ON FREQUENCY RESPONSE OF A HYDRAULIC SERVOMOTOR

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§ 1. Introduction.

The mechanism of a pilot valve controlled hydraulic servomotor can be explained with reference to Fig. 1. The flow of oil induced by a displacement of the pilot valve A causes a similar displacement of the piston B. It is important in the design of an apparatus like this to investigate how faithfully B follows the displacement of A.

One of the methods often used is to investigate the frequency response of an apparatus; i.e. to investigate the motion of B when A is displaced sinusoidally.

Let y denote the displacement of B when the displacement of A is

$x=X\sin\omega t$, X, ω: positive constants, t: time.

Then it is known that y satisfies following differential equation:

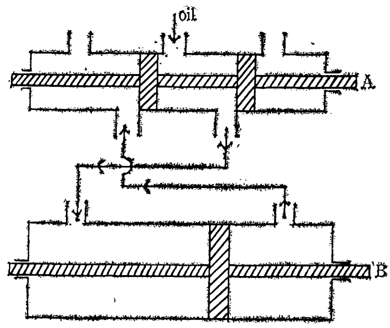

Fig. 1. The mechanism of a pilot valve controlled hydraulic servomotor

$$m\frac{d^2y}{dt^2}+\left(\frac{2A^3}{k^2X^2\sin^2\omega t}+RA^3\right)\left(\frac{dy}{dt}\right)^2-(AP_s-F)=0, \qquad \text{for } \sin\omega t>0,$$

$$m\frac{d^2y}{dt^2}-\left(\frac{2A^3}{k^2X^2\sin^2\omega t}+RA^3\right)\left(\frac{dy}{dt}\right)^2+(AP_s-F)=0, \qquad \text{for } \sin\omega t<0,$$

where m, A, k, R, P_s and F are physical constants determined by the characteristics of the apparatus; cf. [1]. Further explanation of the constants will be omitted.

Put

$$\omega t=\theta, \quad \frac{dy}{d\theta}=u, \quad \frac{2A^3}{mk^2X^2}=a, \quad \frac{RA^3}{m}=b, \quad \frac{AP_s-F}{m\omega^2}=c.$$

Then the above differential equation will be reduced to

$$\text{(1.1)} \qquad \frac{du}{d\theta}+\left(\frac{a}{\sin^2\theta}+b\right)u^2-c=0, \qquad \text{for } \sin\theta>0,$$

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