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DESIGN, CONSTRUCTION AND WORKING OF A VARIABLE FLOW RADIAL PISTON PUMP USING VARIABLE DISPLACEMENT LINKAGES

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ABSTRACT:* *The study of this paper deals with discharge pumps. A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. In hydraulic power systems, variable displacement pumps save power, increase the productivity or control the motion of a load precisely, safely and in an economical manner. The displacement varying mechanism and power to weight ratio of variable displacement piston pump makes them most suitable for control of high power levels. Positive Displacement Pumps are "constant flow machines" The bent axis piston pump can perform this work precisely but it is economically costlier. Thus objective of research is defined to develop a variable displacement linkage that will enable to vary the stroke of a two cylinder radial piston pump, thereby offering to vary the discharge of the pump using manual control and perform the same work as bent axis piston pump in an economical way.

Keywords – piston pump, positive displacement pump, discharge pump.

INTRODUCTION:

A pump is a device that moves fluids liquids or gases, or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In hydraulic power systems, variable displacement pumps save power, increase the productivity or control the motion of a load precisely, safely and in an economical manner .The displacement varying mechanism and power to weight ratio of variable displacement piston pump makes them most suitable for control of high power levels. The bent axis piston pump is preferred in most hydraulic power systems because of its high performance and efficiency. It is also capable of operating at variable conditions of flow, pressure, speed and torque. Axial piston pumps with constant pressure and variable flow have extraordinary possibilities for controlling the flow by change of pressure. Owing to pressure feedback, volumetric control of the pump provides a wide application of these pumps in complex hydraulic systems, particularly in aeronautics and space engineering. The major obstacle in application of the bent axis piston pump is extremely high cost over that of the radial piston pump, it ranges in the range of 5 to 6 times the cost of radial piston pump (2). Hence there is a need to develop a modification in the radial piston pump design that will offer a variable discharge configuration in addition to the advantages of high efficiency and maximum pressure. Thus objective of project is defined to develop a variable displacement linkage that will enable to vary the stroke of an two cylinder radial piston pump, thereby offering to vary the discharge of the pump using manual control.

PRINCIPLE OF OPERATION

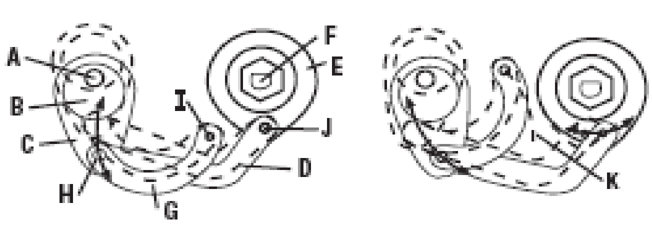

Figure 1 Figure 2

Externally, the variable displacement linkage consists of a rugged case, an input shaft, output shaft and displacement control. Angular displacement of the output shaft is regulated precisely and easily through a control lever which includes a convenient locking mechanism or a screw control to hold angular displacement at a desired setting. Looking at Figure 1, the input section , consisting of a shaft (A), eccentrics(B), and connecting rods(C), converts rotary motion into linear motion. At the zero setting, the main links (D) pivot on points (H) and (J) without moving the clutches. At any setting other than zero, the clutches (E) transfer the linear motion back into rotary motion and drive the output shaft (F). A control link (G) swings through arc (K) when the control lever is moved. At any point along arc (K) a different output angular displacement is produced because the direction of throw of the connecting rod is altered from vertical (Figure 1 zero degree position) toward horizontal (Figure 2 maximum degree position), varying the length of the strokes and thereby the angular displacement of the output-shaft.

CONSTRUCTION

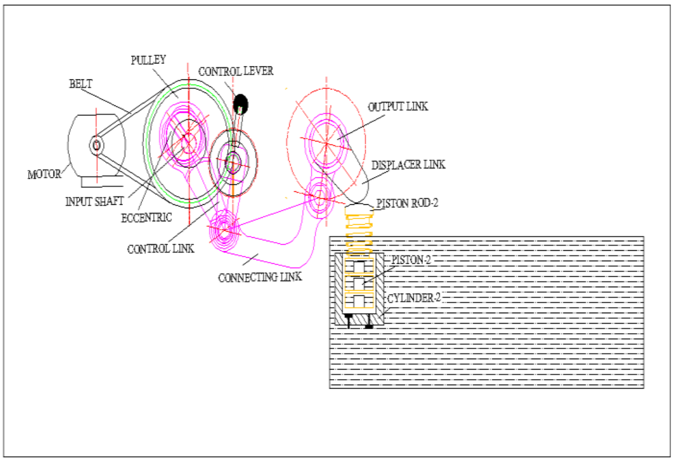

Fig. 3 : Layout of the VDLP.

ELECTRIC MOTOR **of the** specifications - SINGLE PHASE AC MOTOR 230 volt, 50 Hz , 0.5 amp Power = 50 watt. (1/15 Hp) Speed = 0 to 9000 TEFC CONSTRUCTION, COMMUTATOR MOTOR. , REDUCTION PULLEY, INPUT SHAFT high grade steel (EN 24), CONNECTING ROD, CONNECTING LINK , CONTROL LINK, OUTPUT YOKE , UNIDIRECTIONAL CLUTCH , SPEED CHANGING MECHANISM**and** CASING.

WORKING

The speeds are instantly changed by turning the handle indicated by 'G' . On the drive shaft A is mounted a series of eccentrics B. These eccentrics are connected to connecting links C by connecting rod D. As the drive shaft rotates , the eccentrics impart an oscillating movement to the left hand ends of the connecting links 'C' and as these are pivoted to the output yoke E they impart oscillatory movement to the roller clutches within yokes 'E' .Each reciprocating movement of clutch will cause the drive shaft to rotate a fraction of a revolution , and as the eccentrics are spaced uniformly about the drive shaft , the impulse given to the driven shaft will be successive and over lapping .In this way a uniform rotary movement of the driven shaft is obtained .The oscillating movement of the right hand end of the link C determines the amount the driven shaft turns during each impulse, and this oscillating movement depends upon the position of joint M along the path determined by the control link end when the control shaft is rotated about hinge K by handle G. For example if joint M is moved towards the right by which reciprocating movement of clutch will be shorter , and a longer time will be required to rotate the driven shaft thereby reducing the speed of the output shaft. Obviously an entire range of speeds is covered smoothly, enabling the mechanism to glide from one speed to another. The system design comprises of development of the mechanism so that the given concept can perform the desired operation. The mechanism is basically an inversion of four bar kinematic linkage, hence the mechanism is suitably designed using Grashoff's law and the final outcome is shown in the figure 1 below(5).It consist of base four bar crank rocker mechanism which includes the input crank, coupler link, and control link. The position of ground pivot of the control link can be adjusted through the dashed arc centered at the adjusted point. The connecting rod joints the oscillating link to the base four bar at the coupler point. When the adjusted ground pivot collinear with axis of oscillation, then oscillating link will exhibit no oscillation when crank is rotated (1). As the adjustable ground pivot moves away from the axis, the oscillating link translate. An additional benefit of this linkage is that the slider returns to the the same top dead center position independent of displacement setting. This means that all the working fluid, can be ejected on every stroke to minimize compressibility losses.

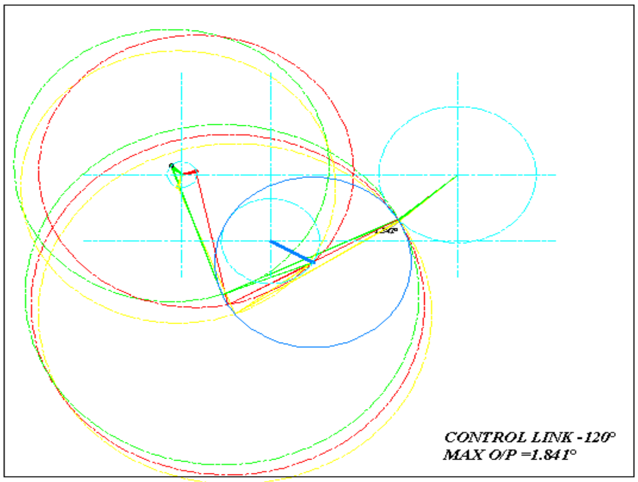

Fig. 4

EXPERIMENTAL OBSERVATIONS

As the Variable Displacement Linkage Pump (VDLP) started running effectively, some observations were made at constant speed and varying control angle.

TABLE NO. 1 -

SR. NO.	CONTROL ANGLE	SPEED (RPM)	VOLUME IN BEAKER (ml)	TIME (sec)	ACTUAL FLOW RATE (lpm)	VOLUMETRIC EFFICIENCY
1	0	800	500	100	0.3012	82.63
2	30	800	500	170	0.17	81.46
3	60	800	500	259	0.11	81.08
4	90	800	500	526	0.057	80.68
5	120	800	500	1173	0.025	80.27

As per different observations we produce line graph of analysis of flow rate characteristics at various control angles.

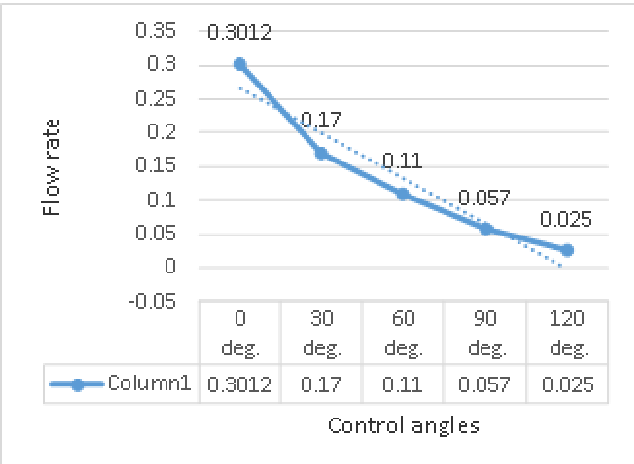

Fig. 5 - LINE GRAPH OF FLOW RATE CHARACTERISTICS AT VARIOUS CONTROL ANGLES

CONCLUSION :

1. From the observations and graph we can see that as the control angle increases from 0 to 120 degrees, at each 30 degrees there is a proportional reduction in the discharge from the pump.
2. It can also be assumed that the discharge of the pump increases with increase in speed at all control angles.
3 . Precise control of control angle will provide a wide range of flow rates therby causing the pump to find multiple applications in various fields of engineering.
4. Volumetric efficiency is also affected slightly due to variation in control angle.
5. Hence the VARIABLE FLOW RADIAL PISTON PUMP USING VARIABLE DISPLACEMENT LINKAGES was successfully designed and manufactured for perfectly economical and efficient applications.

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