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Design and Fabrication of Semi-Automatic Simultaneous Jolt Squeeze Machine

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Abstract:- *The improvement in productivity and quality is largely dependent on optimizing new techniques. In conventional foundry process, different operations were required to be performed by different methods which increased the time and reduced productivity. The main purpose of the paper is to develop a circuit for special moulding machine for squeezing and jolting with a wide range of pressure acceptance. Jolt Pressure of 8000kg to 11340kg can be attained.*

Keywords *– Jolting, Squeezing, Productivity, Optimization.*

I. INTRODUCTION

In foundry the casting is manufacturing, the hot metal is poured into the cavity formed by the use of sand. The cavity is developed according to the shape desired. For proper formation of the cavity, the squeezing and jolting operation is done. In this operation, the sand is filled into the cope and drag, and the compaction is done. Earlier the pressing operation was done by hand, now the machines are used for obtaining high pressure. The main aim is that silica sand should retain the shape until the casting solidifies so the pressure applied during squeezing should be adequate.
There are 2 operations performed

1. Jolting - in this process the sand is filled by sand slinger machine in the cope and drag .the sand along with core is pressed in order to properly fill the sand with no air cavities and sand particles get tightly packed with each other. The mould box is placed on a table and a plate is provided on the top to compact the sand. During this operation, the extra sand is removed from the cope and drag surface.
2. Squeezing- in this process the squeezing is done so that the sand particles get packed tightly above and around the pattern. In this process, the cope and drag are placed on a table which is above a piston and cylinder arrangement. They are raised and lowered to obtain squeezing force. The process is performed continuous and fast. The range is 3-7 strokes/sec. The number of 'squeeze' may vary depending on the size and hardness of the mould required. Usually, less than 20 squeeze are sufficient for a good moulding.

The above processes require high pressure to perform the operation. Both the process can be combined in one machine in order to improve productivity and reduce cost.

II. COMPONENT OF SQUEEZE JOLTING MACHINE

The system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

1. Hydro pneumatic cylinder- It is the most important part of moulding machine. The transmission and conversion of hydraulic energy into mechanical energy is done by this cylinder.
2. Oil tank- It is a container for storage of oil. Its capacity is of 10 liters. It has an inlet port and outlet port. The oil used is HP-Enclo 53 Indian Oil Servo System 57.
3. Lift cylinder hanging bracket- It is used to support the cylinder in a vertical way. It is enclosed by pin on both sides.
4. Spring- Due to elasticity property of spring it is basically used for squeezing operation. It is mounted below the jolt piston and above the jolt cylinder.
5. Piston- Its basic function is used to transform hydraulic energy into mechanical energy. It is made from steel and nickel chrome plating. A tolerance is provided to safeguard and increase the efficiency of the machine.
6. Jolt guide bar- Its function is to guide the table in vertical manner. It has a bushing support for achieving the vertical degree. These are provided on both the sides of the table.
7. Table- It is the mainframe of the machine. The box is placed on the table for performing the operations. The table is attached to the piston by using fasteners.
8. Main hydraulic valve- To control the flow of hydraulic oil, main valve is used. It performs 2 functions- flow of oil and stopping of oil. It consists of parts like spring, spool and cover.
9. Jolt valve- Its function to provide oil for jolting operation in jolt cylinder it consist of spring, spool and top cover
10. Squeeze valve-Its function to provide oil for squeezing operation in jolt cylinder it consist of spring, spool and top cover.
11. Polyurethane calibrated 98 shore pipes- It is a transporting medium for oil. The oil is carried out through pipes. The material is generally polyurethane calibrated 98 shore.

12. Shaft supporter- Its function is to support and guide the lifting shaft. It has a cylindrical hole and 4 holes for the screw placement
13. 3/2 DC Valve- the direction control valve is used to actuate the main valve for operation and pin lift.
14. Swing arm– The squeezing of pattern is supported by the upper part of swing arm. It is operated manually. The plate is attached on the swing arm.
15. Lift long bracket- The function of lift long bracket is to oscillate the downward force of cylinder into upward motion of lift pins.
16. Quadrant and lifting pin – The box is lifted through the pins. The box is moved in upward direction. 2 lift pins are used on both side.
    Compressor- It supplies pressurized air of 10 bar pressure. The air in the machine is supplied by the compressor. It is a double acting cylinder with intercooler placed in it.

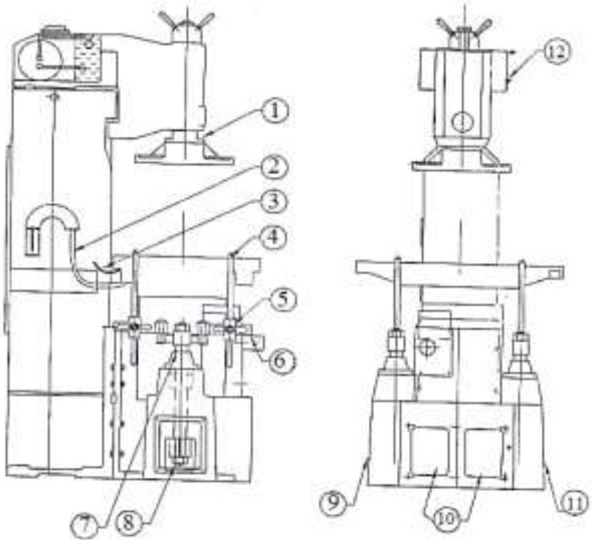

Fig -1: Moulding machine (side and Front view)

Designation	Name
1	Swing Arm
2	Polyurethane calibrated 98 shore pipes
3	Table
4	Quadrant and lifting pin
5	Lift long bracket
6	Hydraulic cylinder
7	Shaft supporter
8	Squeezing and jolting shaft
9	Left lift pin supporter frame
10	Jolted Sand exit space
11	Right lift pin arm supporter
12	Swing arm frame

Table -1: Part name of moulding machine

III. GAPS IN THE REVIEW

1. After our initial survey, I found that most of the small-scale industries are using the traditional way (hand ramming) to squeeze the sand.
2. Due to the hand ramming it requires a lot of effort, more time for performing the operation, high squeezing pressure cannot be obtained, non-uniformity in the performing the operation by hand and its more tedious work.
3.

IV. OBJECTIVE

Structural optimization tools have gained the paramount importance in industrial applications as a result of innovative designs, reduced weight and cost-effective products. Especially, in this paper, casting industries require minimum machining of casting in order to save cost. Sand stiffness should in required range so that the sand does not fall when metal is poured. In this project, topology optimization has been applied to various components of jolting squeeze machine.

V. WORKING PRINCIPLE

The jolting and squeezing machine works on the principle of Pascal's law which states that: "when fluid is at rest (static, the intensity of pressure in a closed system remains same in all directions." Hydraulic system uses pressurized oil which is circulated through various components of the hydraulic system to perform the task. The various components of the hydraulic system have to perform its intended function and they are arranged to form a layout of the system as per sequence of operation of the hydraulic system.

VI. Design procedure

To find out the maximum force that can be attained in the machine. The hydraulic cylinder has been used

- The compaction force has been assumed to be 10 kN/cm^2
- The air pressure is 10 bar through compressor
- The squeeze head diameter = 65 cm. Double acting cylinder is used.

According to the above information the diameter of the cylinder bore has been calculated as 10 cm. The struck has been calculated to be 10 cm.

Two squeeze heads are designed with 10 mm thickness. One is used for the flask which contains the pattern and the runners. Second head is flat with two holes for the sprue and riser is used for the second.

F_D= Total force on the flask (N)
F_B= The force which acting on cylinder piston (N)
P = Inlet pressure from the compressor (10 bar)
P_P = Estimated pressure (10 N/cm^2)
A_P= Flask area (cm^2)
A_B = Piston area (cm^2)
d_B = Piston diameter (cm)
$F_D = F_B x P$
$P = 10 \text{ bar} = 10 \ N/cm^2$
$F_D = F_d = A_P \text{ x } P_P$
$F_D = F_d = [\pi\ (65)^2/4] \text{ x}10 = 33183.07 \ N/cm^2$
$F_D = A_B x\ p \Rightarrow A_B = 33183.07/100 = 331.830 \ cm^2$
$A_B = 331.830 = 350 = (\pi/4)(d_B)^2 \Rightarrow d_B = 21.11 \text{ cm}$

The calculated diameter of piston is safe to utilize the working load.

VII. Working of Hydraulic Circuit

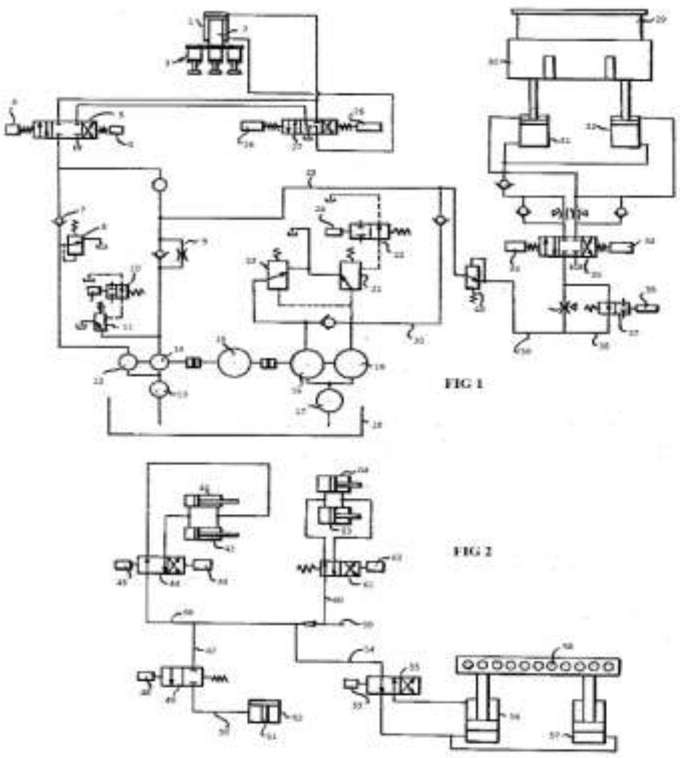

Fig -2: Circuit Diagram of Moulding Machine

Designation	Name
1,3,31,32,41,42,52,56,57,63,64	Double acting Cylinder
18	Oil tank
2,51	Piston rod
4,6,24,26,28,33,34,36,43,45,48,53,62	Push button actuator
5,27,35	5 by 3 DC Valve
7	Non return valve
9	Flow control with check valve
8	Pressure relief valve
10	Sequence valve
12,13,14,16,17,19	Hydraulic pump
15	Hydraulic motor
22	Drain line
29	table
30	Dead weight supporter
37,44,61	2 by 2 dc valve
49	1 by 2 dc valve
58	Table
20,25,38,39,46,47,50,54,60	Working line

Table -2: Parts used in circuit diagram

The oil used in the machine is HP-Enclo 53 Indian Oil Servo System 57 because of 16.8 CST at 50 dc. The oil is stored in the tank the oil is pumped in the system with high pressure through hydraulic pump. The pump is run by motor. The box is kept on the table. The first task is jolting of sand which is shown in the Fig 1. The oil is passed through hose pipes. The pressure relief valve is used in order to obtain the required pressure. After the pressure relief valve the oil is passed to 5 by 3 DC valve with push button actuator. When the actuator is pushed the oil flow to the cylinder causing the piston to actuate the stroke resulting in jolting. Below the table there are 2 cylinder placed, when the valve is actuated the piston moved in upward direction causing lifting of the table. The purpose of this circuit is to obtain a vertical movement of the table.

In Fig 2, the circuit is of squeezing operation. After the jolting is done the jolting valve is closed and squeezing valve is actuated. 2 by 2 DC valve with push button actuation are used. When the valve is actuated the oil moves to 4 cylinders. After the cylinder piston is moved the oil of piston end pressurizes the table cylinder and then actuates the stroke. During the return stroke the spring is compressed. Again after actuation the spring expands resulting in development of high speed actuation. The to and fro movement of table is fast and continuous till the valve is actuated. The purpose of this circuit is to obtain a continuous vertical movement of the table.

VIII. WORKING OF HYDRAULIC CYLINDER

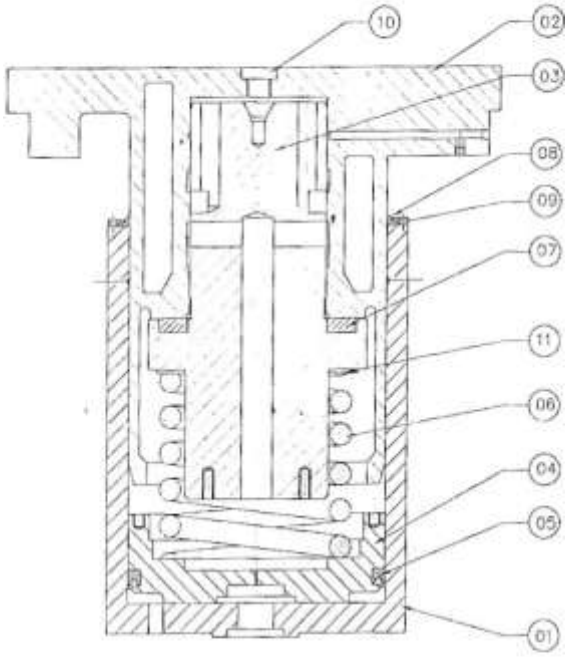

Fig -3: Cylinder Assembly

Designation	Component name
01	Anvil
02	Jolting Table
03	Jolting Piston
04	Squeeze Plunger
05	Squeeze Plunger Seal
06	Compression Spring
07	Impact Ring
08	Table Scrapper Ring
09	Table Scrapper Ring Holder
10	Centre Dummy
11	Spring Spacer Ring

Table -3: Parts in cylinder assembly

The anvil is placed in the cylinder hub in order to hold the cylinder. The mould box is placed on the jolting table's centre dummy. The pressurized oil is supplied from bottom port. Due to pressurized oil, the spring is compressed resulting in movement of the piston. For squeezing operation continuous low-pressure oil is passed in the cylinder. For jolting operation fluctuating high-pressure oil is passed, due to high pressure fluctuating of spring occurs resulting in fluctuation of piston and table. The fluctuation range can be varied from 3-10 jolts/ sec. by controlling the pressure. The conversion of jolting force is converted by the jolting piston. The impact ring is used to sustain the squeezing and jolting strokes impact during the return stroke.

The scrapper ring is used to prevent leakage of oil from the cylinder.

IX. MACHINE DRAFTING

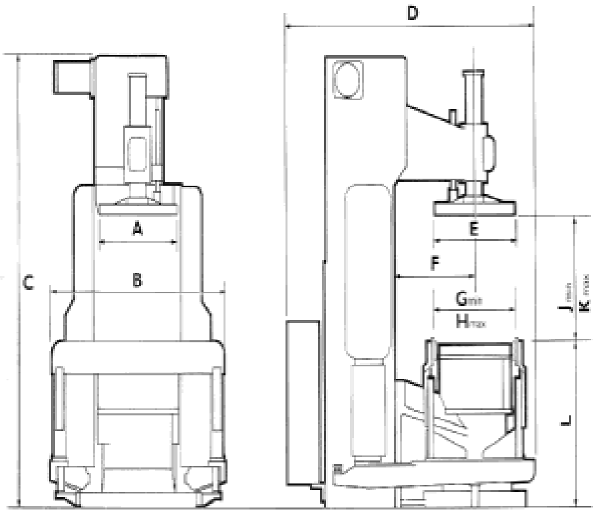

Fig -4: Moulding machine dimensions

ITEM	DIMENSIONS
A	762 mm
B	1105 mm
C	2159 mm
D	1899 mm
E	533 mm
F	546 mm
G	660 mm
H	956 mm
J	419 mm
K	686 mm
L	813 mm

Table -4: Dimensions of moulding machine

1. Jolt capacity and static squeeze pressure calculated at 90 PSI.
2. Static squeeze pressure increase by approximately 100% during simultaneous jolt squeezes.

X. CONCLUSIONS

1. The sand with high strength can be obtained with this machine.
2. The maneuverability of the device is quite good and simple to use.
3. The jolting, squeezing and pin lift operations are carried out on a single machine which helps to reduce the transfer time if performed individually.
4. Optimization design is compared to the actual part design that is being manufactured for the scrap baling press and hydraulic press.
5. It is inferred that under the same loading conditions, constraints and intended design purposes, shape optimization results in better and more reliable design.
6. The cost is comparatively low than the machine performing the individual task.

XI. ACKNOWLEDGEMENT

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