DESIGN AND FABRICATION OF HYDRAULICALLY OPERATED VICE

Project Report 1998 - 99

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Sponsored by
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GANAPATHY, COIMBATORE.

Submitted in partial fulfillment
of the requirement for the degree of
BACHELOR OF ENGINEERING
in the Mechanical Engineering Branch of the
BHARATHIAR UNIVERSITY,Coimbatore.

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09-03-'99

CERTIFICATE

This is to certify that Mr. R.KARUPPUCHAMY, P.SUBASH and B.PRAVEEN KUMAR, students of final year Mechanical Engineering of Kumaraguru College of Technology, have designed and fabricated a Hydraulic Vice. They have involved themselves from design stage to total manufacturing of the unit. We are confident that they have acquired a good level of understanding of the technology involved in completing the project. I am sure that they will be extremely successful in furthering their knowledge in their chosen Profession.

P.N. RAGHAVAN

Managing Partner.

Dedicated to our beloved

Parents, Teachers & Friends

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ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

We express our eternal indebtness towards the ALMIGHTY for HIS grace guidance, lustre and blessings showered during the whole of our lives incessantly upon us including the period of putting forth this project work.

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Our sincere and deep sense of gratitude belongs to Mr.D.Lakshmanan M.E.,Lecturer,Department of Mechanical Engineering, Kumaraguru College of Technology, Coimbatore for his expert guidance and for his efforts and constant encouragement given to achieve this goal.

We thank Mr. P.N.Raghavan , Managing Partner, Amar Metering Pumps for giving us an opportunity to do our project work in their reputed concern.

We express our thankfulness to Mr.M.C.Krishnan Kutty , Engineer - Development, Amar Metering Pumps , Coimbatore for giving cardinal guidance in completing this project.

We thank Mr.S.Bhaskar , Mr. Gunasekaran , Mr. Mohandas Gandhi, Mr. James for their excellent counselling during the seminar session.

We thank our beloved friends and classmates for their good interactions, valuable suggestions and encouragement in course of our project.

We acknowledge in our hearts with cheerful tears rolling down on our cheeks to the unbounded love and encouragement shown by our family members for whose whim and pleasure we perspire and despair and live on this earth.

SYNOPSIS

SYNOPSIS

A growing affluence appears to be spreading to every corner of the globe . Greater demand for manufactured products is evident. Ever improved transportation for goods and people is becoming essential.

These social changes , which directly affect the world market place, have added some new dimensions to requirements for fluid power transmission.

Sophisticated controls are now associated with agricultural machinery. High - Pressure machinery needed to bolster production also demands better trained personnel within all areas of industry. Fluid power systems are now basic to virtually every major machinery segment.

We have, in our endeavour attempted to delve into some of the concepts and intricacies involved in the designs of hydraulic systems. We have used these concepts in our work holding device.

We have cofirmed our efforts by designing and fabricating a hydraulic vice. We have designed the cylinder , piston , screwrods and handle of the device .

COMPANY PROFILE

COMPANY PROFILE

AMAR METERING PUMPS

Amar Metering Pumps was established in the year 1974 as a precision small industry . During this period of operations they have built up an excellent rapport with leading Public Sector and Private Sector companies and the ministry of Defence and Railways for supply of a range of precision products.

RANGE OF PRODUCTS :

1. Lubrication oil Pumps.
2. Pre-Heating and cooling systems.
3. Air Distributors for Diesel Engine.
4. Air cylinder.
5. Pump support Assembly.
6. Nipper Assembly.
7. Truing machine.
8. CNC Tool Holders.

Manufacturing of lubrication oil pumps constitutes their main product and the list of valued clients are as follows :

* KERALA AGRO MACHINERY CORP. LTD , ATHANI.
* TATA ENGINEERING AND LOCOMOTIVE CO LTD , PUNE
* INDIAN RAILWAYS.
* CHITTARANJAN LOCOMOTIVE WORKS , CHITTARANJAN.
* VEEJAY LAKSHMI ENGG WORKS , COIMBATORE.
* BHARAT FRITZ WERNER LTD , BANGALORE.
* H.M.T. LIMITED , KALAMASSERY.

EXPORTS :

On the export front at present they have been machining and supplying mining equipment out of steel casting through an Indian Exporter to Canada. They have also exported maintenance spares of G.E.C through M/s. K & M International , U.S.A.. Negotiations are on the anvil for direct export to Canada of machined components. Presently , they are exporting lubrication oil pumps to M/s. TOYODA AUTOMATIC LOOM WORKS, JAPAN and Slitting Knives to M/s. PAPER PRODUCTS , TANZANIA.

TURNOVER :

The company has recorded a turnover of Rs.60 Lakhs for the year ended 1997-98 recording an increase of 20 % over the corresponding previous year.

EMPLOYEES:

The company employs a total of about 45 employees. The employees are highly skilled and trained in the manufacture of precision products. They have been provided training at the works in order to meet the exacting specifications and accuracy of the manufactured .

MANUFACTURING FACILITIES:

The company has a well equipped machine shop with all facilities for precision manufacture. The company designs and manufactures all jigs, fixtures and gauges for the products manufactured.

PROFILE OF MANAGING PARTNER:

The Managing Partner has worked in TELCO-Automobile Division from 1957 to 1967 engaged in the Training, Development of Products and as incharge of small parts and Automats and from 1967 to 1975 as a Training Manager in Lakshmi Machine Works , Coimbatore. He has more than 40 years of experience in development of products, manufacturing, tooling ,tool design, etc.

NOMENCLATURE

NOMENCLATURE

A	Area – m^2
F	Force or load – kgf
P	Pressure intensity – N/cm^2
σ	Stress at the inside circumference – N/m^2
n	Factor of safety
b	Breadth – mm
h	Height – mm
t	Thickness – mm
d_0	Outer diameter – mm
d_i	Inner diameter – mm
d	diameter – mm
γ	Poison's ratio
M, C_1, C_2	Constants
P	Axial load on spring – kgf
y	Deflection – mm
E	Modulus of elasticity – N/mm^2
d_p	Thread pitch diameter – mm
s	Thread pitch (lead) – mm
ψ	Ratio H/d
Z	Number of starts
t_2	Depth of thread engagement – mm

INTRODUCTION

CHAPTER I

INTRODUCTION

AIM OF THE PROJECT :

Work holding device is an area which has gained enormous importance in recent years . The quality of the device leads to improved accuracy and precision of work is attained . Work holding device is one of the basic requirements in each and every production oriented industries.

We have dealt in the design and fabrication of a hydraulic vice. The vice is a device which is used to clamp or hold a component . The need for more accuracy in the outcome of a product has led us to the above project.

Nowadays there is a greater stress in improved quality. So we have tried to incorporate the techniques of hydraulics to achieve the following factors.

The factors which were considered are :

i) Precise control of applied force .

ii) Instant reversibility in rotary and linear applications .

iii) Vibrations of component is nil.

iv) Compactness.

v) Should be versatile.

EXISTING MODEL :

The vice which is put into use now in the current Industrial area are the mechanical vices. The mechanical vices are most economical one's but with respect to the gripping pressure on the job is very minimal which is applied by the operator manually does not yield very high pressures.

When it is used in the milling machines, the cutting force is so high that the component vibrates due to the high speed of the cutter and ultimately leads to inaccurate dimensions on the job.

Furthermore the clamping of the workpiece on which drilling, milling, shaping , etc operation is to be performed is not accurate and precise. The mechanical effort taken to clamp the workpiece is very high.

The above factors were thoroughly scrutinised and we forward with a new and improvised model.

IMPROVED MODEL :

In the improved model , we had made use of the fluid power ie. Hydraulics so that the above shortcomings were avoided. The hydraulic fluid helps us to attain very high gripping pressures which leads to the following advantages :

* Mechanical effort involved to attain high gripping pressure is minimised .
* Clamping is more precise and accurate .
* All requirements regarding precision, rigidity, wear resistance as well as universal application are met.
* Rigid in construction and simple in design .
* Cost is economical.

The hyraulic vice is a special type of machine vice which is used in CNC and NC machines and is a versatile one. The various details have been incorporated into a detailed production drawing.

FLUID POWER SYSTEM

CHAPTER II

FLUID POWER SYSTEMS

INTRODUCTION TO FLUID POWER SYSTEMS:

Fluid power is the technology that deals with the generation , control and transmission of power using pressurised fluids . It can be said that the fluid power is the muscle that moves every Industry . This is because power is used to push , pull , regulate or drive virtually all the machines of modern industry . For example, fluid power steers and brakes automobiles , launches space crafts , drives machine tools, control aeroplanes, processes food and even drills teeth . In fact, it is almost impossible to find a manufactured product that has not been fluid powered in some way at some stage of its production .

Since a fluid can be either liquid or gas , fluid power is actually the general term used for hydraulics and pneumatics.

Hydraulics is employing a pressurized fluid and Pneumatics is employing a compressed gas.

INTRODUCTION TO HYDRAULICS :

Hydraulics has been used by man, since 2000 years ago. But the real practical industrial application of hydraulics in production dates back entry to about 1950. This could partly be due to ignorance and lack of education. Today it is not possible to imagine mordern factories being without hydraulics.

ADVANTAGES IN USING HYDRAULICS :

1. The resultant pressure created will be many times.
2. It has good time response.
3. It is economical for high pressure and force applications.
4. Easy to attain uniform speed.
5. Source is available in plenty.

Thus summerising it up we can conclude that even though oil is an expensive source of energy, but these costs are compensated by the inexpensive components.

Higher productivity ,Greater efficiency , lower wages and no maintenance.

HYDRAULIC VICE

CHAPTER III

HYDRAULIC VICE

The hydraulic vice is a work holding device which clamps the work piece at very high pressure. This pressure is attained by means of a piston cylinder assembly.

This vice is highly a versatile one and it is been constructed rigidly . The vice has been designed in such a way that it undergoes a very minimal deflection at maximum operating pressure . So this is considered to be one of the advantages of this vice .

The thereby achieved clamping precision is a requirement for a correspondingly increased machining and work piece quality . It consists of a movable and stationary jaw . The jaw plates are heat treated on the face to resist wear and tear due to frequent holding of work piece.

The jaw plates are interchangeable and the stroke length of the movable jaw can be varied by means of adjusting the lock pin. It also consists of a swivelling base to rotate the work piece to required angles. The hydraulic equipment is only in the movable jaw.

Hence the hydraulic vice fabricated is a compact, versatile one, is more precise and is an ideal one to use.

APPLICATION OF HYDRAULIC VICE :

Since it is basically machine vice, it is put into use in CNC and NC machining centres in which various machining operations like milling, drilling, shaping, etc are performed.

ADVANTAGES OF THIS VICE :

* Easy to operate and control.
* Clamping is more precise.
* Fatigue on the part of the operator is reduced to a great extent.
* Wear resistant due to heat treatment of jaws.

* Rigid in construction .
* Simple in design .
* Cost is economical .
* Instantaneous and is very fast .

COMPONENTS OF VICE

CHAPTER IV

COMPONENTS OF HYDRAULIC VICE :

1. SWIVELLING BASE :

The swivelling base is mainly used to rotate the fixed jaw base to the required angle for the purpose of machining to the required dimensions .

It consists of a T-slot which is provided to hold the jaw base by means of two T-bolts which is fastened to the holes provided in the jaw base. Further it has a pivot in the centre which is also used to hold the jaw base and it also consists of a U slot at the sides which is used to bolt the base to the table . The material used for manufacturing this swivelling base is cast iron .

1. FIXED JAW BASE :

The fixed jaw base consists of a stationary jaw at one end and the jaw plates are interchangeable and they are tightened by means of allen screws . In the jaw base it has a pivot hole in which the pivot in the swivelling base will seat into the hole so that the fixed jaw base is easily rotated through 360 degrees.

The stroke length of the movable jaw can be varied by inserting a lock pin. Two holes are provided on the rim of the fixed jaw base so that the stroke length is set for the required length which avoids time delay due to the excess movement during return stroke.

3. LOCK PIN :

The lock pin is a small cylindrical rod which is used to connect the movable jaw base through the screw rod nut.

The lock pin only facilitates in movement of the movable jaw in the forward and reverse direction which is connected through the screw rod nut which has the screw rod coming through it.

4. MOVABLE JAW BASE :

The movable jaw base consists of a cylindrical bore in which the hydraulic fluid is pressurized by means of a piston assembly. By the linear movement of the screw shaft, the piston is made to move forward and thus the pressure is attained by compressing the air inside the cylinder.

The fluid port is sealed by means of a plug which is provided with a gasket to avoid leakage through the fluid port. The plug is provided with a hexagonal head which provides easy removal and tightening of the plug.

A series of holes are provided on both the ends to hold the guide plate which is fixed by means of bolts. The other jaw plate is screwed to the face of the movable jaw base by means of allen screws.

5. GUIDE PLATE :

The guide plate is a plate of length 225 mm and 12 mm thickness which is bolted to the movable jaw base and its main use is to avoid lifting of the movable jaw base at the maximum return stroke length .

6. SCREW ROD :

The screw rod consists of an external and internal ACME thread. Internally it is in the form of stepped bores of varying diameters in which the screw shaft is fixed to it. The detailed drawing is provided in the drawing section which would give a better idea. The screw rod is held by the screw rod nut and is made up of steel.

7. SCREW SHAFT :

The screw shaft consists of a hexagonal head at one end in which the handle is fixed and has a key way to hold the collar lock which is provided while rotating in for the high pressure loading or increased gripping pressure.

Three grooves are made on the pheriphery of the shaft to indicate the three positions where the hydraulic forces are attained. The first groove indicates that the component is clamped at no load condition, the second groove indicates that the component is clamped at medium or initial load condition and finally the third groove indicates that the component is clamped at maximum or final load condition.

As the screw shaft is rotated by the handle, the screw rod is made to rotate and thus the movable jaw moves forward and backward. For more understanding the detailed drawing would be much clear which is affixed in the drawing section.

8. SCREW ROD NUT :

The screw rod nut is in the form of L shape and consists of two bores. One of the bore is provided for the screw rod to rotate through it and the other bore is for the lock pin.

The screw rod nut is a solid bar which is brought to L shape by means of machining process. The grinding is the machining process which is used for producing the screw rod nut.

9. JAW PLATE :

The jaw plate is a plate is a plate which is interchangeable and is heat treated inorder to reduce wear and tear due to frequent holding of work piece. The material used for jaw plate is OHNS – Oil Hardened non shrinkable material.

10. PISTON ASSEMBLY :

The piston assembly consists of a stepped shaft and there is a plastic cup which is made up of polyurethane which pressurizes the fluid inside the cylinder.

Further a metal bush is provided to the cup just to act as a support to it. A series of belleville springs are put together to absorb the compression force acting on the piston assembly.

The piston is finely machined and the tolerances are met to the requirements. Care is taken that all the dimensions are properly achieved since it mates with the cylinder bore.

11. BEARING PLATE :

The bearing plate is a plate which guides the screw rod and is fixed to the movable jaw base by means of allen screws.

12. BEARING CAP :

The bearing cap is used for holding the piston assembly and is bolted with series of belleville springs since it undergoes compressive force from the piston shaft.

This cap is made up of mild steel and then subjected to machining process.

PROCESS INVOLVED IN FABRICATION

CHAPTER V

PROCESSES INVOLVED IN FABRICATING COMPONENTS:

PATTERN MAKING :

Pattern is the principal tool during the casting process. It may be defined as a model of anything. So constructed that it may be used for forming an impression called mould in damp sand or other suitable material. When this mould is filled with molten metal and the metal is allowed to solidify, it forms a reproduction of the pattern and is known as casting. The process of making a pattern is known as pattern making .

Foundry engineering deals with the process of making castings in moulds prepared by patterns. The whole process of producing castings may be classified into 5 stages :

1) Pattern Making 2) Moulding and core Making 3) Melting and casting 4) Felting 5) Testing and inspection .

Except pattern making all other stages to produce castings are done in foundry shops.

Pattern Materials :

The selection of pattern materials depends primarily on the following factors :

1) Service requirements eg . Quantity , Quality and intricacy of casting, degree of accuracy and finish required .
2) Type of production of casting and the type of moulding process.
3) Possibility of design changes .
4) Number of castings to be produced .

To be good of its kind, pattern material should be :

1) Easily worked , shaped and joined .
2) Light in weight .

2) Strong, hard and durable so that it may be resistant to wear and abrasion, to corrosion and to chemical action .

3) Dimensionally stable in all situation .

4) Easily available at low cost .

5) Repairable and reused .

6) Able to take good surface finish .

Wide variety of pattern materials which meet these characteristics are wood and wood products, metals and metal alloys, plasters, plastics, rubbers and waxes . From this we have to choose the wood material to make the pattern.

Wood :

Wood is the most common material for pattern as it satisfies many of the aforesaid requirements. It is easy to work and readily available. Wood can be cut and fabricated into numerous forms by glueing , bending and curving . It is easily sanded to a smooth surface and may be preserved with shellac which is the most commonly used finishing material for wooden pattern . Wood has its disadvantage as a pattern material. It is readily affected by moisture. But they are generally used when a small number of castings are to be produced .

Wood used for pattern making should be properly dried before it is used. It should be straight grained,free from knots and free from excessive sapwood . The most common wood used for pattern is teak wood. This wood is straight grained , light , easy to work has little tendency to break and warp and has resonable cost .

DIFFERENT TYPES OF PATTERNS :

Several commonly used patterns are as follows :

- Single Piece Pattern .
- Split Pattern .
- Match plate Pattern .
- Cope and drag Pattern.
- Gated Pattern .

- Loose Piece Pattern .
- Sweep Pattern .
- Skeleton Pattern .
- Segmental Pattern.
- Shell Pattern.

From these we make use of only two types of patterns. They are :

1. Single Piece Pattern :

A pattern that is made without joints, partings or any loose pieces in its construction is called a single piece pattern. A single piece pattern is not attached to a frame and is therefore sometimes known as loose pattern. These pattern are cheaper and they are usually used for large castings of simple shapes .

2. Split Pattern :

Many patterns cannot be made a single piece because of the difficulties encountered in moulding them.To eliminate this difficulty and for the castings of intricate design split patterns are employed to form the mould. These patterns are usually made in two parts, so that one part will produce the lower half of the mould and the other the upper half.

The two parts which may or may not be of the same size and shape are held in their proper relative positions by means of dowel pins fastened in one piece and fitting holes bored in the other. The surface formed at the line of separation of the two parts usually at the centreline of the pattern is called the parting surface or parting line.

It is sometimes necessary to construct a pattern for a complicating casting that requires three or more parts instead of two to make the completed pattern. This type of pattern is known as multipiece pattern.

Spindles, cylinders, steam valve bodies, water stop cocks and taps, bearings , small pulleys and wheels are few examples of castings that require the use of split patterns .Other type of patterns are not used in this vice.

PATTERN MAKING ALLOWANCES :

Patterns are not made the exact same size as the desired casting for several reasons . Such a pattern would produce castings which are undersize .

Allowance must therefore be made for shrinkage , draft , finish , distortion and rapping.

Shrinkage Allowance :

As metal solidifies and cools it shrinks and contracts in size . To compensate for this a pattern is made larger than the finished casting by means of a shrinkage or contraction allowance. In laying measurements for the pattern the patternmaker allows for this by using shrink or contraction rule which is slightly longer than the ordinary rule of the same length . Different metals have different shrinkages .

Draft Allowance :

When a pattern is drawn from a mould , there is always some possibility of injuring the edges of the mould . This danger is greatly decreased if the vertical surfaces of a pattern are tapered inward slightly. This slight taper inward on the vertical surface of the pattern known as the draft .

Draft may be expressed in millimetre per metre on a side or in degrees and the amount needed in each case depends upon

- Length of the vertical slide .
- Intricacy of the pattern.
- Method of moulding .

Under nominal conditions the draft is about 10 to 20 mm per metre on exterior surfaces and 40 to 60 mm per metre on interior surfaces.

Machining Allowance :

Rough surfaces of castings that have to be machined are made to dimensions somewhat over those indicated on the finished working drawings . The extra amount of metal provided on the surfaces which is to be machined is known as machine finish allowance . The amount that is to be added depends upon the kind of metal to be used , size and shape of casting , method of moulding . The standard finish allowance for different cast metals in mm for hand moulding is given in tables :

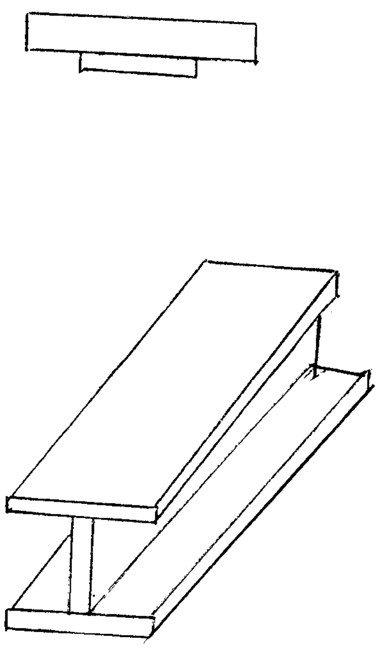
STANDARD MACHINING ALLOWANCE :

Diameter of hole/distace from locating point	Cast iron Bore	Cast iron Surface	Cast Steel Bore	Cast Steel Surface	Non-ferrous Bore	Non-ferrous Surface
200	3	3	4	4	15-20	1.5
200-400	4.5	4	5.5	5	2.0	1.5
400-700	6	5	7	6	3.0	2.0
700-1100	7	6	9	7	3.5	2.5
1100-1600	9	7	11	9	4.0	3.0
1600-2200	10	8	13	11	-	-
2200-3000	12	9	15	13	-	-

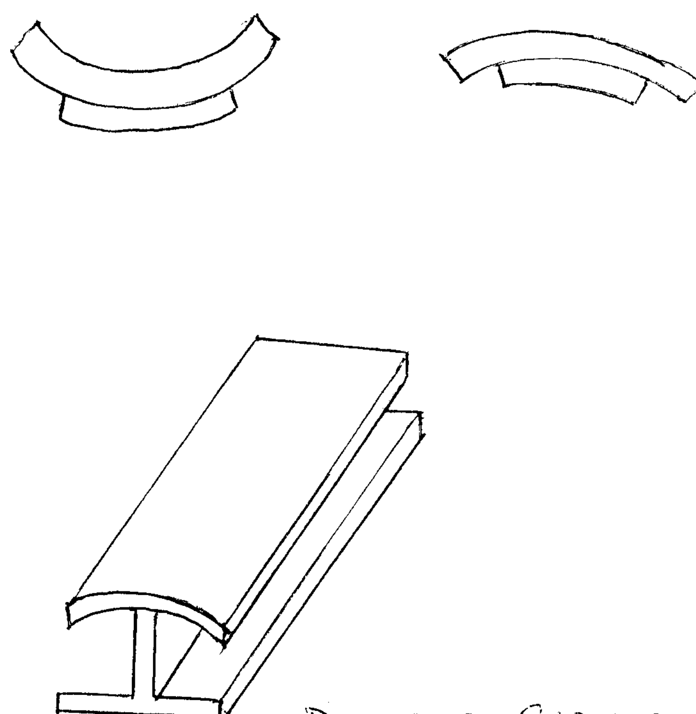
DISTORTION OR CAMBER ALLOWANCE :

Some castings because of their size, shape and type of metal , tend to warp or distort during the cooling period . This is a result of uneven metal shrinkage and is due to uneven metal thickness or to one exposed than another, causing it to cool more rapidly .

The shape of the pattern is thus bent in the opposite direction to overcome this distortion. This feature is called distortion or camber allowance.



REQUIRED SHAPE OF CASTING



DISTORTED CASTING

RAPPING ALLOWANCE :

When a pattern is rapped in the mould before it is withdrawn , the cavity in the mould is slightly increased. In every cases where castings must be uniform and true to pattern , rapping or shake allowance is provided for by making this pattern slightly smaller than the actual size to compensate for the rapping of the mould .

COREPRINT :

Castings are often required to have holes , recesses , etc of various sizes and shapes . These impression are obtained by using sand cores which are separately made in boxes known as coreboxes . For supporting the cores in the mould cavity , an impression in the form of a recess is made in the mould with the help of a projection suitably placed on the pattern . This projection on the pattern is known as the coreprint .

A coreprint is therefore an added projection on a pattern , and it forms a seat which is used to support and locate the core in the mould . There are several types of coreprints .They are horizontal or parting line coreprint , vertical or cope and drag coreprint, balancing coreprint , cover or hanging coreprint , wing or drop coreprint.

CORE BOXES :

A core box is essentially a type of pattern made of wood or metal into which sand is rammed or packed to form of a core. The types of core boxes , in common use in foundry work are given below :

Half Box :

A half box is used to form two identical halves of a symmetrical core. After they are shaped to form and baked the core halves are pasted together to form a completed core.

Dump Box :

A dump box is designed to form a complete core that requires no pasting. If the core thus made is in the shape of a slab or rectangle , it is called a rectangular box.

Split Box :

It consists of two halves which are clamped together . One half of the box has two or more dowels to hold the parts in correct alignment . It is arranged with opening at one or both ends for filling and ramming the sand .

Right Hand and Left Hand Box :

Right hand and left hand core boxes are necessary when two half cores made in the same box cannot be pasted together to form an entire core . The core halves are made in these two boxes and pasted together .

Gang Box :

In instances where large number of cores are to be made, a gang core box , in which several core cavities are rammed in a single operation is employed .

MOULDING SANDS :

The principal material used in the foundry shop for moulding is the sand . This is because it possess the properties vital for foundry purposes .

Principal Ingredients :

The ingredients of moulding sand are silica sand grains , clay, moisture and miscellaneous materials .

Silica in the form of granular quartz , itself a sand is the chief constituent of moulding sand .Silica sand contains about 80 to 90 % SiO_2 and it is high softening temperature and thermal stability .

Clay is defined as those particles of sand that fail to settle at a rate of 25 mm per minute when suspended in water clay consists of two ingredients fine silt and true clay .

Moisture in requisite amount furnishes the bonding action of clay. When water is added to clay it penetrates the mixture and forms a micro film which coats the surface of flake shaped clay particles . The water should be between 2 to 8 %.

Miscellaneous materials in addition to silica and clay in moulding sand are oxide of iron, limestone, magnesia , soda and potash . The impurities should be below 2%.

Moulding sands can be classified generally into three types. They are the natural moulding sands , synthetic or high silica sand and special sand .

HEAT TREATMENT

It is defined as an operation of heating and cooling of metals in the solid state to induce certain desired properties into them.

It is done for the following purposes :

1. To improve machinability, mechanical properties.
2. To change or refine grain size.
3. To increase resistance to wear, heat and corrosion.

The most commonly used operations of heat treatment are : 1) Annealing 2) Normalising 3) Hardening 4) Tempering 5) Carburising 6)Cyaniding 7) Nitriding 8) Induction hardening 9) Flame hardening.

STAGES OF HEAT TREATMENT PROCESS :

i. Heating a metal / alloy to definite temperature.

ii. Holding at that temperature for a sufficient period to allow necessary changes to occur.

iii. Cooling at a rate necessary to obtain desired properties.

NORMALIZING:

It is defined as a process in which iron base alloys are heated 40 - 50°C above the upper transformation range and held there for a specified period (to ensure that a fully austenitic structure is produced) and followed by cooling in still air at room temperature.

Normalizing produces microstructures consisting of ferrite and pearlite for hypoeutectic (i.e.upto about 0.8%C) steels.

For eutectoid steels the microstructure is only pearlite

For hypeeutectoid steels the microstructure is cementite.

PURPOSE OF NORMALISING :

1. Produces a uniform structure .
2. Reduces internal stresses.
3. Refines the grain size.
4. Produces a harder and stronger steel than full annealing .

HARDENING :

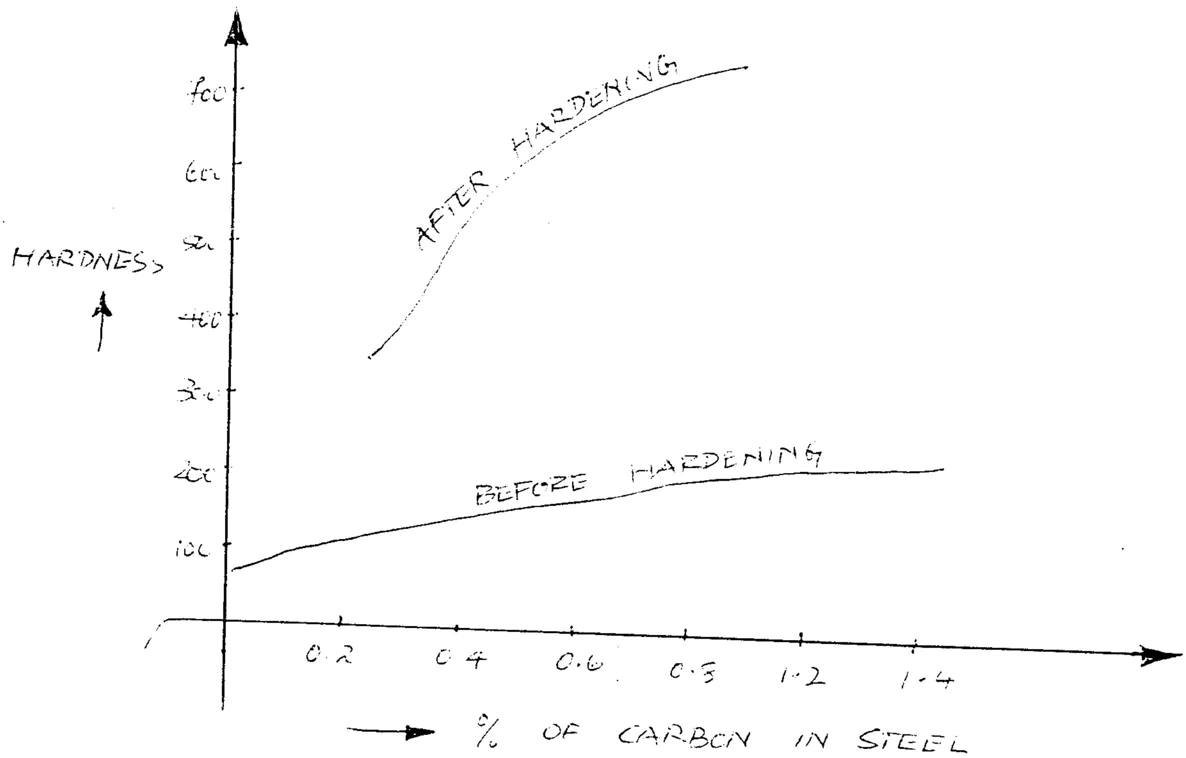
- It is that heat treatment of steel which increases its hardness by quenching (and tempering) .
- Tools and machine parts required to undergo heavy duty service are oftenly hardened .

HARDENING FOLLOWED BY TEMPERING :

1. Hardened steels to resist wear .
2. Enables steel to cut other metals .
3. Improves strength, toughness and ductility .

HARDENING PROCEDURE :

- Steel with sufficient carbon (0.35% to 0.70%).
- Is heated 30 to 50c above the upper transformation range .
- Is held at that temperature from 15 to 30 min/ 25mm of cross section.
- Is cooled rapidly or quenched in a suitable medium (e.g. water,brine,oil, etc)



- As the hardness in steel is due to carbon content only, the hardening process is carrried out only on high carbon steels.
- It is also applied on tool and structural steels.

TEMPERING :

- It is a reheat process, reheating being carried out under sub-critical temperatures.
- It is an operation used to modify the properties of steel hardened by quenching for the purpose of increasing its usefulness .
- The mechanical properties produced by hardening and tempering depend upon the carbon content of the steel , the rate at which it is cooled during the hardening process and the tempering temperature .

Tempering is divided into 3 classes according to the usefulness of steel required :

1) low temperature tempering .

2) medium temperature tempering .

3) high temperature tempering .

Quenching characteristics of coolants are controlled by the following factors:-

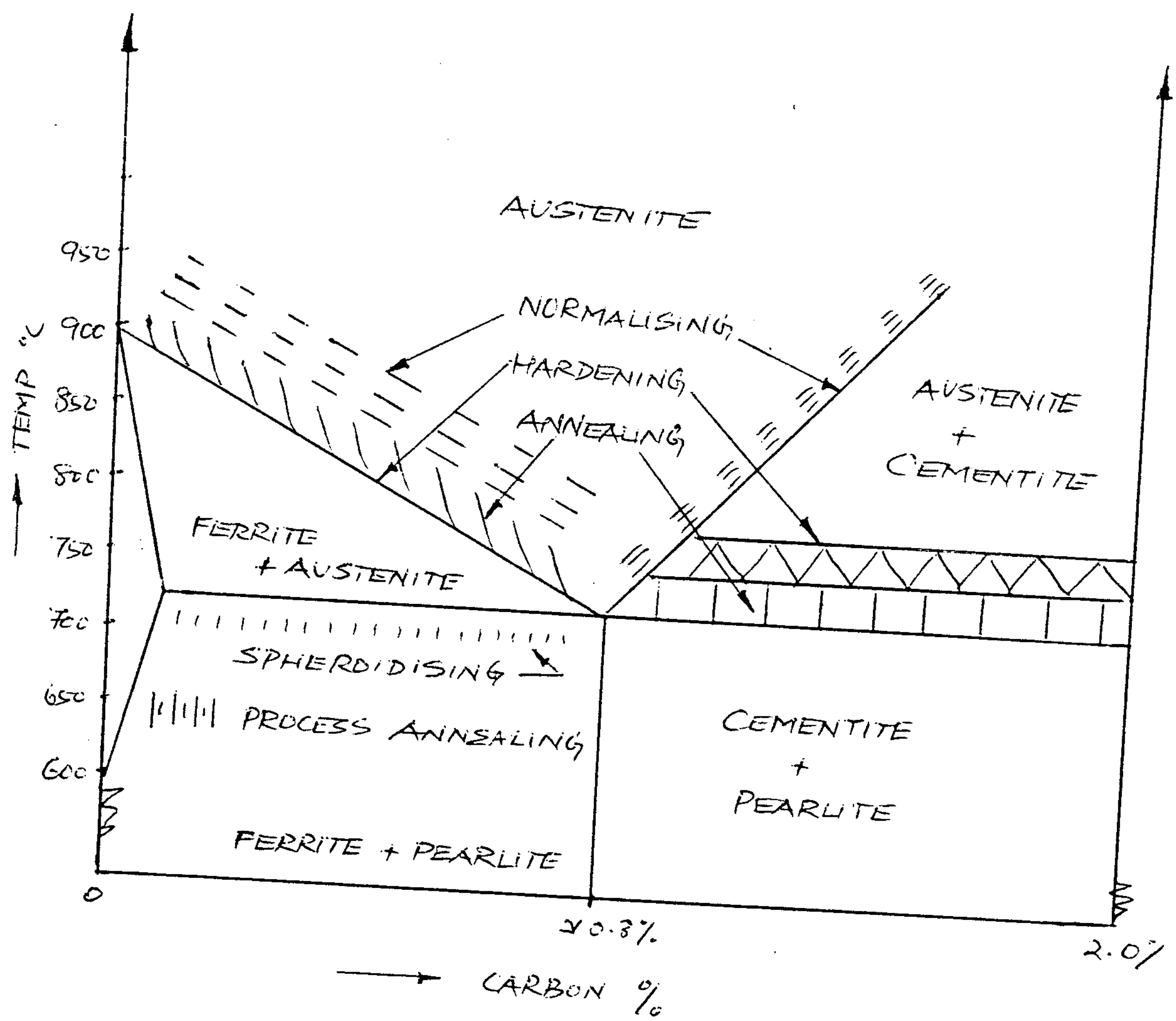
1) Temperature of quenching medium .

2) Specific heat .

3) Thermal conductivity.

4) Viscosity

5) Agitation .



MACHINING :

Machining is defined as a process of metal removal . Due to rapid growth in the development of harder and difficult –to – machine materials such as hastalloy nitralloy, wasalloy , nimonics , carbides , stainless steel ,heat resisting steels and many other high-strength –temperature resistant (HSTR) alloys .

These materials have wide application in aerospace , nuclear engineering and other industries owing to their high strength to weight ratio, hardness and heat resisting qualities . For such materials the conventional edged tool machining is used .

Some of the machining process involved in the fabrication of the unit are grinding , milling , shaping , drilling and turning. Machinability is the ability with which a material can be machined .

Grinding :

Grinding is a metal cutting operation where metal is cut by rotating abrasive wheel. By grinding , very good surface finish is obtained on work piece . High dimensional accuracy is also attained . Grinding is predominantly used as a finishing operation . Very hard surface can be finished by grinding .

Grinding wheel is made up of small abrasive particles held together by a bonding material . The abrasive particles are very hard, these hard abrasive particles or grains project on the surface of the wheel . The abrasive particles form multiple cutting edges, while grinding the wheel is rotated and either the work or the wheel is moved to contact each other depending on the type of machine . The abrasive particles move past the work with high velocity and shears off small metal particles from the work piece .

The different process of grinding are as follows :

External Cylindrical Grinding :

This produces a straight or tapered surface on t work piece . The work piece must be rotated about its own axis betwe centres as it passes length wise across the face of a revolving grindi wheel .

Internal Cylindrical Grinding :

This produces internal cylindrical hole and tapers .Th workpieces are chucked and precisely rotated about their own axis . Th grinding wheel are in the case of small bore holes , the cylinder whee rotates againist the sense of rotation of the work piece.

Surface Grinding :

This produces flat surfaces. The work may be ground by either the periphery or by the end face of the grinding wheel . The work piece is reciprocated at a constant speed below or on the end face of the grinding wheel .

Form Grinding :

This is done with specially shaped grinding wheels that grind the formed surfaces as in the grinding gear teeth , threads , splined shafts , holes and spheres , etc .

MILLING :

Milling is the process of removing metal by feeding the work past a rotating multipoint cutter. In milling the rate of metal removal is rapid as the cutter rotates at a high speed and has many cutting edges. Thus the jobs are machined at a faster rate than with single point tools and the surface finish is also better due to multicutting edges.

In milling operation the cutting edge of the cutter is kept continuously in contact with the material being cut . The cut picks up gradually only with the variety of milling cutters, the machine can produce wide variety of flat and formed surfaces. Milling machine can be used for machining flat surfaces, contoured surfaces complex and irregular, surfaces of revolution etc., to close tolerances for both limited quantity and mass production .

The versatility and accuracy of the milling process causes it to be widely used in modern manufacturing .

MILLING CUTTERS :

The milling cutters employed in the manufacturing process of this vice are : Fly cutters and end mill cutters .

A milling cutter is provided with equally spaced teeth which engages the work piece intermittently and rotates on its own axis

MATERIAL OF MILLING CUTTERS :

All important tool materials like carbon steel , HSS , cast non-ferrous cutting alloys, sintered carbide etc. are used for milling cutters.

FLY CUTTER:

Basically, the fly cutter is a cylinder with provision for mounting one or more tool bits or single point cutters on the face of the periphery. This is particularly suitable for quick operation by giving more feed per tooth on metals like magnesium and aluminium.

END MILL CUTTERS:

These cutters have an integral shaft for driving and have teeth on both periphery and ends. These are the cutters with teeth on the periphery and end integral with a shank for holding and driving. These are used to mill flat, horizontal, vertical, bevel, slant surfaces, grooves, keyways etc. It may have either taper shank or straight shank. End mills with high helix are used for milling aluminium and like metals.

SHAPING:

The shaper makes use of a single point tool that traverses the work and feeds over at the end of each stroke. It is used principally to machine flat or plain surfaces in horizontal, vertical and angular planes. The following operations can be performed on a shaper: machining a thin job, cutting on a large job, cutting a dovetail bearing, shaping a V or keyway centrally in a block, shaping an irregularly curved surface, machining angular surfaces on shapers.

DRILLING:

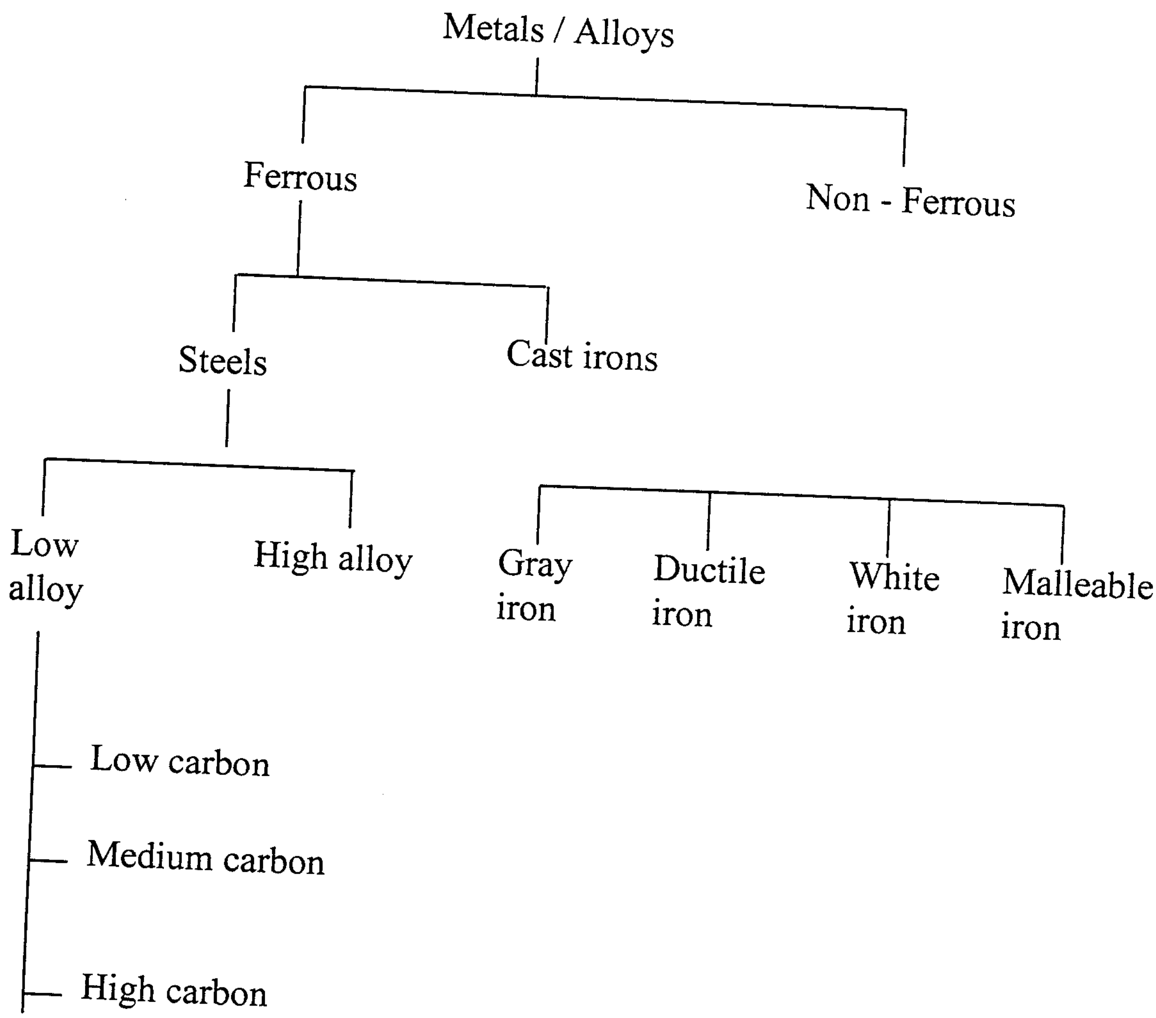
Drilling is the operation of producing a cylindrical hole by removing metal by the rotating edge of a cutting tool called the drill. The process of drilling is one of the simplest methods of producing a hole. Before drilling the centre of the hole is located on the workpiece by drawing two lines at right angles to each other and a thin centre punch is used to produce an indentation at the centre. The drill point is pressed at this centre point to produce the required hole. Drilling does not produce an accurate hole in a workpiece and the hole location is not perfect. The internal surface of the hole so generated by drilling becomes rough and the hole is always slightly oversized than the drill used due to the vibration of the spindle. A 12mm

MATERIAL PROPERTIES

FERROUS MATERIALS:

It contain iron and the one element people use more than all other is iron.

Ferrous materials are the most important metals/alloys in the metallurgical and mechanical industries because of their extensive use.



Gray cast iron , Mild steel , Tool steel are certain metals used in this vice. The central or main body is made up of gray cast iron, the work holding jaws of tool steel and the body where the piston assembly is located is made of mild steel.

GRAY CAST IRON :

- It is a low cost material .
- Available to the foundry as virgin ingots and selected scrap.

MECHANICAL PROPERTIES :

1) High compressive strength .
2) Low tensile strength .
3) High rigidity, high stability .

CASTING PROPERTIES:

1) High fluidity and ability to make sound castings
2) Relatively low melting temperature 1130 – 1250 °C

SPECIAL PROPERTIES:

1) Self damping
2) Self lubricating
3) Good antifriction properties

CHARACTERISTICS :

- Gray iron basically is an alloy of carbon and silicon with iron .
- It contains 2.5 - 3.8%C

  1.1 - 2.8% Si

  0.4 - 1%Mn

  0.15% P

  0.10% S
- It is marked by the presence of flakes of graphite in a matrix of ferrite, pearlite or austenite.
- Low ductility and low impact strength
- It has a solidification range of 2400 - 2000°C
- It has shrinkage of 1/8 inch/foot.

Type	**Hardness BHN**	**Tensile strength MN/m^2**	**Machineability**	**Properties and uses**
Grey	170-190	120-185	Good	Brittle. Used for beds and slides of machines
Malleable	120-200	350-390	Good	For small weak castings needing greater strength
Alloy	200-260	340-390	Excellent	For castings needing high strength

iii) Mild steel containing 0.20 to 0.30 % carbon has a tensile strength of $555 N/mm^2$ and a hardness of 140 BHN .

It is used for making valves , gears , crankshafts , connecting rods, railway axles.

TOOL STEELS :

Tool and die steels may be defined as special steels which have been developed to form , cut or otherwise change the shape of a material into a finished or semifinished product .

PROPERTIES:

i. Good toughness .
ii. Slight change of form during hardening .
iii. A definite hardening temperature .
iv. Resistance to softening on heating .
v. A good degree of through hardening .
vi. Little risk of cracking during hardening .

APPLICATIONS :

- Drills , reamers, chasers .
- General tool & die applications in which resistance to distortion is needed.
- Pneumatic tools , hand chisels.

APPLICATIONS:

1) Machine tool structures.

2) Tunnel segment .

3) Cylinder heads & blocks for IC engines, piston rings .

4) Gas or water pipes for underground purposes .

5) Ingot moulds.

6) Frames for electric motors

7) Sanitary wares

MILD STEEL :

Mild steels or low carbon steels may be classified as follows :

i) Dead Mild steel - C 0.05 to 0.15 %

It is used for making steel wires , sheets , rivets , screws , pipes , nails.

It has a tensile strength of 390 N/mm^2 and a hardness of about 115 BHN .

ii) Mild steel

It contains 0.15 to 0.20 % carbon and has a tensile strength of 420 N/mm^2 and hardness 125 BHN.

It is used for making cam shafts, sheets, strips for fan blades , forgings ,welded tubing.

drill may produce a hole as much as 0.125mm oversize and a 22mm drill may produce one as much as 0.5mm oversize.

THREADS:

Threads are commonly used for the following purposes.

1) As fasteners

2) To transmit power or motion

3) For adjustment

Fasteners like bolts and screws have a single start thread, while worms and power screws sometimes have double, triple threads. Multistart threads are employed when a large lead or high efficiency is desired.

FORMS OF THREADS:

SQUARE THREAD:

This type of thread is more difficult to cut i.e. withdrawal of the tool at the end of cutting operation is difficult. It has no means of adjustment for wear.

ACME THREAD:

It is in the form of an angular thread and is used where a split nut is required (as in the lead screw of a lathe). Wear may be taken up by means of an adjustable split nut. Efficiency of the acme thread is slightly less than that of a square thread. For acme threads $2\beta = 29°$, for trapezoidal threads $2\beta = 30°$

BUTTRESS THREAD:

It is used for translation under load in one direction only. It is stronger than other forms of thread because of the greater thickness at the base of the thread.

DESIGN ANALYSIS

DESIGN OF SCREW ROD

Outer dia, d_0 = 44mm. ; Pitch, p = 5mm. Axial Load,

W = 50 KN; Coefficient of friction of Screw, $\mu_s = 0.15$,

Coefficient of friction of Collar, $\mu_c = 0.12$,

D_1= 52mm, D_2= 38 mm.

1. Torque required to overcome friction :

$$d = d_0 - P/2$$

$$= 44\text{-}5/2 = 41.5 \text{ mm.}$$

$$\tan\alpha = \frac{P}{\pi d} = \frac{5}{\pi \times 41.5}$$

$$= 0.0384$$

For Acme threads, $2\beta = 29^0$

$$\therefore \beta \quad = 14.5^0$$

Virtual coefficient of friction is

$$\mu 1 = \tan\phi_1 = \frac{\mu}{\cos\beta} = \frac{0.15}{\cos 14.5^0} = 0.155$$

Torque required to overcome friction at the screw,

$$T_1 = p \times \frac{d}{2} = W \tan(\alpha + \phi_1)\frac{d}{2}$$

$$= W\left(\frac{\tan\alpha + \tan\phi_1}{1 - \tan\alpha \times \tan\phi_1}\right)\frac{d}{2}$$

$$= 50 \times 10^3 \left(\frac{0.0384 + 0.155}{1 - 0.0384 \times 0.155}\right)\frac{41.5}{2}$$

$$= 201863.6 \text{ Nmm}$$

$$= 201.86 \text{ Nm.}$$

We know that mean radius of collar

$$R = \frac{R_1 + R_2}{2} = \frac{26 + 19}{2} = 22.5\text{mm}$$

Assuming uniform wear, the torque required to overcome friction at collars,

$$T_2 = \mu_2 WR = 0.12 \times 50 \times 10^3 \times 22.5$$

$$= 135000 \text{ Nmm.}$$

$$= 135\text{Nm.}$$

Total torque required to overcome friction,

$$T = T_1 + T_2 = 201.86 + 135$$

$$T = 336.86 \text{ Nm.}$$

2. Efficiency of screw rod,

$T_0 = W\tan\alpha \times d/2$

$$= 50 \times 10^3 \times 0.0384 \times \frac{41.5}{2}$$

$T_0 = 39840$ Nmm.

$= 39.84$ Nm.

$\therefore$ Efficiency of screw rod, $\eta = T_0/T = 39.8/336.86$

$= 0.118 = 11.8\%$

Stresses in Screw rod :

1. Bearing Pressure :

$$P_b = \frac{W}{\frac{\pi}{4}\left[(d_0)^2 - (d_C)^2\right]n}$$

$$P_b = \frac{W}{\pi\left[\frac{d_0 + d_C}{2} \times \frac{d_0 - d_C}{2}\right]n} = \frac{W}{\pi dtn}$$

$$= \frac{50 \times 10^3}{\pi \times 41.5 \times 2.5 \times 36.6} = 4.2 N/mm^2$$

Therefore Design is safe

$d_c = d_0 - p = 44 - 5 = 39$ mm.

Core area of the Screw $A_C = \frac{\pi}{4}(d_C)^2 = \frac{\pi}{4}(39)^2 = 1195 mm^2$

Direct compressive stress on the screw due to axial load,

$$f_C = \frac{W}{A_C} = \frac{50 \times 10^3}{1195} = 41.8 N/mm^2$$

According to max. shear stress theory,

$$f_s(max) = \frac{1}{2}\sqrt{(f_C)^2 + 4(f_S)^2}$$

Torsional Shear stress $T = \frac{\pi}{16} f_S (d_C)^3$

$$336860 = \frac{\pi}{16} f_S (39)^3 = 11647.2 f_s; \quad f_s = 28.92\ N/mm^2$$

$$f_s(max) = \frac{1}{2}\sqrt{(41.8)^2 + 4(28.92)^2}$$

$$f_s(max) = \frac{1}{2}\sqrt{5092.7} = 35.68 N/mm^2$$

From D.D.B., yield stress of shear = 120 N/mm^2

$$\text{Factor of Safety} = \frac{f_{sy}}{f_s(max)} = \frac{120}{35.68} = 3.36$$

From D.D.B. According to Johnson's Formula, Critical load,

$$W_{cr} = A_c \times f_y\left[1 - \frac{f_y}{4C\pi^2 E}\left(\frac{L}{K}\right)^2\right] N$$

$f_y = 200 N/mm^2 =$ Yield stress in tension or compression

$$W_{cr} = 1195 \times 200 \left[1 - \frac{200}{4 \times 0.25 \times \pi^2 \times 210 \times 10^3} \left(\frac{183}{9.75} \right)^2 \right] N$$

$= 230875.4$ N

$\therefore$ Factor of Safety = $W_{cr}/W = (230875.4)/(50 \times 10^3)$

$= 4.617$

We shall take larger value of factor of safety,

$\therefore$ Factor of Safety = $4.6 \simeq 5$

DESIGN OF DISC SPRING :

From design data book

$$C_2 = \frac{6}{\pi Log_e(\frac{d_0}{d_i})} = \frac{6}{\pi Log_e(\frac{46}{26})} = 7.7$$

$$C_1 = \frac{6}{\pi Log_e(\frac{d_0}{d_i})} \left[\frac{\frac{d_0}{d_i} - 1}{Log_e(\frac{d_0}{d_i})} - 1 \right] = 7.7 \left[\frac{0.77}{0.247} - 1 \right] = 16.30$$

$$M = \frac{6}{\pi Log_e(\frac{d_0}{d_i})} \left[\frac{(\frac{d_0}{d_i} - 1)}{(\frac{d_0}{d_i})} \right]^2 = 7.7 \left[\frac{0.769}{1.769} \right]^2 = 1.455$$

Stress at the inside circumference,

$$\sigma = \frac{E \times y}{(1-\gamma^2)M(\frac{d_0}{2})^2}\left[C_1\left(h-\frac{y}{2}\right)+C_2 t\right]$$

$\gamma = 0.30$

$E = 2 \times 10^4$ Kgf/mm²

$$\sigma = \frac{2\times10^6 \times 0.1}{(1-0.3^2)(1.45)(\frac{4.6}{2})^2}\left[16.3(0.12-0.05)+7.7\times0.35\right]$$

$= 1096.81 \text{kgf/cm}^2$

$$P = \frac{E \times y}{(1-\gamma^2)M(\frac{d_0}{2})^2}\left[\left(h-\frac{y}{2}\right)(h-y)t+t^3\right]$$

$$= \frac{2\times10^6 \times 0.1}{(1-0.3^2)1.455(\frac{4.6}{2})^2}\left[(0.12-0.05)(0.12-0.1)0.35+0.35^3\right]$$

P $= 4944$ kgf

∴ Design is safe.

1. **Cylinder bore calculation :**

Max. allowable stress choosen (approx.) = 2.3 KN

Stress = Load/Area

$= 2.3 \times 10^3 = (50,000)/((\pi/4) \times d^2)$

$\therefore$ d = 5.2 cm. = 52mm.

Diameter of the piston (or) Cylinder bore dia = 52 mm.

2. **Cylinder bore length**

Work done by the Piston = Volume x Pressure

Force x distance moved = $\pi r^2 l \times p$

3. Volume of oil contained inside the cylinder = 50 ml.

Volume = $\pi r^2 l$ (or) $\pi/4 d^2 l$

$0.05 \times 10^{-3} = \pi(2.6 \times 10^{-2}) \times l$

l = 2.3 cm.

4. The cylinder bore length after pre loading = 2.3 cm. (or) 23mm.

The Piston and spring containing the shaft length i.e. going inside the cylinder bore = 57 mm.

5. Pressure Created inside the Cylinder :

When screw rod moves 10mm. towards = 2500 kgf

∴ 5 mm. movement = 1250 kgf.

Pressure = Force/Area

$$P = \frac{1250x10}{\frac{\pi}{4} \times (5.2)^2}$$

$$= 588.5 N/cm^2$$

5mm. movement of screw rod creates inside the cylinder pressure = $588.5 N/cm^2$

∴ 20mm. movement creates inside the cylinder pressure = $2354 N/cm^2$.

Maximum pressure created inside the cylinder = $2354 N/cm^2$

Designing of the acme thread

From design data book

Nominal thread dia = 44mm.

Pitch = 5mm.

d_1 = 36.5mm, D = 44.5mm, D_1 = 38mm, d_2 = 40.5,

r = 0.25, e = 2.42, t_1 = 3.75mm, T_1 = 3.25mm,

a = 0.25, b = 0.75

From design data book

$t = 1.866\ p$
$= 1.866\ (5)$
$t = 9.33$ mm.

$t_1 = 0.5p + a$
$= 0.5\ (5) + 0.25$
$t_1 = 2.75$mm

$t_2 = 0.5p + a - b$
$= 0.5(5) + 0.25 - 0.75$
$t_2 = 2$mm.

$T1 = 0.5\ p + 2a - b$
$= 0.5(5) + 2(0.25) - 0.75$
$T_1 = 2.25$mm

$C = 0.25\ p$
$= 0.25(5)$
$c = 1.25$mm.

$t = 9.33$mm	$t_1 = 2.75$mm	$t_2 = 2$mm
$T_1 = 2.25$mm	$c = 12.5$mm	

WORKING OF VICE

WORKING OF VICE:

The hydraulic vice consists of hydraulic cylinder built into the sliding jar with piston and housing. The oil seals located on the housing are held in position by a steel flange to prevent leakage of oil. The hydraulic system is self contained and no external supply of oil need be given.

OPERATION:

The handle is mounted on screw. Before operating the vice, confirm that green colour on screw is outside the spindle.

Move the handle to engage spindle teeth, then start rotating the handle, with that the spindle will start rotating and sliding jaw starts moving towards workpiece.

The sliding jaw after touching the workpiece will stop moving. Then apply a small force on the handle which is an initial force on the workpiece.

To give hydraulic force, move the handle back where it will engage the key fitted on the screw and start rotating clockwise to develop the hydraulic force on the workpiece.

At green, the hydraulic force will be NIL.

At yellow, the hydraulic force will be medium.

At red, the hydraulic force will be maximum.

This is how the working of the hydraulic vice goes.

Hydraulic fluid:

The hydraulic fluid used in the vice is Servo 60. This oil is one of the recommended grades and it is also known as spindle oil.

The other alternative oils are Servo 61 to Servo 68 series. The number refers to the viscosity factor of the oil. But the best preferred and recommended oil is Servo 60.

If the viscosity of the oil is less, the hydraulic force attained is more. Thus in order to attain very high hydraulic forces we have to choose an oil which has less viscosity factor.

CONCLUSION

CONCLUSION

Hydraulics is rated by scientists and engineers to be the most rapidly developing field. The main advantage is that very high pressure is developed which can be attained by means of a cylinder piston arrangement. Thus, there is no limit to the applications of pneumatics.

We have designed and fabricated the components of the hydraulic vice. Detailed drawings of the various components have been drawn to confirm the designed values. The net result of our work has given a very satisfactory output. The system has produced significant change on the economics of the work done.

It has resulted in considerable increase in output quality of product and less fatigue to the operator. It has also reduced the setting time of the workpiece. Thus, this device can be used in all engineering industries.

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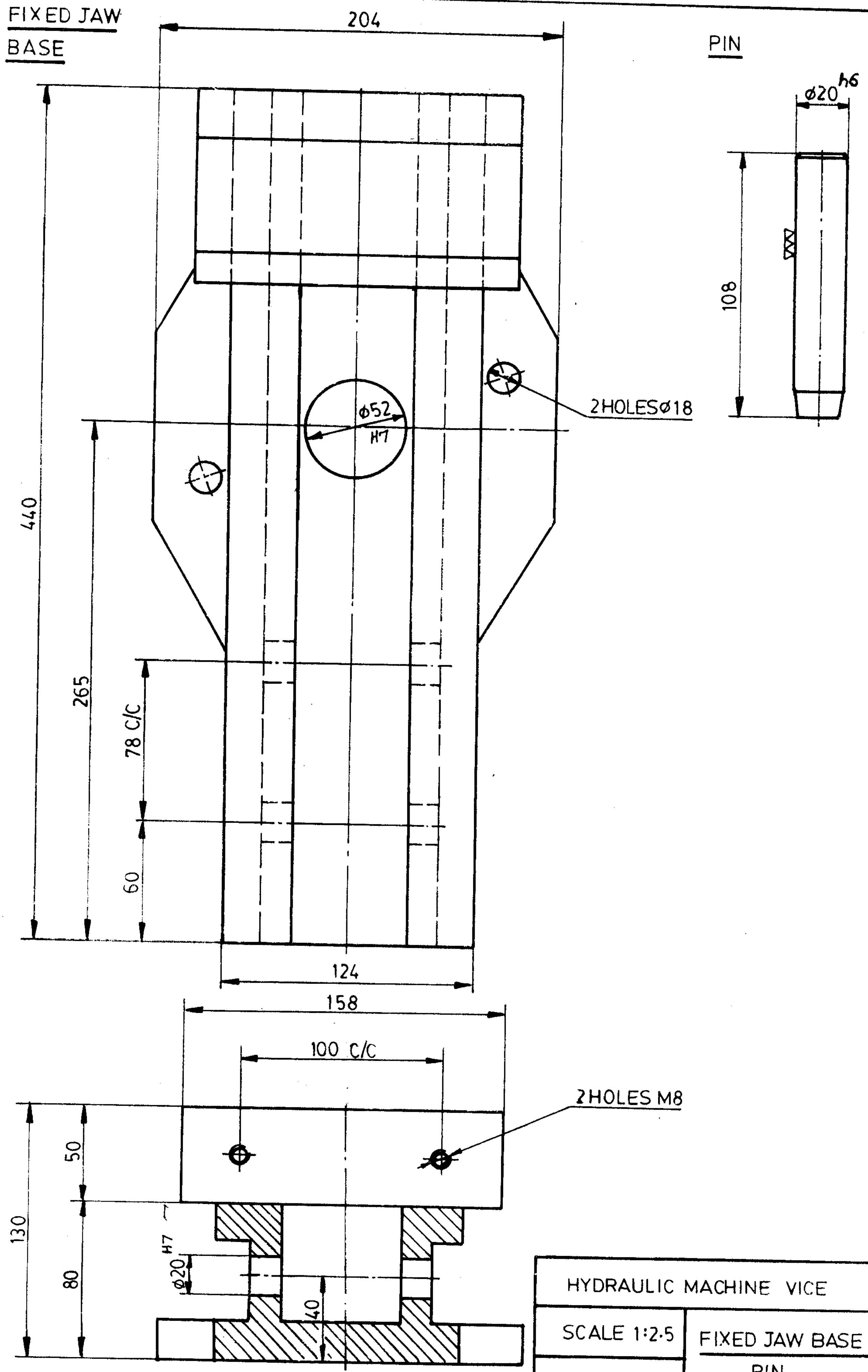
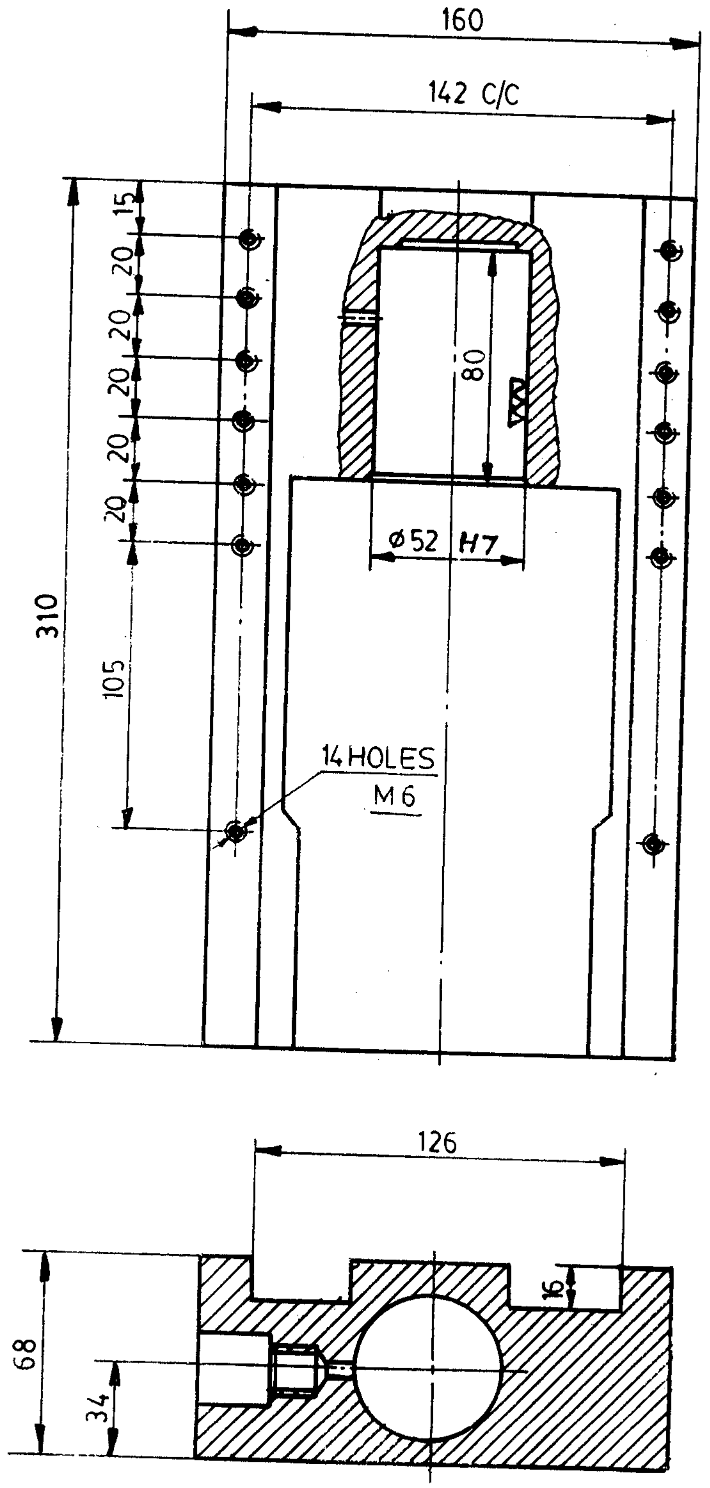
DRAWINGS

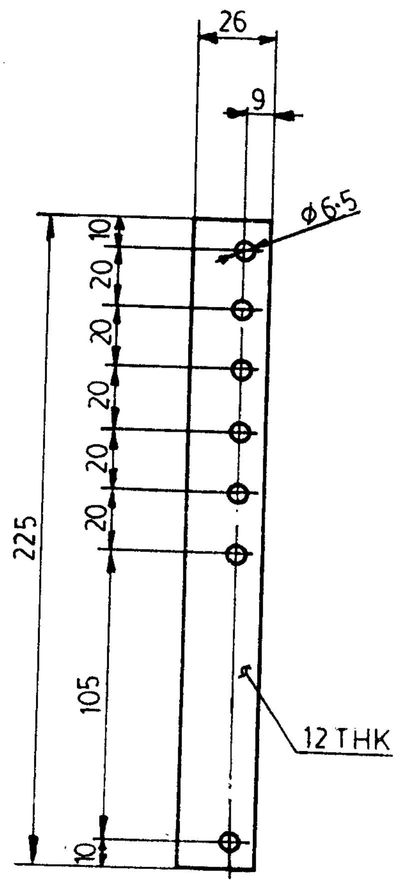


HYDRAULIC MACHINE VICE	
SCALE 1:2·5	FIXED JAW BASE & PIN
THD ANGLE	

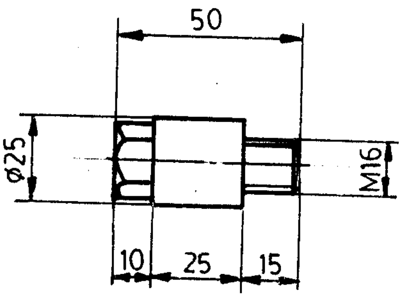
MOVABLE JAW BASE



GUIDE PLATE

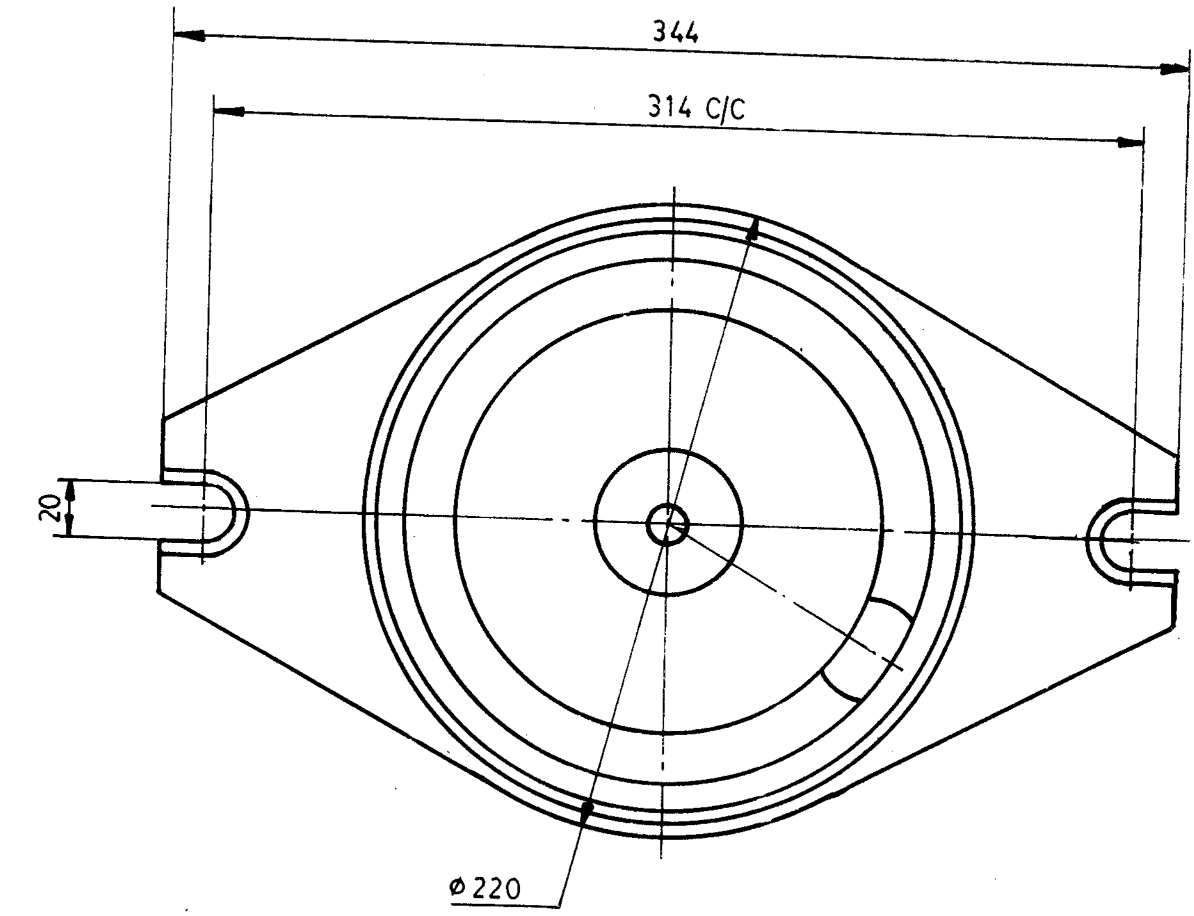


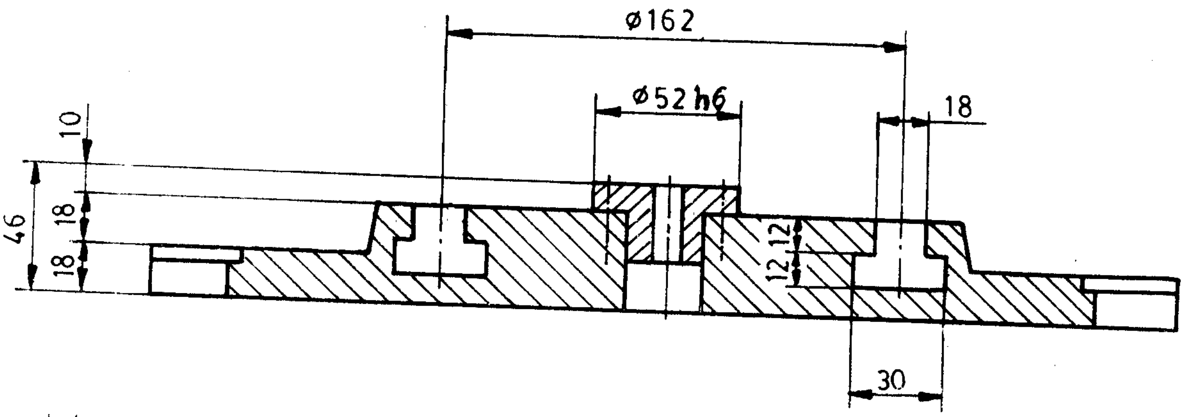
PLUG



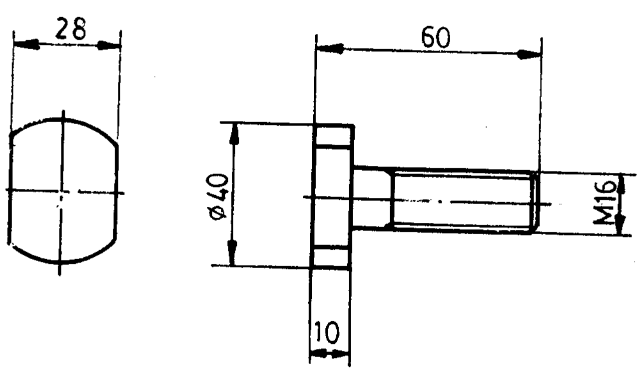
HYDRAULIC MACHINE VICE	
SCALE 1:2·5	MOVABLE JAW BASE GUIDE PLATE & PLUG
THD ANGLE	

BASE

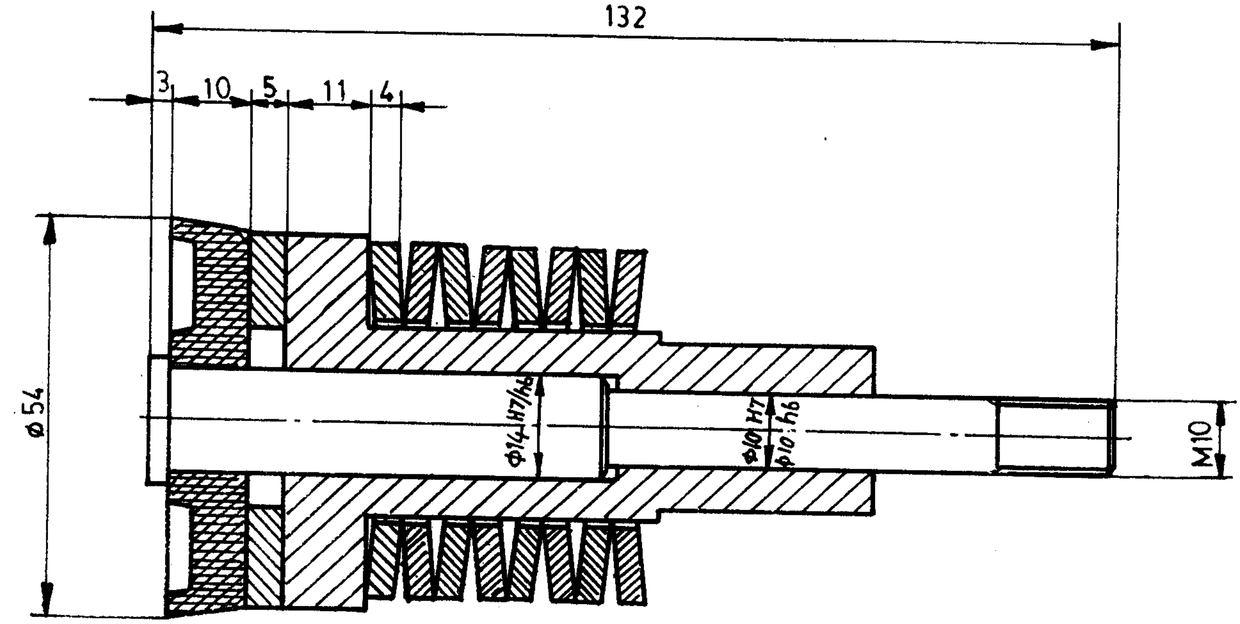




'T' BOLT

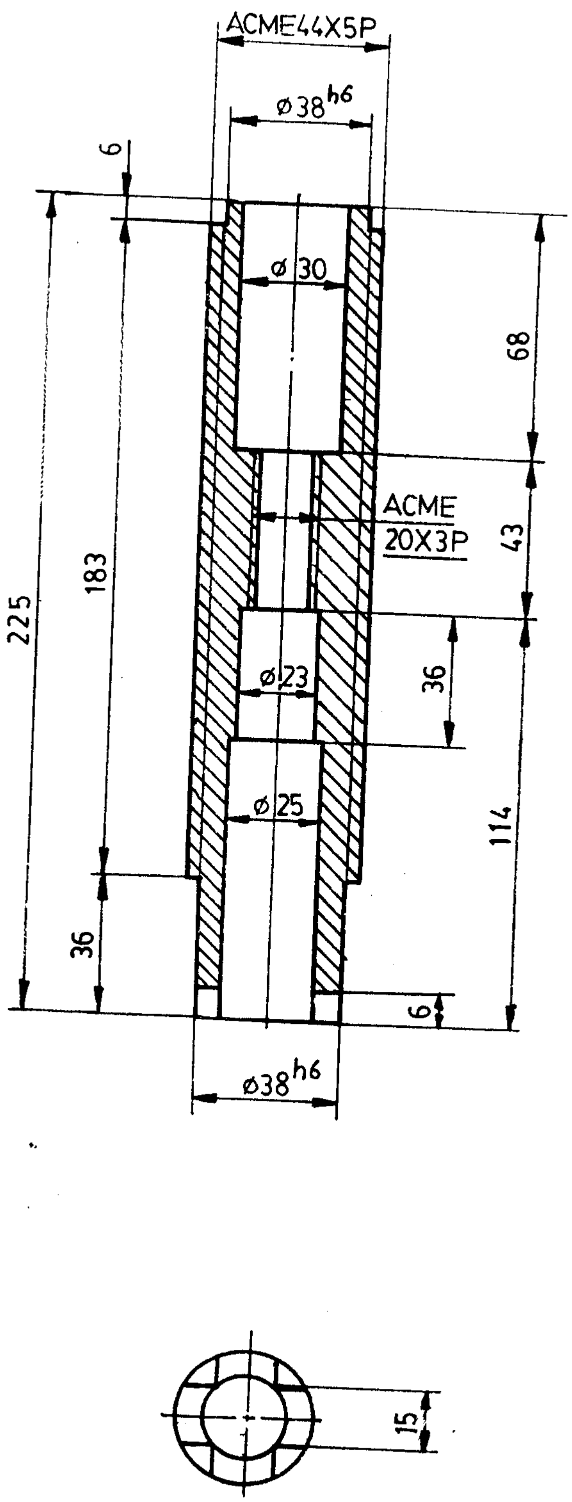


HYDRAULIC MACHINE VICE	
SCALE 1:2·5	BASE & 'T' BOLT
THD ANGLE	

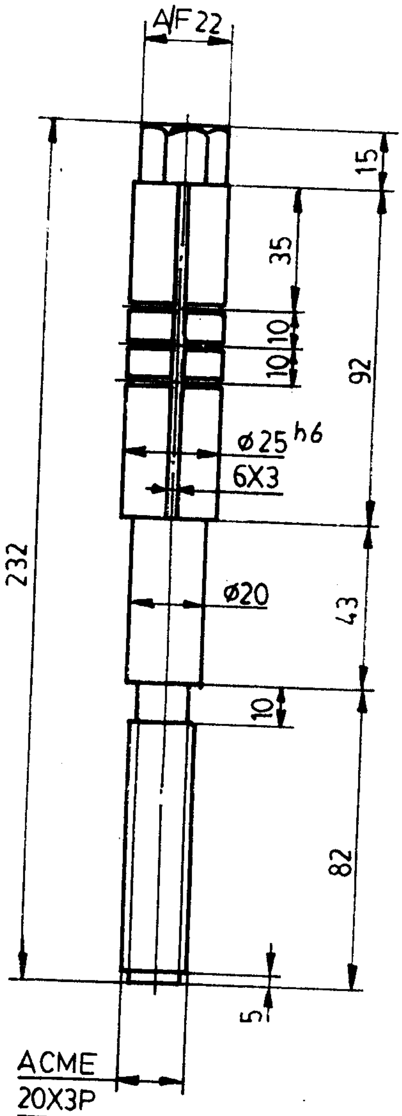


HYDRAULIC MACHINE VICE	
SCALE 1:1	PISTON ASSLY.
THD ANGLE	

SCREW ROD

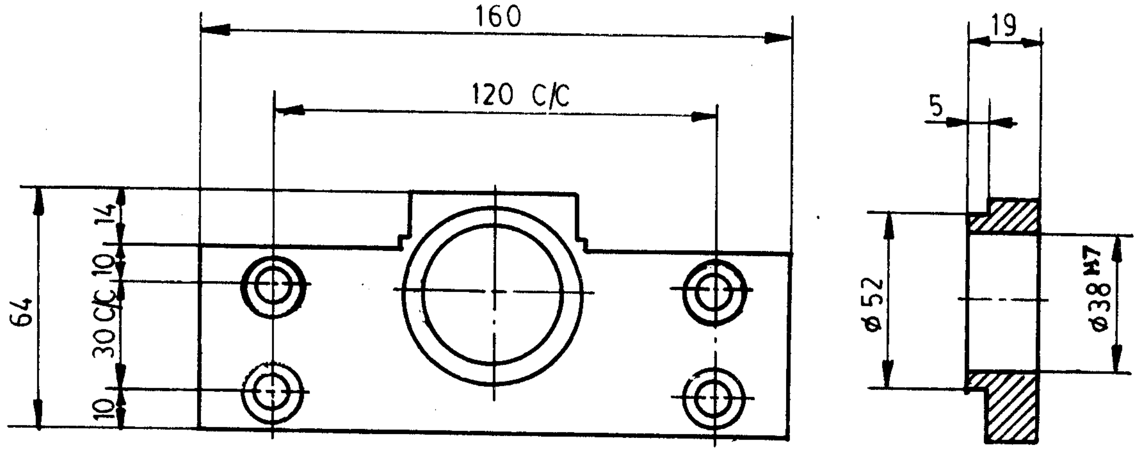


SCREW SHAFT

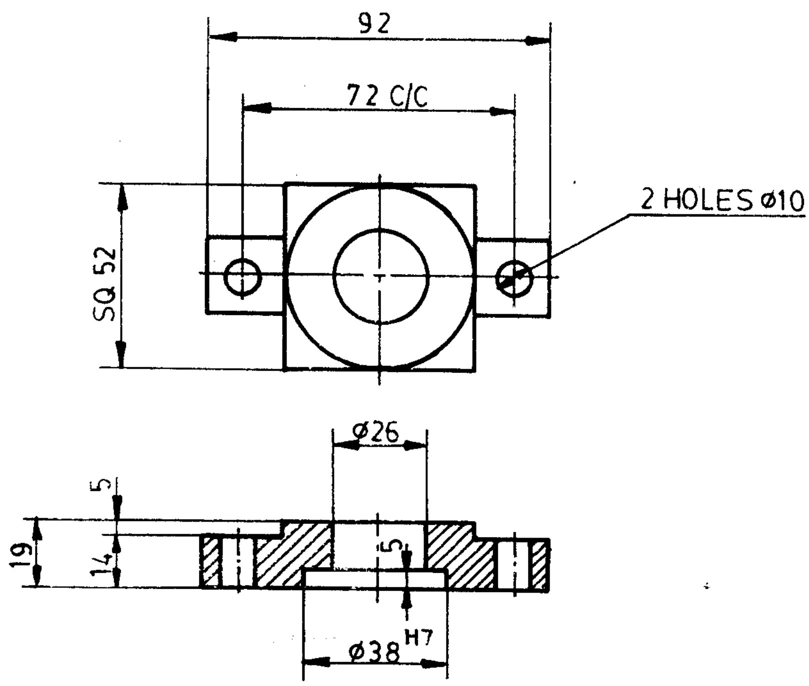


HYDRAULIC MACHINE VICE	
SCALE 1:2	SCREW SHAFT & SCREW ROD
THD ANGLE	

BEARING PLATE

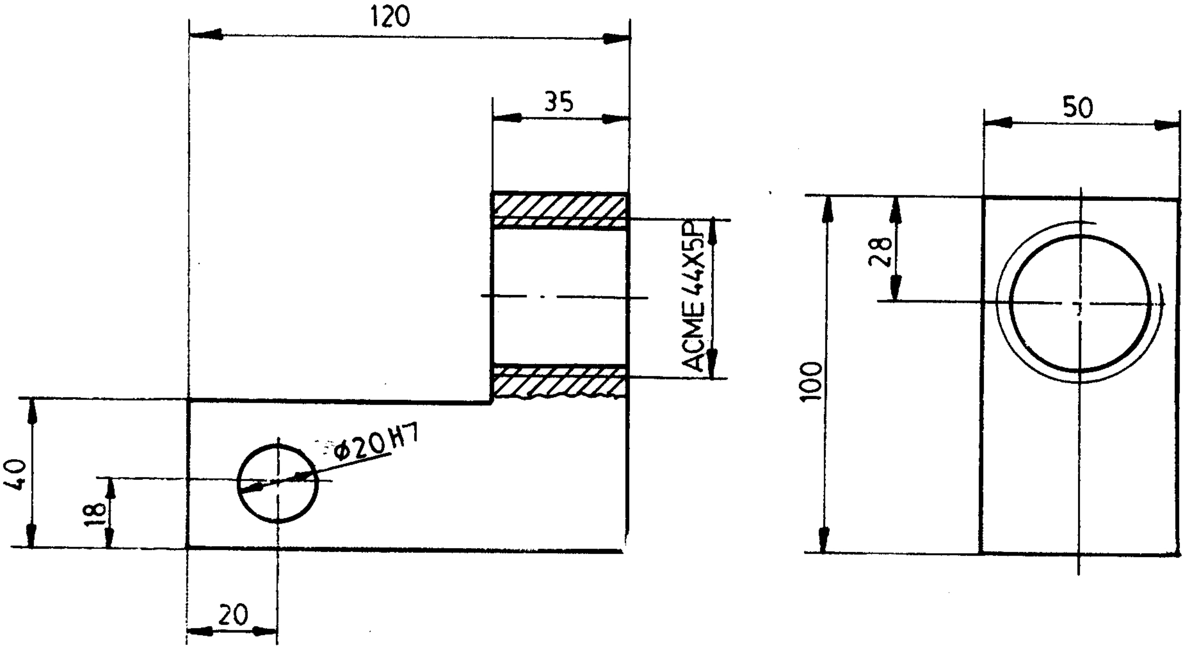


BEARING CAP

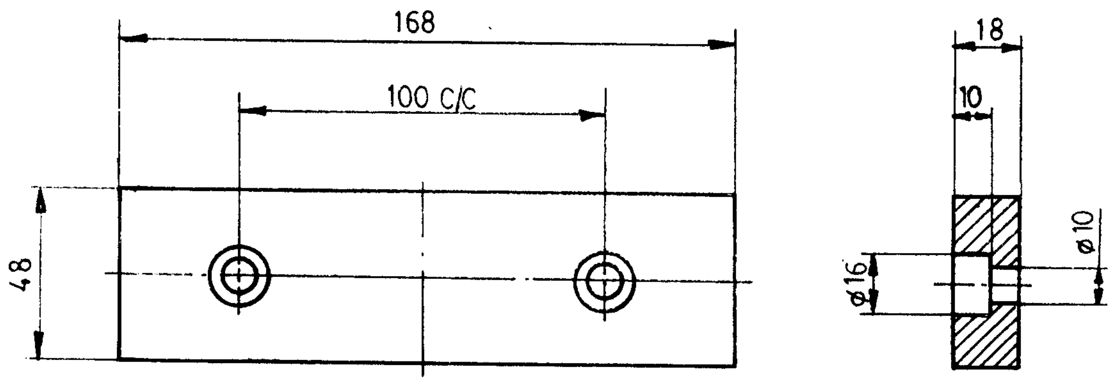


HYDRAULIC MACHINE VICE	
SCALE 1: 2	BEARING PLATE & BEARING CAP
THD ANGLE	

SCREW ROD NUT

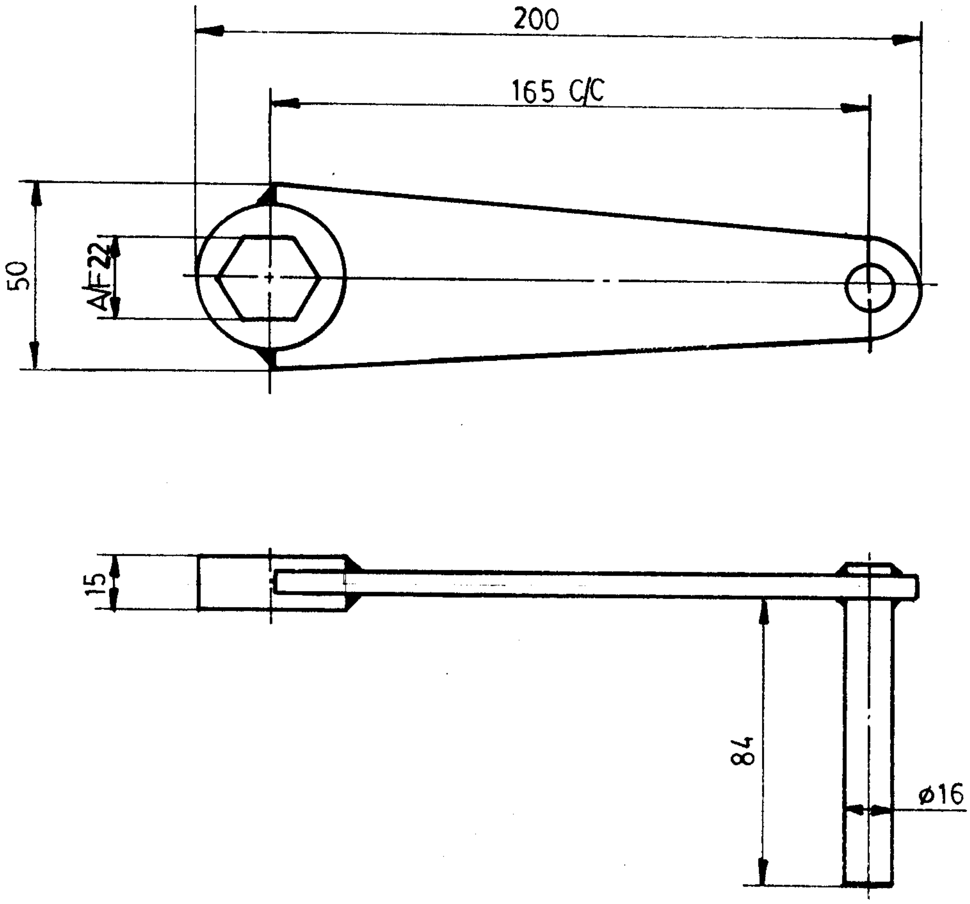


JAW PLATE

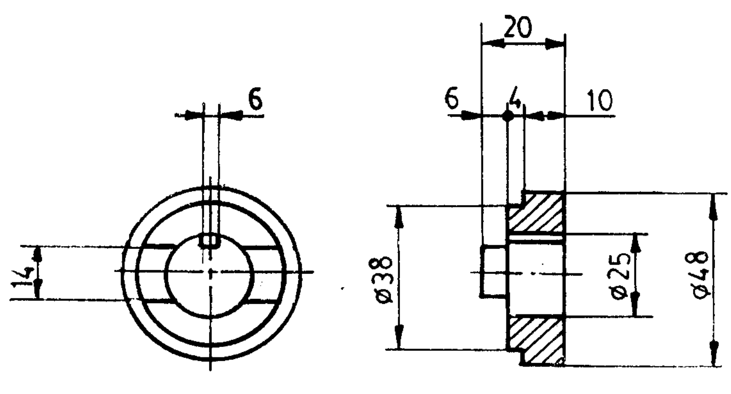


HYDRAULIC MACHINE VICE	
SCALE 1:2	SCREW ROD NUT JAW PLATE
THD ANGLE	

HANDLE



LOCK



HYDRAULIC MACHINE VICE	
SCALE 1:2	HANDLE & LOCK
THD ANGLE	

PHOTOS