E.H. SMITH

V 20-S

Scovill Tops Its Top

New 650-lb 750-F unit exhausts to 250-lb condensing turbines and bleeding-condensing "top" at end of 4000-ft high-pressure outdoor pipeline

▶ INITIAL OPERATION on June 1 of a high-pressure, high-temperature boiler and topping turbine forms a modern climax to nearly a century and a half of industrial-power history at the Waterbury, Conn., plant of Scovill Mfg Co. From its beginnings in 1802, this oldest of American brass factories has generated its own power; at first literally by "horse" power, then by water power, and, for almost a century, by steam. The story of this development, paralleling the growth of industrial power itself, will be found on page 92; here we are concerned with the record of continuous modernization necessary to keep pace with the changing demands of the last 25 years.

The sketch map, Fig. 1, shows the general outline of the mile-long Scovill works and the location of the east and west power houses. When the heavy loads of World War I came along, the West Power House contained two 500-kw vertical turbines, a 750-kw horizontal unit, and two 250-kw engine generators. Twelve chain-grate-fired boilers supplied steam at 125 lb to these prime movers and to six compound-engine-driven air compressors exhausting to the West Works heating system. The turbines were equipped with barometric condensers.

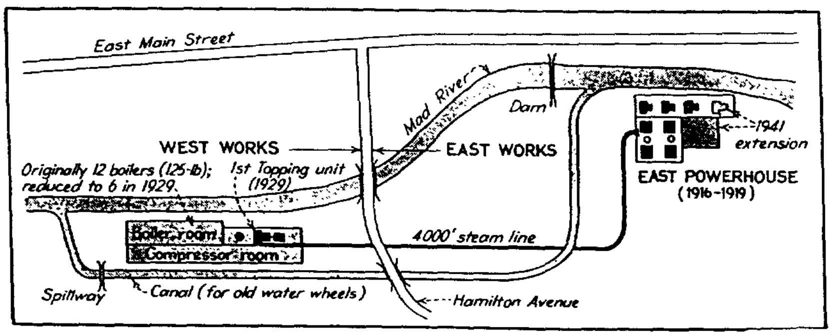

Fig. 1—Sketch map locates east and west power houses and pipeline

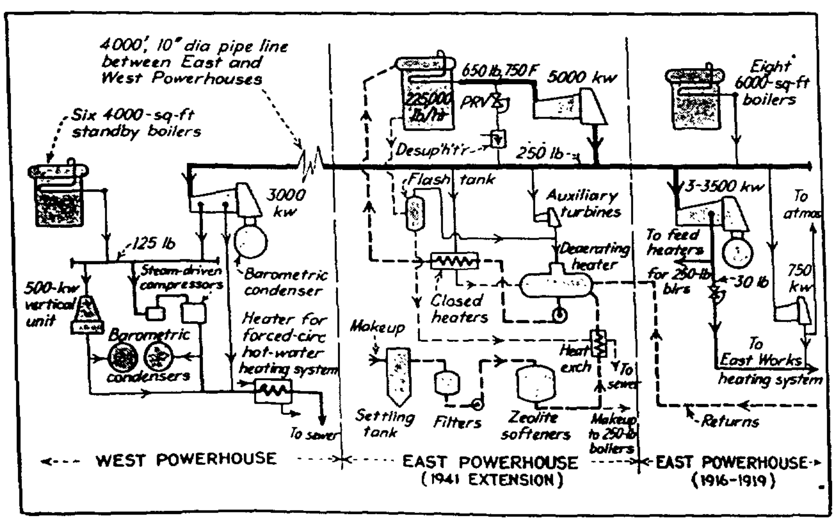

Fig. 2—Simplified flow diagram shows how new and old "topping" units fit into and modernize existing power and steam setup, making maximum use of each Btu

East Power House construction began in 1915 and two 3500-kw condensing turbines went into service late in 1916. A third similar unit was installed and the turbine room extended in 1919. The boiler house contained eight 6000-sq-ft boilers originally equipped with chain grates designed and built at Scovill's because of war-time difficulty in securing equipment. These were later replaced with Harrington traveling grates. It is interesting to note that this plant was designed for 250 lb at a time when only a few central-stations had dared to use such "high" pressure.

It was in 1929 that Scovill got its first "top": a rather unusual one, but nevertheless true to the topping principle. It had its origin in the desire to cut costs by centralizing steam generation in the more efficient East Power House. The answer was a 4000-ft pipeline connecting the two plants. One of the 500-kw vertical units and the 750-kw turbine were removed and replaced by a 3000-kw condensing turbine designed for 2-point extraction. The high-pressure extraction (125 lb) supplied the steam-driven compressors and the turbine thus "topped" these units.

The simplified flow diagram, Fig. 2, shows the ingenuity exercised in utilizing existing facilities. In winter, compressor exhaust supplies three closed heaters in the forced-circulation hot-water heating system for the West Works. The lower extraction point on the 3000-kw turbine and the exhaust from the remaining 500-kw vertical unit, kept for standby, supplement the compressor exhaust for hot-water heating. Steam from the 125-lb extraction point also supplies various auxiliaries, and industrial uses in the West Works.

Existing Condensers Used

The existing barometric condensers were all put to use, serving the new turbine, the 500-kw unit, the compressor engines and the auxiliaries, in summer. Under normal conditions, only enough steam goes to the condenser of the 3000-kw machine to keep the last stages cool, but the condenser makes available for emergencies the full turbine capacity. Not only did utilization of the old barometric condensers cost nothing beyond the small sums involved in re-connection, but their operation costs nothing, because gravity does the work. The canal shown on the map, running along one side of the power house, stands high enough above Mad River to maintain water flow without pumping.

The pipeline that takes the place of

PLAINTIFF'S EXHIBIT

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freezing point of water, namely 32 F. Few realize that the limit may be the acid instead of the soda-solution. Concentrated sulphuric acid of 1.835 specific gravity has a freezing point of about 30 F. This acid, however, will readily absorb moisture. If the stopple fits too loosely on the bottle, moisture absorption may be quite rapid, lowering the specific gravity of the acid. When reduced to about 1.77 specific gravity the freezing point will have risen to approximately 46 F, Fig. 1.

Soda-acid extinguishers should be kept at a temperature above 50 F. In exposed locations, the soda-acid extinguisher may be stored in an insulated and heated cabinet, shown in Fig. 2.

Turn Current Off

The soda-acid extinguisher also comes in a 40-gal size mounted on large carriage wheels. Due to the high conductivity of the stream from either the $2\frac{1}{2}$- or 40-gal size, it is desirable to label each with a red enameled tag reading "not to be used on electrical equipment until current is off".

The $2\frac{1}{2}$-gal soda-acid unit has a range of about 30 to 40 ft, and discharge takes place for about 60 seconds. The 40-gal extinguisher can throw a stream some 50 or 60 ft.

Where it is necessary to install extinguishers in unheated buildings and where it is not desired to use heated cabinets, an anti-freeze type is available. Some are so designed that, in addition to turning them over, it is necessary to bump them on the floor while in the inverted position to start the chemical reaction.

Although seldom found in modern power plants, water buckets and tanks should be mentioned. A rack containing five 12-qt fibre pails with tight-fitting lids is equivalent protection to one $2\frac{1}{2}$-gal soda-acid extinguisher, and each pail would thus be rated A-5: five pieces of equipment (water pails) per unit of floor area as protection for Class A fires. Sometimes a 50-gal covered tank, full of water, with five galvanized pails submerged in it is provided. Water in a full pail can be thrown about ten feet. Where low temperatures are encountered, the freezing point of the water may be depressed by adding three pounds of calcium chloride to each gallon of water. This will be satisfactory for temperatures down to about 10 F.

In parts of power plants such as storerooms, automatic sprinklers may be installed. These consist of a branched network of pipe of varying sizes, and outlets spaced 10 ft apart both longitudinally and transversely in the building, with additional outlets as required over special hazards. Each outlet is equipped with a sprinkler nozzle having a serrated cap arranged to spread the water being discharged. This device, known as a sprinkler head, is kept sealed by a piece of metal having a low melting point or by a tiny glass bulb filled with liquid which expands under heat. When the temperature reaches about 135 F, solder melts or the glass bulb breaks, releasing the water.

The static pressure should be not less than 15 lb at the highest sprinkler head. This may be provided by a gravity tank on the roof, by a hydro-pneumatic pressure tank in the pent house or by a fire pump.

Subsequent articles will deal with equipment for use on Class B and Class C fires in power stations.

TABLE II—SAFE DISTANCES FROM HIGH-TENSION CONDUCTORS

	Fresh Water	
Voltage	*$1\frac{1}{8}$-in. Nozzle*	*$1\frac{1}{2}$-in. Nozzle*
1100	6 ft	9 ft
2200	11	16
3300	15	22
5500	18	27
6600	19	29
11000	20	30
22000	25	33
33000	30	40

Stream from foam extinguisher has $2\frac{1}{8}$ times the conductivity of fresh water.
Well water has 15 times the conductivity of fresh water.
Stream from soda-acid extinguisher has 27 times the conductivity of fresh water.
Stream from antifreeze extinguisher has 36 times the conductivity of fresh water.
Sea water has 200 times the conductivity of fresh water.

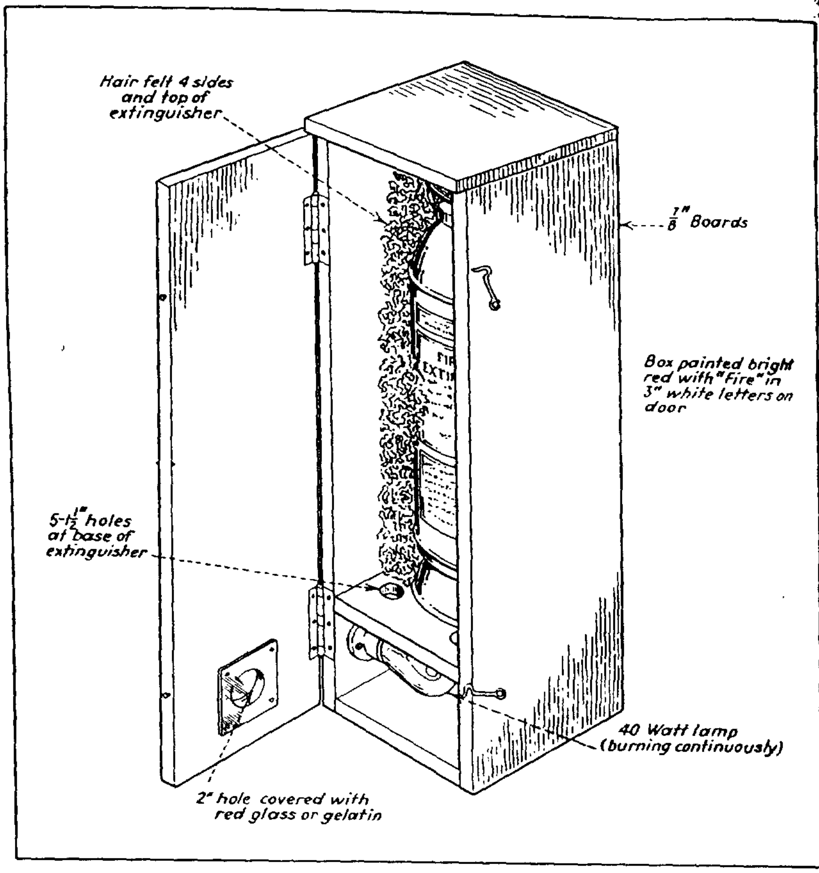

Fig. 2—Insulated cabinet for soda-acid units exposed to temperatures below 50 F.

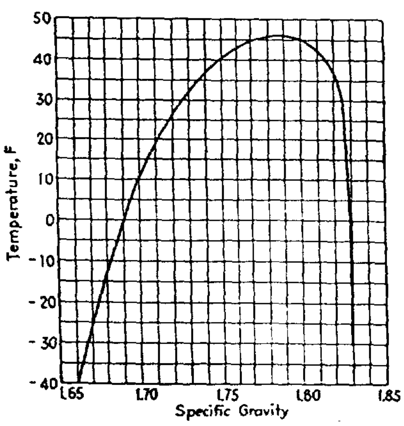

Fig. 1—Freezing temperature of sulphuric acid in soda-acid extinguishers

the old boilers (6 were removed and 6 converted to oil for standby) is 10-in. in diameter and designed for 500-lb pressure. The 3000-kw turbine is also designed for 500 lb. with a dummy high-pressure wheel, so that the system can operate at the higher level if future circumstances so dictate.

Design of the pipeline, which is all outdoors, aimed at reducing maintenance and possible trouble to a minimum. Covering consists of an inch of high-temperature insulation, 3 in. of 85% magnesia, and sheet-metal lagging. At selected points, rigid anchors divide the line into sections and, between these points, expansion loops and slip joints (where space isn't available for loops) take care of thermal expansion. Single-roller guides on straight runs and double-roller guides at bends support the line between anchors. All bearings on the rollers are chromium plated and require no lubrication. Minor changes in design, and installation of Alemite fittings for packing lubrication, have reduced slip-joint maintenance to the vanishing point. The entire line pitches toward the West Power House and contains not a single drain, all condensate coming out in a large combination separator and receiver at the west end. By eliminating need for handling coal and ash at two places, and three shifts of boiler-room labor, installation of the pipeline paid its $150,000 cost in about 4 years.

"Topping the top" represents the lat-

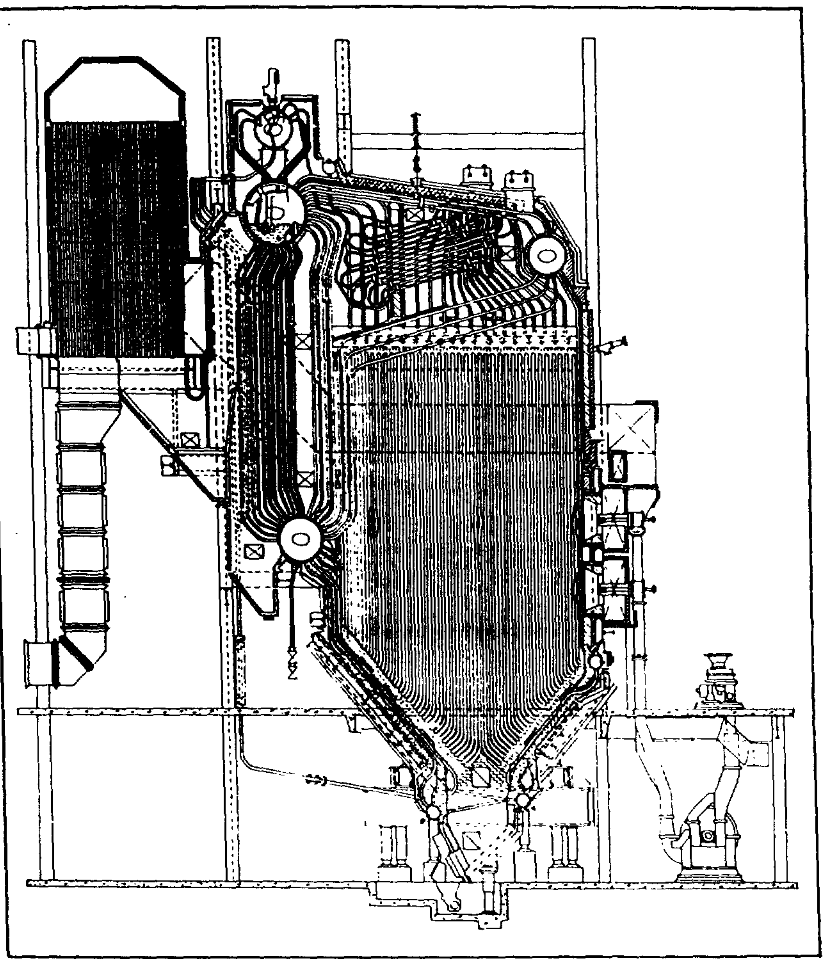

Fig. 3—New 4-drum pulverized-coal-and-oil-fired high-pressure boiler

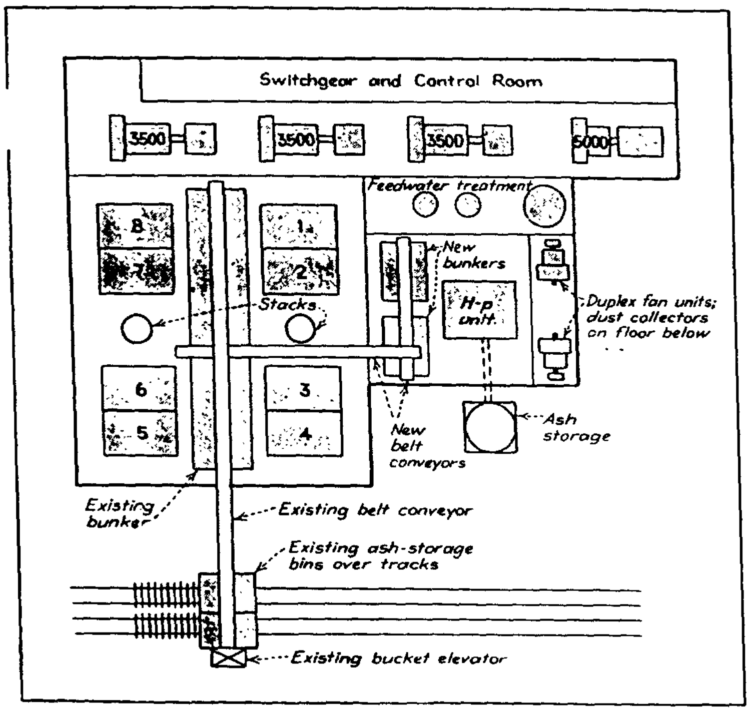

Fig. 4—Rough plan of East Power House, showing new boiler and turbine and modifications to coal- and ash-handling systems

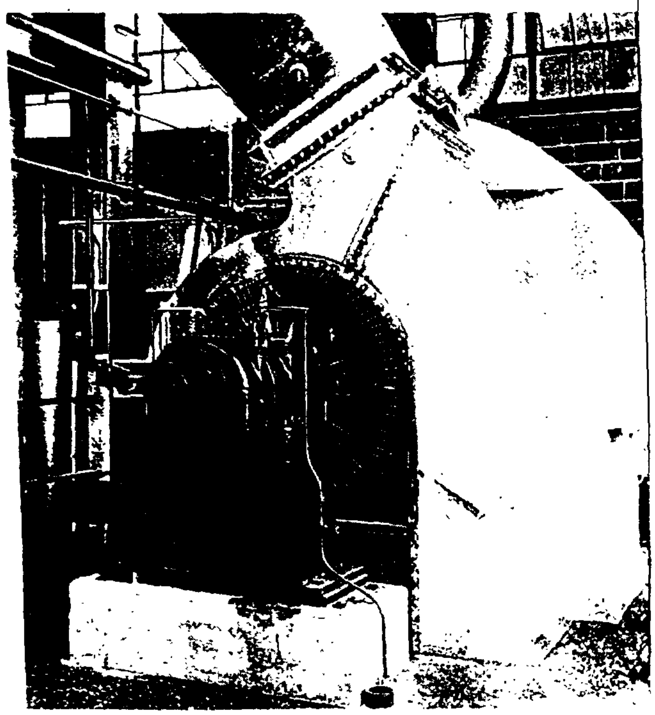

Fig. 5—One of two duplex turbine-driven forced- and induced-draft units equipped with vane control

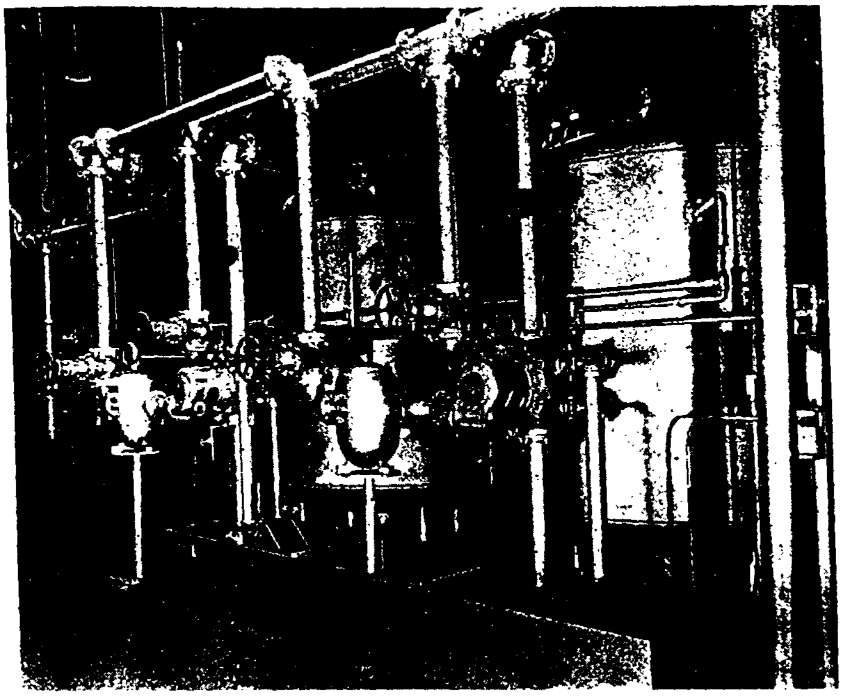

Fig. 6—Two sodium-cycle zeolite softeners in makeup-water-treatment bay

est but certainly not the last step in the continuous modernization of Scovill power facilities. Just as was the case 25 years ago. the present emergency has thrown a tremendous load on the works and the farsighted planning that lead up to the new high-pressure installation is now paying dividends. All steam from the 225,000-lb-per-hr, 660-lb 750-F boiler goes through the new 5000-kw turbine which exhausts at 250 lb to the East Power House turbines and to the pipeline. Several of the older boilers operate to supplement the 250-lb steam from the turbine exhaust.

The new boiler, a 4-drum, bent-tube unit, has a fully water-cooled furnace, with a dry hopper bottom. designed for a conservative heat release of 21,300 Btu per cu ft per hr. The horizontal-flare pulverized-coal burners are fitted with oil burners; on oil the unit has a rated continuous capacity of 250,000 lb per hr. Two 146,000-gal steel tanks (above ground) store oil for emergencies or for use when price is favorable. A combined preheating and pumping unit takes care of oil handling.

Coal comes to the plant by rail from New Haven, where tidewater shipments are received from Norfolk. The coal-handling system for the 250-lb boilers consisted of unloading pits under the tracks, with a bucket elevator to raise the fuel to a belt conveyor running through the center of the boiler house and over the bunkers (Fig. 4). To utilize the existing facilities and avoid unnecessary investment. a belt conveyor was installed at right angles to the existing conveyor. fitted with an unloader at the junction point. Still another conveyor was installed over the new bunker, which parallels the old.

Ash handling in the old plant was unsatisfactory by modern standards: stokers discharged below into cars which were wheeled to the bucket elevator to raise the ash to bins over the tracks. Ash from furnace- and dust-collector hoppers of the new unit goes into a completely enclosed pneumatic system which transports it to an elevated silo just outside the boiler-house extension. A dustless unloader discharges the ash to trucks driven under the silo.

Two forced- and two induced-draft fans serve the new boiler. These are duplex units: a single turbine drives one forced- and one induced-draft fan. mounted on a single shaft. The automatic combustion-control system regulates turbine speed and adjusts the fan vanes. The forced-draft fans discharge through a tubular air heater; induced-draft fans pull gas through the air heater and through multiple-cyclone dust collectors located on the boiler-room floor below the fan platform. The induced-draft fans discharge to the nearest of the existing steel stacks.

In common with many industrial power plants, the new Scovill unit must contend with a high percentage of makeup. During the summer, this runs close to 50%. Raw water comes from Mad River and goes first to a settling tank, where ferric sulphate and soda ash aid in flocculation and coagulation. After passing through gravity filters, the water goes to two zeolite units operated on the sodium cycle. A heat exchanger, fed by condensate from the continuous-blowdown flash tank, raises makeup temperature before it goes to the deaerating heater. Sulphite addition at this point controls residual oxygen and caustic raises pH.

The two boiler-feed pumps, one motor- and one turbine-driven, take their suction from the deaerating heater and discharge through two closed heaters, in parallel, to the boiler. Makeup for the 250-lb boilers comes from the new water-treating system, just ahead of the blowdown heat exchanger. Exhaust from auxiliaries supplies the deaerating heater; steam from the 250-lb system goes to the closed heaters; and steam bled at 30 lb from the 3500-kw turbines supplies the open feedwater heaters in the old boiler house.

Under normal conditions, the high-pressure boiler runs continuously at rated load (225,000 lb per hr), and all this steam goes to the topping turbine. A reducing valve and desuperheater will supply 250-lb 600-F steam to the low-pressure system in case the turbine is out of service. About 50% of the topping unit's exhaust goes to the 3500-kw turbines. In winter, two of these units will handle the load after the topping unit does its share, but in summer, with higher river temperatures. two units cannot swing the job and three must run. Channeling the discharge for some distance downstream. to prevent recirculation to the nearby intake, has improved circulating-water temperature conditions. The remaining 50% of the new turbine's exhaust goes into the long pipeline to supply the older "topping" turbine in the West Power House and through that, air compressors, steam-driven auxiliaries, and industrial uses.

Electric-Furnace Supply

The 750-kw turbine-generator shown in the diagram of the East Power House (Fig. 2) was moved there from the West Power House to provide emergency protection for the electric-furnace supply. Normally, these furnaces receive current from the regular bus and feeders, but in the event of failure anywhere along the line, the 750-kw unit will feed the furnaces directly by a separate cable. Its capacity is adequate to keep the furnaces at "holding" heat and prevent the costly freezeup that would follow complete service failure. Condensing facilities would'nt pay for this standby service, so the exhaust goes to atmosphere or to the heating system, depending on the season.

The new boiler has met all demands with full satisfaction. Tests and preliminary operating experience indicate that the guaranteed efficiency can be exceeded by a slight margin. Loads in excess of 250,000 lb per hr have been carried, with coal, and it is believed that the unit could produce 300,000 lb per hr if needed. There is a slight tendency to slagging at loads above the continuous rating and because this unit must operate without shutdown during the entire heating season, it is considered safer to hold it to rated capacity.

More H-P Boilers Planned

If demands for steam and electricity continue to grow, space will be made in the 250-lb boiler house for additional high-pressure units, by removing several old boilers. Because of space limitations, these units will be smaller than the present high-pressure boiler, probably about 150.000 lb per hr, each. The first of these projected units will replace the present No. 7 and 8, and the second No. 5 and 6. This will permit utilizing the existing steel stack.

More pressing than steam and power demands at the moment is demand for compressed air. New machines and production methods using air in large quantities and a large volume of building construction have caused the compressed-air load curve to climb at a rate several times as fast as the steam and power curves. When this situation began to grow acute, the main source of compressed air was the six steam-engine-driven compressors in the West Power House, totalling 8700 cfm capacity. In addition, two 750-cfm motor-driven units and three portable gasoline-engine-driven units (two owned and one rented) fed the growing load. When opportunity presented, a new 1500-cfm motor-driven compressor was literally snatched from the market after the original purchaser had decided not to install the unit.

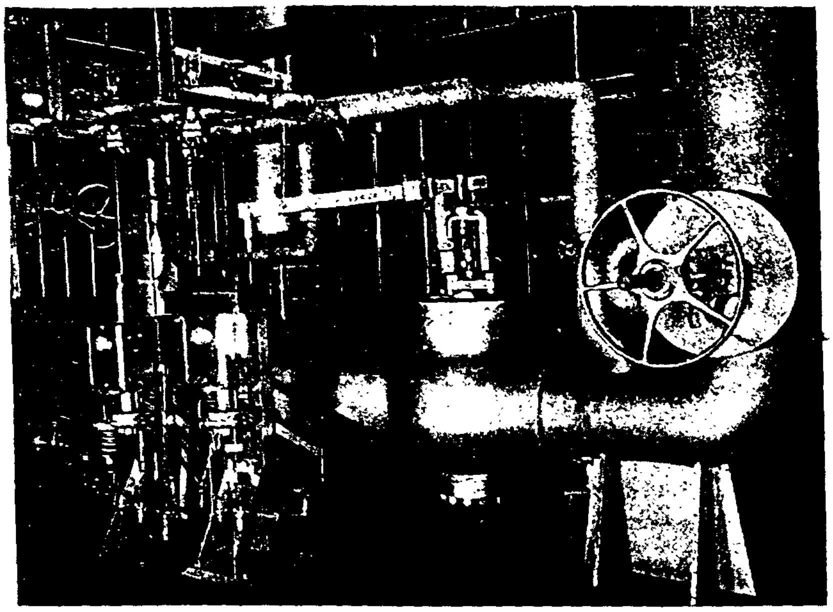

Fig. 7—Reducing and desuperheating station for new high-pressure unit

This acquisition helped, but not enough, and five more portable compressors were obtained, two bought and three rented. With the situation still tight, the high-pressure valve gear on one of the engine-driven compressors failed. To tide over the repair period, the operators hit on the ingenious solution of connecting the high-pressure supply to the low-pressure cylinder. Calculations showed the cylinder would take it, and it did, at least long enough to permit repairs to be made. Delivery of a 5400-cfm unit, driven by a 1000-hp motor and two and a half times as big as any single unit now installed, will relieve the situation, still rather tight.

Operation of this and other Scovill plants is under the general direction of A J German, chief engineer, and Leo Niekerk, asst chief engineer. William Carew and William Foley supervise the East and West Power Houses, respectively. The new installation was designed and installed by Scovill engineers with Messrs German and Niekerk in direct charge and under the general supervision of Hugh L Thompson, consulting engineer of the Scovill Mfg Co. Shepard T Powell was consultant on the water-treatment system.

Principal New Power-Plant Equipment

Scovill Mfg Co, Waterbury, Conn.

Steam-Generating Equipment:

Boilers and water-cooled furnace....................Riley Stoker Corp
One 4-drum unit; 225,000 lb per hr of 660-lb 750-F steam, continuous rating on coal; 250,000 lb per hr continuous on oil; 84% guaranteed efficiency at 225,000 lb per hr; 12,500 sq ft boiler surface; 6812 sq ft waterwall surface; 19 ft 6 in. furnace width; 2465 cu ft furnace volume; 21,300 Btu per cu ft per hr heat release; 3030 sq ft superheater; and steel-clad insulated setting
Air heater, 33,000 sq ft....................Riley Stoker Corp

Boiler Auxiliary Equipment:

Pulverizers, coal feeders, 2 each....................Riley Stoker Corp
Burners, 4, horizontal flare....................Riley Stoker Corp
Oil burners (combined with p-c units)....................Engineer Co
Coal scales, 2....................Richardson Scale Co
Combustion control....................Hays Corp
Soot blowers....................Diamond Power Specialty Corp
Gage glasses....................Diamond Power Specialty Corp
Non-return valve....................Crane Co
Feedwater regulators (Copes)....................Northern Equipment Co
Boiler heat insulation....................Johns-Manville

Draft Equipment:

Forced- and induced-draft fans, duplex, 2 units....B F Sturtevant Co
Single Westinghouse 635-hp, 250-5-lb, turbine drives, through a reducing gear, one 40,000-cfm forced-draft fan and one 68,000-cfm induced-draft fan; both fans equipped with vane control
Dust collectors, multiple-cyclone....................Buell Engineering Corp

Fuel and Ash-Handling Equipment:

Belt conveyors, 2....................Link-Belt Co
They connect existing coal-handling equipment to new bunker
Oil pump and heater unit....................Engineer Co
Ash and flyash removal system....................United Conveyor Corp
Pneumatic collection system from furnace hoppers and dust-collector hoppers; storage silo; and dustless unloader

Feedwater System:

Boiler-feed pumps, 2....................Ingersoll-Rand Co
300,000-lb-per-hr 3600-rpm units, one driven by a 500-hp Westinghouse motor, the other by a 450-hp, 250-5-lb turbine
Closed feedwater heaters....................Griscom-Russell Co
Deaerating heater....................Permutit Co
Makeup-water treatment system....................Permutit Co
Settling tank with motor-driven agitator and ferric sulphate and soda-ash feed tanks and pumps; two 10x14-ft gravity filters; two zeolite softeners with brine and salt-storage tanks; sulphite and caustic distributor; phosphate-dissolving tank and pump; two booster pumps
Continuous blowdown system....................Permutit Co
Flash tank; blowdown heat exchanger

Power-Generating Equipment:

Turbine-generator....................General Electric Co
Throttle pressure 650 lb, backpressure 250 lb g; 5000-kw, 3600-rpm, 0.8-pf, 3-phase, 60-cycle, 4600-volt, completely enclosed, air-cooled generator

Miscellaneous Equipment:

Meters and instruments....................Bristol Co, Hays Corp, Cochrane Corp, Foxboro Co, Sentry Co
Piping and valves....................M W Kellogg Co
Backpressure relief valves....................Consolidated Safety Valve Div
Pressure-reducing valve, desuperheater....................Republic Flow Meters Co

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Troubleshooting Fluorescent Lamp

Dean M Warren and L R Keiffer, General Electric Co l experts, tell of a few things that happen in the life of rescent lamp, their causes, and how to find the trouble

▶ WITH THE INTRODUCTION of fluorescent lamps three years ago, man-made lighting came another step closer to competing successfully with daylight, both as to quantity and quality. Through this development, not only has artificial daylight been made available at high efficiency, but 50 and more footcandles are now being provided without the discomfort from heat usually associated with high intensities.

This new source, as explained in POWER (Nov 1940, p 74), differs radically from filament lamps both in appearance and characteristics. New information is being accumulated daily regarding the operation of fluorescent lamps under various conditions. As found by actual experience, such factors as temperature, drafts, and various circuit conditions will materially affect lamp performance. Another source of possible difficulties lies in improper equipment connections. These may cause peculiar lamp behavior, sometimes difficult to understand. A knowledge of these factors should enable the user to obtain the most satisfactory service from the lamps, and also enable him to take corrective measures in cases where unusual operating conditions prevail and impair lamp service.

Lamp Sizes

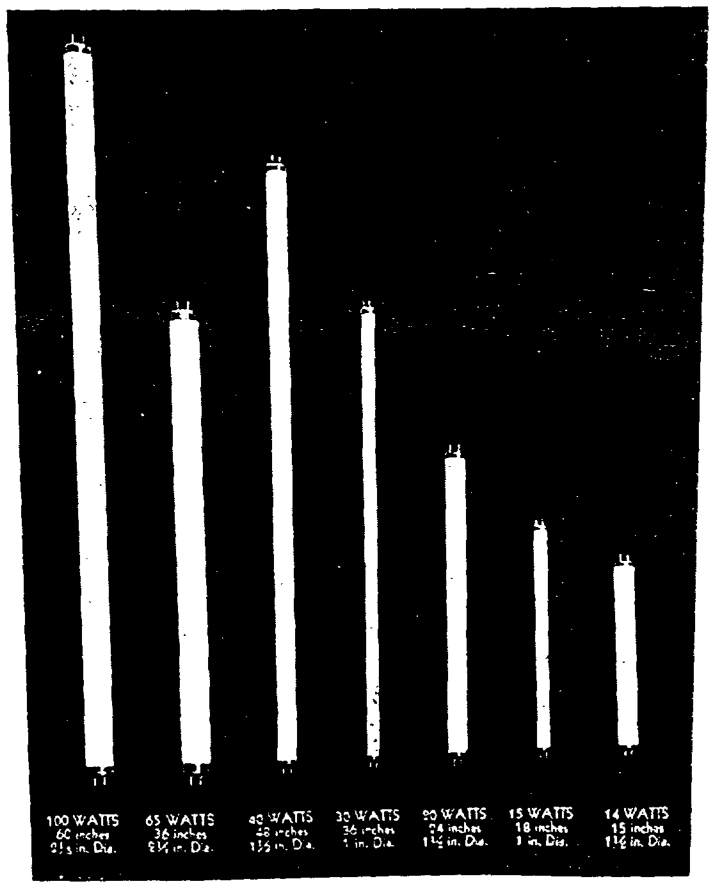
While the common lamp sizes have a design life of 2500 hours, it is not unlikely for some lamps to fail at the end of a few hundred hours, while still others may operate for 5000 hours. With respect to life-expectancy, however, the lamps conform to the same general pattern of the filament lamps, in that the early failures are offset by those of long life. This provides the average of 2500 hours.

Normal lamp failure occurs when the active material with which the electrodes are coated is used up. Most of this material dissipates during starting, giving rise to the observation that switching the lamp on or off repeatedly is an important factor in lamp life. On the average, however, if the lamps are on 3 or 4 hours at a time, they should live their rated life. When the lamps blink on and off at the end of life, it signifies that the active material is gone and that the lamps should be replaced.

It is normal for the lamp to show a general darkening throughout the tube, but unless a long-life lamp is compared to a new one, the difference isn't noticeable to the casual observer.

Sometimes a mercury deposit collects at the lamp end and is confused with normal end blackening. This deposit is most common in the 1-in. diameter lamps and often becomes evident soon after the lamps are lighted. Generally it evaporates after a short time of operation, although it may reappear after the lamps have cooled. Sometin mercury spot will appear or a cold object is allowed to li for a short time. If this sho near the center section of may not evaporate. Rotatin 180 degrees in the socket is ful when this situation

Blackening at the ends of a normal occurrence. Howe blackening occurs early in is a signal that the lamp under abnormal conditions occurs it can be generally



Some typical lamps now in use. Wattages and sizes are manufac