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SURGE TANK PROBLEMS

AN INVESTIGATION OF SURGE TANK REGULATION DETERMINING BY GRAPHICAL AND ANALYTICAL METHODS PROPER SOLUTIONS OF PROBLEMS CREATED BY LONG PIPE LINES.

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PART I.

IN case the main conduit leading to a turbine is comparatively long, beginning at the intake on a comparatively light slope (canal, tunnel or low-pressure pipe) and concluding in a short steep slope leading directly to the turbines, (high-pressure pipe or penstock), it is common practice to construct at the junction an open tank, called the surge tank, by which the main conduit is separated into two parts, in which with a constant discharge of the turbines the flow in the conduit is constant, and with a variable turbine discharge a variable conduit flow results. In the first case, the water surface in the surge tank is lower than the water surface at the intake by an amount dependent upon the flow in the low-pressure pipe. This difference of head is determined by the friction head in the main conduit. In an increment of time just as much water flows into the surge tank as flows out of it through the penstocks to the turbines.

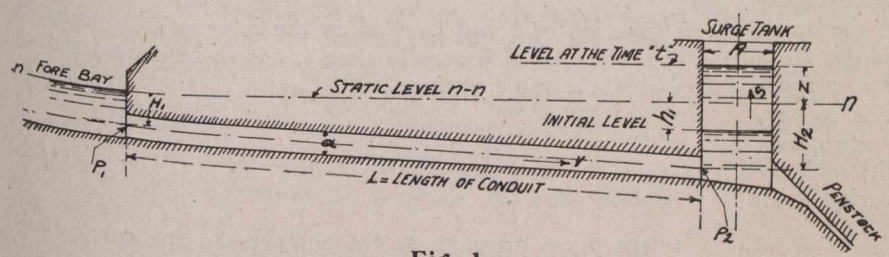

Fig. 1.

In the second case, the inertia of the moving mass in the main conduit prevents this equality of inflow and outflow. The water surface in the surge tank has variable heights, that is, it rises or falls above and below the elevation due to the steady flow. The extent of this fluctuation of the water surface depends upon the dimensions of the main conduit, the amount of flow, and also on the size and form of the surge tank. In this case, if an overflow or an excessive lowering or too large fluctuations of the water surface are to be prevented, the surge tank must be dimensioned according to the area and length of the main conduit and according to the inflow and outflow. In this article the problems leading to the determination of the dimensions will be discussed, and the methods, partly analytical and partly graphical, involved in the solution of these problems, will be developed upon the assumption that the main conduit from the intake to the surge tank consists of a pipe or tunnel running full under pressure.

I. Introduction.

The investigation is developed (see Fig. 1) under the following additional assumptions:

(1) The intake is provided with a spillway whose dimensions are such that the elevation $n-n$ in the forebay may be considered as constant during the period under investigation.

(2) The sectional area of the main conduit is constant.

(3) The volume of the conduit, compared to the volume of the surge tank and compared to that part of the volume of the forebay which is affected, is so large that the influence of both of these masses of water toward decreasing the flow may be neglected.

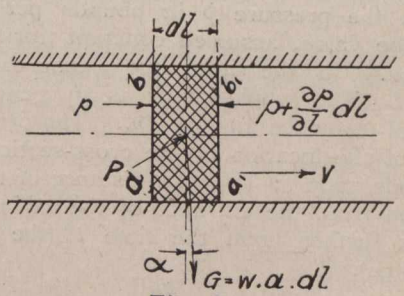

Fig. 2.

(4) Elastic and temperature conditions are neglected.

In the derivations of the formulæ, the following abbreviations are used:

L = Length of main conduit in feet.

a = Sectional area of main conduit in square feet.

p = Wetted perimeter of main conduit in feet.

v = Velocity of water in main conduit in feet per second at the time "t".

v_1 = Normal velocity of water in the main conduit in feet per second, during the period of steady flow.

v_2 = Initial velocity in the main conduit in feet per second, at the time $t = o$.
(v, v_1 and v_2 are average values and are assumed as constant throughout the entire length of the main conduit).

H_1 = Vertical distance from the water surface $n-n$ in the forebay to the centre of gravity of the entrance to the main conduit.