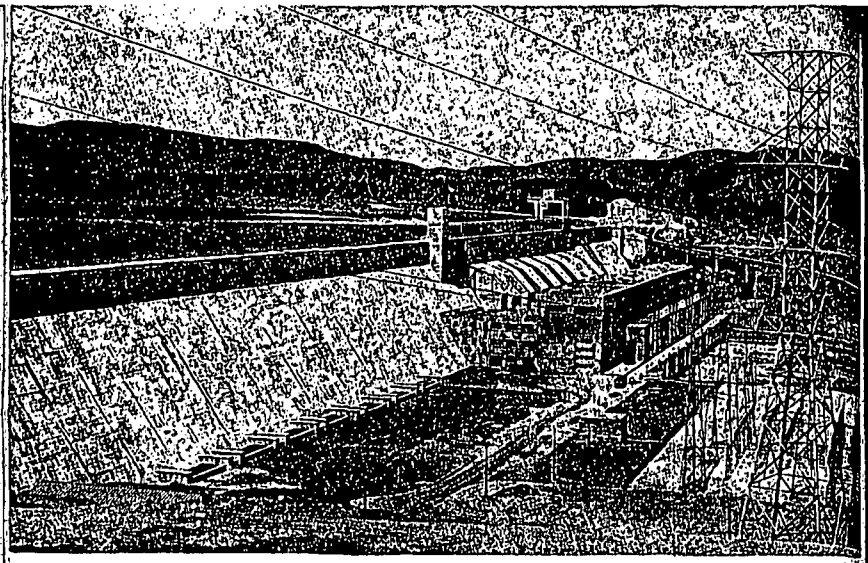
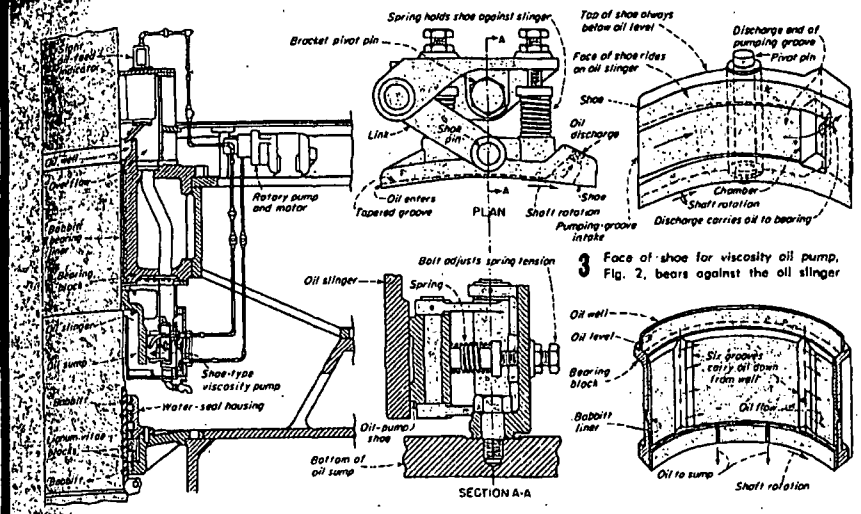


DES JOACHIMS PROJECT, one of three built on Ottawa River by Hydro-Electric Power Commission of Ontario, runs with 135-ft head. Has total capacity of 496,000 hp installed in eight 62,000-hp francis turbines turning at 105.9-rpm speed



1 Section through turbine bearing and water seal on the La Cave units 1-4

2 Details of shoe-type viscosity-oil pump installed on La Cave units 1-4

3 Face of shoe for viscosity oil pump, Fig. 2, bears against the oil slinger

4 Section of guide bearing shows oil-distribution grooves, La Cave units

Design Features of Three Canadian Hydroelectric Projects Analyzed

Here are factors that influenced turbine selection for three hydro plants with 40, 77 and 135 ft heads and total capacity of 900,000 hp. Authors discuss reason for using oil-lubricated guide bearings, different bearing designs and shaft water seals*

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► FROM THE NORTHERN END of Lake Temiskaming to Point Fortune, 22 miles above Montreal Island, the distance is 450 miles. Here the Ottawa River forms the boundary between the provinces of Ontario and Quebec, Canada. On the upper section of this river the Hydro-Electric Power Commission of Ontario is developing three large power sites.

Three Plants. About 33 miles below the outlet of Lake Temiskaming, La Cave development was completed in 1952. It has a capacity of 264,000 hp in eight 33,000-hp units, to operate under a 77-ft head. Des Joachims, 60 miles down river from La Cave, is the largest of the three plants. It has 135-ft head, eight 62,000-hp units for a total capacity of 496,000 hp, and is now in full operation. Chenaux, about 11 miles above Renfrew, Ont., has the relatively low head of 40 ft, eight 21,000-hp units or a total capacity of 168,000 hp. All eight units are now in full operation.

Water Storage. Upstream from La Cave several water-storage basins with 5,000,000 acre-ft capacity regulate the river flow. One of these basins, Lake Temiskaming, when drawn down to low levels will reduce the head at La Cave slightly. But generally at all three plants forebay levels will be controlled for daily pondage needs.

Turbine-Selection Factors. Range in heads, 77, 135 and 40 ft, afforded an interesting selection of turbines. For heads between 60 and 90 ft a choice can be made of high-speed propeller and the slower-speed francis types. To make the selection requires a study of: (1) cost for equipment (2) substructure (3) excavation (4) crane capacity. In addition, reliability, maintenance cost and kilowatt-hours output for the different types of turbines have to be evaluated. When selecting the turbines other factors must also be considered, such as:

1. Adjustable-blade propeller (kaplan) turbines have over 80% efficiency at loads above 25%. This efficiency can be had with fixed-blade propeller turbines at loads above 70%, and from francis type above 50% load. Kaplan turbines have their best efficiency at about 60% load. But, in plants that have several units, high efficiency can be maintained by adjusting the load on a number of units and starting and stopping machines as load requires. This can be readily done by automatic start-stop governors and synchronizing equipment operated from the control room.

The kaplan turbines' advantage of high efficiency over a wide range of loads is largely discounted in a group of plants having several units. This is the experience in Chats Falls plant, 30 miles below Chenaux, which went into service in 1932 with eight fixed-blade propeller turbines. In spite of the units' peaked efficiency curves, over-all plant efficiency is high.

2. Kaplan and propeller turbines have a decided advantage over francis runners in the size of their water passages and higher speed. The latter reduces generator cost. Since kaplan turbines have more moving parts than a francis or propeller runner, they may be out of service longer for maintenance.

3. As specific speed of the runner is increased the turbine must be set lower to prevent cavitation. This increases the cost of excavation and draft tubes. Advantages here rest with the francis turbine as it can be set higher above tail-water level without serious runner pitting.

4. At the plants discussed, heads will be reduced during spring floods because of increased tailwater level and maybe forebay level will be reduced. Reduced head decreases output of francis turbine more than kaplan or propeller types. But a seasonal load reduction on the Southern Ontario system usually occurs during flood period on the Ottawa River. So, reduction in head on the plants due to floods was not important when selecting the turbines.

Choice of turbines was based on a careful evaluation of these and other factors. For the La Cave 77-ft-head plant, choice was between francis and propeller turbines of either fixed or adjustable-blade types. Francis turbines were chosen. Under 135-ft head at Des Joachims, francis turbines were a natural choice, even though the kaplan was considered. Choice for the 40-ft-head Chenaux lay between fixed-blade propeller units and kaplan automatically adjustable-blade type. Fixed-blade propeller turbines were selected as best suited to power-system conditions.

Difference in unit capacity at the three plants is due largely to the difference in head. There is not a wide difference in physical size and weight, and all turbines may be considered of large size. Table, p 88, gives main physical features.

Water Passages. Chenaux and La Cave turbines have reinforced concrete scroll cases. Three passages formed in the concrete as part of the scroll case conducts water from the forebay to the Chenaux turbines. Two passages do a like service on La Cave units. Low pressure on the Chenaux casing permitted using partial speed rings. These have separate steel stay vanes bolted to a top cast-steel ring. Lower end of each vane is cast in concrete and arranged to carry load from top to bottom of the scroll case.

At La Cave the higher pressures, 77-ft head, required complete cast-steel speed rings with separate stay vanes bolted to upper and lower rings. In

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