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A Desing of Fuel Injection Pipe Head Forming Machine

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Abstract:- Hydraulics is a branch of engineering concerned mainly moving liquids. It is proven to be the most effective and economical system. Nowadays, the forming machine has lot of scope. This machine can do forming of materials with easy. In order to achieve the same, a hydraulic head forming machine is fabricated can extend highest benefits. Hydraulic head forming is a machine to produce compressive force by means of fluid. By using Pascal's law principle. Head forming is extensively employed in many of the fuel pipe industries. Head form working processes make use of large forces by head form tools for a short time interval which results in plastic deformation causes bulging in the head part of the pipe. Since, head forming does not involve heating of the parts, close tolerances and high surface finish can be obtained on the part. Hence in this project to overcome the disadvantage of exiting method such as "Screw Press" implemented and designed fabricated fuel injection pipe head forming machine which reduced production time, production cost, increased product accuracy and laborers work becomes more convenient and increase in the accuracy .there is higher initial cost involved we have tried to make the system cost effective and also add different enhancements to make the system more efficient.

Keywords:- *Solenoid , Cylinder , Head Forming Machine , Geared Pump , Double Acting Cylinder , Directional Control Valve, Hydraulic, Pascal, Fuel Injection Pipe, Screw Press.*

I. INTRODUCTION

➢ *Hydraulics*

Hydraulics is a branch of engineering concerned mainly moving liquids. The term is applied commonly to the study of the mechanical properties of water, other liquids, and even gasses when the effects of comprehensibility are small. Pascal's law states that the pressure or intensity of pressure at point in a static fluid is equal in all the directions. Hydraulic is proven to be the most effective and economical system. First used by the ancient Greece mainly for the elevating the stage of their amphitheater the principle of the hydraulics were explained scientifically by the 17th century scholar Pascal the law discover that the effort of pressure on fluid and gases in confined area form the basic principle of the mechanical advantage. The word hydraulic is derived from the Greek word hydro meaning liquid or "water" and "aulos" meaning pipe or tubing hydraulic therefore is an adjective implying that the word is modifies in some major ways concerned with the liquid. Example can be found in every day usage of the hydraulic is connection with familiar items such as automobile breaks and jacks. As further example the phrase hydraulics freight elevator elevating ascending and descending of the column of liquid instead of using cables and drum. On the other hand the term hydraulics is a generic name of a subject. According to the dictionary is defined as a branch of science the deals with the practical application (such as transmission of energy or the effect of the fluid) of a liquid in a motion.

➢ *Head Forming Machine*

Hydraulic head forming is a machine to produce compressive force by means of fluid. It depends upon Pascal's principle that the "pressure or intensity of pressure at point in a static fluid is equal in all the directions". By means of hydraulic system larger forces can be produced in contrast with mechanical. Such forces can be used for the forming work application.

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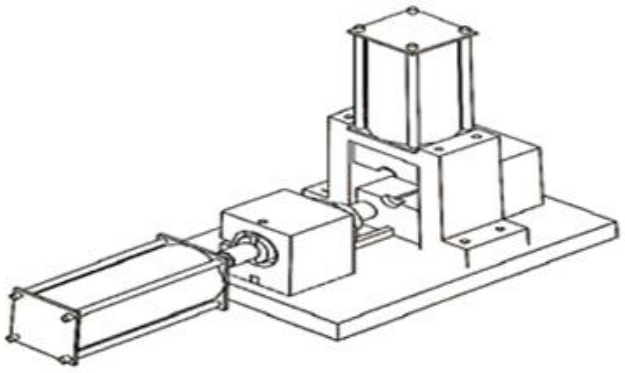

Fig1 Design of Head forming machine

Head forming work is a method involving the cold working process. Head forming is extensively employed in many of the pipe industries. Head form working processes make use of large forces by head form tools for a short time interval which results in plastic deformation causes bulging in the head part of the pipe. Since, head forming does not involve heating of the parts, close tolerances and high surface finish can be obtained on the part. Since forming can produce components at fairly fast rates, the unit cost of labor for operating the press is fairly low. Head form working forces are set up, guided and controlled in a machine referred to as a form. The inputs and outputs of the control system including hydraulic mechanism are solely mechanical such as rotating shaft or reciprocating plunger.

The prime payment of implementing this system is the movement of the mechanical devices can be operated by means of hydraulic components such as hydraulic cylinders to initiate the movement which could be in the form of switches. There are two hydraulic cylinders one for the movement of the head form tool and other for the movement of dies to hold the fuel pipes. Furthermore, direction solenoid valve have been implemented to control the directions of piston movements and regulate the same. Thus the whole mechanism has been simplified with the use of hydraulic equipment. Moreover, the use of pressure control valve and solenoid valves, makes it easier to regulate the forces and control the speed of the setup.

➢ *Screw Press*

Fig 2 Screw Press

A screw press is a type of machine press in which the ram is driven up and down by a screw. The screw shaft can be driven by a handle or a wheel. It works by using a coarse screw to convert the rotation of the handle or drive-wheel into a small downward movement of greater force. The overhead handle usually incorporates balls as flyweights.

The weights help to maintain the momentum and thrust of the tool to make it easier to operate. The head form tool is fixed to the ram and on the base pipe holder is place which holds the pipe rigidly. When handle is rotated ram moves down by using coarse screw and compress the fuel pipe with some pressure causing bulging in the head part of the pipe.

➢ *Problems In Screw Press*

To explore the present system of forming method to the advanced hydraulic pressure type of forming device and to fabricate and test validates the result. To arrive this following problems are faced and are discussed below.

- Wear in screw press: Extensive use of screw press causes wear in the screw part. This will cause serious problem.
- Work set up time is more: worker has to place the fuel pipe in between the holder in such a way that it should coincide with the center of the tool.
- Accuracy of the job is less: If the pipe in the holder does not match with the center of the tool it will cause some error.
- Wastage of material is more: Due to some inaccuracies while performing the job the wastage of material will be more.
- Production rate is less: as the set up time is more the production rate is less
- Less safety: while rotating the handle it can hurt his body parts.

➢ *Objectives*

- To design and fabricate the fuel injection pipe head forming machine
- To compare the form ability with the existing device.
- To test validate the result.

➢ *Scope of the Project*

Nowadays, the forming machine has lot of scope. This machine can do forming of materials with easy. In order to achieve the same, a hydraulic head forming machine is fabricated can extend highest benefits.

II. RESEARCH METHODOLOGY

➢ *The Steps in the Design Process Proposed as Follows:*

- Problem identification
- Preliminary ideas
- Design
- Analysis
- Decision
- Implementation

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Fig 3 Research methodology

- *Problem Identification:*

It needs to gather data of several types: fixed data, opinion surveys, experimental data, and personal observations.

- *Preliminary Ideas:*

It is the generation of as many ideas as possible. These ideas should be sufficiently broad to evolutionize existing methods. All thoughts should be recorded in written form with diagrams. A technical approach should be used to gather preliminary ideas for the design problem.

- *Design:*

Refinement several of the preliminary ideas are selected for further refinement to determine their true merits. Consideration is given to spatial relationships, angles between planes lengths of structural members, intersections of the surfaces and planes.

- *Analysis:*

In involves the evolution of the best design to determine the required merits of each part of the machine with respect to price, cost, and strength function and market appeal.

- *Decision:*

Decision of any design is taken after the different type of the analysis done with the design and its matching with the requirement in the industries. It is the final stage of the administration group before implementation of any design in the factory. So, it is the crucial stage of the administration how and up to which extant the design is to be implementing for the improvement.

- *Implementation:*

It is the presentation of the final design concept in a workable form, primarily as working drawings and specifications that are used as the actual for fabrication of a product.

III. LITERATURE REVIEW

Mr. K.Shravan Kumaret.al carried out a research on Design & fabrication of hydraulic press -IJSDR in their research they mainly focus on reducing operator fatigue and increase safety, improving the flexibility and makes operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, it compatibility with operation like machining, welding, finishing, cutting etc. and cost as economic factor.

Vivek Sharma.et. al carried out a research on Improvement in the design of the small manual press - ISSN in their research they relived that machine is capable to do work with some shear force by putting (diametrically opposite variable additional weights on the fly wheel we can obtain that desired energy levels to suit the maximum load required for manufacturing different types engineering parts. Of course it is understood that only limited variation in capacity is possible. If at all some bigger or odd components to be manufactured one can choose the next higher range of the fly press. It is very clear that for the given press reasonable flexibility is possible as far as the energy of the total load is concerned.

Oseni K Owolarafe. et al carried out a work on press machine & give conclusion that The comparative evaluation of the DSP system which is being developed and the conventional hydraulic press system undertaken in this study revealed that the DSP system has many comparatively favorable attributes and is to be preferred to the hydraulic system.

Abin Baburaj, K. B. et.al carried out a research on an Abrasive Wear Behavior of En31 Steel J stage journals Ni-C-Mo steels are widely used in machine part members, gears and shafts. Steels with higher carbon content (~1%) are used for heavy machine parts and bearings. Abrasive wear resistance is often a very important requirement for these high carbon steels, apart from sliding wear properties.

Karl-Erik Rydberg [S] carried out research on SAE 60 hydraulic oil the pressure media is the most important component in the hydraulic system because it takes care of the energy transfer in the whole system from pump to cylinder/ motor. Additionally hydraulic fluid has to provide lubrication and cooling. Especially in mobile applications it is of great importance to minimize the negative environmental influence from hydraulics.

Syed Mufeez Ahmed 16 carried out a research on Basic Components of Hydraulic Systems - IJETT journals A hydraulic system contains and confines a liquid in such a way that it uses the laws governing liquids to transmit power and do work. This paper describes some basic systems and discusses components of a hydraulic system that store and condition the fluid. The oil reservoir (sump or tank) usually

serves as a storehouse and a fluid conditioner. Filters remove harmful impurities that could clog passages and damage parts.

H.Ebertshauser provides information about the symbols used in hydraulic circuit. The circuit diagram of a fluid power system is a graphic display using symbols to denote individual components and to describe their functional sequence. He also explains how to read the symbols.

➢ *Present Works*

- *Designing*

Design consists of application of scientific principles, technical information, imagination for the development of new and improved machine and mechanism to perform specific function with maximum economy and accuracy. The following are the list of the design for head forming machine.

✓ Base
✓ Supporting block
✓ Cylinder holder
✓ Fuel pipe holders
✓ Tool holder
✓ Head form tool

✓ Base

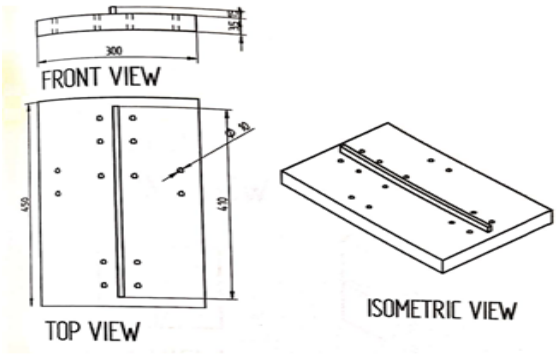

Fig 4 Base

The base the dimension length-450mm, breadth-300mm is fitted to the frame. The base is made up of mild steel. The base provides support to all the parts. It has to with stand all the loads. It has a slot which helps to fit all the parts correctly.

✓ Supporting block:

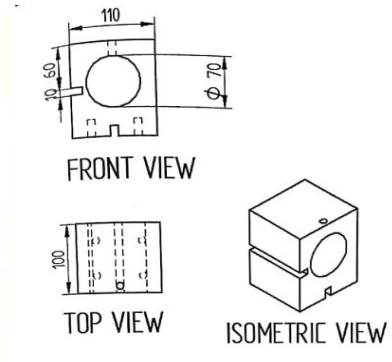

Fig 5 supporting block

The block has the dimension length=100mm and breadth=110mm. It is made up of mild steel. There are two blocks. The two blocks are placed at both the end of the base. It provide support to the tool holder and the fuel pipe

✓ Cylinder holder:

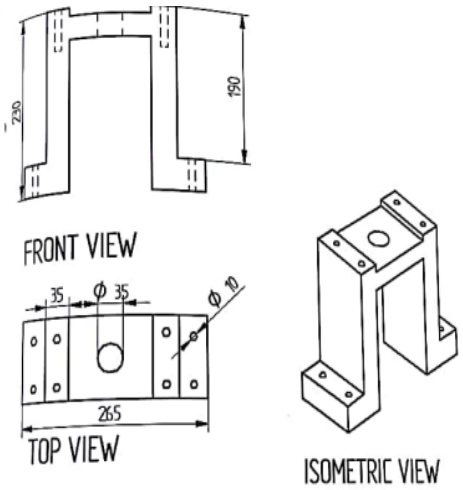

Fig 6 cylinder holder

Cylinder holder has a dimension length=230mm and breadth-265. It is made up of mild steel. It is used to hold double acting cylinder.

✓ Fuel pipe holders:

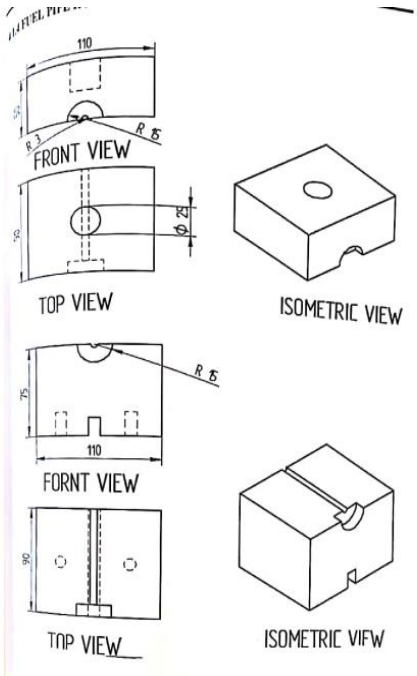

Fig 7 Fuel Holder Pump

Fuel pipe holder has a dimension length 90mm and breadth-110mm. It is made up of EN31 steel. It has a groove of diameter- 6 mm to hold the pipe rigidly. The usage is more frequent so in order to avoid wear EN31 steel is used.

✓ Tool holder:

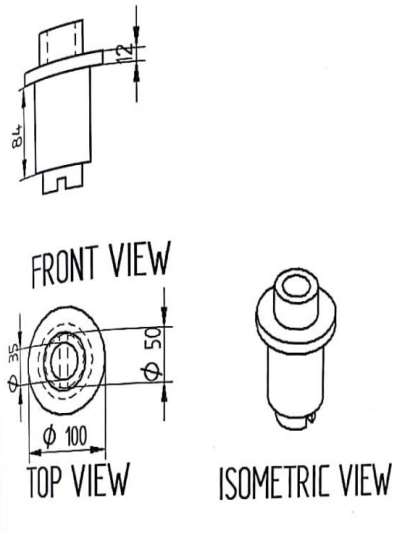

Fig 8 Tool Holder

The tool holder has a dimension length-100mm and breadth-50mm. It is made up of mild steel. It has a hole of diameter 32mm and depth of 30mm to fix the tool. The tool holder is supported by block.

✓ Head form tool:

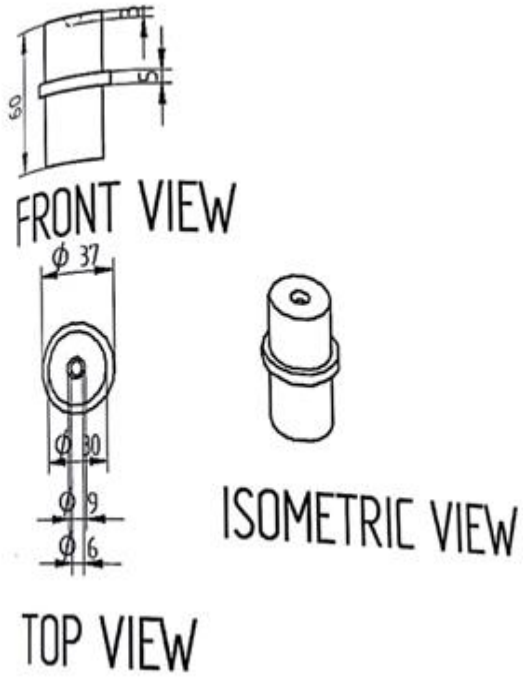

Fig 9 Head Form Tool

The head form toll has a dimension of length-60mm and breadth=30mm. It has a hole of 1mm diameter with 3mm depth. It is made up of EN31 steel. Tool is fitted into tool holder. It is driven by hydraulic cylinder and produces compressive stress on the fuel pipe ad causes bulging in the head part of the pipe. The usage is more frequent so in order to avoid wear EN31 steel is used.

➢ *Head Forming Machine (3D View)*

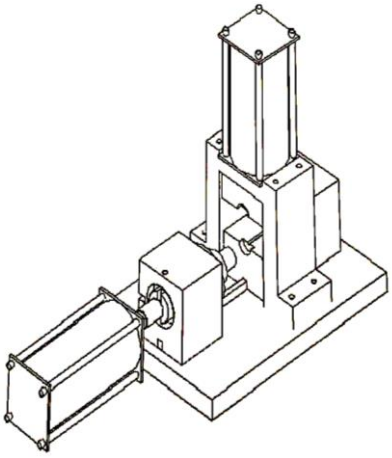

Fig 10 Head Forming Machine

Hydraulic head forming is a machine to produce compressive force by means of fluid. It depends upon Pascal's principle. Head forming work is a method involving the old working process. Head form working processes make use of large forces by head form tools for a short time interval which results in plastic deformation causes bulging in the head pat of the pipe. Head forming is extensively employed in many of the fuel pipe industries. tad form is done in order to prevent the leakage of the fuel.

➢ *Design Calculation*
- *Geared Pump*

✓ Data
Frame size = 25
Displacement = 1.58 in¾
Speed = 1440 pm
Volumetric efficiency = 70%
Pressure = 11 psi

✓ Theoretical pump out let flow
Pump Outlet Flow (gpm) = pump speed (rpm) x pump displacement (cu ins/rev) / 231
Pump Outlet Flow (gpm) = 1440 x 1.58/231
Pump Outlet Flow (gpm) = 9.84 gpm

✓ Actual pump out let flow
Pump Outlet Flow (gpm) = Theoretical pump out let flow x Volumetric efficiency
Pump Outlet Flow (gpm) = 9.84 x 70%
Pump Outlet Flow (gpm) = 6.89 gpm

✓ Pump Horsepower
Pump Horsepower (hp) - flow rate (spm) × pressure (Psi) / 1,714 x pump efficiency factor
Pump Horsepower (hp) = 9.84 x 11 /1714 x0.7
Pump Horsepower (hp) = 0.09 hp

✓ Pump Torque
pump Torque (in los) - pressure (psi) x pump displacement (cu insitev) / 628

Pump Torque (in Ibs) = 11 x 1.58 / 6.28
Pump Torque (in Ibs) = 2.767 Ibs

- Double acting cylinder

✓ Data
Bore = 2.36 inch
Rod size = 1.377 inch
Stroke = 3.93 inch
Pressure = 11 psi
Oil flow rate = 6.89 gpm

✓ Piston Cylinder Area
Piston Cylinder Area (in?) = diameter 3x0.7854
Piston Cylinder Area (in?) = 2.36? ×0.7854
Piston Cylinder Area (in?) = 4.374 in?

✓ Piston Rod End (annulus end) Area
Piston Rod End (annulus end) Area (in?) = piston cylinder area (in?) - rod area (in?)
Rod area (in?) = 1.3777 x 0.7845
Rod area (in?) = 1.487 in?
Piston Rod End (annulus end) Area (in?) = 4.374-1.487
Piston Rod End (annulus end) Area (in?) = 2.887 in

✓ Cylinder Force
cylinder Force (bs) = pressure (psi) x area (in?)
Cylinder Force (Ibs) = 11 x 2.887
Cylinder Force (lbs) = 31.757 Ibs

✓ Cylinder Speed
Cylinder Speed (ft/min) = 19.25 x flow rate (gpm) / area (in?)
Cylinder Speed (A/min) = 19.2 x 6.891 2.887
Cylinder Speed (ft/min) = 45.821 ft/min
Cylinder Speed (ft/sec) = 45.821/60 ft/sec
Cylinder Speed (ft/sec) = 0.763 ft/sec

✓ Cylinder Time
Cylinder Time (sec) = area (in?) × cylinder stroke (ins) × 0.26 / flow rate (gm)
Cylinder Time (sec) = 2.887 × 3.93 x 0.26 /6.89
Cylinder Time (sec) = 0.42 sec

✓ Cylinder Volume Capacity
Cylinder Volume Capacity (gals) = cylinder area (in?) x cylinder stroke (ins) / 231
Cylinder Volume Capacity (gals) = 2.887 × 3.93 / 231
Cylinder Volume Capacity (gals) = 0.049 gals

➢ *Specification of the components*

Table 1 Specification of the components

Sl no.	Components	Materials	Dimensions (Mm)
1.	Base	Mild steel	450x300
2.	Block	Mild steel	100x110
3.	Cylinder holder	Mild steel	230x265
4.	Fuel pipe holder	EN31 steel	90x110
5.	Tool holder	Mild steel	100x50
6.	Tool	EN31 steel	60x30

➢ *Components Of Head Forming Machine*

Head forming machine works on the principle of Pascal's principle. Here head forming tool produces compressive stress on the fuel pipe. It is a cold forming process. The movement of the mechanical devices can be operated by the mean of hydraulics. The following are the list of the component for head forming machine.

- AC Motor
- Geared pump
- Filter
- Double acting cylinder
- Solenoid valve
- Pressure-compensated flow control valves
- Pressure relief valve

- *AC Motor*

Fig 11 AC Motor

An AC motor is an electric motor driven by an alternating current (AC). It is electro mechanical device that convert electrical energy into mechanical energy. A motor is a prime mover that generates torque and speed of a rotating shaft. It provides mechanical energy to pump.

- *Geared pump:*

Fig 12 Geared Pump

In hydraulics, pump is a mechanical device which lifts the fluid from a place by means of suction and delivers it with pressure and velocity. This Pump is driven by Electrical Motor. Here we have used geared pump. This is the simplest of rotary positive displacement pumps. It consists of two meshed gears that rotate in a closely fitted casing. The tooth spaces trap fluid and force it around the outer periphery. The fluid does not travel back on the meshed part, because the

teeth mesh closely in the center. The hydraulic fluid is first drawn into the pump chamber by the moving gears. The moving part then contract the pumping chamber to build up pressure as the hydraulic fluid moves through and exits the pump. The high pressure hydraulic fluid that exits the pump is then used to do work.

- *Filter*:

Fig 13 Filter

The primary function of the filter is the retention by some porous medium of insoluble contamination from the fluid. "Porous medium" is simply refers to screening or filtering material that allows the fluid to flow through it but stops other material.

- *Double Acting Cylinder:*

Fig 14 double acting cylinder

A double-acting cylinder is a cylinder in which the working fluid acts alternately on both sides of the piston. A double-acting hydraulic cylinder has a port at each end, supplied with hydraulic fluid for both the retraction and extension of the piston. A double-acting cylinder is used where an external force is not available to retract the piston or it can be used where high force is required in both directions of travel.

- *Solenoid Valve:*

Solenoid valve is used wherever fluid flow has to be controlled automatically. There are three parts in solenoid valve.

➢ *Directional Control Valves (DCVs)*

Fig 15 Directional Control Valves (DCVs)

Directional Control Valves (DCVs) are one of the most fundamental parts of hydraulic systems. DCVs allow fluid flow (hydraulic oil, water or air) into different paths from one or more sources. DCVs will usually consist of a spool inside a cylinder which is mechanically or electrically actuated. The position of the spool restricts or permits flow, thus it controls the fluid flow.

➢ *Throttle and Modular Valves*

Fig 16 Throttle and Modular Valves

Throttle valve is the one of the simplest and widely used as a flow control valve, it is often equipped with pressure relief valve to control variety of throttle speed adjustment hydraulic circuit.

➢ *Relief Modular Valves*

Fig 17 Relief modular valves

Relief modular valves protect the hydraulic system from excessive pressure and can be used to maintain constant pressure in a hydraulic system.

➢ *Pressure-Compensated Flow Control Valves*

Fig 18 Pressure-Compensated Flow Control Valves

Pressure-compensated flow control valves are designed to control and maintain a constant irrespective of the pressure variations upstream and downstream of the regulation section. Pressure-compensated flow control valves are used with actuators that must move at a constant rate, regardless of pressure.

➢ *Pressure Relief Valve:*

Fig 19 Pressure Relief Valve

A relief valve or pressure relief valve (PRV) is a type of safety valve used to control or limit the pressure in a system; pressure might otherwise build up and create a process upset, instrument or equipment failure, or fire. The pressure is relieved by allowing the pressurized fluid to flow from an auxiliary passage out of the system.

IV. FLOW CONTROL CIRCUIT: BLEED OFF CIRCUIT

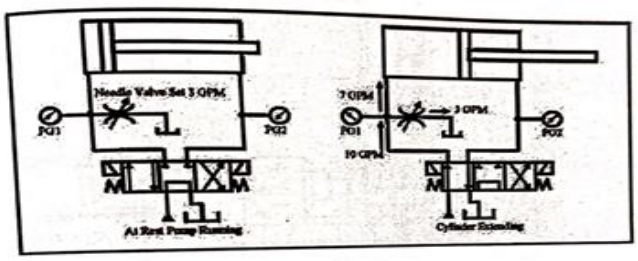

Fig 20 Bleed Off Circuit

A typical bleed-off circuit is not installed directly in a feed line. It is Td into this line with its outlet connected to a return line. A valve regulates flow to a cylinder by diverting an adjustable portion of a pump's flow to a tank. Since fluid delivered to a work cylinder does not have to pass through a flow-control valve, excess fluid does not have to be dumped through a relief valve. This type of circuit usually involves less heat generation because pressure on a pump equals the work resistance during a feed operation.

V. WORKING PROCESS OF HEAD FORMING MACHINE

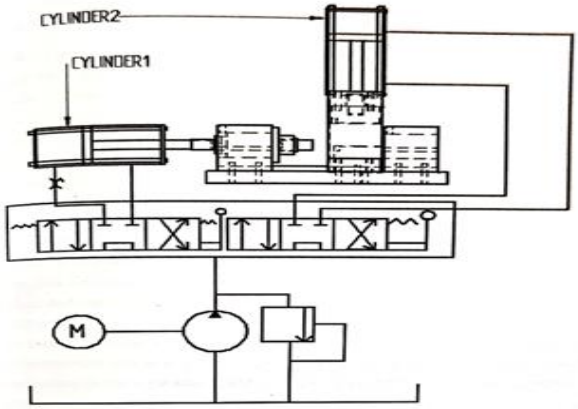

Fig 21 Circuit Diagram of Head Forming Machine

A hydraulic head-form is a machine that uses pressurized liquid to create a force.These machines are composed of a simple cylinder and piston mechanism. The head-form consists of two cylinders and piston. The two cylinders are connected to solenoid valve by the mean of pipes. The two cylinders and the pipes connecting them are filled with a liquid. The hydraulic head-form works on the Pascal's principle. Pump lifts the fluid from a reservoir by means of suction and delivers it with pressure and velocity. The pump is fitted by a filter and driven by an Electrical Motor. The pressurized oil flows towards the solenoid. It consists of three parts- relief valve, throttle valve and directional control valve. The relief valve is used to maintain the constant pressure in the hydraulic system. The Throttle and modular valve is used to restrict the flow to one direction. The directional control valve is used to change the path of the fluid. After entering solenoid the valve make use of the electro mechanical solenoids for sliding of the spool by using electric power these valves can be controlled. The directional control valve solenoid has a four-way three-position directional control valve. Which means one way for pump (P), one for reservoir (R) or tank (I) and two for the inlet to the actuator And it has 3 positions: one normal, one cross way, and one straight way. The solenoid! is connected to cylinder1 and solenoid2 is connected to cylinder. When the flow of the fluid is from the solenoid1 from the position1 the fluid enters to the cap end part of the cylinder and leaves out from the rod end part of the cylinder, the extension of the piston in the cylinder takes place and when the flow is from the position3 the fluid enters rod end of the cylinder and leaves out from cap end of the cylinder, retraction of the piston takes place. Cylinder1 is fitted with the tool when it extends it creates compressive force on the fuel pipe. Similarly when the flow takes place in solenoid2 in the position1 extension of the piston in the cylinder takes place and when the fluid flows through the position3 retraction of the piston takes place cylinder2 is fitted with pipe holder. When piston extends it holds the fuel pipe and when it retraces back it releases the pipe. To maintain the pressure and to adjust the speed of the piston Pressure-compensated

flow control valves is used. Bleed off circuit is used for the pressure control in the hydraulic system. The pressure relief valve is used to remove excess of pressure.

VI. CONCLUSION

The project was carried out in the company St Sachidananda industry Mysore. After going through a detailed procedure of designing, fabrication we came to conclusion that By implementing this fuel injection pipe head forming machine the work load on laborers is reduced and their job is made easy.

- By implementing this fuel injection pipe head forming machine the work set up time reduces.
- Designing of fuel injection pipe head forming machine can effectively used for production with reduced production time, production cost, increased product accuracy and laborers work becomes more convenient.
- Hence we can say that the project aim for reducing the production time along with increase in the accuracy has been successfully achieved.

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BIOGRAPHIES

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