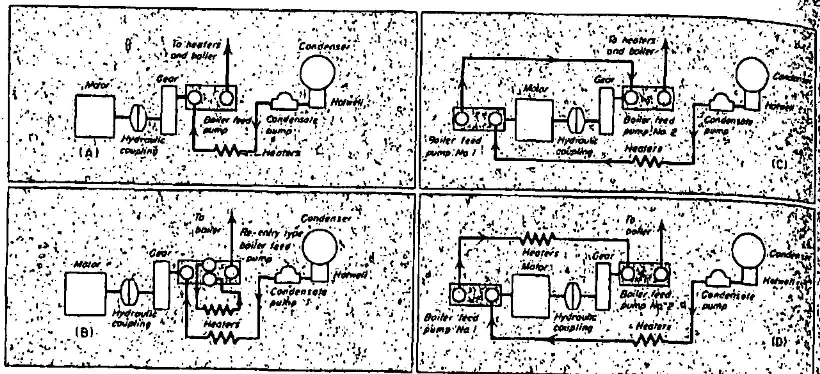
Design of Pumps for High Pressures Requires Careful Study of Different Schemes



1 Four schemes studied for the application of special-type feed pumps to boilers operating above the critical pressure of steam. Single-casing arrangements *A* and *B* proved unsuitable. Using two casings, *C* and *D*, is more conservative

► As reported in July Power, p 150, and Sept, pp 80-85, we're at the start of a great stride forward in power-plant design—a move into the region far above the critical pressure of steam. This necessitates development of boiler-feed pumps having discharge pressures of 5000 psi or more. Superpressures are today's answer to the need for higher over-all thermal efficiency in large plants.

Present Practice. Today's central stations need boiler feed pumps suitable for maximum pressures in the 2600-psi range. A few of the latest stations use pumps discharging at 2800 psi.

In many plants it is standard practice to use a single-casing barrel-type pump, Fig. 3, below, running at 3550 rpm for this job. This type of unit must have as many as 12 or 13 stages. For a discharge pressure of 5000 psi, or more, about twice this number of stages would be required if pump ran at the same speed, 3550 rpm. This presents a most difficult design problem and requires a new approach.

Our firm has done much work on this problem, investigating several possibilities. It appeared evident from the start that for the high pressures involved, speeds higher than 3600 rpm must be considered to reduce the number of stages needed in the pump.

First Study. We started with a single-casing design running at 6500 rpm. Capacity selected was about 1000 gpm of 350-F water. Using a double-suction first-stage impeller, we chose a 9-stage pump. Our calculations show it should be possible to obtain reasonably good efficiency with this pump by driving it through a hydraulic coupling and gear, Fig. 1A. Specific speed of unit will be in line with that of other successful installations.

Further studies of this arrangement show that application of the feed system's high-pressure components (such as heaters) make it impractical for economic and design reasons. It is not now feasible to place high-pressure heaters between pump discharge and boiler.

Second Study. Next approach, Fig. 1B, used a similar pump, but it was fitted with re-entry features. First half of the unit would deliver to the heaters at 2500 psi the relatively cold water coming from the deaerator. After passage through the heaters, the water would return to the pump at about 500 F. Second half of pump would discharge the water at the rated design pressure.

Because half of the pump must handle water with a specific gravity of 0.786 as against a gravity of 0.892 for 350-F water, the horsepower of the second half of the pump will be increased about 13%, assuming the efficiency of both halves is about the same.

Studies of the design and economics of arrangement 1A and 1B show a more conservative hookup is preferable.

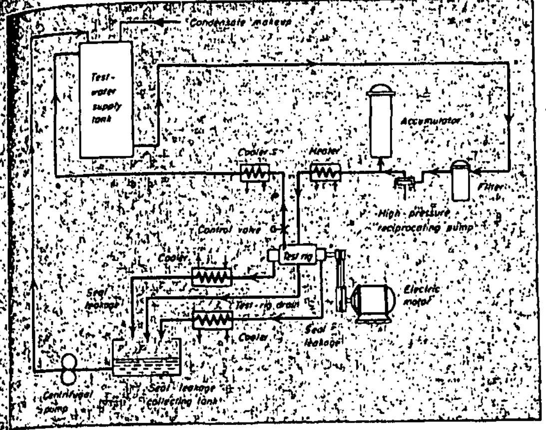
Third Study. Arrangement worked out resembles the setup that some utilities are now using. One pump feeds the heaters, its discharge going to a second unit after passage through heaters. Second pump discharges to boiler, Fig. 1D.

In effect, this design splits the pump into two casings, the first consisting of a standard up-to-date barrel-type feed pump, designed for a dischage pressure of about 2100 psi and operating at 3550 rpm. Second pump handles the remainder of the work in eight stages, turns at 6500 rpm.

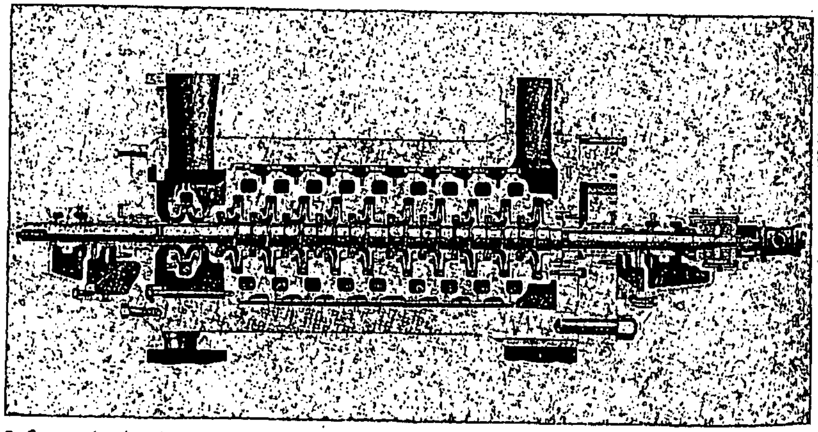
Both pumps can be driven from the *same motor*, the discharge pump being driven through a variable-speed hydraulic coupling and a speed-increasing gear. Second pump handles 500-F water if hooked up as in 1D. With hookup 1C, second pump handles 350-F water but heaters are uneconomical, as in 1A.

Two-casing arrangement has some *additional operational* advantages. Hydraulic coupling size is smaller and its full-speed loss is less than for the arrangements in Fig. 1A and 1B. Part of this advantage is retained when the discharge pump runs at reduced speed.

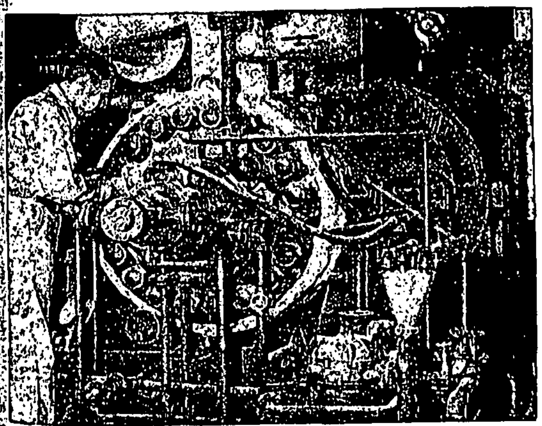
It is interesting to note here that



2 Seal test arrangement developed to insure adequate investigation of conditions at the seal during actual operation of the pump at pressures above the critical



3 Cross section through a typical modern barrel-type feed pump designed for high-temperature high-pressure service. The pump consists of a single-suction radially-split diaphragm-type multistage pumping unit running in the forged-steel barrel



4 End view of a barrel-type feed pump in a large utility station. The piping and service connections to high-temperature high-pressure units are important