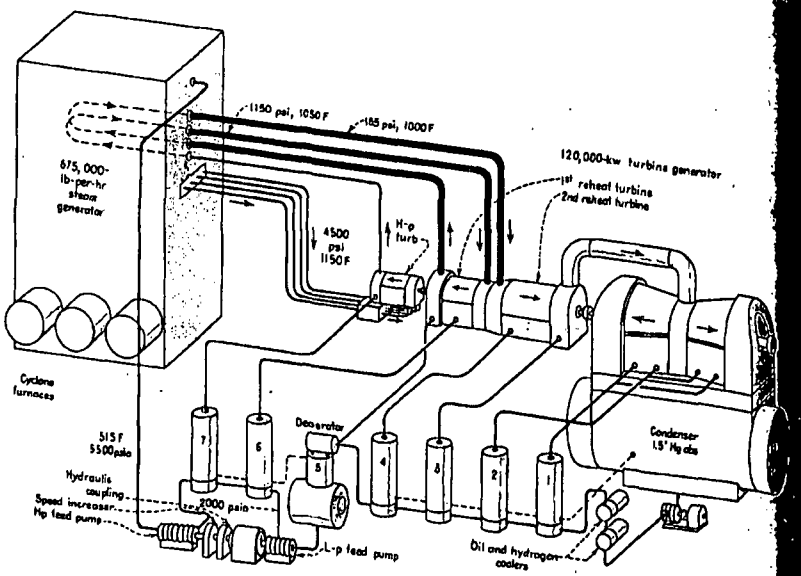
Projected Plant to Use Superpressure Stea



Station Heat Balance ...

Preliminary details of a new unit incorporating the advantages of very high steam pressures and temperatures were revealed recently by Philip Sporn, President, American Gas and Electric Service Corp, in an article in *Electrical World*, June 29, 1953, p 72-6. The new 120,000-kw unit will replace Unit No. 1 (40,000 kw, reheat) at the Philo Station of the Ohio Power Co. This unit was installed in 1924.

POWER's dimetric schematic sketch, above, shows the preliminary heat-balance arrangement being considered as a basis for design. It conforms closely to Cycle VI, which we were talking about on the preceding page. The plant will use double reheating. Steam conditions at the throttle and two reheat inlets are (1) 4500 psig, 1150 F (2) 1150 psig, 1050 F and (3) 165 psig, 1000 F.

New Features. The throttle pressure is just about double the highest steam pressure now being used in a few plants. This factor leads to adopting small-diameter tubing at the high end of the cycle to develop needed strength with an economy of materials.

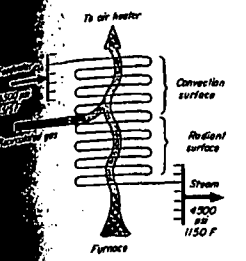
The supercritical steam pressure means elimination of conventional boiler designs. The steam generator needs no drums because boiling is not involved. *The unit utilizes the once-through principle of heating.*

The once-through feature, and utilization of cyclone furnaces, is expected to result in a very compact steam generator. Head room needed should be unusually low. The 1150-F throttle temperature demands using austenitic materials at the outlet end of the steam-generator tubing, steam leads, and front end of the h-p turbine. This temperature is 50 F above the highest now being used.

The 5500-psig feedwater pressure requires a new design of pump, perhaps new pump arrangement. Water conditioning and control of solids in the steam generator, turbine and other parts of the cycle will have to be watched carefully. There will probably be new concepts developed in the field of water treatment.

Seven stages of feedwater heating reflect the great economy of the *regenerative cycle with the high heat* used in this plant. Highest number of heaters used in a few modern plants today is eight. Deaeration will be performed in the fifth heater using 165 psig bleed steam from the main turbine.

While superior performance is achieved at the expense of more complicated equipment, this is offset by smaller over-all size of the steam generator, turbine and condenser. The sketches, *lower left and right pages* and 83, show relative sizes for Cycles I, III and VI as higher steam conditions and more complicated cycles are



Steam Generator ...

...called a Universal Pressure steam ...erator, will be built by Babcock & ...Wilcox Co. This will be the first time it is used in this country commercially. Although made up of many tubes connected in parallel, the unit acts as one long tube. It takes in 5500-psig ... at one end. Continuous heating ...expands the water as it travels through the tubing till it emerges as 4500-psig, 1150-F steam. There is no boiling. The ...pressure drop through the ...generator assures uniform distribution of water in the parallel tubes.

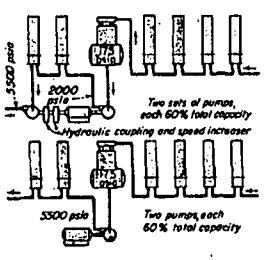
The entire h-p side of the steam generator must be made up of small-diameter tubing of considerable thickness. The composition varies with the temperature, carbon steel at the feedwater-inlet end, and stainless steel at the high-temperature steam-outlet end.

Three cyclone furnaces will burn crushed coal to fire this unit. Gas leaving the primary furnace will be cooled to 1900 F before entering the convection surfaces. Recirculated flue gas will be the coolant. This will prevent slagging of the convection surfaces.

Gas leaving the convection passes over a tubular-type air heater, the forced-draft fans and the stack. Part of the gas is recirculated before entering the air heater. No dust removal equipment will be installed.

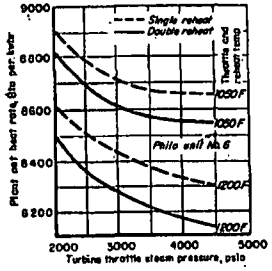
Discharge pressure of the feed pumps controls the steam-generator pressure. ...a pressure regulator at the turbine throttle controls the pump speeds. The main steam flow and temperature will control the firing rate. Dampers in the gas passes will control steam temperatures at the two reheat points.

To take care of starting and transient conditions recirculating valves with ... orifices will pass fluid to the deaerator from the steam generator. The deaerator, in turn, passes saturated steam to condenser.



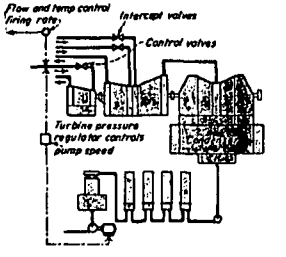
Feedwater System ...

... may use one of two schemes shown above. First scheme uses conventional barrel-type pumps at constant speed to develop 2000 psia through last two heaters. Variable-speed h-p pumps boost water out of last heater to 5500 psia. Each of two pump sets will have single-motor drive. Second scheme uses two pumps in parallel under deaerator to raise pressure directly to 5500 psia for flow through last two heaters of new design for these high pressures.



Performance ...

... depends a great deal on the steam conditions used in a steam plant. At 1050 F, with either single or double reheat, little gain in efficiency can be obtained at pressures above 4000 psig. Boosting the temperatures to 1200 F keeps efficiency rising with pressure increase to about 7000 psig. Philo Unit No. 6 is expected to run at 8500 Btu per kwhr. This is an over-all thermal efficiency of 40.1%, highest to be attained so far.



Turbine-Generator...

... to be built by General Electric Co will be a single-shaft machine running at 3600 rpm. A special h-p turbine in tandem with reheat turbines of the reverse-flow type and a double-flow l-p turbine make up the unit.

Steam at 4500 psi, 1150 F from the steam generator will pass through four steam leads to four pairs of stop and control valves at the front of the turbine. The throttling control valves vary steam pressure to the first stage of the h-p turbine. Intercept valves in each of the hot reheat lines will protect the turbine from overspeeding in event of a tripout.

Stop and control valves, steam leads, flanges and part of the inner shell of the h-p turbine will be made of austenitic materials. GE is now studying the rotor to see whether it may be made of ferritic materials with steam cooling, or whether the high-temperature parts must be made of more costly austenitic materials.

The h-p element will be of double-shell construction; the low-temperature parts of the inner shell and all the outer shell and fittings are to be of ferritic materials. From the first reheat point to the condenser the turbine will be built entirely of ferritic materials.

Two sets of reheat stop and intercept valves must be provided. A special initial temperature regulator will sense the steam temperature at the turbine throttle and will close the control valves if the temperature drops either too low or too fast. This will protect both the steam generator and the turbine by preventing a condition like water carryover should the fire be lost. The protection scheme is similar to that given by an initial-pressure regulator on a conventional boiler.

Because of limited cooling-water availability, and to use existing tunnels, the main condenser will be of 2-pass design. It must be completely tight.