Design and Fabrication of a Hydropneumatic System By Low Cost Automation for M/s. Meenu Equipments

Project Work 1991-92

SUBMITTED BY

Joe Jacob
Nalluswamy .N
Pandian .M
Senthil Arunachalam .S

GUIDED BY

Mr. D. Senthil Kumaran, M.E., M.I.S.T.E

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
BACHELOR OF ENGINEERING
IN MECHANICAL ENGINEERING
OF THE BHARATHIAR UNIVERSITY

Department of Mechanical Engineering
Kumaraguru College of Technology
Coimbatore - 641 006

Department of Mechanical Engineering

Kumaraguru College of Technology

Coimbatore - 641 006

Certificate

This is to certify that the Report entitled

"Design and Fabrication of a Hydropneumatic System By Low Cost Automation for M/s. Meenu Equipments"

has been submitted by

Mr. ....

in partial fulfilment for the award of Bachelor of Engineering

in Mechanical Engineering Branch

of Bharathiar University, Coimbatore-641 046

during the academic year 1991-'92

....
Guide

....
Head of the Department

Certified that the candidate was Examined by us in the project work Viva-Voce Examination held on .... and the University Register Number was ....

....
Internal Examiner

....
External Examiner

Dedicated to our Beloved Parents

Acknowledgement

ACKNOWLEDGEMENT

We accord ourselves the privilege of thanking Sri. B. **SASIDHARAN,** Managing Partner of **M/s. MEENU EQUIPMENTS** for sponsoring our project and giving us valuable guidance throughout the project.

We are grateful to our Principal **MAJOR T.S. RAMAMOORTHY,** for his permission and the help he extended to carryout our project.

Also we wish to record our immense appreciation and deep felt gratigude to our guide **Mr. D. SENTHIL KUMARAN,** for his able guidance, constructive critisisms and suggestions at all stages of the project.

Our equally intense gratitude and obligation are due to **Prof. K. KANDASWAMY,** Assistant Professsor, Mechanical Engineering Department, for his valuable guidance. We are also highly thankful to **Mr. R. SANTHANAM,** Assembly In-charge, Janatics and **Mr.JOSEPH,** supervisor, Meenu Equipments for their valuable suggestions that helped us greatly at every stage in shaping this project.

Finally we thank all the staff members, non teaching staffs of the Department of Mechanical Engineering and our classmates for their kind co-operation.

Contents

C O N T E N T S

Synopsis

SYNOPSIS

The aim of the project is to design and fabricate a special purpose hydropneumatic attachment for a turret lathe, for mechining the motor cover used in **'Meenu'** mixies.

At present the job is done manually which requires skilled labour and also it is uneconomical to buy a special purpose machine in a small scale industry for this job. Under these circumstances, such an attachment will avoid heavy investment cost and also it will permit unskilled labour to carryout the operation with a high degree of accuracy.

The requirement of the attachment is satisfied with the help of hydropneumatic circuitry consisting of three pneumatic cylinders. One cylinder is used for chucking and the other two are sequenced to complete all operations on the job. The sequencing is done by using solenoid valves and limit switches. It is quite compact and simple arrangement.

The attachment was fabricated and it was tested for its performance. Its performance was satisfactory and met with the desired requirements.

Photographs and drawings have been furnished in ordeto give a clear understanding of the special purpose attachment.

Introduction

INTRODUCTION

1.1. Need for attachment:

In recent years, newer fabrication techniques have been developed to satisfy the technological demands, however, emphasis is stressed on attachments. Attachments are used in various fields and machines, depending upon the needs to be fulfilled and mode or operation. They allow the use of existing machines for a different purpose and thereby eliminate the investment cost on a new unit which serves the same purpose.

Our project deals with design and fabrication of special purpose attachment for machining motor field cover. By implementing this type of attachment to a unit, the existing capacity of the unit can be increased. This purpose is found to be very economical. Generally and spe cial attachment is capable of producing only one type of job.

1.2. Automation:

1.2.1. Significance and Development of Machine Tool Automation

The automation of a machine tool increases the productivity of the operator's labour due to the increase in the production capacity of the machine tool. The operator is freed of direct participation in the machining process and it becomes feasible for him to operate several machine tools at the same time.

In the machining of metals (and other materials), integrated automation of the manufacturing process is accomplished by incorating machine tools into an automatic transfer machine or line.

Automation reduces the physical effort required of the operator, frees him of tediously repeated movements and from monotonous nervous and physical stresses. At the same time, automation requires a much higher level of servicing, both in setting up the machine and in subsequent regular operation. It lightens the burden of physical labour of the operator by increasing the share of required brain work.

As a result of the increase in production capacity in automation, the required number of machine tools is reduced and a higher output is achieved per unit of shop floor space. Automation imparts a rhythmical pace to the machining process and ensures stable quality of the blanks and workpieces in all stages of manufacture.

1.2.2. Basic Concepts and Definitions:

The concept of an automatic machine tool includes:

1. the manufacturing process or sequence of machining operations which determines the motions of the working members, classified as main (directly participating in the cutting process) and auxiliary (not directly participating in the cutting process)

2. operative mechanism of the working members for imparting the movements of their working cycle to these members

3. transmitting mechanisms of the drive for the operative mechanisms of the working members

4. self - acting system for controlling the mechanisms of the machine tool to accomplish the working cycle of machining without the participation of the operator.

The system of automation of a machine tool should be considered as an integrated whole.

1.3.1. Operating cycles of Automatic Machine Tools

An automatic operating cycle is the whole complex of periodically repeated movements of the main and auxiliary working members of a machine tool that are required to machine a workpiece and that take place under the conditions of automatic control in a definite sequence, according to definite laws of motion, at definite sections of the paths.

The cycle in automatic machine tools is usually of the closed type, i.e., at the end of the cycle each working member comes to a position which is its initial point in the next cycle.

A general automatic cycle consists of the particular cycles of the main and auxiliary working members. The main working members of an automatic machine tool participate directly in the cutting process, though their operation is part of the general automatic cycle.

A semiautomatic cycle includes certain nonautomatic handling operations which are accomplished with the participation of the operator. As a rule, such operations include loading, clamping, unclamping, releasing and removing the workpiece, and starting the machine to repeat the operating cycle. As their name infers, semiautomatic machine tools operate on a semiautomatic cycle.

In the setting - up mode of operation of automatic and semiautomatic machine tools the movements of the working members are manually controlled by the operator (or setter-up).

1.3.2. Particular Cycles of the Operative Members:

In their general nature, the cycles of the main and most of the auxiliary working members are closed, repeating cycles of rectilinear reciprocating motions (much less frequently - rocking motions).

The particular cycles of the main working members may be either simple or complex. Simple linear cycles are accomplished along a straight line. They consist of rapid approach (denoted by ->), working feed (--->), dwell (0) and rapid withdrawal (<-). In some cases certain of these elements are absent and in others they are repeated. In complex cycles, the main working

1.4. Advantages of pneumo hydraulic systems:

1. Pneumo - Hydraulic Devices:

There are circumstances when pneumatic devices are superior to hydraulic and electrical equipment. The advantages are:

1 When compressed air is available no electric motors or pumps are needed to drive mechanisms.

2 Compressed air can be used to drive machines in rooms with highly inflamable materials, i.e., in case where no electric motors can be used.

3 Pneumatic equipment is safer in operation than electric devices.

4 Compared with a hydraulic system the friction losses in air pipes and fittings are low. Much higher velocities of the fluid and mechanisms can therefore be employed. A flow velocity of between 10 to 15 m/sec in pipes are commonly used, this can be increased to 300 m/sec (e.g. in air brakes) Pneuamtic machanisms are used to obtain rotation speeds of up to 10,000 and more rev./min.

5 Because of the low losses pneumatic systems can be operated over distances of hundreds of meters and even kilometers.

6 The temperature of the surrounding medium has little effect on the operation of a pneumatic system.

7 Where higher pressures can be used the pipes and fittings of pneumatic systems are smaller, lighter, and cheaper than those of hydraulic systems.

8 Compared with cheap constant delivery hydraulic systems, a pneumatic systems, with accumulators, can be run more economically (air can be stored in cylinders at pressures upto 150 to 200 atm).

9 The cooling of air during its expansion prevents the heating of mechanisms of a pressure air system. Heating occurs in the operation of electric and hydraulic devices.

10 No measures need to be taken in air mains to ensure the return of leakage to the tank as is done in hydraulic systems.

11 They enable easy and extensive automation and can be readily combined with other drives.

12 Low cost of compressed air.

The disadvantages of pneumatic systems are as follows:-

i Large pressure drops and expansion processes in pneumatic systems cause of intense cooling of the compressed air. This results in condensation and even freezing of water contained in the air. As a result valve and and fittings can become blocked with ice. In order to avoid this condensation and freezing measures must be taken to remove water from the air.

METAL CUTTING THEORY

1.5. Principles of Metal Cutting:

Metal Cutting represents a machining process by which a finished surface of desired shape and dimension is obtained by separating a layer from the parent workpiece in the form of chips, thus being distinctly differing from chip-less machining like rolling, forging, extrusion, spinning and similar process. In otherwords metal forming can be sub divided into several groups depending on the nature of chip formation.

The process of metal cutting is affected by a relative motion between the workpiece, held against the hard edge of a combination of rotary and translatory movements, either of the workpiece or of the cutting tool or of both. Depending on the nature of this relative motion metal cutting process are called either turning or planning or boring or other operation.

Conventionally the translatory displacement of the cutting edge of the tool along the work surface during a given period of time is called **'Feed(s)'**. While the rate of traverse of work surface past the cutting edge is designated as **'cutting velocity'** or simply **'cutting speed'**. In the case of a single point turning it is the peripheral velocity of the work piece.

1.5.2. The force system:

The force system in a conventional turning process is shown in the Fig. The resultant cutting force R is expressed by its components.

Px Feed force in the horizontal plane against the direction of feed (frictional force)

Py Thrust force - in the horizontal plane perpendicular to the direction of feed

Pz The **'cutting force'** or the **'Main force'** acting in the direction of the cutting velocity vector.

P2 is the vertical plane, perpendicular to both Px and Py.

These three forces depend on fine essential characteristics namely tool geometry, depth of cut, feed material and condition of working such as provision of coolant etc. The influence of speed is not very appreciable.

It is difficult to calculate, the exact force acting on the tool under a cutting condition, because it is difficult to take care of the different variable factors that come into play in our actual cutting operation. The exponential formula determining the force Pz can be expressed as under:

$$Pz = Cp. txs. \; Y. K$$

Cp - Co-efficient, characterised by the work material and condition of working such as tool coolant etc.

t depth of cut in mm

s feed in mm.rev

K overall correlation co-efficient consisting of the actual working condition and tool angles which varies from 0.9 to 1.0 K again consists of four different co-efficient

where K = K. KQ x Kr x Kn

Kc correction co-efficient for coolant

Kq correction co-efficient depending upon the entering angle

Kr correction co-efficient depending upon the back rake angle

Kn correction co-efficinet depending upon the material.

member travels in mutually perpendicular directions (Fig.1).

Most of the auxiliary working members execute closed cycle of reciprocating motion. Certain auxiliary working members may have a rotary and, in most cases, indexing cycle of motions for changing the stations or positions of the workpieces (spindle carriers of multiple - spindle automatics, spindle carries of vertical multiple - spindle semiautomatics and work tables of multiple - station unit - built machines) or of the tools (turrets of turret lathes, indexing attachments for drilling and tapping in single -spindle automatic screw machines, etc,).

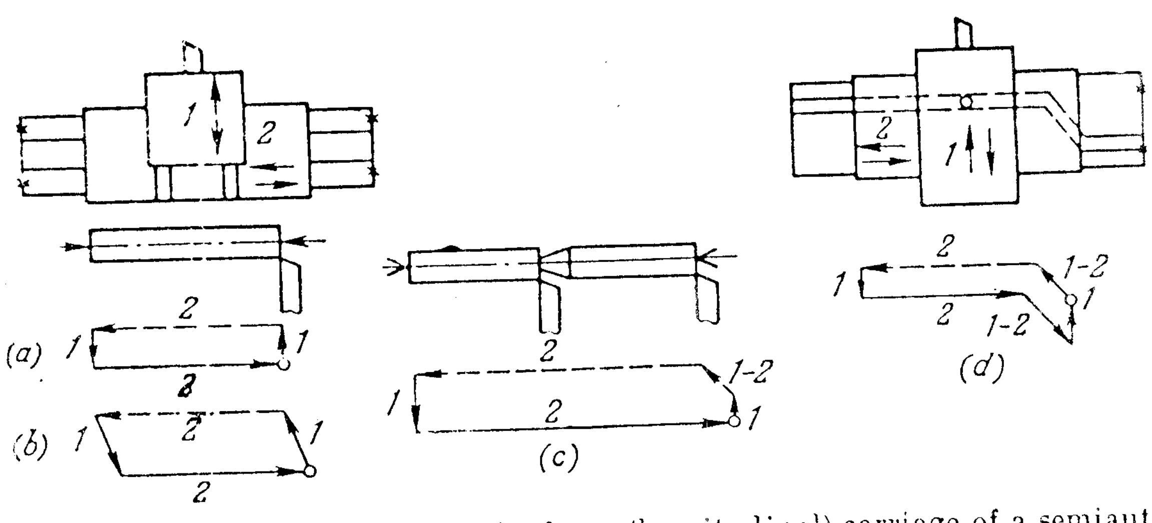


Fig. 8.1 Diagrams of complex cycles of the front (longitudinal) carriage of a semiautomatic lathe:

(a) only straight withdrawal possible; (b) approach and withdrawal with travel of both saddle and cross slides; (c) straight withdrawal and angular infeed with feed of both saddle and cross slides; (d) retraction of cross slide for tool relief, angular withdrawal and approach of cross slide and angular infeed to a cam

Nomenclature

2. NOMENCLATURE

SYMBOL	DESCRIPTION	UNIT
B	Machining exponent	–
S	Feed	mm/rev
K	Material factor	–
V	Cutting speed	M/min
P	Power	H.P
F	Cutting force	Kgf
a	Depth of cut	MM
tm	Machine time	Sec
Pr	Pressure	Kgf/cm^2
μ	Co-efficient of friction	–
FT	Tangential cutting force	Kgf
N	Speed of spindle	rpm
D2	Dia of component	mm
D	Dia of cylinder	mm
L	Stroke length	mm
Z	No. of cutting edges in contact	
A	Area	mm^2
V	Volume	mm^3
D	Density	Kg/mm^3
N	Self weight of parts	Kg

Design Analysis

2. DESIGN ANALYSIS

Component material	: Aluminium
Modulus of elasticity (E)	; 0.675×10^5 N/mm^2
Specific weight	: 0.027 N/cc
Tool material	: Carbide tip
Tool bar material	: Mild steel

3.1. POWER CALCULATION:

From PSG Date Book P.NO: 12.1

Power required for boring $= 13.2 \times 10^{-3}$ xKxZxV $(1.55as)^B$

Where K = material factor = 0.55

B = Machine component = 0.94

Z = no. of cutting edges in contact = 2

V = cutting speed M/min = 210 M/min

a = Depth of cut = 1mm

S = Feed/rev = 0.375mm

Power = $13.2 \times 10^{-3} \times 0.55 \times 2 \times 210 \times (1.55 \times 1 \times 0.375)0.94$

P = 1.831 KW

3.2. CUTTING FORCE CALCULATION:

Tangential cutting force (Fr) - DDB 12.1

$$FT = \frac{19.5 \times 10^6 \text{ (KN)}}{D2n}$$

N = Spindle rpm

$D2$ = maximum dia on which cut is taken

FT = 243.086 N

Therefore cutting force $F = FT$ + Friction force

3.2.1. TO CALCULATE FRICTION FORCE:

$$\text{Friction - Force} = \mu x F$$

Co - efficient of friction (μ) for cast iron is given in hand book of Mechanical, Design (Maitra & Prased)

From the book for sliding over oil film is 0.15

3.2.2. TO FIND SELFWEIGHT OF CARRIAGE & CROSS SLIDE

To find out the selfweight we have to find the volume of carriage parts.

I Refer Fig - 1

$$\text{Volume} = 1 + 2 + 3 + 4 + 5$$

$$A5 = A1 = 187 \text{ mm}^2$$

$$A4 = 118 \times 18 = 2124\text{mm}^2$$

$$A2 = A3 = \tfrac{1}{2} \times 11 \times 8 = 44\text{mm}^2$$

$$A = 2 \times 187 + 2124 + 2 \times 44$$

$$= 2586\text{mm}^2$$

Volume = A x l = 2586 x 390

V1 = 10,08,540 mm^3

II Refer Fig - 2

Volume = $\pi r^2 h$

= $\pi/4 \times (110)^2 \times 10$

v2 95033.17mm^3

III Refer Fig - 3

Area = 1 + 2 + 3 + 4

A1 = 91 x 15 = 1365 mm^2

A2 = 39 x 11 429 mm^2

A3 = A4 = ½ x 7.5 x 11 = 41.25mm^2

Area = 1365 + 429 + 2 x 41.25

A = 1876.5 mm^2

Volume = A x l

= 1876.5 x 196

V3 = 367794 mm^3

IV Refer fig - 4

$A1 = 21 \times 91 = 1911\ mm^2$

$A2 + A3 = 11 \times 7.5 = 82.5\ mm2$

$A4 + A5 = 2 \times 11 \times 14.5 = 319\ mm^2$

$A = 1911 + 82.5 + 319 = 2312.5\ mm2$

$V = A \times L = 2312.5 \times 242$

$V4 = \underline{659625\ mm^3}$

V Refer fig. 5

$A = 91 \times 50 = 4550\ mm2$

$V = 4550 \times 91 = \underline{414050\ mm^3}$

VI Refer fig. 6

$A = 13.5 \times 8 = 108$

$V6 = A \times L = 108 \times 342 = \underline{26136\ mm^3}$

VII Refer fig - 7

$V7 = 13.6 \times 8 \times 390$

$= \underline{42436.59\ mm^3}$

Total valume of the carriage

$$V_A = V1 + V2 + V3 + V4 + V5 + V6 + V7$$

$$= 1008540 + 95033.17 + 367794 + 559625$$

$$+ 414050 + 26136 + 42436.6$$

$$= \underline{2573614.77 \text{ mm}^3}$$

Volume of the cross slide aline

$$V_B = V4 + V5 + V6$$

$$= 559625 + 414050 + 26136$$

$$= \underline{999811 \text{ mm}^3}$$

Density of cast iron (p) $= 7150 \times 10^{-9}$ kg/mm³

weight of carriage WA = volume x P

WA = VA x P

$$= 251361.77 \times 7150 \times 10^{-9}$$

$$= 17.97 = \underline{18\text{kg}}$$

weight of cross slide W_B $= V_B \times 1$

$$= 999811 \times 7150 \times 10^{-4}$$

$$= 7.15 \text{ kg} = \underline{7.5\text{kg}}.$$

3.3. DESIGN OF CYLINDERS:

CYLINDER - I

Total force to be carried by the cylinder

= Tangential force (F6) + selfwt (W1)

+ Friction force (μ W1)

For the first cylinder self wt means the total weight of the carriage

Ft = 24.78 kgf

W1 = 18kg

W1 = 2.7 kgf

Assuming factor of safety = 1.5

Total force F1 = $(F_T + W_1 + \mu W1) \times 1.5$

= (24.78 + 18 + 2.7) 1.5

= 68.55 kgf

Normal pressure = 5kgf/CM^2

A = F/P = $\frac{68.55}{5}$ = 13.71 CM^2

¶ /4 D^2 = 13.71 CM^2

D1 = 4/¶ x 13.71 = 4.17CM

D1 = 42mm

CYLINDER - II

FT	=	24.78kgf
W2	=	7.5 kgf
W2	=	1.125 kg

Total force F2 = $(F_t + W_2 + \mu W2) \times F.S.$

= 33.625 x 1.5

= 50.4375 kgf

Pressure = 5 kgf / CM^2

A = F/P = $\frac{50.4375}{5}$

A = 10.0875 CM^2

$\P/4\ D^2{}_2$ = 10.0875

D^2 = $4/\P \times 10.0875$ = 3.59 CM

D_2 = 36mm

CYLINDER III

Assuming the force to be 25kg

A = F/P = 25/5 CM^2

$\P/4\ D^2{}_3$ = 5

$D_3 = 4/\pi \times 5$

$D_3 = 2.53CM$

Therefore $D = 26mm$

3.4. DESIGN OF OIL TANKS:

TANK I

Volume of cylinder I $V1 = \pi r_1^2 h_1$

$$= \frac{\pi}{4} d_1^2 h_1$$

Where,

d_1 -> diameter of cylinder I = 50mm

h_1 -> stroke length of cylinder I = 160mm,

$$\text{Therefore } V_1 = \frac{\pi}{4} \times (50)^2 \times 160$$

$$= 314159.265 \text{ mm}^3$$

$$= \underline{400000\text{mm}^3}$$

We are provided with a C.I. pipe of 50mm diameter for the fabrication of the tank

let $d_3 = d_4 = 50mm$

Volume of tank I V_3 = safety factor x volume of cylinder I where,

safety factor = 1.5,

volume of cylinder I = 400000 mm^3

Therefore V_3 = 1.5 x 400000

= 600000 mm^3

$$V_3 = \frac{¶}{4} \times d_3^2 \times h_3$$

$$\text{Therfore } 600000 = \frac{¶}{4} \times (50)^2 \times h_3$$

therefore height of the tank,

h_3 = 305.57mm

= 300mm

TANK II

$$\text{volume of cylinder II } V_2 = \frac{¶}{4} \times d_2^2 \times h_2$$

$$= \frac{¶}{4} \times (40)^2 \times 30$$

= 37699.112 mm^3

40000 mm^3

where,

d_2 = diameter of cylinder II = 40mm

h_2 = stroke length of cylinder II = 30mm volume of tank II = V_4 = safety factor x vol of cyl II.

safety factor = 3

vol. of cy.l II = 40000 mm^3

Therefore V_A = 3 x 40000

= 120000 mm^3

also $V_A = \frac{\pi}{4} \times d_4^2 \times h_4^2$

$120000 = \frac{\pi}{4} \times (50)^2 \times h_4$

Therefore the height of tank II h_4 = 61.115 mm.

70mm.

3.5. To calculate machining time;

Spindle speed (N) = 1440 rpm

FROM HMT DATA BOOK

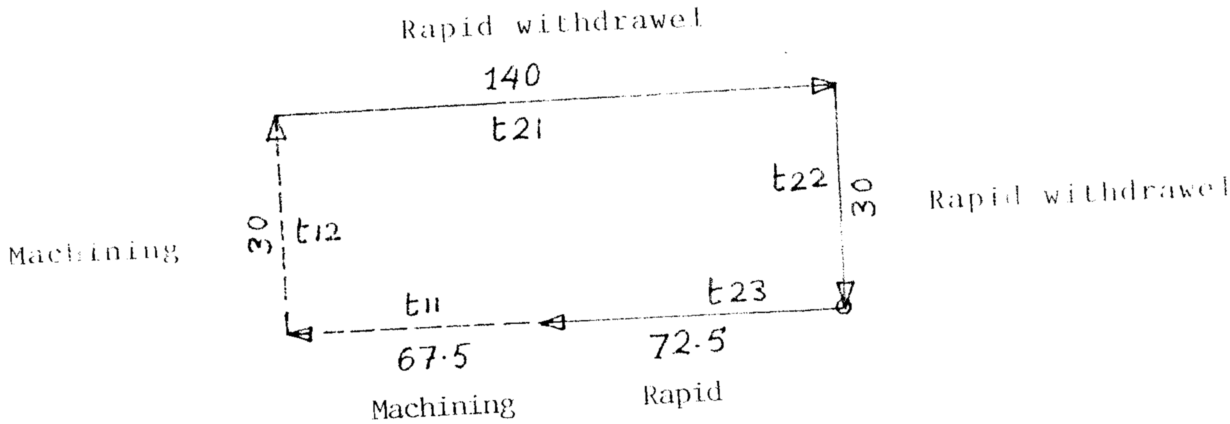
Material	Tool Material	Depth of cut (MM)	
		0.1-0.4	0.4-2.5
		Feed mm/rev	
		0.05-0.125	0.125-0.375
Aluminium & Alloys	H S S	1.5 - 150	65 - 105
	Cost alloy	135 - 195	90 - 135
	Carbide	210 - 300	135 - 210

Here

Depth of cut = 1mm

so feed is taken as 0.375mm/rev

(maximum value)



$$\text{Machining time } (t) = \frac{\text{Mkg length}}{\text{Speed} \times \text{Feed}}$$

$$t11 = \frac{675 \times 60}{1440 \times 0.375} = 7.5 \text{ seconds}$$

$$t12 = \frac{30 \times 60}{1440 \times 0.375} = 3.5 \text{ seconds}$$

Total M/cg time (Tm) = 7.5 + 3.5 = 11sec

For return stroke:

i) allot 3 seconds for travelling 140MM

ii) For 30mm t_{22} = 0.64 sec => 1 sec

iii) For 72.5MM t_{23} = 1.6 sec

so time taken for completing the job

T = 11 + 3 + 1 + 1.6 = 16.6 sec > 17 sec

Linear Velocity (V):

During machining:

$$V_{11} = \frac{L11}{} = \frac{67.5 \times 10^{-3}}{7.5} \times 60 = 0.54 \text{ m/min}$$

$$V_{12} = \frac{30 \times 10^{-8} \times 60}{3.5} = 0.54 \text{ m/min}$$

<u>During retrading strokes</u>

$$V = \frac{140 \times 10^{-3} \times 60}{3} = \underline{2.8 \text{ m/min}}$$

3.6. Selection of Tools:

In the tool bar three tools are used. The first two tools are used for boring and stephoring and also for facing. In order to satisfy these needs we selected IS 163 carbide tipped tools.

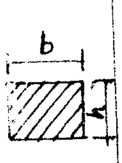
The third tool is used for facing the arms of the field cover. When the first tool finishes boring, the third tool should take its position and should take a depth of 1mm cut. Facing is doneby moving the tool from outside of the component towards inside. To satisfy this need one of the tool available is IS02 and hence this tool is selected.

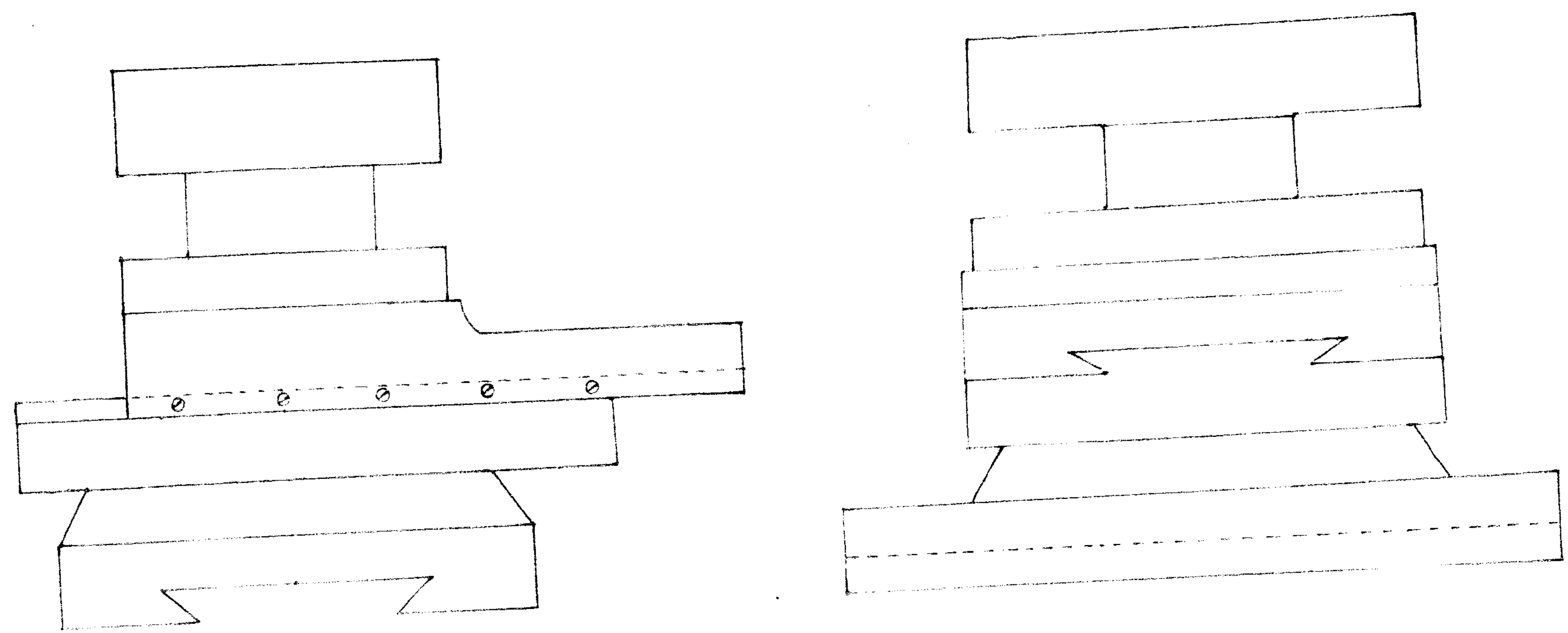
The details of the IS02 is given below:

<u>Designation:</u> A cranked turning and facing tool having shank section 1010 for left hand cutting shall be desigbated as:

Cranked turning and facing tool

Style IS02 L1010 IS: 3019

Shank				L1 ± 5%	L2 min	C Approx	V ± 0.1
Section	h	b	Design-ation				
	10	10	1010	90	20	6	0.4
	12	12	1212	100	20	8	0.4



CROSS SLIDE AND TOOL POST ASSEMBLY

FIG:1

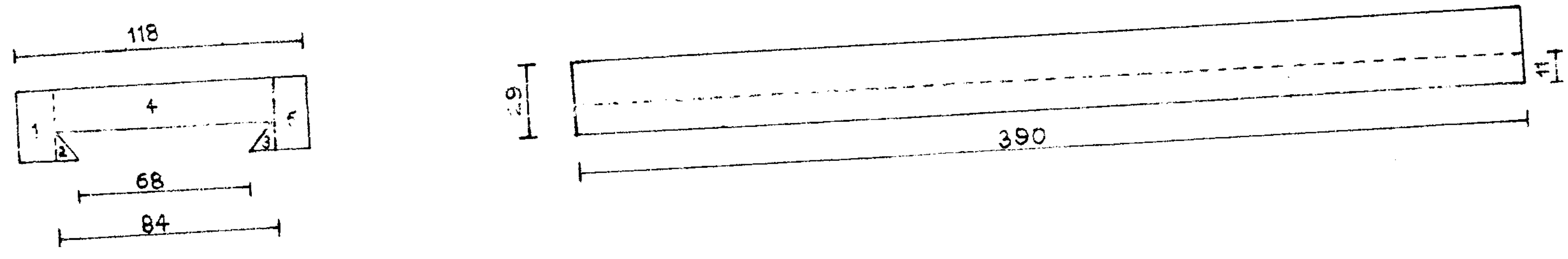


FIG:3

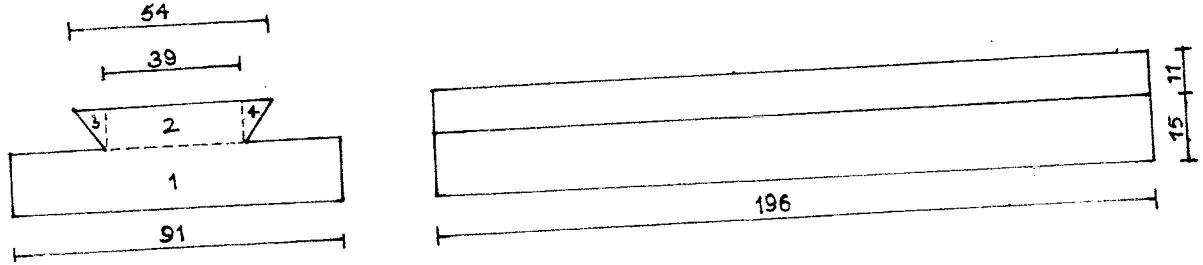
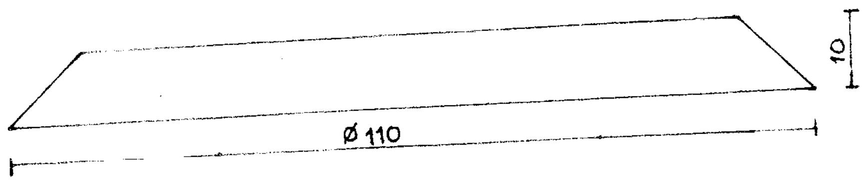


FIG:2



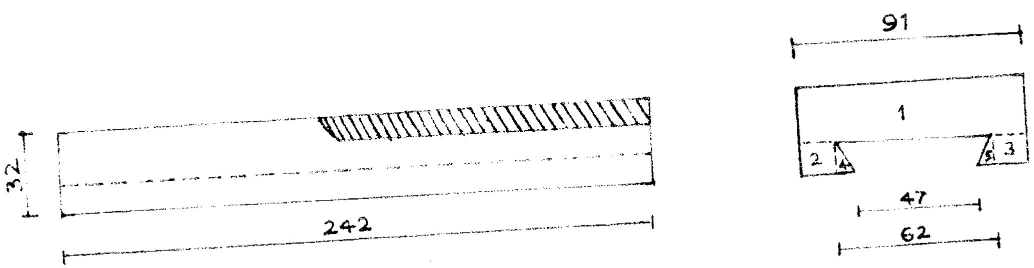


FIG:4

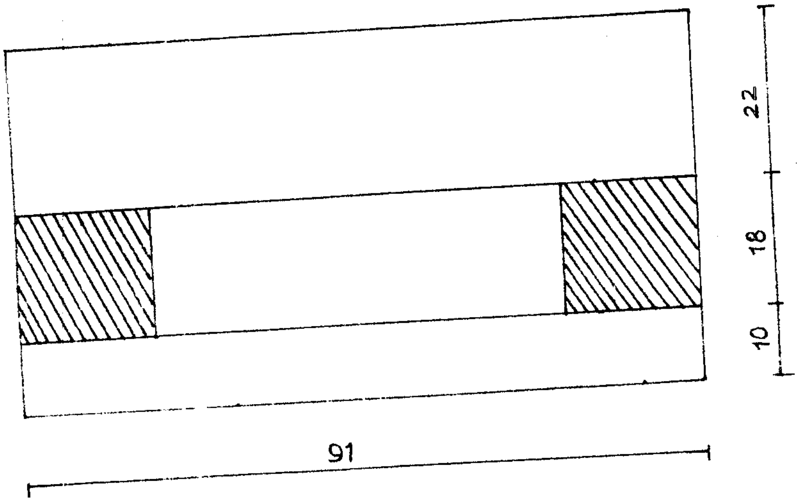


FIG:5

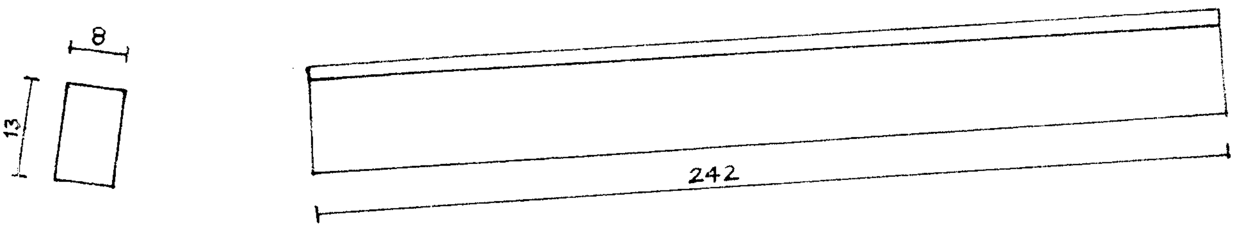


FIG:6

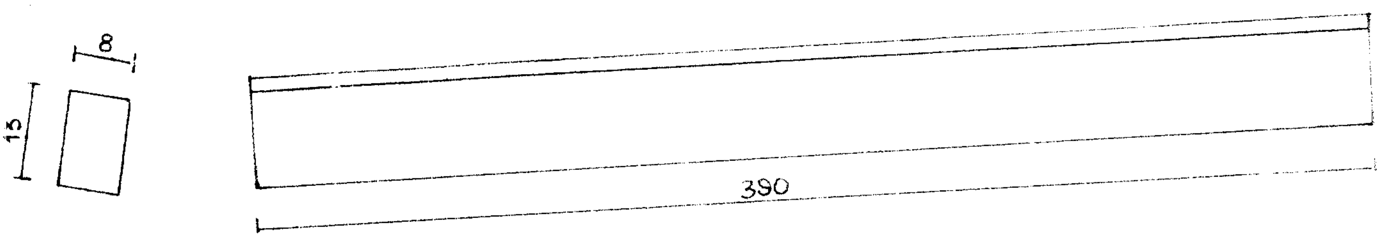


FIG:7

Details of The Attachment

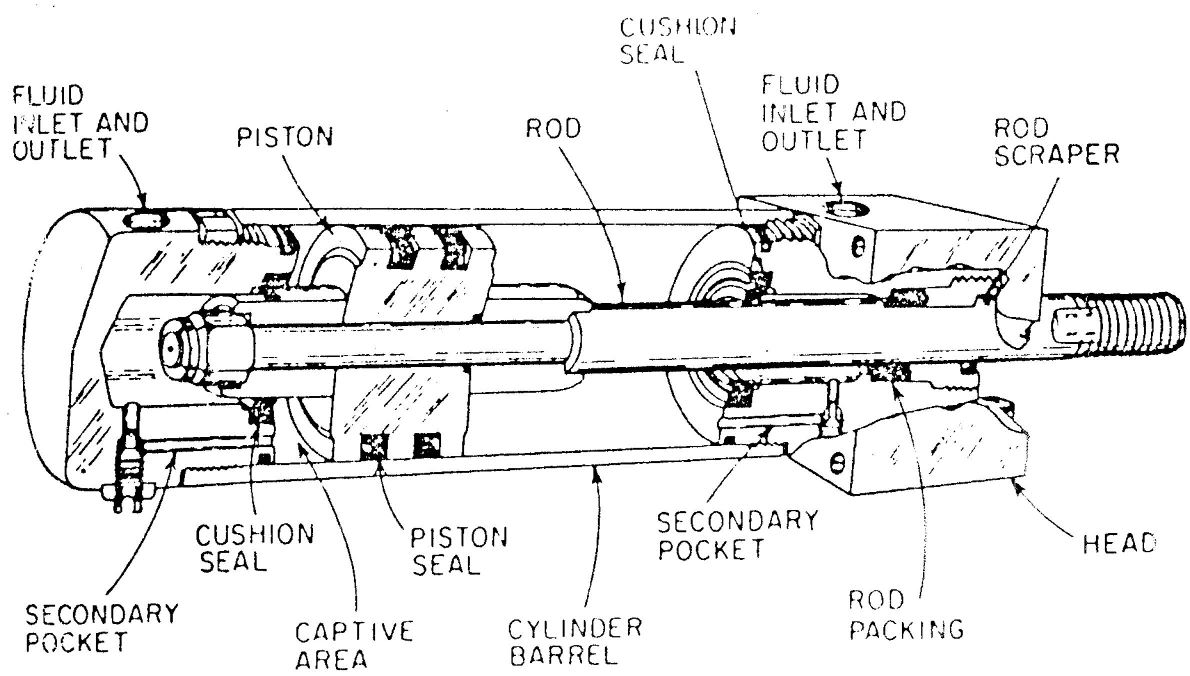
4. DESCRIPTION OF COMPONENTS

4.1. Pneumatic cylinders (3Nos.)

Pneumatic cylinders are widely used in industrial applications. These cylinders are also called linear motors and reciprocating motors. The usual cylinder consists of circular tube, sealed at both ends, in which piston and its rod move. The piston rod projets through either around the piston rod is controlled by a suitably designed seal usually containing papcking. A hydraulic or pneumatic cylinder transforms the flow of pressurized fluid into a push or pull of the piston rod.

The surface finish of the metal on which the seals slide is very critical, otherwise the seals, which are usually made of synthetic compound or impregnated fabric material, would soon become damaged, and premature leakage would take place.

The bore of the cylinder tube must be bored to 15 micro inch finish, because part of the piston rod is exposed outside the cylinder, it is usual to protect it from corrosion and abrasion by depositing a thin layer of hard chromium on it after grinding, this must then be polished to a smooth finish. Piston rods are usually made of Castiron because of its rigidity and good bearing qualities.



CUSHION SEAL
FLUID INLET AND OUTLET
PISTON
ROD
FLUID INLET AND OUTLET
ROD SCRAPER
CUSHION SEAL
PISTON SEAL
SECONDARY POCKET
HEAD
SECONDARY POCKET
CAPTIVE AREA
CYLINDER BARREL
ROD PACKING

Apart from the clearance between the piston and the cylinder bore, fluid could also leak along the rod, inside the piston itself to prevent this, static type seals are used, usually in the form of circular section rings of synthetic rubber known as '0' rings.

Fluid is fed to the cylinder via ports, which can be incorporated either in the end caps or in suitable bosses welded to the steel tube. These ports are usually threaded to accept one or the many standard pipe fittings available care must be taken when designing a cylinder not to allow the piston seals to pass over oil parts, otherwise damage to the seals will almost certainly result.

A problem often facing designers is the need to absorb the inertia forces of the moving parts at the end of the piston travel without over - stressing the mechanism, as would happen if the piston were simply allowed to hit the cylinder end at full speed. One method of overcoming this is to provide a 'cushion' of fluid trapped between the piston and the mechanical limit of travel, and arrange that this fluid be released slowly at a controolled rate so as to incure a gradual deceleration of the moving mass.

In our circuit we are using 3 cylinders. One cylinder of size of 25 x 30 mm used for clamping the work piece, one is of size 50 x 150mm is attached to the carriage for longitudinal motion. The third one of size 40 x 30 is attached to the cross slide in order to provide cross wise motion.

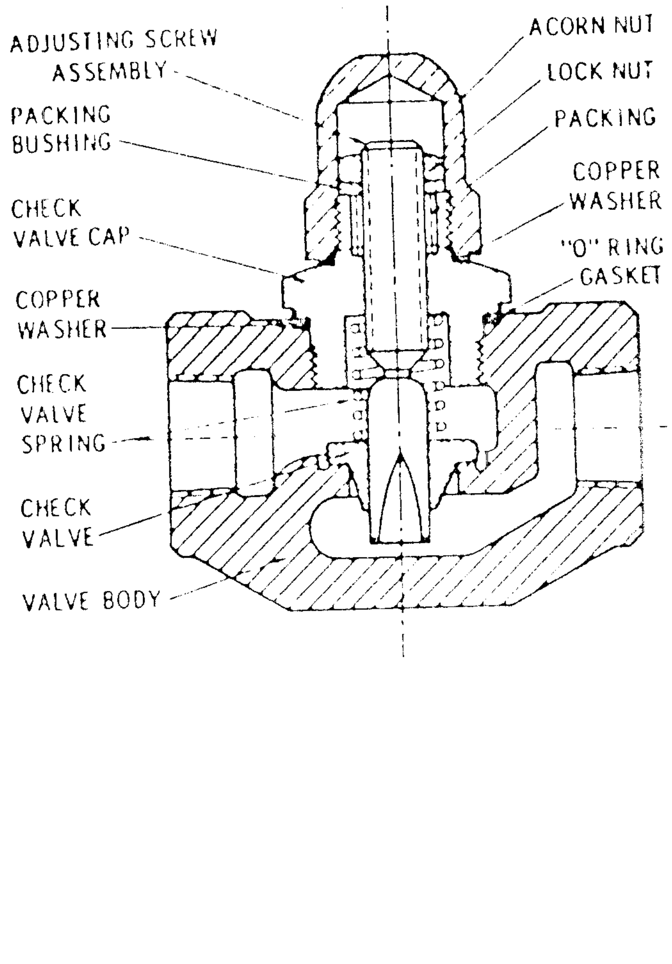
4.2. Flow control valve (1number)

Flow - control valves are used to regulate the flow of fluid in hydraulic circuits. Control of fluid flow is extremely important because the rate of movement of machine elements depends on the rate of flow of the pressurized hydraulic fluid.

A variety of flow - control valves are used in hydraulic circuits. In our circuit needle valves are used. Needle valves have pointed stem that can be adjusted manually to control accurately the rate of fluid flow through the valve. Needle valves are often made from steel - bar stock and are the most common hydraulic flow - control devices.

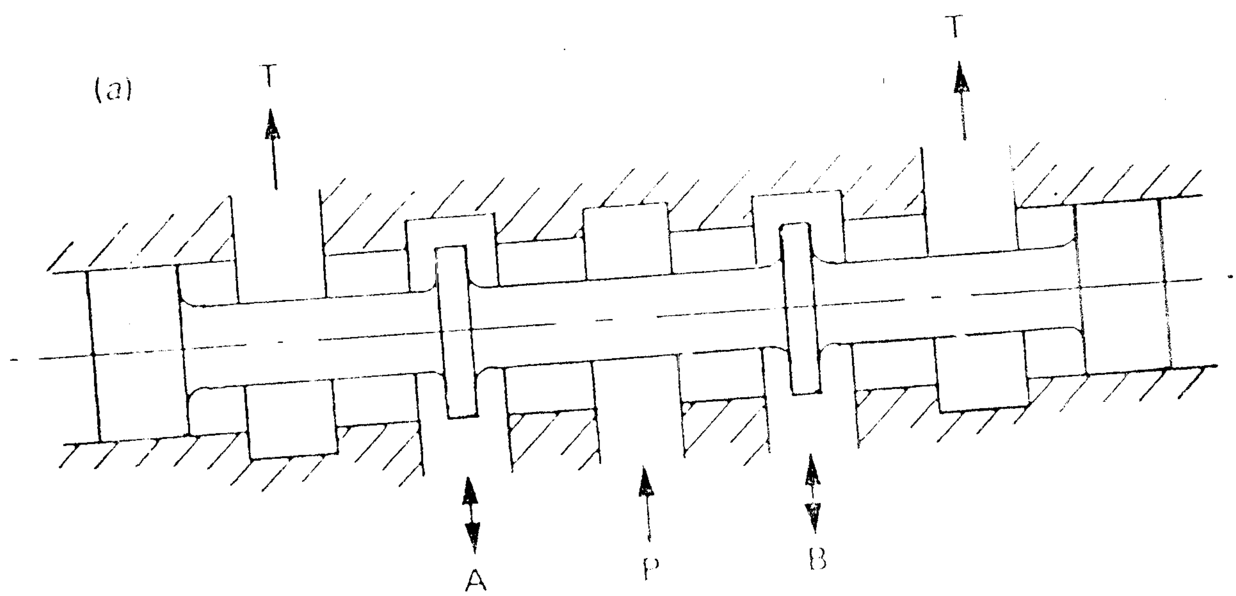
4.3. Solenoid controlled pilot operated direction control valve:

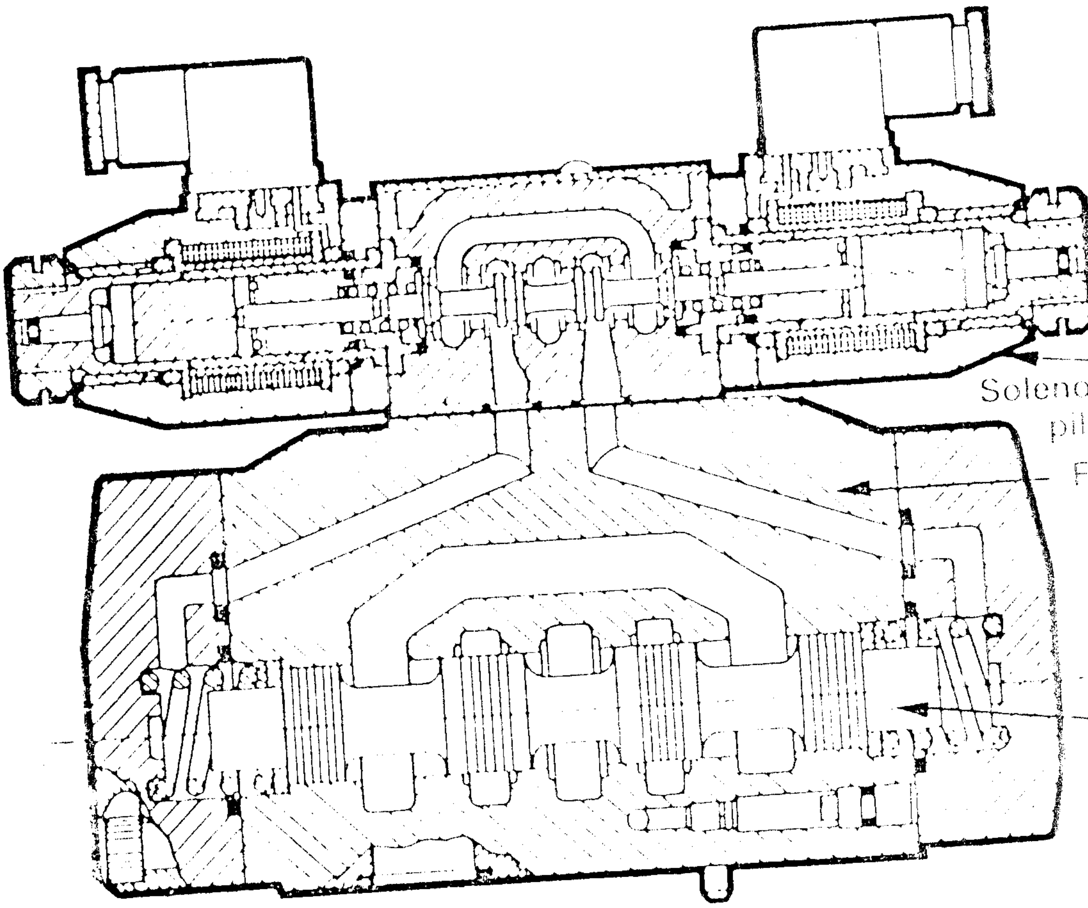
Direction control valves regulate the direction in which the hydraulic fluid flows in a circuit. In most of the direction control valves sliding spools are used. These spools direct the fluid to various parts of



ADJUSTING SCREW ASSEMBLY
PACKING BUSHING
CHECK VALVE CAP
COPPER WASHER
CHECK VALVE SPRING
CHECK VALVE
VALVE BODY
ACORN NUT
LOCK NUT
PACKING
COPPER WASHER
"O" RING GASKET

(a)




Solenoid-operated
pilot valve
Fluid passages
Main spool

the circuit as required. The spools may be operated by hand levers, pilot pressure signals, electric motors mechanical cams or various other devices. A typical application for a sliding spool direction control valve is to actuate hydraulic cylinders, when the spool is moving in one direction it directs pressurised fluid to one side of the piston while the other side is connected to the tank drain line. To move the cylinder in the opposite direction these connection must be reversed.

In our circuit we are using solenoid controlled pilot operated direction control valve. The reason for using pilot operated valve is due to the fact that smaller valves are aften operated electrically by solenoids acting directly on the ends of the spool However, valves having flow rates in excess of about 75 1/min require a seperate pilot control valve, due to the greater force needed to move the spool.

Pressure signals from the pilot valve act on the ends of the mainspool shifting it in the required direction when the right solenoid is energised, the pilot spool will shift to the left causing a pressure signal through the drilled passage to the lefthand end of the main spool and thus forcing it to the right. Similarly energizing the left hand will move the main spool to the left. The minimum pilot pressure required to shift the main spool varies from about 5 to 15 bar.

4.4. Hand lever operated valve (1 Number)

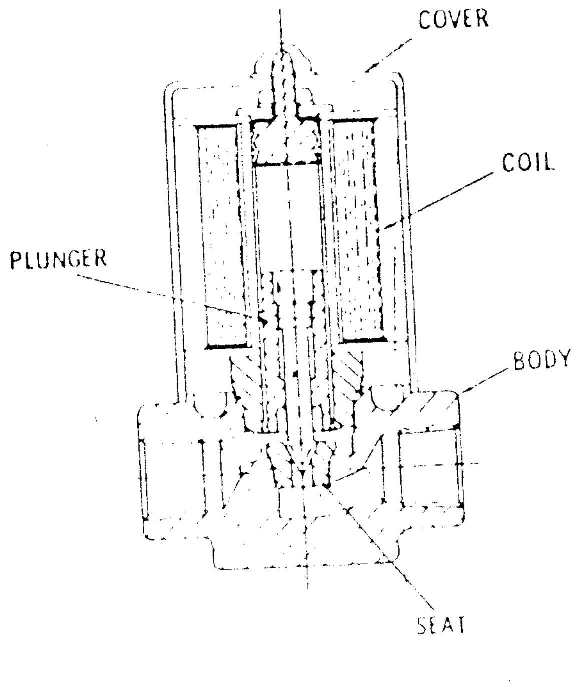
Hand lever operated valve is a spool type direction control valve. Here the motion of the spool is achieved by the hand lever. This value is used to supply air to the cylinder which is used for clamping the workpiece.

When the hand lever is pushed forward the spool moves and it will direct fluid to cylinder. Thus the extension stroke takes place and the job gets clamped. Inorder to release the job the handlever is pushed back and there by the spool will direct the air in the reverse direction and hence retraction stroke takes place and the job gets declamped.

4.5. Single solenoid controlled pilot operated:

2 position 3 way Direction Control Valve:

This valve is used in our circuit to divert the working fluid through the flow control valve in order to obtain a different speed rate. This valve is normally open type. At normal position of the spool oil enters through port 2 comes out through port 1. The flow


COVER
COIL
PLUNGER
BODY
SEAT

control valve is attached to port 3. In order to divert the flow through port 3, the solenoid valve is energised which causes a shift in spool position. This movement will divert the fluid to pass through port 3.

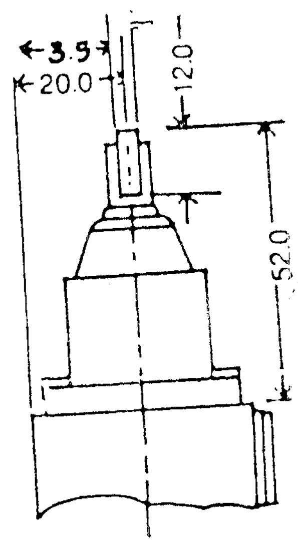
The pilot source is air and is taken from the main line and connected to the port provided for it. Here air is used only for operating the valve.

In order to bring the flow to original condition the solenoid is denergised. Due to this, the pilot spool returns to its original position and the oil flows through the 2-1 passage.

4.6. Limit switches:

Limit switches are designed for remote control of automatic starters, contactors etc. for both AC and DC supply.

Limit switches are completely oil tight, water tight, and dust proof. There is a shaft seal between the lever and head nd internal diaphragm. Seal between the head and enclosure and an external seal between the cover and the body. Oil, water or chips cannot get into th switch.



Top push roller

1. ELECTRICAL LIMIT SWITCH

Terminals have ample wiring space for easier wiring. The contact structure has solid thermoplastic barriers between terminals to prevent short circuiting. Terminals are serrated to give a firm grip to the straight wire.

The contact of mechanism is enclosed in a phenolic moulding with a transparent thermoplastic front cover. The complete unit can be removed and repl[c]ed without the risk of changing the operting characteristic of the limit switch.

Operating Heads (JLSTPR) spring return.

We have selected top push roller type limit switch. It has a metal roller of 12.0 mm dia. The top push roller is easier to apply because the direction operation and repeat accuracy is less critical.

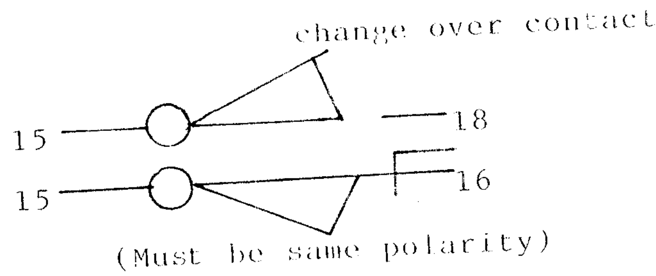
Electrical and Mechanical ratings:

Utilisation category	:	AC 11 and DC 11 as per IEC 337-2 and LS 6875 (Part I) - 1973.
Thermal current (1th)	:	10 A
Insulation Voltage (Vi)	:	600v AC.

Operational Current and Voltage:

AC 11 Rating	:	6 A at 110V.
		3 A at 220 V
		1.5A at 440 V
		1.2 A at 550 V.
DC 11 Rating		0.2 A at 110V.
		0.1 A at 220 V
Contact combination		1 No + 1 NC, SPDT
		Switch change over contact.
Frequency of operation	;	2500 operations per hour
Mechanical life	:	20×10^6 operations
Enclosure category	:	Zine dia cost enclosure to 1P
		- 65 as per IS 2147 - 1962
Terminal capacity	:	2.5mm² solid or stranded

Wiring diagram

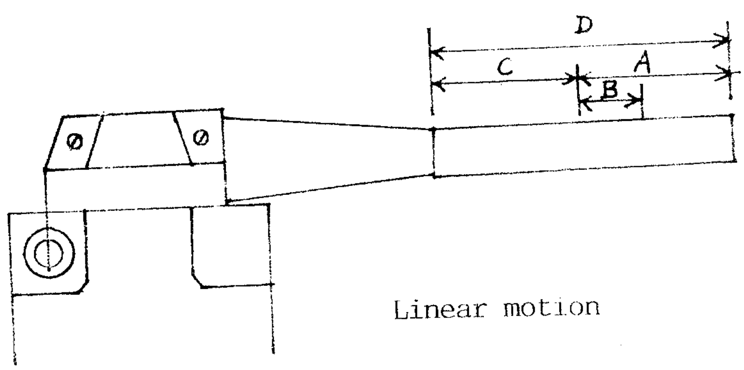


Operating data:

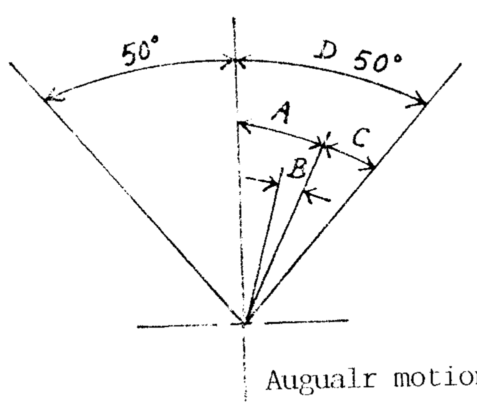
Types	JLSTPR (mm)
Travel to trip A	1.3+
Travel to reset from trip point B	1.1
Over travel	5.5
Total travel	6.8
Force to trip (Max)Kg.	2.0
Force to be applied at a radins of (mm)	–

\+ Maximum

* Minimum



Linear motion



Augualr motion

A = Travel to trip

B = Travel to resut from trip point

C = Over travel

D = Total Travel

Working of The Circuit

5. CIRCUIT DESCRIPTION

Our hydropneumatic circuit contain three pneuamtic cylinders using which various operations such as chucking, facing and boring are done. The sequencing of the circuit is carried out by using various solenoid valves and limit switches.

The working of the circuit can be explained as follows:

Compressed air at a pressure of 5 Kgf enters the junction - 1. The air from JN - 1 is diverted to JN-2 and JN-3 . A part of this air used for the extension stroke of the cylinder-III which is used for holding the workpiece. In order to control the extension and retraction strokes of cylinder-III, a hand lever operated valve is used. When the hand lever is operated, the air from JN -2 is diverted to the inlet or outlet of cylinder-III and hence the chucking or releasing of the workpiece takes place.

Now the machining of the component is done by sequencing the cylinders I and II. In order to start the sequencing the push button is pressed. This will actuate the solenoid valve - I and hence the air from JN-3 passes through the solenoid valve - 1 and operates pilot operated valve - 1. Due to this the pilot operated valve - 1 will divert the pressurised air from JN - 3 to the oil tank- 1. valve - 1. The pressurised air causes the oil from the oil tank to enter into the normally opened solenoid operated pilot control valve and is diverted into the cap end of the cylinder - 1. As the piston extends to a distance of 73mm it will turn the LS-1 on. This inturn will actuate the solenoid operated pilot control valve, and hence the oil is diverted into the flow control valve. Due to this, reduction in piston speed takes place in order to achieve smooth finish. When the piston further extends to 67mm at a slower rate, the FS-2 is turned on. This will actuate the solenoid valve-3 and hence the air from JN-2, passes through solenoid valve - 3 and operates pilot vlave-2. Due to this the pilot valve-2 will divert the pressurised air from JN-2 to the oil tank-2. The pressurised air causes the oil to enter into the cap end of the cylinder - II and causes its extension. When the piston extends to a distance of 30mm it will turn LS-3 on. This is turn will actuate the solenoid valve-2, which causes the PV-1 to change its position and thereby the retraction stroke of cylinder-I takes places. At the end of the retraction stroke of cylinder - I LS-4 is turned on, which will actuate the solenoid valve-4 and cause the pilot valve-2 to change its position. Due to this the retraction stroke of cylinder-II takes place. Thus the cycle is completed and the cylinders return to the home position. This cycle is repeated again by pressing the push button.

Fabrication and Assembly

6. FABRICATION DETAILS

6.1.1. oil tank

1. 50 x 300mm
2. 50 x 70mm

Material - Mild steel pipe

Ouantity - 2 Nos.

Machines used - Lathe, drilling machine, milling machine, cutting machine and electric arc welding

Pipe of diameter 50mm is taken and cut to the required length using a cutting machine. The piece thus obtained is loaded on the centre lathe. In the lathe first facing is done so that ends are finished. Then 0.5mm turning is done for a depth of 25mm on the inside surface of the cylin der. This boring is done in order to suit properly the covers and the inside plate.

The piece is next held in the fixture provided in the milling machine , and the outside surface is milled. Milling operation is done on two spots at a distance of 15mm from both the ends. At these two spots holes are drilled using drill bits of dia 8.7mm and then tapped using 1/8 B.S.P tap. These holes at either ends form the inlet and outlet. Three circular plates of 4mm thicknes out of which 2 is of 50mm dia and one is of

4.6mm dia is required for closing both ends of the pipe and one to be kept just below the inlet. The plates are obtained by cutting thin pieces from shafts of appropriate dia and then finished in lathe. The plate which is used as inside plate is placed in drilling machine and holes are drilled throughout. The purpose of this inside plate is to make uniform flow of air and hence to pressurize the oil uniformly. The plates are kept in the proper position and then welded using electric are welding.

Refer fig. 8

6.1.2. Junctions (2-3way, 1-4way, 1-5way)

Material : Aluminium

Machines used - Milling machine and driling machine

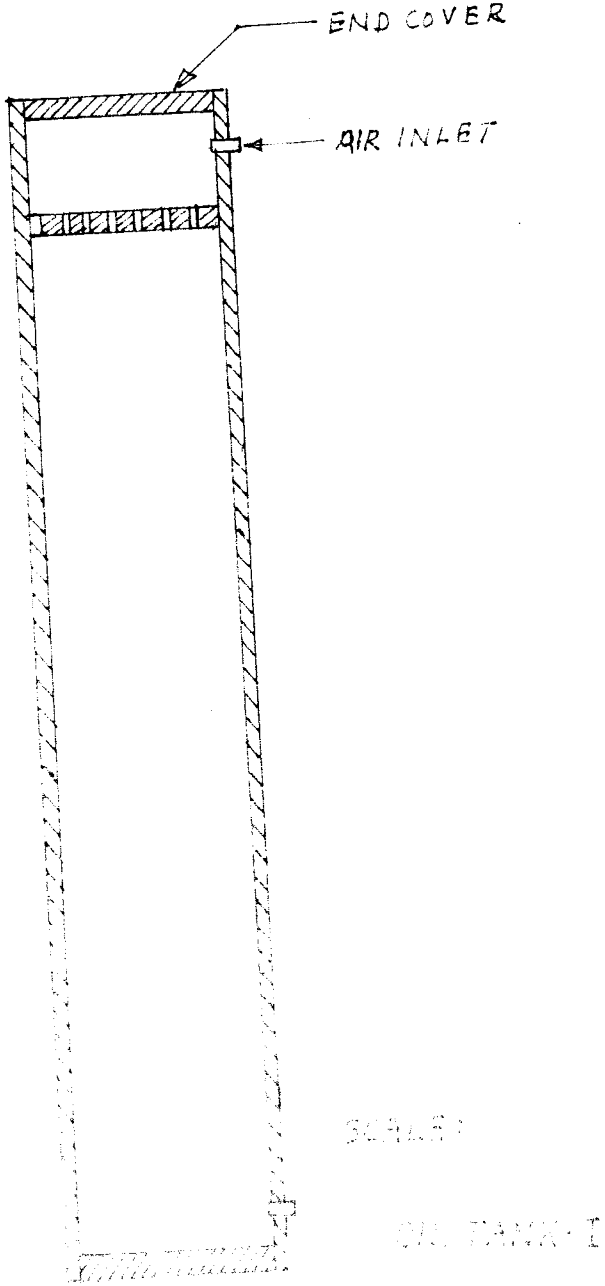
Quantity - 4 Nos.

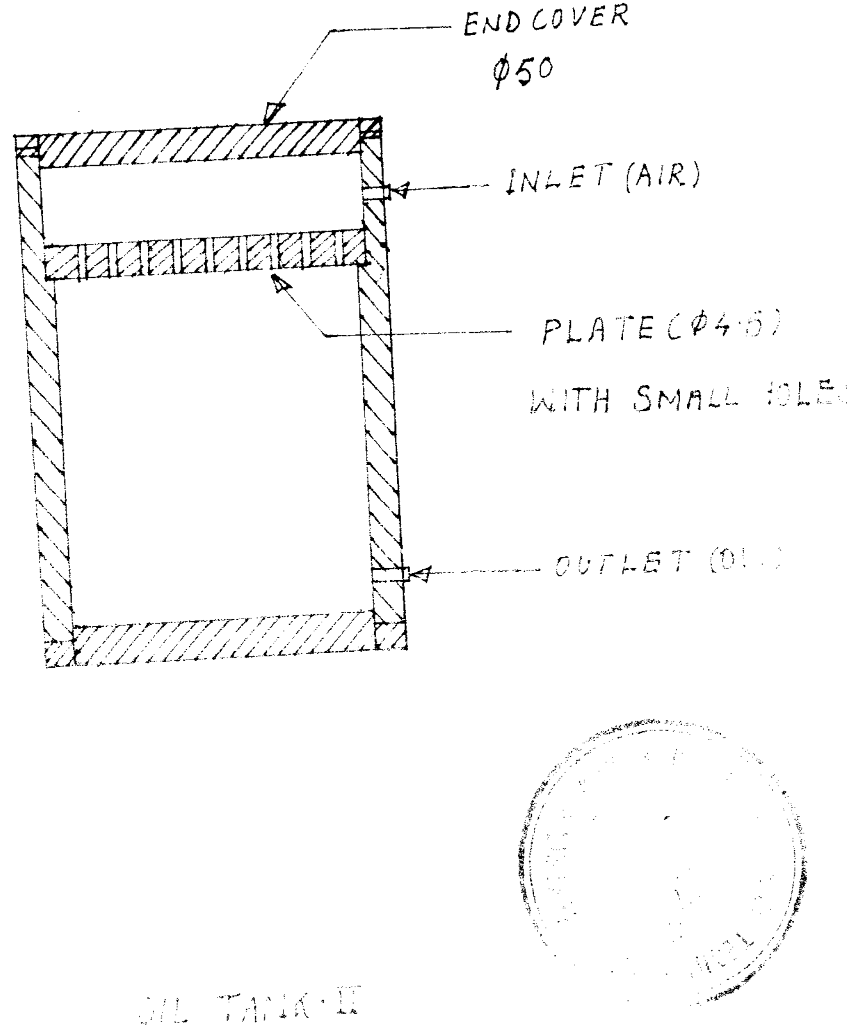
The rectangular aluminium block which is available is placed in the milling machine and all the faces are milled so that they are perfectly parallel.

Refer fig. 9

The block is then placed in drilling machine. On the face B at a distance of 25mm, a 6mm hole is drilled for a length of about 100mm. On the face 'L'

FIG:8 OIL TANKS





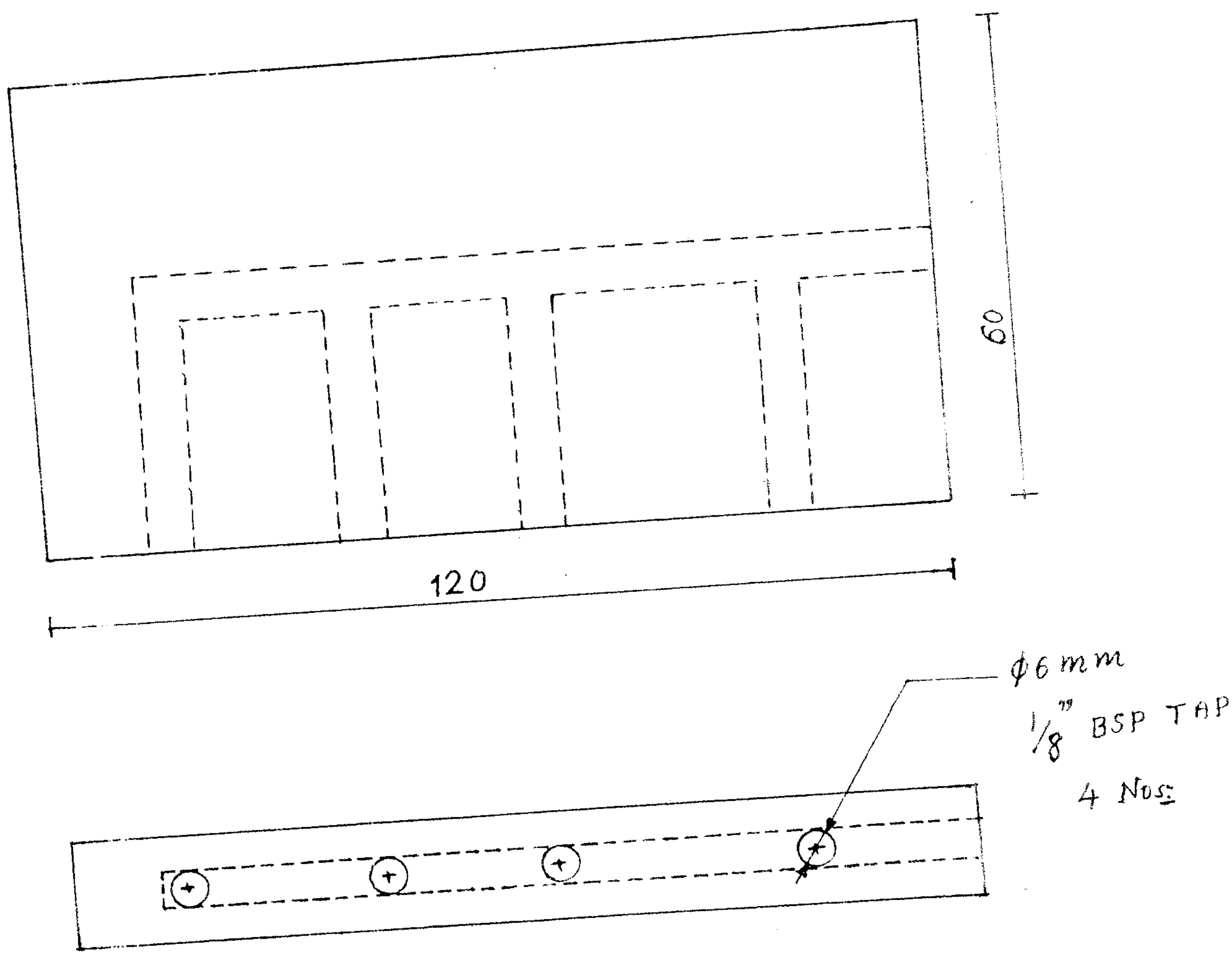


FIG: 9 JUNCTION

required no: of holes are drilled at equal distance until they meet the previously drilled hole. All the holes are then counter bored for a length of 12mm using a drill of dia 8.7mm. The counter bored holes are then taped using 1/8" BSP for a depth of 12mm Adaptors are fixed in the holes and the junction are ready for use.

6.1.3. Tool Bar:

Material	;	En8
Size	:	30 x 30 x 210mm
Quantity	:	1
Machiner used	:	Milling machine Drilling machine Cutting machine

The tool used is combination tool in which three tool tips are fixed to a single bar.

The tool bar is fabricated as follows:

En 8 rod of square cross section is cut to a length of 210mm by using a milling machine. All the faces of the square rod is levelled by milling. Then the rod is loaded on the drilling machine and at a distance of 15mm from one end hole of 10mm dia is drilled at an angle of 45°. (As shown in drawing). Then at a distance of 40mm from the centre of the first hole, another hole as previous is drilled. Next at a distance of 27mm from the centre of second hole, a hole of 10mm is drilled at an angle of 70° and then the drilled hole is made square by filling.

In the first two holes carbide tipped tools are inserted for step boring. In the third hole ISO 2 type tool is inserted for facing the ends of the arms.

6.1.4. Cylinder Mountings:

a) Mounting for the cylinder - I (50 x 150mm)

Material - Mild steel

Machines used - Milling machine, drilling and cutting machine

A metal plate of size 100 x 100 x 10mm is cut by using a cutting machine. All the faces of the plates are levelled perfectly by milling. Next the plate is mounted on the drilling machine and hole of dia 20mm is drilled at the centre of the plate through which the piston moves freely. Next 4 holes of dia 3mm are drilled inorder to fix the cylinder to the plate. At the bottom of the plate two more holes of dia 8mm are drilled and tapped inorder to fix the plate to the saddle.

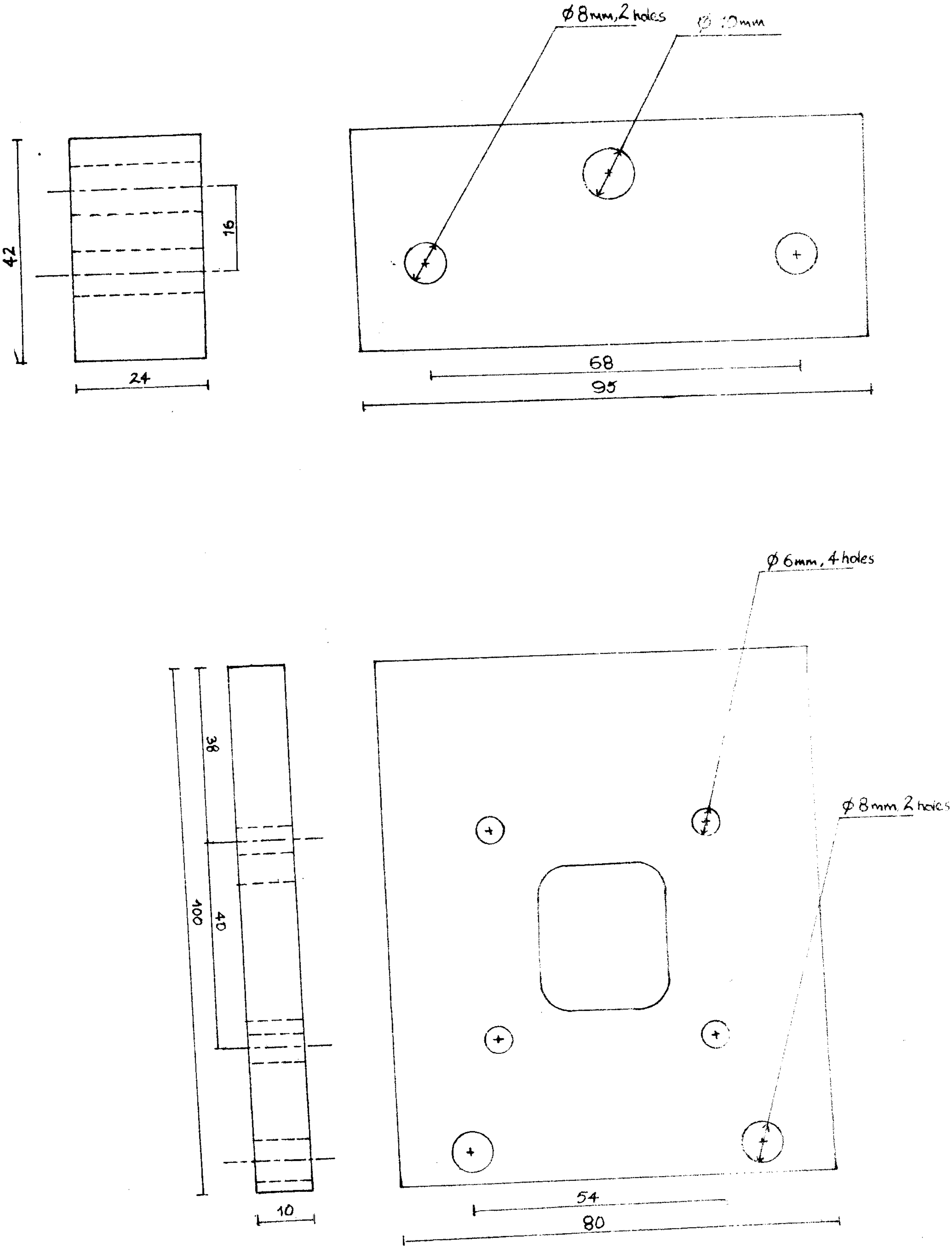


FIG: 10 MOUNTINGS OF CYLINDER_I

b) Mounting for the cylinder of size 40x30mm

Material : Mild steel

Machines used: Milling, cutting and drilling machines.

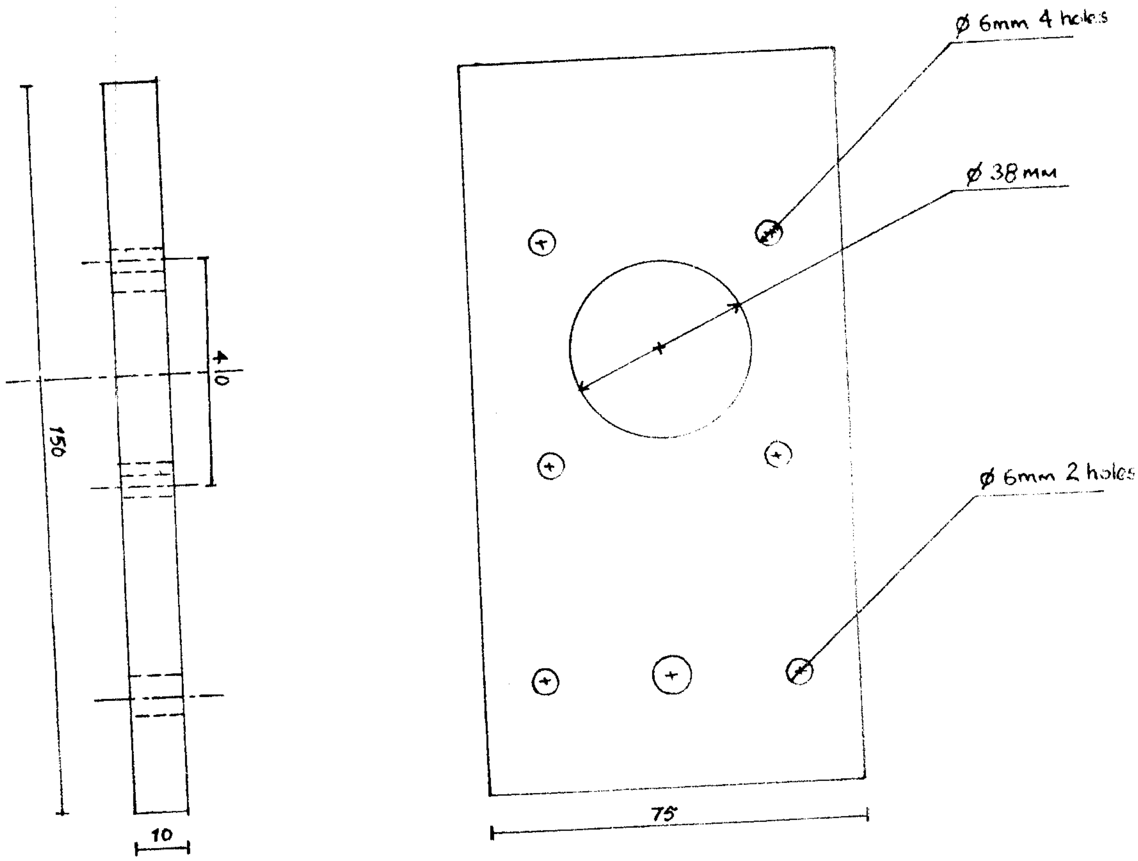
A metal plate of size 150x100x5mm is taken and it is bent by hammering in the form of angle plate. Two holes of 6mm dia is drilled on vertical side. This side is fixed to the plate of the cross slide in which guide ways are provided. In order to provide support a rectangular plate of 20x5mm and of 150mm length is fixed in between the angle plates. The cylinder is mounted in the horizontal plate by means of clamping.

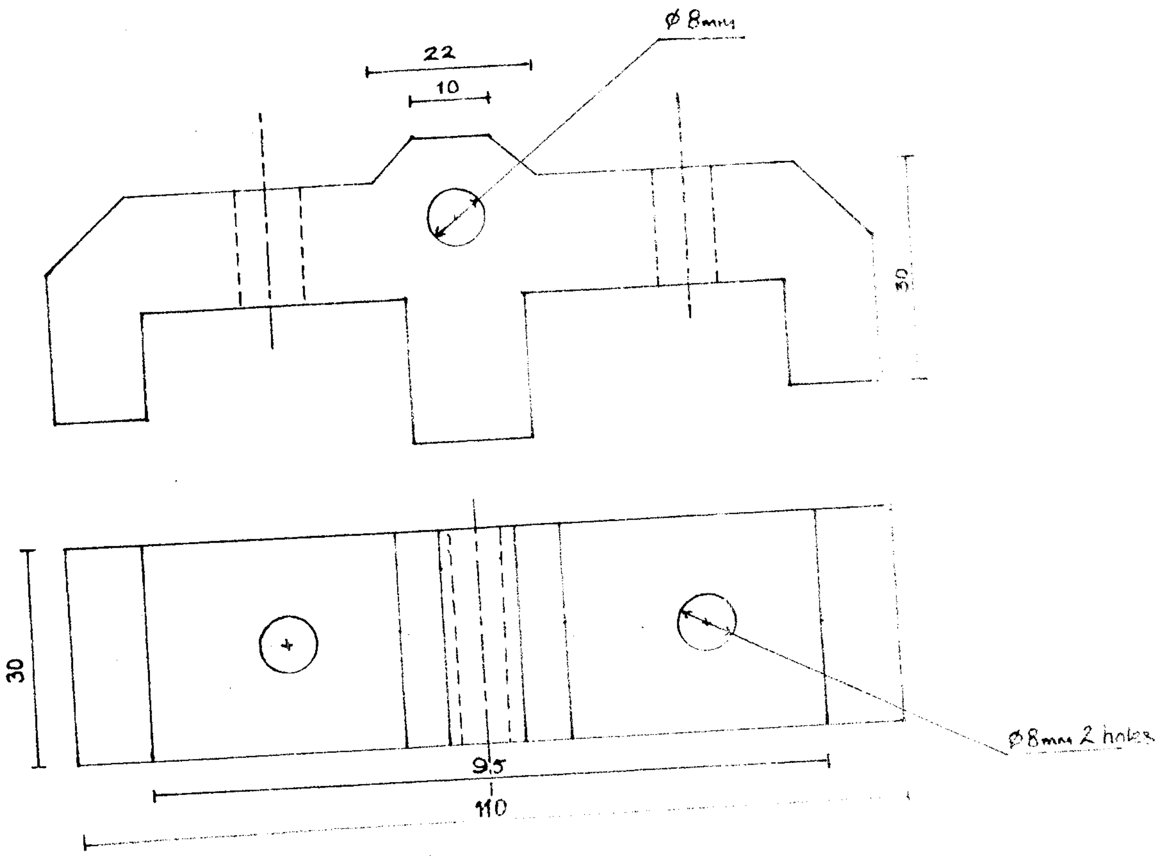
Refer fig. 11.a & 11.b

6.1.5. Tool Holder:

Material : Mild steel

A plate of the shape as shown in the figure is machined in the milling machine. A hole of dia 10mm is drilled. A rod of dia 10mm threaded at ends is provided vertically in the saddle to which a spring is inserted and above the spring the plate inserted through the 10mm hole which have been drilled. Above the plate a nut is provided. The tool bar is kept below the plate and when the nut is tightened the plate will exert a uniform


ø 6mm 4 holes
ø 38 mm
ø 6mm 2 holes
150
40
10
75


ø 8mm
22
10
30
30
95
110
ø 8mm 2 holes

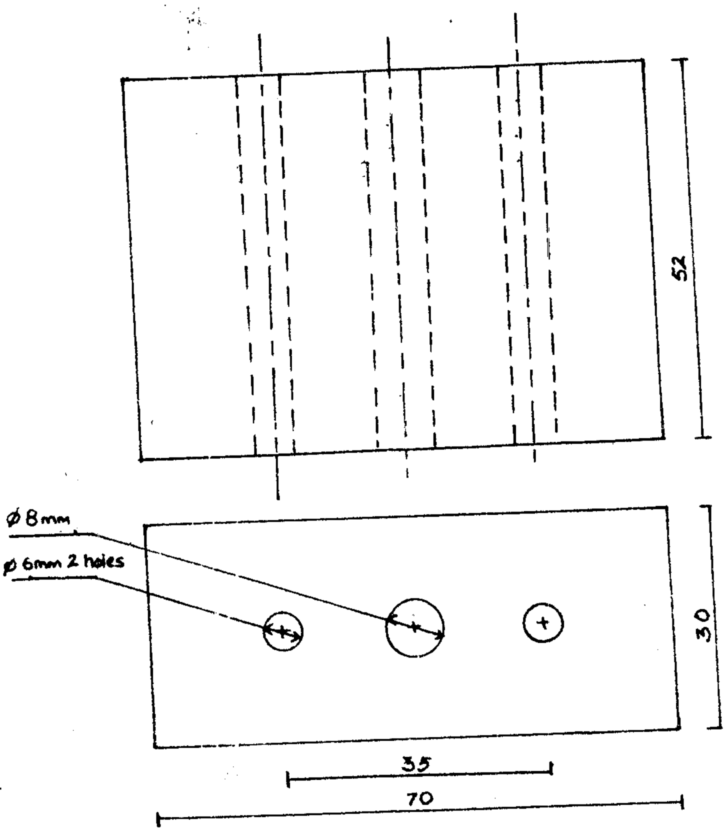


FIG: 11. b

MOUNTINGS OF CYLINDER-II

pressure on the tool bar and will hold the tool rigidly. The spring is provided inorder to release the plate when the nut is loosened.

6.1.6. Work Holder:

Work holder consists of two parts as shown in the figure. The Female part is tightened to the spindle and rotates along with the spindle. the female part is hollow and is tappered inside. The male part is conical in shape and machined in such a way that it suits exactly to the taper portion of the female part. The conical shaped male part while holds the workpiece at its bigger end is made flexible by cutting three thin clots at a space 120°. At the smaller end of male part a hollow shaft is provided, which is connected to the collet.

As the handle of the collet is pushed the female part gets inserted into the male part. The female part compresses the flexible male part and due to the pressure the work will be held firmly. On releasing the handle the pressure will get released. Thus by employing this work holding device the job can be loaded and unloaded very easily.

6.2. ASSEMBLY

The assembly of the hydropneumatic attachment can be done in three stages.

1. Assembly of components
2. Electrical circuit
3. Testing

6.2.1. Assembly of components:

The cylinder-I piston is fixed to the base plate of the saddle and as the piston moves the sliding member of the saddle on which the tool bar is fixed also moves.

The mounting of the second cylinder is connected to the base plate of the cross slide. The mounting is in the form of 'L' bracket and the cylinder is clampled on it.

The third cylinder is clamped near the head stock and connected to the handle of the collect chuck through a linkage.

A mild steel plate is welded to the side of the lathe in order to accomodate the valves at appropriate position. After fixing the various components connections are given to each other with the help of plastic hoses as per the circuit diagram.

6.2.2. Electrical circuit:

For electrical connections, connectors are used. From all the solenoid valves negative lead is connected to the negative lead of the connection. The positive lead is connected to the limit switch and from the limit switch the connection is given to positive lead of the connector. Similarly from all other valves, connections are given to the connector through the limit switches. Finally the power supply is given to the connector.

Thus the assembly is completed.

6.2.3. Testing:

After fixing all the components, the tool bar is mounted on the tool post. Before testing, the following parameters should be checked.

1. Checking centre height of tool

After fixing the tool in the tool holder the centre height of the cutting edge with respect to machine centre is checked. If the centre heights do not coincide, suitable shims may be used.

2. Checking parallelism;

There are various methods to check the parallelism of the attachment.

They are,

1. straight edge method
2. spirit level (or) optical method
3. microscope method

A spirit level is placed on the attachment and parallelism is checked at different places.

3. Checking straightness:

The straightness of the cylinder piston is checked by using dial gauge. The stylus of the indicator is made to touch the piston at one end by applying small amount of pressure and it is moved along the piston. if the deflection of indicator dial is same within the limits thoughout the length, then the piston is said to be straight.

Cost Analysis

7. COST ANALYSIS

Machining cost/hr.

Milling	-	Rs. 45
Lathe	-	Rs. 20
Drilling	-	Rs. 15
Labour	-	Rs. 10

Material cost/kg.

Mild steel	-	Rs. 19
Aluminium	-	Rs. 60
M.S. Pipe	-	Rs. 35
En 8	-	Rs. 26

PURCHASING COST

COMPONENTS	QTY	COST/UNIT Rs. P.	TOTAL COST Rs. P.
1 Pneumatic cylinder			
a) 50 x 150mm	1	1180.00	1180.00
b) 40 x 25 mm	1	528.00	528.00
c) 25 x 30 mm	1	375.00	375.00
2 Solenoid valve 3 port 2 position normally closed (C 102)	4	525.00	2100.00
3 Double pilot valve 5/2 way ¼" BSP (C 66)	2	321.00	642.00
4 Solenoid valve 3 port 2 position single pilot operated (C 304)	1	1200.00	1200.00
5 Hand lever valve 5/2 way ¼" BSP (C 31)	1	432.00	432.00
6 Flow control valve ½" BSP (C 299)	1	355.00	355.00
7 Cutler hammer limit switches	4	512.00	2048.00

COMPONENTS	QTY	COST/UNIT Rs. P.	TOTAL COST Rs. P.
Brass Union ¼" BSP	52	10.35	538.02
Brass nut ¼" BSP	52	6.25	325.00
Brass alive ¼" BSP	62	1.25	77.5
Brass union 1/8" BSP	5	6.35	31.75
Brass nut 1/8" BSP	5	4.10	20.5
Brass olive 1/8" BSP	5	1.25	6.25
Nylon tube Ø 6mm	11mts	9.00	99.00
SAE 40 oil	1 lit	27.50	27.50
Bolts, nut & washer units	–	–	48.90
			10034.60

MACHINING COST

S.NO	PART NAME	QTY	RAW MATERIAL SIZE	DRAWING SIZE	WT in kg	COST OF MATERIAL Rs. P.	MACHINING OPERATION	M/C TIME Min	M/C COST Rs. P.	TOTAL COST Rs. P.
1	Oil tank	2	Mild steel 150x310 150x100	150x300 150x70	2.7 1.0	94.50 35.00	Facing Boring Milling Driling	30 30 25 125	10.00 10.00 18.75 30.00	198.25
2	Junction	4	Aluminium 84x84x24 166x84x24	80x80x20 160x80x20	3x½ 1x1.6	90.00 144.00	Milling Drilling	60 45	45.00 11.25	2[illegible].25
3	Tool Bar	1	En 8 30x30x210	30x30x210	1.2	31.20	Milling	120	90.00	1[illegible].20
4	Mounting (cylinder)	2	M.S 110x84x12 150x84x12	100x80x10 140x80x10	3 2	57.00 38.00	Milling Drilling	120 60	90.00 15.00	1[illegible].00
5	[illegible] (valves)	2	300 x 400 400 x 400	300 x 400	8	19 x8	Drilling	60	15.00	[illegible].00

Time requiring for machining	=	11 hrs 15 min
Time required for fittings	=	2 hrs 30 min
Total time	=	13hrs 45min

Labour charge = Rs. 137.50

Total fabrication Expense	=	Rs. 1019.20
Purchase cost	=	Rs.10034.60

Total cost = Purchase cost + Fabrication cost

Total cost = Rs. 11,053.80

Drawings

D R A W I N G S

Conclusion

9. CONCLUSION

The model fabricated is viable and easily operatable attachment for a lathe. The manufacturing details and operative credibility of the attachment has been successfully demonstrated. It facilitates mass production of accurately machined products since it can be easily installed and operated.

The attachment can be used on only turret lathe and could be operated by a semi skilled operator. The possibility for automation increases its operative value.

Bibliography

10. BIBLIOGRAPHY

1. Production technology by HMT
2. PSG Design data Book
3. Industrial Hydraulics by Pippenger and Hicks
4. Pneumatics and Hydraulics by Harry L.Stewart
5. Industrial hydraulic system by D.D. Banks & D.S.Banks
6. ABC'S of pneumatic circuits by Harry L.Stewart & John M. Storer
7. Production technology by R.K. Jain
8. Production technology by P.C. Sharma
9. Hand book of Mechanical design by G.M. Maitra L.V. Prasad
10. Principles of machine tools by G.C. Sen A. Bhattacharya
11. Machine tool design Vol.4 - N. Acherkan, D.Sc.