The reducer is one of the most important parts of conveyor centrifuges. It provides slow conveyor rotation (relative to the high-speed rotor) for cake discharge from the rotor. At present two-stage gear planetary reducers [1, 2] cycloid meshing reducers [2], and devices which allow control of conveyor relative rotational speed are used [3]. They are all difficult and expensive to manufacture (especially cycloreducers, which require special equipment and extremely accurate fabrication), are unreliable, and have short service life.

The device examined in this article (Fig. 1) is recommended for driving conveyor centrifuges. It is a standard multistage vane (plate, slide) hydraulic motor [4]. It includes housing 6, which is attached to the centrifuge rotor by mating flange 7, and impeller 1, which is attached to the conveyor shaft through slotted connection 19 of hub 17. This hydraulic motor construction has certain special features and improvements compared to the standard design. Shaft 14 is installed in bearings 16, coaxially with the hydraulic motor, inside hub 17 of impeller 1. Shaft 14 extends through cover 10 of the housing with gland 13 and is restrained. Scoop pipe 9 is rigidly mounted on the shaft. This pipe connects the peripheral area of chamber 8 with annular pocket 12 through opening 15 (radius R_l). Pocket 12 is connected to inner chamber 18 by ports 11. There is no constant supply of operating fluid to the hydraulic motor, but it is filled with a fixed volume of fluid before operation.

The hydraulic motor is filled with operating fluid (any mineral oil). It rotates together with the centrifuge rotor and conveyor filling the peripheral areas with the fluid under centrifugal force. Fluid is supplied

![Fig. 1. Construction schematic of a centrifugal hydraulic motor.](image-url)
Fig. 2. Unit torque $M_1$ as a function of free surface radius $R_0$ of the rotating fluid volume and the inner radius $R_i$ of the pressurizing compartment.

Fig. 3. Qualitative torque characteristics of a centrifugal hydraulic motor.

Into pocket 12 from chamber 8 by scoop pipe 9 and flows to inner chamber 18 through port 11. It fills chamber 18 forming a rotating liquid mass. The mass has a free surface of radius $R_0$ (minimum $R_i$). Liquid from inner chamber 18, under centrifugal force, enters pressurizing compartment 20 (inner and outer radii are $R_i$ and $R_{out}$) through inlet channel 4 and fills the compartment. Port 4 is opened by slide ring 23, which is an integral part of housing 6. This creates centrifugal hydrostatic pressure $p$. Slide vanes 21 of impeller 1 slide out under centrifugal force. Impeller grooves are connected to inlet channels 4 by ports 5 to facilitate sliding movement (out and in) of the vanes in the grooves. Impeller 1 starts to move, clockwise relative to the housing under hydrostatic pressure $p$ in pressurizing compartments 20. This causes the centrifuge conveyor to move in the same direction relative to the centrifuge rotor. Discharge compartments 22 are connected to chamber 8 by discharge ports 3 and channels 2. The operating fluid is returned from 8 to inner chamber 18 through scoop pipe 9.

The pressure of fluid (density $\rho$) at any point located on current radius $r$ can be determined by the following formula [1] at hydraulic motor rotational frequency $\omega$:

$$p = \rho \frac{\omega^2}{2} (r^2 - R_0^2).$$

Let us determine circumferential force $P_1$ acting on one operating (i.e., forming the pressurizing compartment) vane, assuming that scoop pipe 9 maintains the level in chamber 8 so that discharge ports 3 are not flooded. Atmospheric pressure, therefore, acts on the discharge compartments if the width of the vane and pressurizing compartment is $B$:

$$P_1 = \int_{R_i}^{R_{out}} \rho BDr = \int_{R_i}^{R_{out}} \frac{\rho B}{2} (r^2 - R_0^2) BDr = \frac{1}{6} \rho \omega^2 B \left[ R_{out}^3 - 3 R_i^2 (R_{out} - R_i) \right].$$

The moment transmitted by one operating vane to hydraulic motor impeller 1, relative to housing 6, is determined by the expression

$$M_1 = \int_{R_i}^{R_{out}} \rho BDr = \int_{R_i}^{R_{out}} \frac{\rho B}{2} (r^2 - R_0^2) BDr = \frac{1}{8} \rho \omega^2 B \left[ R_{out}^4 - 2 R_i^3 (R_{out} - R_i) \right].$$

The total torque (with a multiplicity of vanes in the hydraulic motor) on impeller 1 relative to housing 6, i.e., the moment on centrifuge conveyor relative to its rotor, will equal

$$M = \sum \frac{1}{8} \rho \omega^2 B \left[ R_{out}^4 - 2 R_i^3 (R_{out} - R_i) \right].$$

Equation (1) shows that torque is a function of operating liquid density $\rho$, the rotational frequency of the