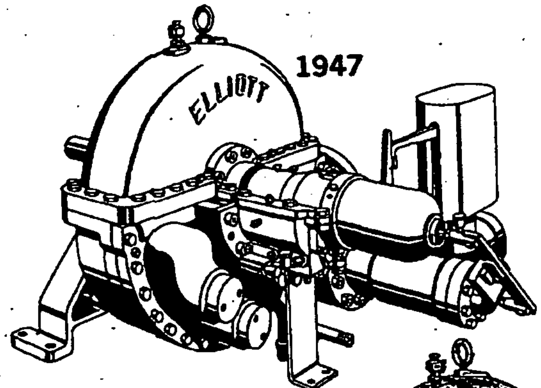

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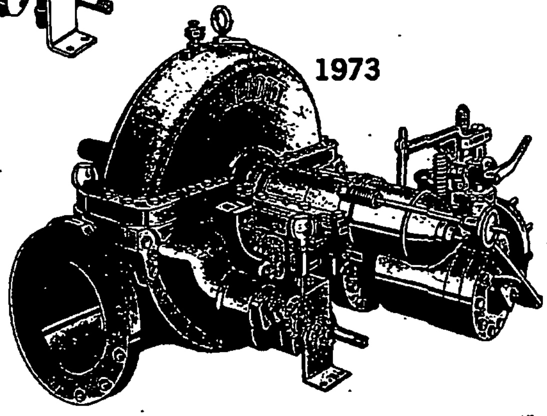

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Turbine helps fix itself

Cutting tools and welding equipment mount on turbine runner to restore cavitation-damaged tube

When Public Service Co of Indiana's Markland hydro station sustained heavy cavitation damage on three low-head Kaplan turbines, repairs became necessary. Cavitation in a hydraulic turbine is caused by small air bubbles formed in the water during the reduction in pressure that occurs in conversion of head to velocity. The bubbles are suddenly forced to implode as pressure increases again. If they implode near a metal surface, the stress set up in the metal is high enough to fatigue the metal quickly and break out metal particles. This can occur on tubes or blades.

The utility, at suggestion of the author's company, decided to try to speed repairs by an assist from the turbine runner for part of the work, on the draft tube. On-site inspection led to a decision that much of the work on the stationary tube could be done semiautomatically. This meant a machine boring operation on the tube wall.

Although blade repairs would have to be done conventionally by hand-welding and hand-finishing, overall downtime seemed likely to be reduced.

If it could be rotated at low speed, the turbine runner would be a steady support for the necessary tooling, but this would be only the first step. A special remote-controlled drive unit had to be devised to revolve the turbine runner. The controls for the variable-speed drive were placed near it. The drive system included safety devices to insure protection for the guide bearings and thrust bearings. The drive system control also applied and released the air brakes of the turbine, bypassing the turbine's own air-brake control system.

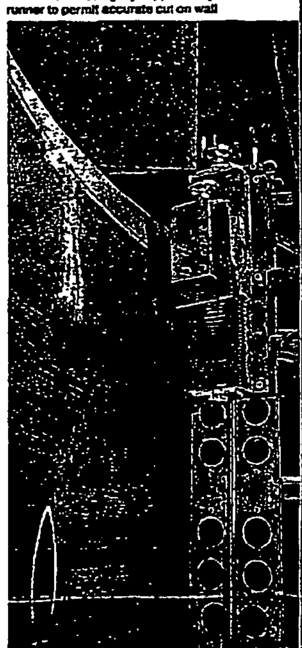
A rotary-joint and slip-ring arrangement at the runner bottom was necessary to supply electric power and air to the platform attached to the runner. Voltages were 440, 220 and 110 V ac. Ground leads were needed, too, to ground the wall area and prevent current from passing through the thrust-bearing area.

Stainless steel, type 308 or 309, is the

By Dean Goings, Engineering Systems of Indiana, Inc

Cavitation on tube wall (left) and on blades (right) called for weld deposit

Tool holder was rigidly supported by runner to permit accurate cut on wall



Tube wall at end of machining still showed considerable depth of cavitation damage. Remaining cratered areas were air-arced and hand-welded before another machining