University of Rochester Installs New Heating Plant

Relocation of Buildings on New Campus Necessitates the Construction of a Modern Heating Plant—Water-Tube Boilers Supply High-Pressure Steam to Buildings—Complete Set of Measuring Instruments Installed—Plant Used as Testing Laboratory by Engineering Students

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THE University of Rochester has recently completed the construction of its new School of Medicine and Dentistry and the Strong Memorial Hospital on the outskirts of Rochester, several miles from the old campus, which is in the heart of the city. Funds have recently been acquired to construct and endow new buildings for the College of Arts and Science, on a site adjoining the Medical School, the plan being to leave the old campus to the College for Women. These plans were all projected when the new heating plant was designed and had considerable influence on its layout.

The boilers consist of two units of 4,000 sq.ft. each and one of 2,000. All are built for 200 lb. working pressure, so that turbo-generators can be installed later if desired. At present steam is generated at 100 lb. gage for heating and electrical energy is purchased.

Building of Ample Size

The building, which is of steel and brick construction, is large enough to house another 7,000 sq.ft. of boilers to take care of the arts buildings when erected. It so happened that it was possible to erect the boiler house midway between the Medical School and the proposed college site, and at the same time place it close to two railroads and on a paved thoroughfare. This gives a central distribution point and permits carload delivery of coal, as well as easy access for trucks.

The floor area is 95x55 ft. and the height 63 ft. The basement floor is 15 ft. below the firing-floor level, thus giving about 14 ft. clear headroom. This permitted placing most of the piping on the basement ceiling, leaving the firing floor clear of obstructions.

Coal is dumped directly from cars into a conveyor or into a 1,000-ton storage bin, as may be desired. The conveyor carries the coal to the bunker over the firing floor, and a crusher is provided for use if necessary. A weighing larry feeds the stoker hoppers.

It is planned for the near future to distribute coal from this plant to the other two plants operated by the university. For this purpose a telescoping chute, shown in the background of Fig. 2, has been provided to carry coal from the overhead bunker through the north wall of the building into motor trucks. Careful estimates indicate this plan will effect a considerable saving, and it has the further advantage of giving all three plants exactly the same fuel, thus eliminating one variable in comparing operating efficiencies. An automatic sampler will be installed, since the university buys coal on specification and frequent samples must be taken.

Two mains, 10 in. and 6 in. in diameter, respectively, carry the steam at boiler pressure to the main valve room in the basement of the school, through a waterproofed reinforced-concrete tunnel, 6x7 ft. inside and about 700 ft. long. This is shown in Fig. 1 and its course is indicated by the white line between the plant and the buildings in Fig. 4. In the basement the pressure is reduced to 1 lb., or less for heating, and to 25 lb. for water heaters, laundry, sterilizers, etc. The two mains are, of course, cross-connected so that the demand may be supplied from either one or both. High pressure is carried directly through the basement to two of the farther buildings, the Nurses Dormitory and the new Municipal Hospital, to the latter of which the university sells heat.

Low-pressure returns are taken back to the boiler-house basement through an 8-in. main, then lifted by the vacuum pumps to an air-separating tank 30 ft. above the firing floor, from which they flow by gravity to the open heater. The latter is on a platform about 15 ft. above the floor. High-pressure returns are handled by a separate line and are fed directly to the heater by a small pump.

Three feed pumps are installed—a large reciprocating unit and a turbine-driven centrifugal, each capable of handling the ultimate capacity of the plant, and a small reciprocating unit for summer loads.

Modern Pipe Joints

All pipe joints in the tunnel are oxyacetylene-welded. Loops are provided at either end, and two expansion joints are placed at equal intervals along the length of the tunnel.

The plant is equipped with underfeed single-retort stokers, forced draft being supplied by an engine-driven fan in the basement. Air for the fan may be taken from outdoors or from the boiler room as desired. In addition, there are a motor-driven fan of large capacity, and a small turbine-driven high-speed blower for use with the small boiler alone.

Regulation is of the balanced-draft type and is almost entirely automatic. The system has been very satisfactory except on days of high wind, when it is somewhat too sensitive.

It has been the practice so far to carry the load on one of the large units up to about 150 per cent of rating. Above this the small boiler is cut in to carry the excess.

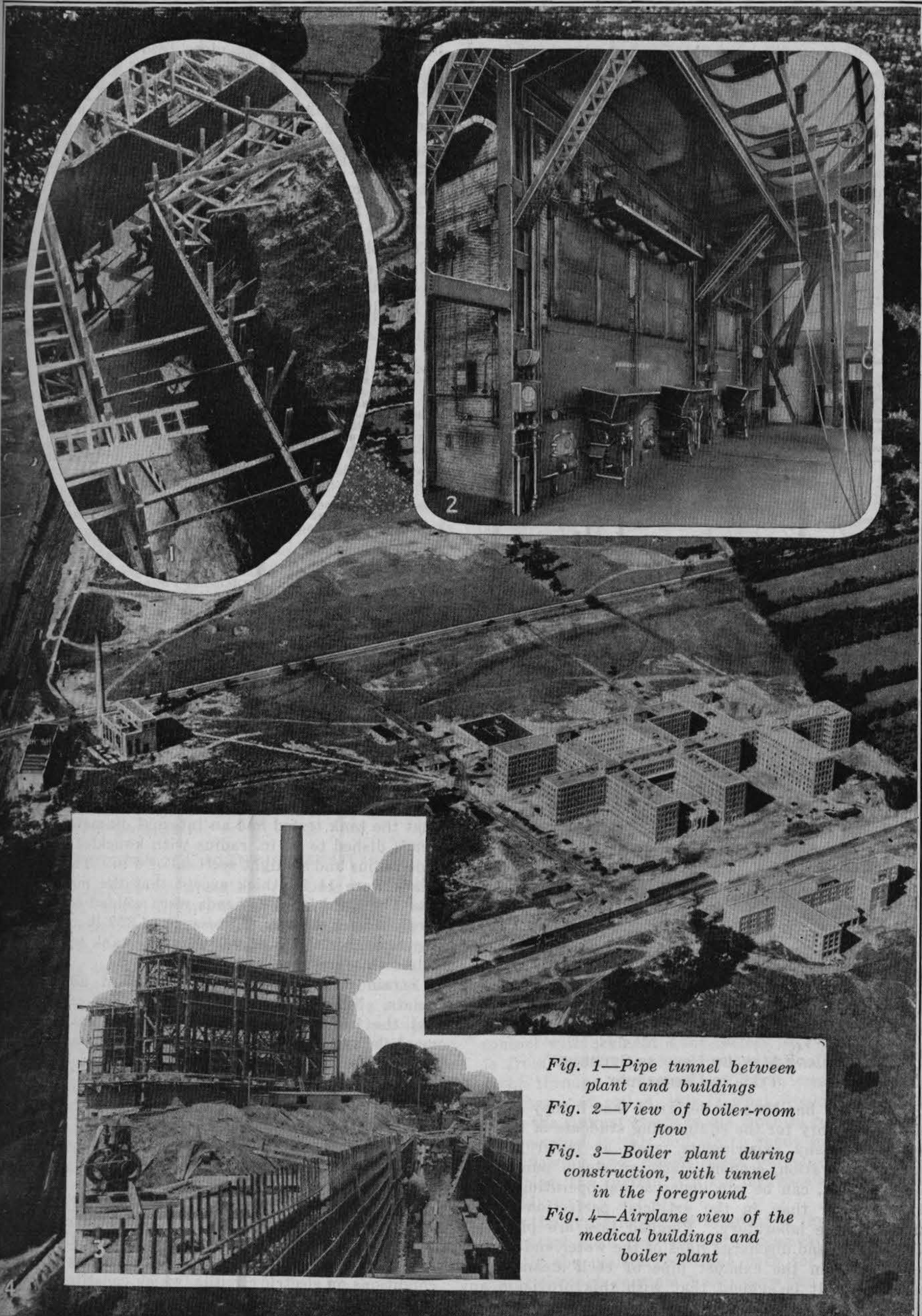

Fig. 1—Pipe tunnel between plant and buildings

Fig. 2—View of boiler-room flow

Fig. 3—Boiler plant during construction, with tunnel in the foreground

Fig. 4—Airplane view of the medical buildings and boiler plant

This has been necessary for a few hours only on the coldest days, with outdoor temperatures of 15 deg. or less. With the available fuel this scheme has been found to give the best average results. The crew of the plant is unusually interested and willing to experiment to find the most economical method of operation.

Devices are installed for measuring the following items: Weight of coal; weight of feed water; weight of steam from each boiler; flue temperature; temperature of water to heater; temperature of water to boilers; temperature of outdoor air; draft in furnace; draft in uptake; pressure in wind-box.

Readings of most of the instruments are taken every hour, water, coal- and steam-meter readings being in-

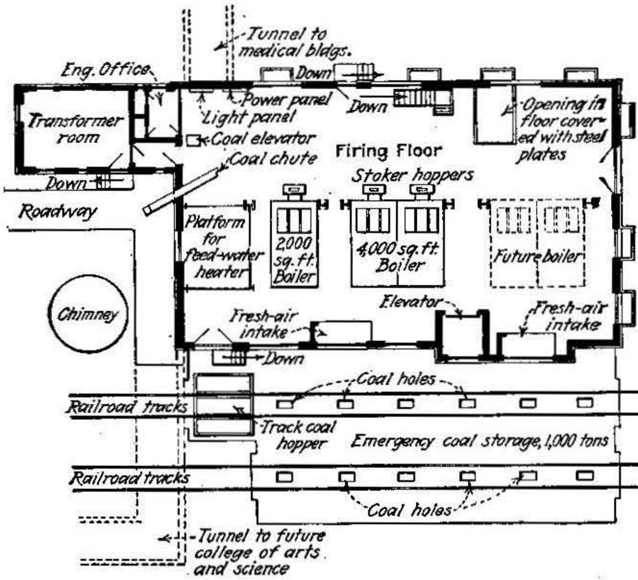

Fig. 5—Floor plan of the boiler house

serted at the end of each eight-hour shift. Averages and totals are taken from this sheet for filling in a small card, which is forwarded to the Department of Mechanical Engineering, where monthly summaries are made and average monthly efficiency computed. Copies of the monthly summaries are sent to the treasurer of the University and to the chief engineers of the respective plants.

Incidentally, the evaporation per pound of coal for each shift is chalked up on a blackboard in the boiler room. These figures, of course, cover too short a period of time to be very accurate, but they form the basis for enthusiastic rivalry between shifts, which has done much to increase the efficiency of operation.

Plant May Be Used as Students' Testing Laboratory

The plant has been so designed that it may be used as a laboratory for the engineering students of the university. Many experiments, such as boiler testing, meter calibration, economy tests on steam pumps and engines, etc., can be run under actual operating conditions rather than in the artificial perfection of the usual college laboratory. Plugged tees are placed in the suction and discharge lines of the water end of each pump and in the exhaust pipe of each steam-driven auxiliary. It is evident that with this provision any alterations in piping incident to testing can be made without interrupting the operation of the plant, and with a minimum of expense. In addition, steam sampling tubes have been inserted in the outlets of the boilers and in the steam pipes feeding the auxiliaries, thus permitting the determination of quality wherever necessary for heat-balance computations.

This plan might well be followed more generally by power-plant designers. Very few small or medium-sized industrial plants can be arranged for testing without difficult and expensive piping changes and possible interruption of operation. On the other hand, the expense of providing for such changes during the construction of a plant is negligible.

The plant was designed by Allen S. Crocker, consulting engineer, associated with Gordon & Kaelber, architects for the Medical School and Hospital group of buildings.

PRINCIPAL EQUIPMENT OF UNIVERSITY OF ROCHESTER HEATING PLANT

Boilers, type	Horizontal water-tube
size (sq.ft. surface)	Two 4,000 and one 2,000
make	Babcock & Wilcox Co.
Stokers, type	Underfeed single-retort
make	Combustion Engineering Corp.
Draft fans, make	B. F. Sturtevant Co.
type	1 steam-driven, 1 motor-driven and 1 turbine-driven
Draft regulation	The Engineer Co.
Heater, type	V-notch open
make	The Cochrane Corp.
Feed pumps, type	2-duplex steam and 1 turbo-centrifugal
make	Worthington Pump & Machinery Corp.
Coal and ash handling equipment	Brown Hoisting Machine Co.
Ash hoppers	Allen-Sherman-Hoff Co.
Chimney	Radial brick, 192 ft. high
Chimney builder	Wm. Summerhay's Sons, Inc.
Soot blowers	Diamond Power Specialty Co.
Boiler meters	Bailey Meter Co.
Draft gages	Bailey Meter Co.

A Test of Dished Heads

In view of the fact that the stresses in dished heads have long been the subject of controversy, designers and inspectors of boilers and other pressure vessels will be interested in the results of tests made by the Union Carbide Corporation and reported by S. W. Miller in the August issue of *Mechanical Engineering.*

Details cannot be given here, but it may be noted that the tank tested had an internal diameter of 60 in., heads dished to 60 in. radius with knuckles of 6 in. inside radius and straight sections of 6 in. The shells and heads were $1\frac{1}{8}$ in. thick except that the manhole head was $1\frac{1}{4}$ in. thick. The heads were welded to the drum. Designed for a working pressure of 337 lb., corresponding to a fiber stress of 9,000 lb., the tank was tested to triple this pressure and stress.

Strain measurements were taken at all important points. No distortion was found in any of the welds, but the heads gave evidence of overstrain near the manhole and at the knuckles. The test was concluded by raising the pressure to 930 lb., at which point the head broke diagonally through the manhole. Mr. Miller draws the conclusion that the A.S.M.E. Code formulas for the radii of knuckles and the dimensions of manhole heads are unreliable and should be the subject of further study.

Water systems have such a comparatively low ground resistance that where they are in proximity to pipe or plate grounds, it has been found that a difference of potential will exist between the two during ground fault conditions on electric circuits, which constitute a hazard to life unless the water system and pipe or plate grounds are connected together.