LITERATURE CITED


UNDERGROUND PNEUMATIC SURGE TANKS OF HYDROELECTRIC STATIONS

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As long ago as 1939, Prof. V. G. Aivaz'yan [1] put forth the idea of using at diversion-type hydroelectric stations pneumatic surge tanks in which the water fluctuations occur in a close chamber with an internal air pressure exceeding atmospheric. However, such chambers did not find practical use at that time.

In the 1950's, in connection with the increased construction of diversion-type hydroelectric stations, especially the construction of hydrostations with underground diversion system and machine halls, interest was shown in pneumatic chambers. The author in 1950-1956, together with Profs. V. G. Aivaz'yan and N. A. Kartvelishvili [2], developed a theory of calculations and specific design of a pneumatic surge tank for the Arzni hydrostation in Armenia. However, owing to the opinion of a number of specialists concerning the insufficient development of automatic regulating systems at that time, the pneumatic chamber was not realized. Thereafter pneumatic surge tanks did not attract attention, since at that time mostly reservoir hydrostations were being constructed. At present, in connection with the increased demands being imposed on ecology and economics interest is markedly increasing in diversion hydrostations least affecting the environment. The majority of hydrostations of the so-called new generation will be of the diversion type, and with their siting often in regions with high seismicity. This is arousing heightened interest in our country and abroad [7] in pneumatic surge tanks most meeting the requirements of environmental protection and economics.

Let us examine the main principles of operation of pneumatic surge tanks, their hydraulic calculation, and economics of construction. As is known, in diversion hydrostations with a pressure diversion system (most often a tunnel), surge tanks of the usual types directly communicating with the atmosphere often have a considerable height and they cannot be completely located underground. The use of multichamber or throttled surge tanks does not produce, as a rule, the desired result. The towers of the tanks rising above the surface require special strengthening in seismic regions and disturb the equilibrium in the environment, which is especially impermissible when all other main structures of the hydrostation are underground. In these cases, an out from the difficulty can be a change to a pneumatic type of surge tank. As was mentioned, a pneumatic surge tank (Fig. 1) is a tank in which the water fluctuations occur in a closed chamber with an internal air pressure exceeding atmospheric. Thanks to the high air pressure, the range of water fluctuations during changes of the load on the hydrostation is reduced considerably, which, accordingly, considerably reduces the necessary height of the tank. The tank, originally filled with a certain volume of air by means of a compressor, will operate like an ordinary tank. During a decrease of the load of the hy-
Fig. 1. Schematic diagram of a pneumatic surge tank: 1) tailrace system; 2) powerhouse; 3) compressed air; 4) pneumatic surge tank.

Fig. 2. Region of stability of the surge tank for small fluctuations of the load of the hydrostation: 1) region of instability; 2) region of stability, $F = 113 \text{ m}^2$, $V_0 = 2500 \text{ m}^3$.

Fig. 3. Maximum rise of water level in tank.

Fig. 4. Changes in the level during buildup of the load.