BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LX No. 3A/2008	15 - 20	Seria Tehnică

Constructive and Functional Aspects of a Distribution System Incorporates in a Hydraulic Linear Engine

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Abstract

The paper is dealing with the analisis of some technological aspects the characterize a distribution system used in order to act the pumps used in the extraction equipment. There are presented some parameters and the inductive transducer used in the experiments.Distribution system has the function to revert the fluid flow direction in the chambers of hydraulic liniar unit when the piston is at the end of the stroke.

Key words: *distribution system, liniar engine ,extraction equipment.*

Introduction

The most complex component of a deep hydraulic unit is the distribution system.

This has the function to revert the fluid flow direction in the chambers of hydraulic liniar unit when the piston is at the end of the stroke. The distribution system can has diferent location places inside of the deep hydraulic unit.

Constructive and functional aspects of the distribution system used on hydraulic liniar engine

It is addopted the variant with the distribution system above the piston motor [1]. Figures 1, 2, and 3 present the 6 distinctive phases. The notes used in these three figures are:

1- distributor body; 2 - distributor; 3 - fix bushing; 4 - comand rod; A_1, A_2, A_3, A_4, - distributor comand arias; Q_1, Q_2, Q_3, C_1, C_2 - fluid feed and blow-off loops and chanals; p_1 - feed pressure of liniar hydraulic engine; p_2 - fluide blow-off pressure.

Phase 1 by fig. 1 presents the end of ascendent stroke of hydraulic liniar engine. Distributor 2 has a superior position.

Feeding of downside of hydraulic liniar engine is making through 3 loops O_1, arranged at 120^0.

Blow-off motor fluid from upside of hydraulic liniar engine is doing through loops O_2.

When comand rod 4 arrived with chanalls C_1 to put in touch the downside of aria A_1 of distributor 2 with the bolow-off pressure p_2, which executs a downstroke displacement.

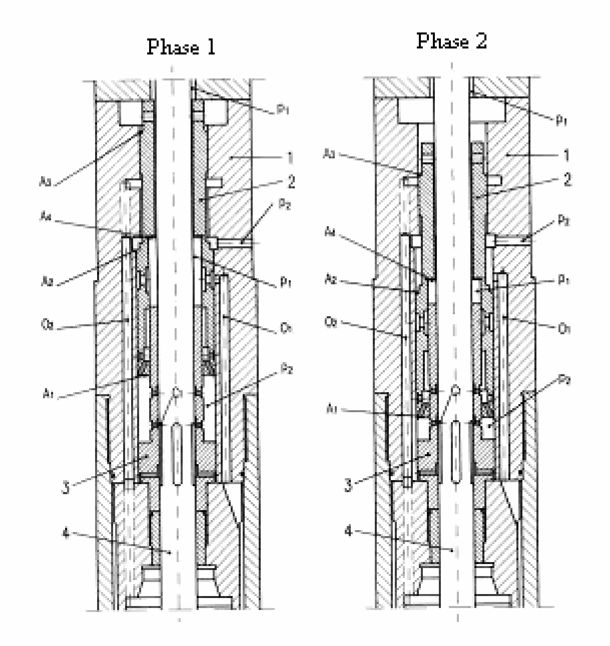


Fig.1. Ascendent stroke of hydraulic liniar engine.

By the four chanalls C_1 the liquid of downside A_1 aria, is rejectes through O_2 loops .

Phase 3 by fig. 2 presents the distributor 2 laied in down position, so, realising the feeding with motor fluid of piston upside. Feeding with fluid motor, of upside is realised by loops C_3, and blow-off of downward liquid by loops O_1.

Phaes 4 is keeping on the downward stroke, this being at the end.

In phase 5 the comand rod carry in the motor fluid pressure under the downside of distributor by chanall C_2 , realising an ascendent movement of it.

In phase 6 the distributor 2 arrives the upposition, the moment when the upmovement of it is begining.

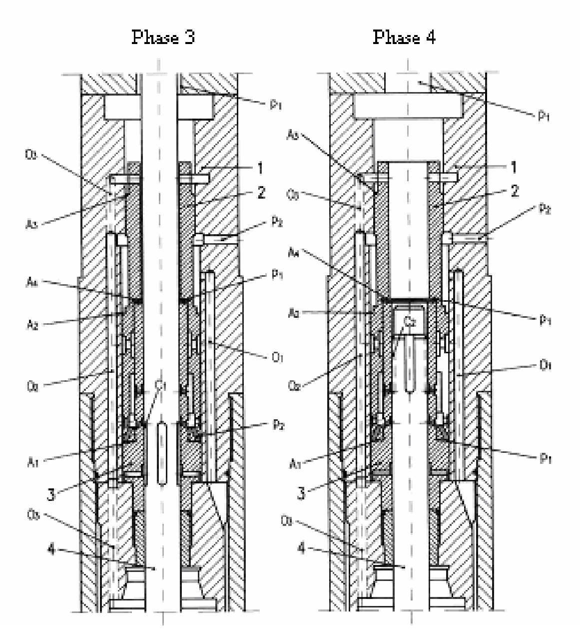


Fig. 2. The downward of hydrulic liniar engine piston.

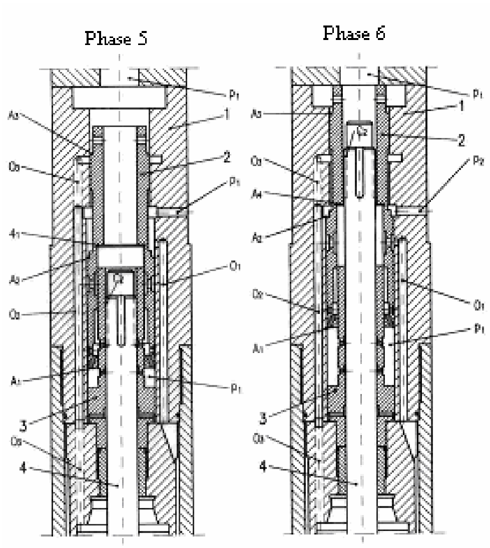


Fig. 3. The end of donnward stroke
and the begining of the up stroke.

The distribution system realizetion is dificult to be done from the technological point of view, expecially for small dimensions units.

The realisad distribution system [2], assures a good operation of the hydraulic liniar engine.

The hydraulic liniar engine mathematic modelling

Based on the previous functional aspects presented upstairs the upstroke of distribuitor can be schematically presents as in fig. 4.

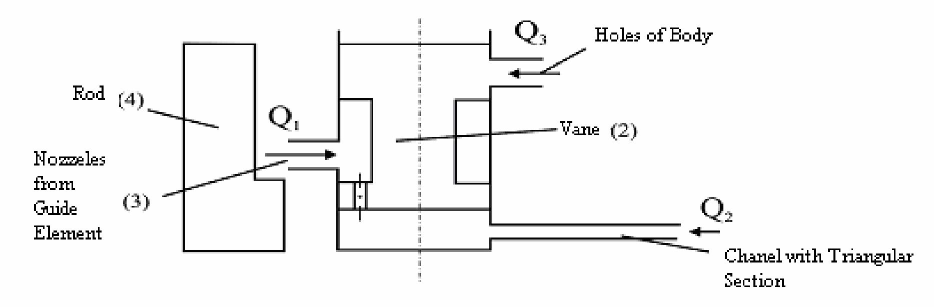


Fig. 4. The upstroke of distribuitor reduced scheme.

The first 5 functional phases of the distribution system are presented in table 1.

Table 1. Functional phases of the distributor description

Phase	1	2	3	4	5
Speed	Very big	Progressivly reduced	Go to zero	Small	Small
Flow	Q_1+Q_2	Q_1 partly+Q_2	$Q_2<<Q_1$	Q_1 partly+Q_2	Q_2+Q_3

The equations which are used for matematic modelling are based on the movement and continuity equations applied on functional phases.

Here,

$$m_d a_d = (p_1 - p_2)A_a - F_f - F_i - F_o + signxF_g, \quad (1)$$

$$Q_a = v_d A_a + Q_s + \frac{V}{E}\frac{dp}{dt} \quad (2)$$

where:
m_d is distributor mass, [3],

$$m_d = m_s + k_{ms} m_f, \quad (3)$$

with m_s–mass of drawer; m_f – the mass of fluid afected by the distributor movement, k_{ms}=0,33 ÷ 0,45;

p_1, p_2–pressures in active chambers (index1 for high pressure, index 2 for low pressure)
A_a–distributor active aria ;
Q_a–feed flow (table 1);
V–volume of liquid under compresion;
E–oil elasticity module ;
Q_s–outlet flow by interstitions,

$$Q_s = \pi \cdot d_s J_m^3 \Delta p / 96 l \mu, \quad (4)$$

where:
d_s is distributor diameter;
J_m – average clearance of the distributor;
Δp – active chambers drop pressure;
l – the lenth of drawers;
μ – dynamic viscosity.
a_d – distributor acceleration;
v_d – distributor speed;
F_f – frictional forces,

$$F_f = \mu F_t, \quad \mu \in (0{,}05 \div 0{,}15); \quad (5)$$

$$F_t = 0{,}5\pi d_s l \Delta J (p_1 - p_2)\left[1/\left(1 - e^2 / J_m^2\right)^{1/2} - 1\right]/e, \quad (6)$$

where:
e is distributor excentricity excentricitatea distribuitorului;
l – the lenth of drawer;
ΔJ – half diferent clerance;
F_i – impuls hydraulic forces;
The inrush force due to liquid displacement in front of the drawers it was considered by mass drawers amplification [see relation (3)], and the inrush force due to liquid evacuation from the law pressure chamber is:

$$F_i = m_x a_d + v_d \frac{dm_x}{dt}, \quad (7)$$

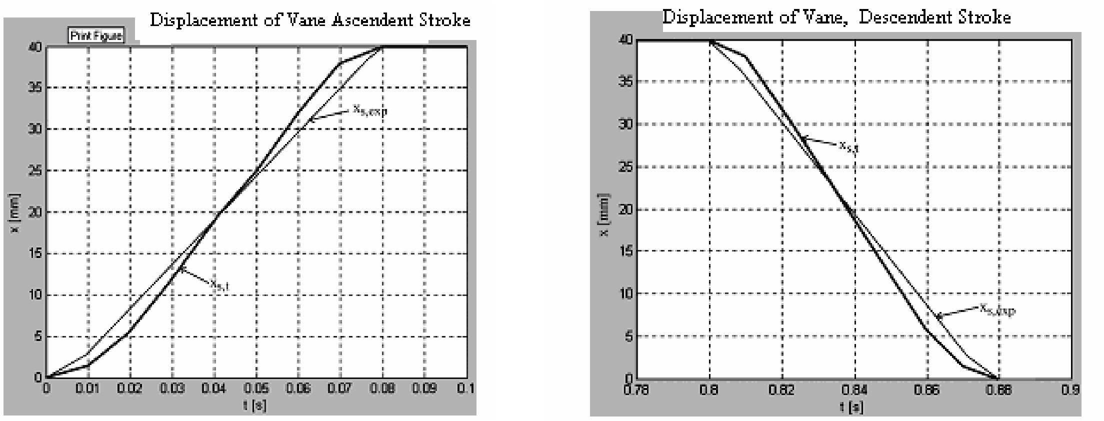
with m_x mass of liquid from this chamber;
F_0–forces due stresses existed between polarisated moleculs of the liquide structures absorbed on distributor surfaces (2) and guided elements (body 1 and element 3 , fig. 4); this being very hard to be monitorizing will be neglectable at calculus; F_g – weight force ,

$$F_g = signxm_d g, \quad (8)$$

where sing$x$ = 1 at distributor dropping and sing$x$ =-1 at distributor hoisting.

The mathematic modelling results are presented in fig. 5. The simulation was done by MATLAB with SIMULINK programe, for a pressure diference on distributor $(p_1 - p_2)$ = 5

MN/m^2, at a external diameter of distributor (element 2) of 44 mm. The distributor stroke lenth is S = 40 mm and the mass m_s= 0,76 kg.



a *b*

Fig. 5: *a* **-** The displacement of drawers at upsurge; $x_{s,t}$ - theoretical displacement of drawers; $x_{s,exp}$ - experimental displacement of drawers; *b* - The displacement of drawers at downward; $x_{s,t}$ - theoretical displacement of drawers; $x_{s,exp}$ - experimental displacement of drawers.

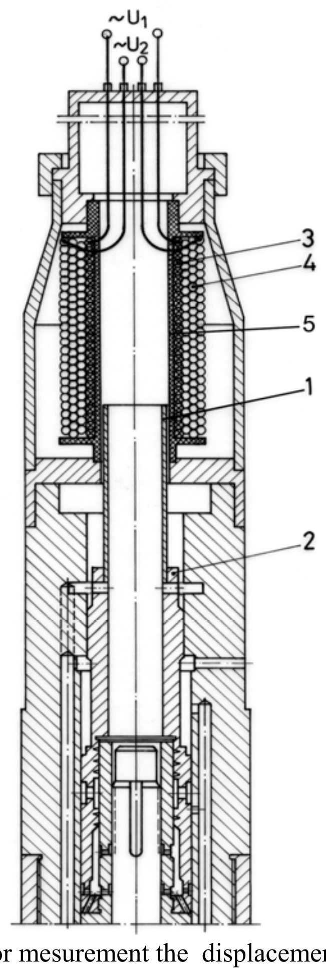


Fig. 6. The transducer for mesurement the displacement of distributor drawser: 1 - hub clasped with distributor drawser; 2 - distributor drawser; 3 - primary wrapping; 4 - secondary wrapping; 5 - pipe of PVC.

To a partial verifying of the values obtained on mathematic modelling it was built an inductive transducer of displacement to watch the drawser displacement on its working time. The scheme of transducer of displacement is presented in fig 6.

The results have an aproximate degree of error because is difficult to assess a lot of factors as (F_f, F_i, F_o),in order to solv the mathematic modell. For each deep hydraulic unit dimension must be done a determination of real cinematic parameters in laboratory conditions which must be very near by the field conditions.

Conclusions

The distribution system built-in the liniar hydraulic engine (realized version) has two concentric distributors 4/2 type. The conclusion of the work are:

- Distribution system has a good size action and assures a rapid reversal of the piston;
- The mathematic modelling (relations 1 and 2) try to symulates functional aspects which apears during the two strokes of distributor drawser.

References

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Aspecte constructive şi functionale ale unui sistem de distribuţie încorporat în motorul hidraulic liniar

Rezumat

Lucrarea prezintă câteva aspecte tehnologice ce caracterizează sistemul de distribuţie încorporat în motorul hidraulic liniar utilizat la acţionarea pompelor de adâncime pentru extracţia petrolului. Sunt prezentaţi câţiva parametri şi traductorul inductiv utilizat la determinarea experimentală. Sistemul de distribuţie are rolul de inversare a sensului de curgere a fluidului în camerele cilindrului motorului hidraulic liniar, atunci când pistonul se apropie de capătul cursei.