A Review on Design of Hydraulic Fixture for Engine Side Cover

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***Abstract*--- These instructions give you basic guidelines for preparing papers for conference proceedings. Fixture is a work-holding device used in the manufacturing industry. Fixture's primary purpose is to create a secure mounting point for a work piece, allowing for support during operation and increased accuracy, precision, reliability, and interchangeability in the finished parts. This paper present design of hydraulic fixture for engine side. This component is a part of three wheeler auto. The operation to be performed is & finishes milling of flange, drilling, reaming & spot facing on VMC. The evaluated fixture uses hydraulic swing clamp, hydraulic cylinders, and hydraulic work support for holding the work piece driven by hydraulic power pack. Thus the new fixture achieves automatic and simultaneous clamping of parts.**

Keywords- Fixture, accuracy, clamping, productivity, VMC .

I. INTRODUCTION

Over the past century, manufacturing has made considerable progress. New machine tools, high-performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. Although work holding methods have also advanced considerably, the basic principles of clamping and locating are still the same. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Fixtures are specially designed so that large numbers of components can be machined identically, and to ensure interchangeability of components. A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. It is a production tool that locates, holds, and supports the work securely so the required machining operations can be performed. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing operation. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually. Jigs are similar to fixtures, but they not only locate and hold the part but also guide the cutting tools in drilling and boring operations. A fixture should be securely fastened to the table of the machine upon which the work is done. Though largely used on milling machines, fixtures are also designed to hold work for various operations on most of the standard machine tools. Fixtures vary in design from relatively simple tools to expensive, complicated devices. Fixtures also help to simplify metalworking operations performed on special equipment.

II. LITERATURE REVIEW

Komal Barge, smiita Bhise et. al. [2015] has discussed about the VMC Hydraulic fixture design and It gives an economically feasible design. Also ensures accurate & efficient clamping of parts. The suggested system helps in achieving sophisticated, precise, reliable, safe as well as accurate production methods. The clamping systems are designed such that they withstand the huge retention forces applied from the machining operations onto the work piece.

Shailesh S. Pachbhai et. al., [2014] focuses on the advantages of Hydraulic Fixture. They also offer a solution of hydraulic fixture, which reduces workpiece distortion due to clamping and machining forces.

Sridharakeshava K. B. et. al., [2013] has discussed about the General Requirements of a Fixture which includes constraints of Deterministic location, contained deflection, geometric constraint in order to maintain the work piece stability during a machining process. They also discussed three broad stages of fixture design, Stage one deals with information gathering and analysis, Stage two involves product analysis, and Stage three involves design of fixture elements.

Satyapal Vaghela, Abhishek Singh et al. [2014] Hydraulic fixtures provide constant clamping force, reduce operation time, increase productivity, give high quality of operation, and reduce accidents. So, it is used for machining process of Rear Cover.

M. Vishala et. al., [2014] discussed about bunch or numerous weld fixtures together work in an automated industry in providing the better gripping as well as the location of the part.

Navya K.R. et. al., [2014] has discussed about basic concept of hydraulic circuit, hydraulic circuit designing. They suggested system which helps in achieving sophisticated, precise, reliable, safe as well as accurate production methods.

S.D.V.V.S.B.Reddy et. al. [2013] has discussed about data required to design fixture, hydraulic fixture elements for transmission case, cutting force calculation and analysis of fixture body to check whether the fixture is withstanding the maximum cutting force during machining.

Vektec, hydraulic clamping information describes Hydraulic

Systems & Circuits which includes Power Supplies, Valves, System Types, Accumulators, Orifices, Filtration, Flow Requirements, Line Sizing, Circuit Design; General Description, information & Application Recommendations of Work Supports, Swing Clamps, Cylinders & Position Sensing.

III. COMPONENT DETAILS

The component is engine side cover made up of ALSI-132 is one of the components of engine. It is mounted on cylinder head of I.C.engine. The component is made by sand casting process. Operations to be performed on are rough & finish milling of flange, drilling of 6 holes, boaring of 2 holes & spot facing on VMC.

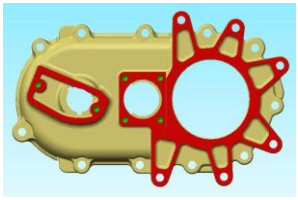

Fig- Front side view

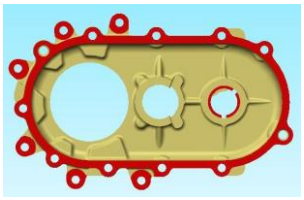

Fig-Rear side view

IV. DESIGN OF HYDRAULIC FIXTURE

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Locating Principles- To perform properly, work holders must accurately and consistently position the work piece relative to the cutting tool, part after part. To accomplish this, the locators must ensure that the work piece is properly referenced and the process is repeatable.

3-2-1 principle: the twelve degrees of freedom all relate to the central axes of the work piece. Notice the six axial degrees of freedom and six radial degrees of freedom. The axial degrees of freedom permit straight-line movement in both directions along the three principal axes, shown as x, y, and z. The radial degrees of freedom permit rotational movement, in both clockwise and counterclockwise radial directions, around the same three axes.

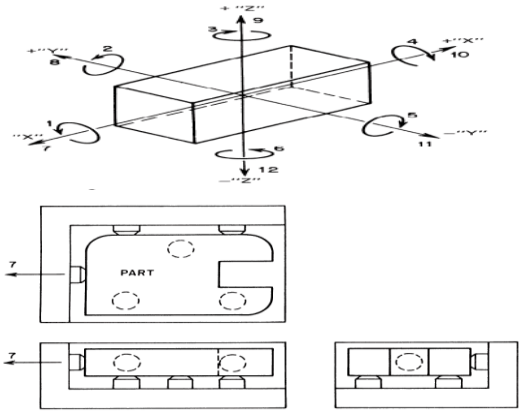


Fig- 3-2-1 Principle

1) Design Principles for clamping-

a) Clamping pressure applied against the work piece must counter act the tool forces.
b) Clamping pressure should not be directed towards the cutting operation.
c) Clamping pressure must only hold the work piece and should never be large enough so as to damage, deform or change any dimensions of the work piece.
d) Clamping and cutting forces should be directed towards the locating pins, otherwise the work piece get bent or first away from the locating pins during machining.
e) Clamping should be simple quick, and fool proof.
f) The movement of the clamp should be strictly limited and if possible it should be positively guided.
g) Whenever possible the lifting of the clamp by hand should be avoided if it can be done by means of spring fitted to it.
h) Clamp should never be never be relied upon for holding the work piece against the work piece.
i) They should always be arranged directly above the points supporting the work piece otherwise distortion of the work piece occurs.
j) Clamp should be design to deliver required clamping force when operated by the smallest force expected.
k) Clamp should strong enough to withstand the reaction imposed upon it when the largest expected operating force is applied.

2) Design Guidelines for location system-

a) At least one datum/reference should be established at first opportunity from which subsequent machining will be measured.
b) For easy of cleaning, location surfaces should be as small as possible consistent with adequate wearing qualities. Location from machining surface.
c) Location surfaces should not hold swarf and thereby misalign the work piece for this proper relief should be provided.
d) Locating surface should be raised above surrounding surfaces of the fixture so that chip falls or can be swept off readily.

e) Sharp corners in the location surfaces must be avoided.
f) Adjustable type of locators should be used for the location of rough surfaces.
g) Work piece should be supported properly in order to avoid distortion.

V. FIXTURE ELEMENTS

A. Base plate: (M.S; Qty-1)

It is made by mild steel. Structure of base plate is rectangular type having size 30 X 400 X 800 mm. It is rigid and can withstand high vibrations. This base plate is machined on VMC milling machine. Front face will accommodate rest pads, locating V blocks, work supports and clamp cylinders. The bottom faces rest on the bed.

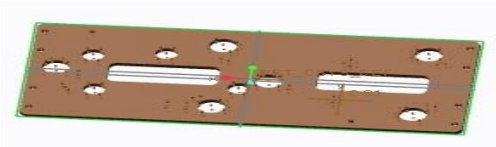


Fig- Base plate

B. Locating Elements

V Block (M.S; Qty-02): V-Blocks are precision metal working jigs typically used to hold round metal. The v block should be used correctly so that the variations in the work piece size are not detrimental to location. Vee can be used both locating and clamping a work piece .It is made from Mild Steel. Angle between two slides of Vee is 90º. This is quick and effective method of locating the work piece with desired level of accuracy.

C. Side butting

Side butting is a fix arrangement where a product will touch to a butting point. Side butting used exactly opposite to pusher to restrict movement.

Fig- V Block

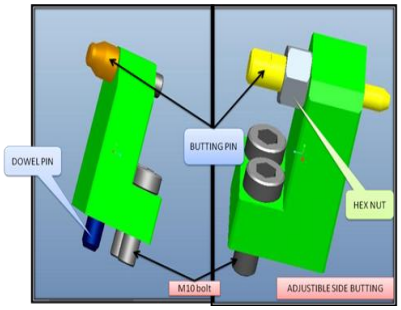


Fig- Side butting

D. Hydraulic Elements:

Hydraulic Coupling Unit: Hydraulic coupling units are used whenever the fixture is separated from the pressure generator. This fully equipped coupling unit has been developed for manual coupling and uncoupling for the purpose of clamping and unclamping. This unit includes two quick disconnect coupling (QDC) to connect / disconnect 'hydraulic power unit', pilot operated check valve to hold pressure in clamping line, accumulator to compensate leakage in clamp line.

Hydraulic Cylinder- Cylinders are linear actuation devices that are typically used to keep a work piece stationary or move work piece into position. They provide axial clamping force proportional to the hydraulic pressure applied. Its Operating pressure is 10-70 bar. Many sizes of cylinder are available in multiple body styles to allow for maximum flexibility in fixture design.

Hydraulic work support-Work supports are supplementary support devices to be used in conjunction with rigid support and / or locating points in a fixture. They also supports reduce the effects of vibration and deflection, helping to maintain work-piece accuracy during machining operations. Work supports use a hydraulically compressed sleeve to lock the plunger in place once it has engaged the work-piece. On the Fluid Advance and Spring Advance work supports, the spring force on the plunger determines the contact force on the work-piece. This type of work support uses an internal spring to advance the plunger to contact the work-piece. The spring keeps the plunger extended when the work support is not loaded. As spring force is always present on the plunger the work-piece could move when hydraulic pressure is removed. The plunger is locked in place by applying hydraulic pressure to the internal compression sleeve thru a separate hydraulic port after the work-piece compresses the plunger.

Fig (a) *Hydraulic Coupling Unit.*

Fig (b) *Hydraulic Cylinder*

Fig (c) *Hydraulic work support*

E. Resting Elements:

a) Resting pad- The resting surface must have a diameter of Ø3-6 mm.
b) Resting button- The material used for these pins is 20mncr5 having a casehardening of 58-60HRC

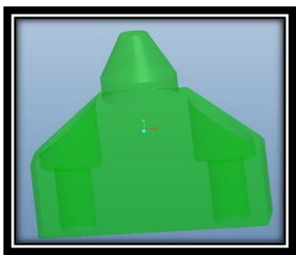


Fig- Resting pad

Fig- Rest button

F. Clamping Elements:

Component shall be clamp above the resting face. Clamping face should have sufficient wall thickness. Four hydraulic clamp cylinders are used to clamp front side of engine side cover in which four swing clamps are used to clamp middle part of the side cover as shown in fig. These three clamps are toughened with 30 to 35 RC. Material used for clamp lever is En8 and cylinder mounting block is mild steel. The cylinders

are double acting and works on 30-70 bar pressure. The Hydraulic connections are given by internal holes in the frame and standard hydraulic fittings. Clamp lever with swivel pad is fitted to this hydraulic cylinder. The job gets clamped in the piston push direction. The clamping strap is connected to the piston by a linkage mechanism.

Fig- Clamp

Fig- Clamp

VI. HYDRAULIC CIRCUIT

A hydraulic circuit is a system comprising an interconnected set of discrete components that transport liquid. The purpose of this system may be to control where fluid flows or to control fluid pressure. This power is used to achieve a specific function resulting in work being performed. It consists of following component Hydraulic power pack transmission lines, hydraulic hoses and hydraulic cylinders.
Before the hydraulic circuit can be designed, the following things must be defined,

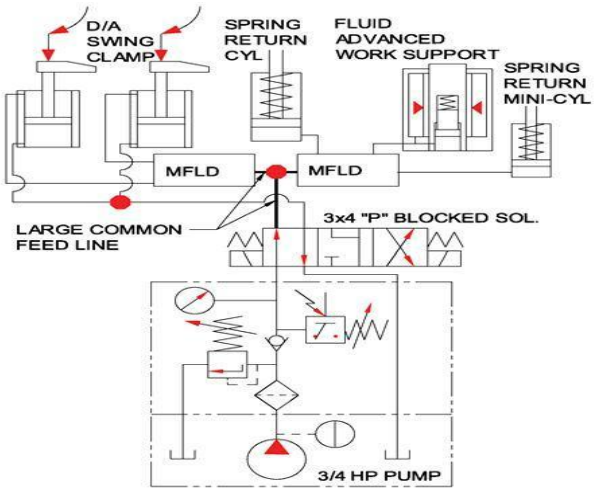


Fig- Sample Circuits

VII. CLAMPING FORCE CALCULATION

Hydraulic Fixture:

Clamping pressure = Clamping Force / clamping area.

Diameter of cylinder bore = 32mm = 3.2 cm

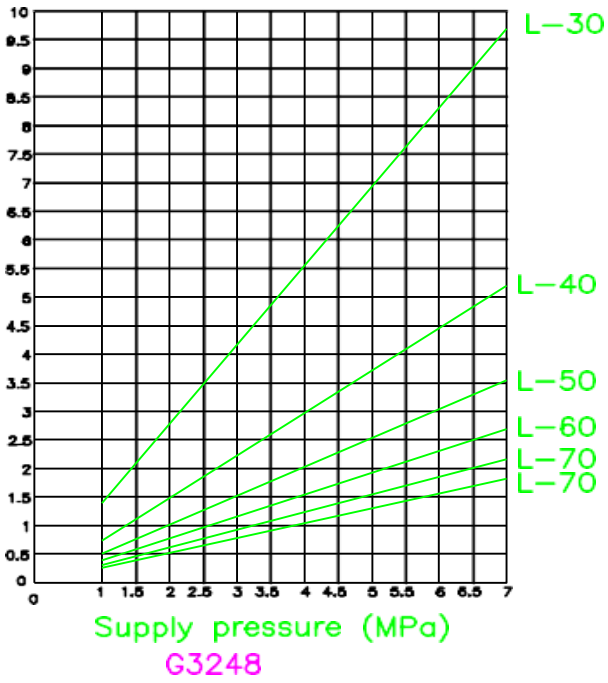
Area of cylinder = 0.785 d^2 = 0.785 x (Piston dia.)^2 = 0.785 x 3.2^2 = 8.0384 cm^2

Cylinder Force = Oil pressure x Plunger effective area x 9.81 Pressure generated in clamping line is 120 bar

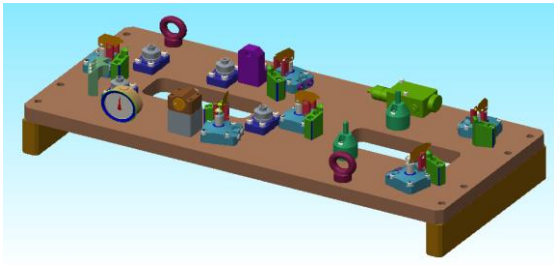
Cylinder bore size = 32 mm = 3.2 cm

CALCULATION TABLE

Model No	G3248
Cylinder bore diameter	32
Locking cylinder area (cm^2)	8.03
Clamping force calculation formula (KN)	$F=\frac{15.96XP}{L-18.5}$
Full stroke (MM)	23.8
Lock stroke (MM)	20.6
Stroke allowance (MM)	3.2
Cylinder capacity at locked	19.13
Cylinder capacity at released	15.93
Maximum operating pressure (MPA)	7
Minimum operating pressure (MPA)	1
Maximum rated pressure (MPA)	10.5
Use pressure (˚C)	70
Weight (KG)	2.7



VIII. HYDRAULIC FIXTURE ASSEMBLY



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