Shore Spillways of Project

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The Caucasus is a region with a great potential of water power resources. Water power potential of the Azerbaijan Republic is estimated as high as 16 billion kWh. At the present time utilizable portion of water power potential is 35.5 %. After construction of HES this portion will be ~ 70 %. The Kura and Aras rivers will get 91 % portion of non-installable potential of water power resources of Azerbaijan. At the present time the design works are carried out for construction of Khudafarine. Project on the Aras river frontier with IRI. Reservoir storage capacity will be 1612 million m^3. It's provided to construct of HES with 2 Turbines Plant 200 mW. Annual-mean discharge in dam site of the Aras River is 276 m^3/s, 1% maximum discharge –2310 m^3/s. Construction of surface and bottom spillways is planned in the project.

The surface spillway is designed for discharge of 1500 m^3/s with open shore trench view. The spillway structure includes water intake head, chute and toe basin. Version of water intake of trench type with one-sided lateral withdrawal is provided in design. The placement of water intake head of the surface spillway is planned on the right bank of reservoir. However, the preliminary reagents showed that the placement of water intake head of the spillway structure with one-sided spillway front is accompanied by specified engineering difficulties. The structure does not meet the requirements of exploitation as at discharge of 1500 m^3/s planned and high-altitude dimensions of water intake head become higher therewith, hydraulic flow regime in water intake head is deteriorated.

Acc. to preliminary calculations length of spillway front will be 150 m, depth of structure - 8 m, width - 30 m. But, local conditions don't permit to place surface spillway head of such dimensions. In connection with stated we worked out some versions of structures of the heads of the surface spillways.

The followings were our purpose during working out of new structures:

- *to increase discharge capacity of spillway head at constantly height of overflowing layer.*
- *to use internal space of the head for increase at the water overflow front*
- *to decrease of pressure losses for mixing of overflowing and transit flows in the head .*

The analyses of hydraulic regime of the existing water intake heads showed that at overall dimensions the internal space of head isn't utilized entirely. Therefor, the assignment on utilization of the internal space of water intake head for increasing of overflowing front of water was stated.

Spillway head with additional chute (1).

Internal space of head above free water level in trench is used for increasing of discharge capacity in this construction. The additional water intake chute is placed in this space. The additional chute is arranged on transverse hollow beams which hold it and at the same time deliver the water. High altitude dimensions of the head are increased by 2-3 m but planned dimensions are decreased approximately 2 times at such arrangement accordingly. Such arrangement of the structure permits to decrease weighting force at the expense of weight of the additional chutes and the water containing in them.

The structure of spillway head includes: trench-1 of variable section, chute-2 of uniform rectangular section installed on transverse hollow beams-3 which hold the chute and at the same time deliver the water into the chute-2. For the purpose of provide the permanent longitudinal velocities the lower part of the trench-1 is carried out along flow. (Fig.1)

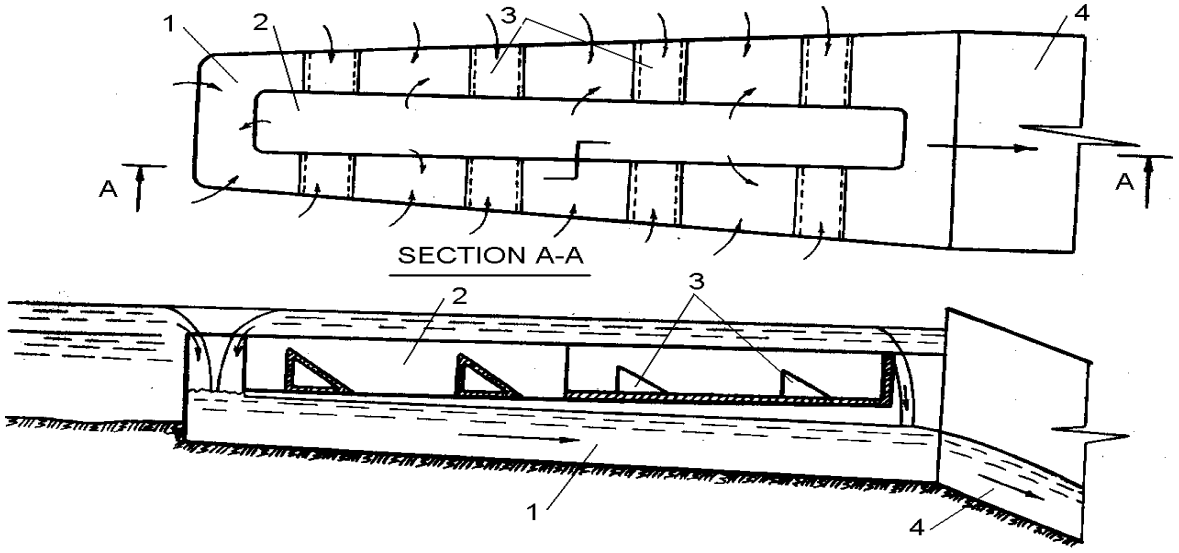

Fig. 1.

When the water level rises up in the storage above NWL (Normal Water Level) the overflow of water is occurred into head through walls of main and additional chutes. Water flow comes from head-1 into tailrace water conduit - 4 and releases in downstream pool. Arrangement of the additional chute into the head permits to construct the easy structure is able to, at three times one- sided receive, at twice two -sided receive, increase spillway front and rise up the discharge capacity of structure.

As known, screw-type motions of water with transverse circulation originate in ordinary trench and chute spillway structures which reduce the spillway discharge capacity. In new construction for purpose of decreasing of screw flow the conditions are created for incoming of overflowing stream part transverse of spillways axis at an angle. Such transverse overflow of water creates

the conditions for screw flow fault in trench and doesn't give the opportunity to be developed along the flow. For this purpose the transverse beams, which hold the additional chute, were carried out by hollow as right triangle. So, the hollow beams at the same time function as directing louvers. Use of such spillway head structure provides the release of maximum catastrophic discharge at low water level in upstream pool of reservoir and permits to decrease the volume of construction works or decrease the planned dimensions 2-3 times in continuously overflowing layers.

Spillway head with additional heads.

The laboratory researches show that for large spillway heads of chute or trench type the water overflow into wide trench creates the condition for irregular velocity distribution in cross-section and therewith head cross-section for water transfer isn't used entirely. For avoid of such disadvantage a new spillway head structure with additional heads were developed by us. The additional head is placed in the middle of spillway head in minimum velocity zone. Therewith head cross-section is decreased in width and part of overflowing water layer is transferred in the middle of head (Fig. 2).

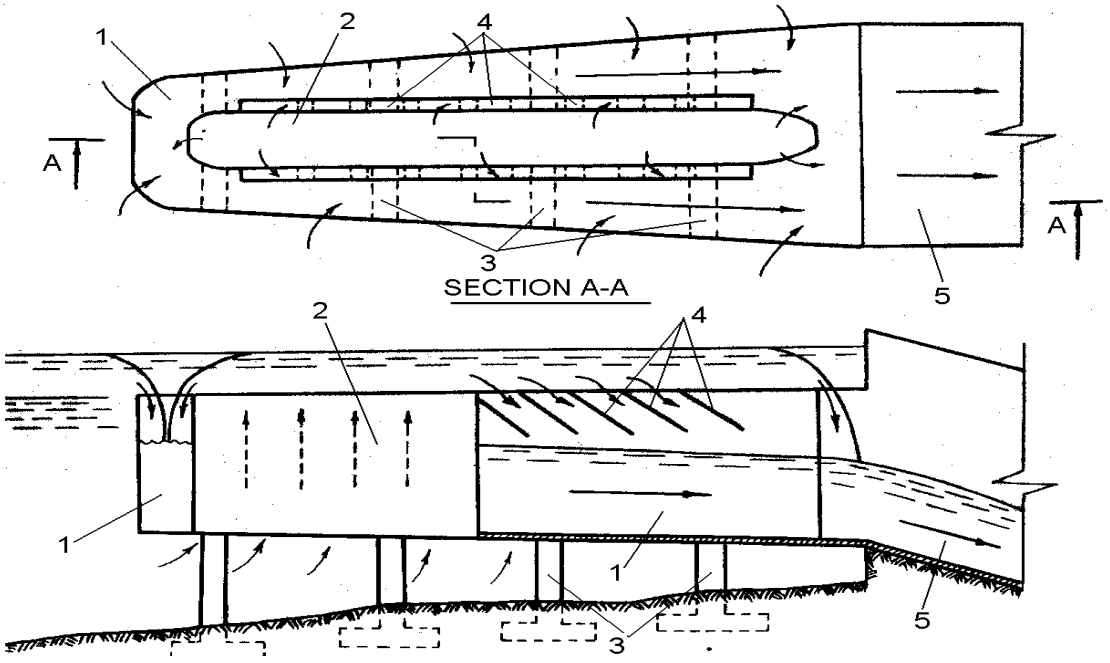

Fig. 2

Inside of main head-1, having the uniform or variable cross-section, there is additional head-2, which is supplied, as distinct from /6/ with the water of storage reservoir through bottom opening-3. The bottom outlets for delivery of the water to the additional head are located in concrete base of the main head. From the storage reservoir to openings the water flow comes through water conduits which could provide one-sided and two-sided delivery of water to the additional head. The water conduit is located within base and in the body of main head wall. With

a purpose of increase the discharge capacity in the trench at the expense of decreasing of backwater and screw flow to external side, internal spillway head is provided by jet guide elements-4. Overflowing escapade discharge from internal head with the help of jet guide element-4 is directed into the trench and decreases the backwater in it. The spillway structure operates as follows. When the water raises up in storage up to normal N.W.L. flood flow comes through free space at the bottom of head into the additional head-2. Then, the water overflow in the trench from main –1 and additional-2 heads and with help of tailrace water conduits –5 discharges into the downstream pool . All head constructions are held on supports –3.

Use of this construction permits to reduce the planned dimensions of spillway head 40-50%.The present design of spillway structure was adopted during designing of Khudafarine Project on the Aras river (Azerbaijan Republic) and Project on the Olga river (Russian Federation).

Based on our research, a coastal spillway was constructed at the Khudaferin Dam with a flood flow of 1500 m^3/s. Figure 3 shows the spillway structure at the Khudaferin Dam.

Fig.3

Main conclusions.

1. Trench spillways in countries with hot climates are typically installed when a hydraulic structure is being built in a narrow, steep-sided canyon. A bank spillway with a frontal entrance is difficult to implement in these conditions due to the need for deep and extensive rock excavations. The main challenge in creating favorable hydraulic conditions for trench spillways is the correct trench size and shape.

2. When designing trench spillways, the primary objective is to eliminate helical flows within the trench while ensuring effective dissipation of excess flow energy within the trench.

3. To efficiently utilize the internal space of trench spillways, we have developed a spillway head with additional overflow channels. This design proposes utilizing the internal space of trench spillways to increase spillway capacity. High catastrophic flow rates make spillways excessively large, requiring significant construction work. These spillway designs create a large, unused space within the trench.

4. To increase trench capacity by reducing backwater and helical flows, the outer surface of the internal spillway head is equipped with flow guide plates.

LIST OF LITERATURE

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2. Patent R.F. (Russian Federation). № 2061817. Spillway structure (Bashirov F.B., Mamedov A.Sh.). in B.I. 1996, № 16