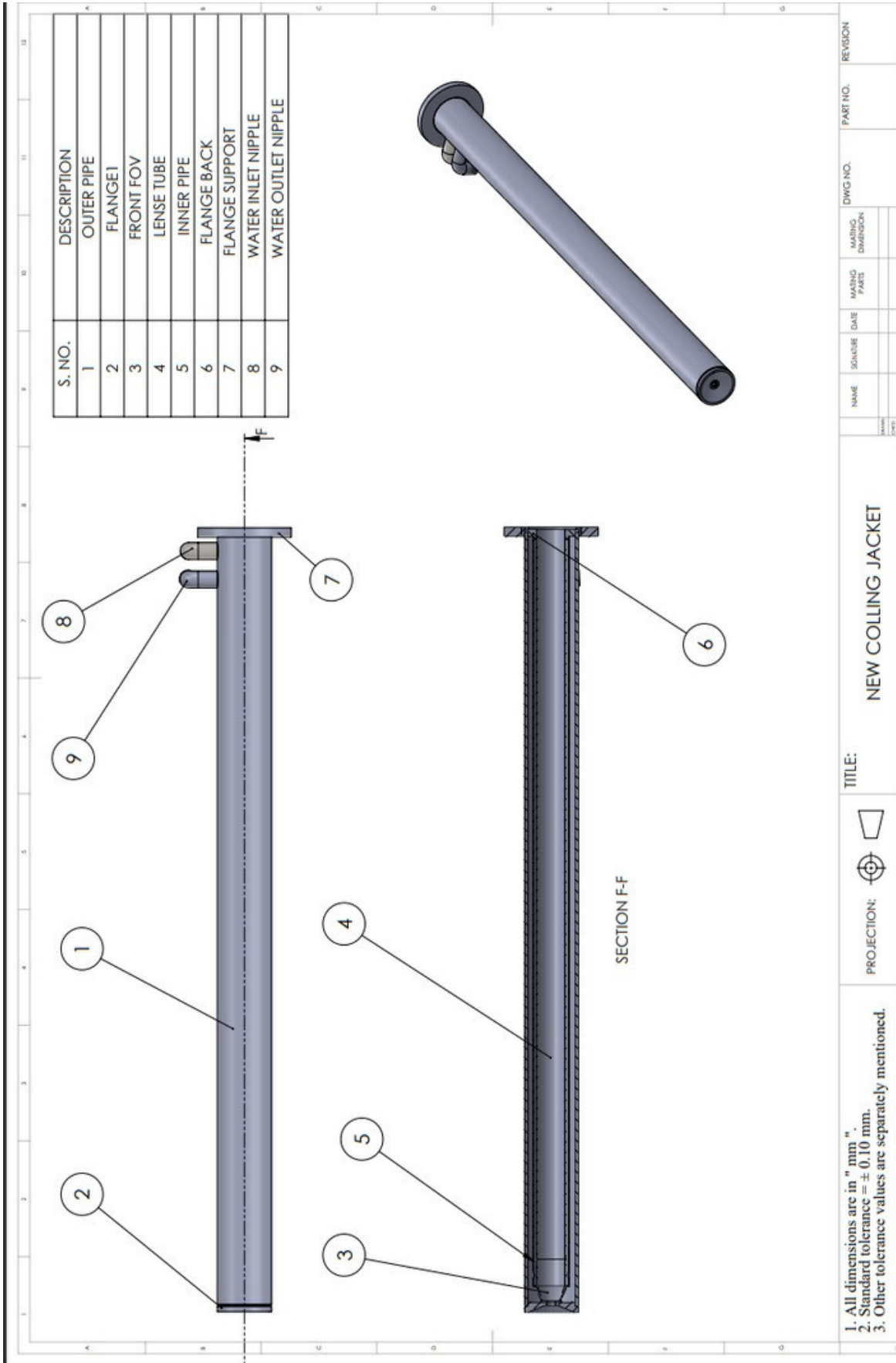


Fig 24: 2D Drawing of New Cooling Jacket

CHAPTER-10

The manufacturing is defined as the processing of raw material or parts into finished goods through the use of tools, human labour, machinery and chemical processing. Manufacturing allows businesses to sell finished products at a very high cost than the value of raw material used.

Welding is a fabrication process that joins materials by using high heat to melt the parts together and allowing them to cool causing fusion. In this process we used arc- welding for some selected components were using MIG welding was not possible. MIG welding was used to fabricate the frame and chassis and a few other components such as collars and foot rests of the vehicle.

Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are melted together forming a join. The gun feeds a shielding gas alongside the electrode helping protect the weld pool from airborne contaminants.

MIG/MAG welding is a versatile technique suitable for both thin sheet and thick section components. An arc is struck between the end of a wire electrode and the workpiece, melting both of them to form a weld pool. The wire serves as both heat source (via the arc at the wire tip) and filler metal for the welding joint. The wire is fed through a copper contact tube (contact tip) which conducts welding current into the wire. The weld pool is protected from the surrounding atmosphere by a shielding gas fed through a nozzle surrounding the wire. Shielding gas selection depends on the material being welded and the application.

The wire is fed from a reel by a motor drive, and the welder moves the welding torch along the joint line. Wires may be solid (simple drawn wires), or cored (composites formed from a metal sheath with a powdered flux or metal filling). Consumables are generally competitively priced compared with those for other processes. The process offers high productivity, as the wire is continuously fed.

Manual MIG/MAG welding is often referred to as a semi-automatic process, as the wire feed rate and arc length are controlled by the power source, but the travel speed and wire position are under manual control. The process can also be mechanized when all the process parameters are not directly controlled by a welder, but might still require manual adjustment during welding. When no manual intervention is needed during welding, the process can be referred to as automatic. The process usually operates with the wire positively charged and connected to a power source delivering a constant voltage. The selection of wire diameter (usually between 0.6 and 1.6mm) and wire feed speed determine the welding current, as the burn-off rate of the wire will form an equilibrium with the feed speed.



Fig 25 : MIG welding

Arc Stick Welding

Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the joint between two work pieces. The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the joint. Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective shielding gas or slag is used to minimise the contact of the molten metal with the air. Once cooled, the molten metals solidify to form a metallurgical bond.

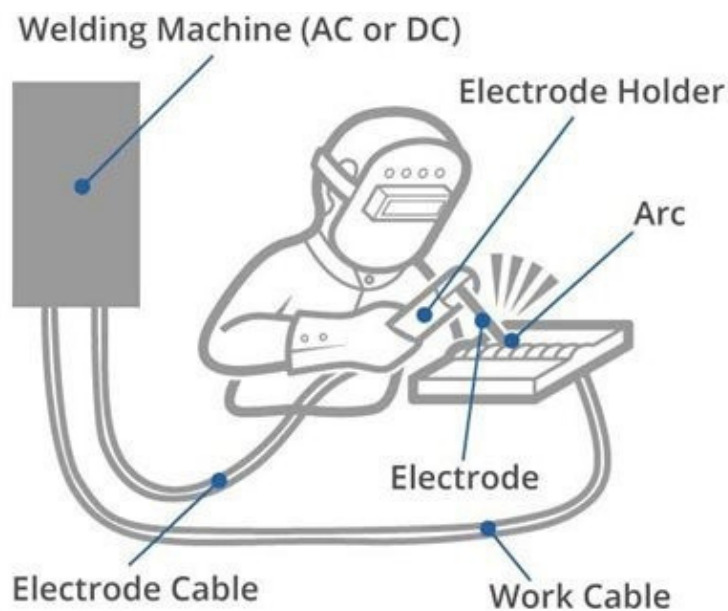


Fig 26: Arc Stick Welding

Grinding is an abrasive machining process that uses a grinding wheel as a cutting tool. Different grades of grinding wheels were used for cutting and surface finishing of unwanted parts and excess welds. Proper safety was ensured by using hand gloves and face masks while performing the procedure. Majority of times angle grinder was used.

Angle Grinder

An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for grinding (abrasive cutting) and polishing. Although developed originally as tools for rigid abrasive discs, the availability of an interchangeable power source has encouraged their use with a wide variety of cutters and attachments.

Angle grinders can be powered by an electric motor or compressed air. The motor drives a geared head at a right angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side handle for two-handed operation. Certain angle grinders, depending on their speed range, can be used as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired. Angle grinders are standard equipment in metal fabrication shops and on construction sites. They are also common in machine shops, along with die grinders and bench grinders.



Fig 27 : Angle Grinder with different abrasive wheels

Cut off machines

Cut-off machines are heavy but versatile tools designed to cut across concrete, metal, and ceramics effortlessly. These saws are known for making cuts of exceptional precision. Abrasive cut saws are ideally suited for metal cutting purposes. Abrasive cut-off devices are also known as cut-off or cut-off saws. These devices are typically designed as circular saws used to cut hardened materials.



Fig 28 : Cut off machine

Surface finishing was done on the body and different components of the vehicle with the help Regmar (Sand Paper) papers of coarse grade(80 and 160 no. grit) followed by finer grades (320 and 400 no. grit). Surf acer paint was applied on the body. Any gaps or dents were evened out with the help of filler (NC) putty.

With help of an Air compressor paint sprayer the body was painted with three coats of metallic paint (gloss). Other small components were painted with the help of brush.

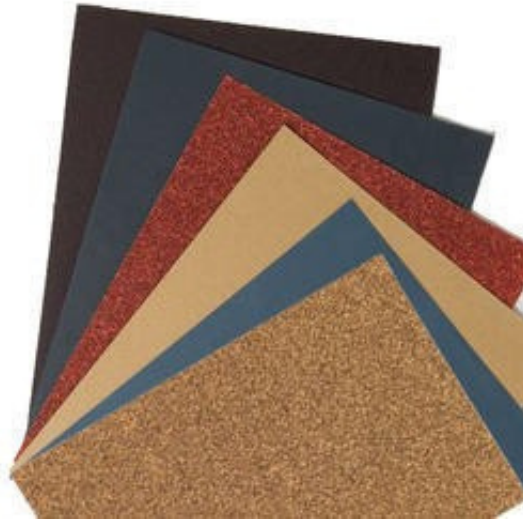


Fig 29 : Vehicle Wiring system

A typical vehicle wiring system consists of alternator, CDI coil, Throttle sensor, ignition switch, kill switch, rectifier/regulator, headlight, tail lights, indicator lights, brake sensors, 12volt battery, ignition coil, spark plugs, on/off switch and relays.

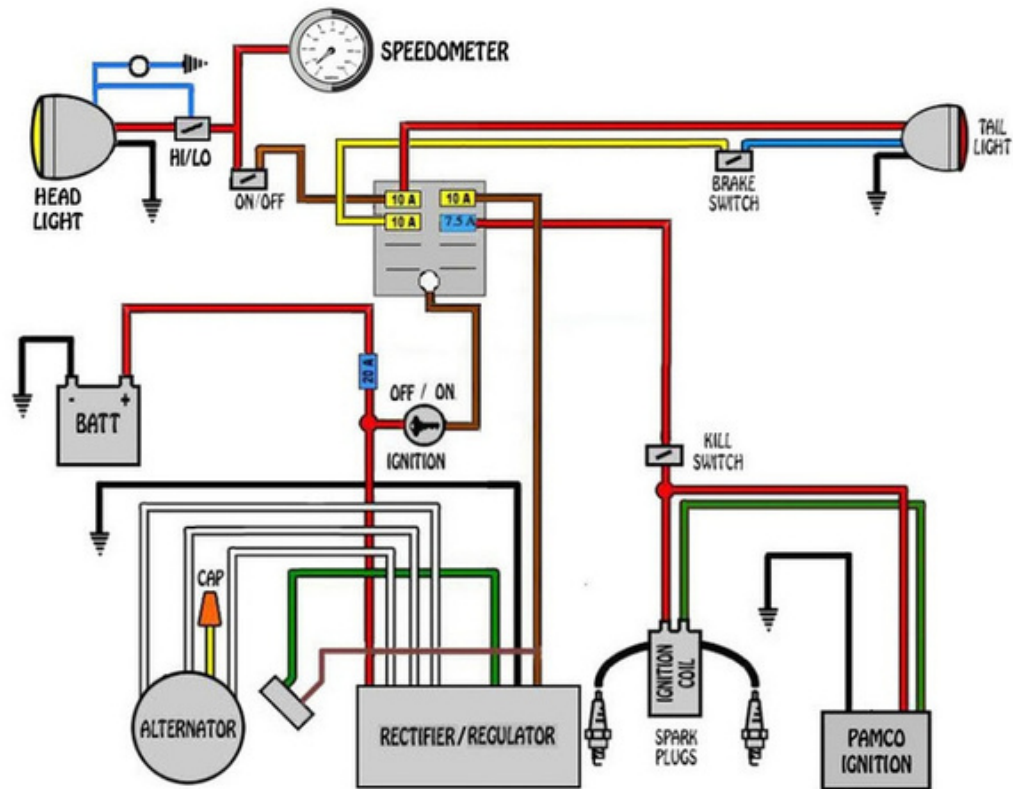


Fig 30: : Schematic wiring diagram

Firstly, the engine was mounted to the chassis. It was followed up with mounting of pedestal bearings and rear axle and sprocket and chain assembly. It was followed by mounting of collar plates and wheels. Sitting components were then assembled followed by the assembly of exhaust pipe. Handle bar and foot pegs were then fitted. After fabrication, proper test trails were conducted to ensure efficient performance

and safety. First the speed tests were conducted to check for maximum actual speeds in different environments and conditions. Secondly, the load bearing test were conducted. Then load towing test was conducted. It was followed by grass cutting and land roller test.

After final tests, small modifications were made and then the finishing touches were given to vehicle.