metal surface. The total superficial expanse of the building is 27,710 sq. ft., and the total actual surface, counting the metal in the corrugations, is 34,658 sq. ft.

The building is heated by a Green's hot-blast heater, consisting of an engine-driven centrifugal fan drawing through a "Positivflo" heater made up of six sections of four rows of pipe each, the sections measuring 7 x 8 ft. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. There are altogether 6,816 lineal feet of 1-in. pipe in the heater, or 2,272 sq. ft. of heating surface. The air is distributed throughout the shop by circular sheet iron conduits with outlets directed down into the zone occupied by the workmen.

The fan and heater had been running for about two hours when the first readings were taken at 8:30 a.m., and the temperature of the shop was maintained constant until readings were discontinued at 11:30 a.m.

During the test the fan was run at 258 r.p.m., receiving 22,416 cu. ft. of air per minute, figured to 50° Fahr., the air actually being received by the heater at 73° Fahr. and delivered from the fan at 156° Fahr. The temperature of the steam in the heater was 212° Farr. The temperature of the air delivered from the farthest outlet was found to be 141½° Fahr. Under these conditions the temperature of the building, measured 3 ft. from the floor, was 66° Fahr., and measured in the gallery 70° Fahr., the temperature out of doors being 15° Fahr.

For the determination of the total heat two methods were employed. First it was calculated from the amount and rise in the temperature of the air passed through the heater, and, secondly, from the condensation in the heater. For the latter purpose the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 b.t.u. per hour, and by the condensate method 2,029,730 b.t.u. per hour.

Using the air figures, the average rate of heat transmission through the superficial area of the building, that is, not counting the corrugations, was 1.42 b.t.u. per square foot per hour per degree difference, and using the steam value 1.38 b.t.u.

According to Professor Woodbridge's figures for the rate of heat transmission through the windows, the result obtained for a window on southern exposure equals 1 b.t.u. per square foot per hour per degree difference, which, however, is to be increased 15 per cent. for eastern exposure and 25 per cent. for western exposure, or in the present case an average of approximately 20 per cent. Figuring the window surface as 1.2, the value for the corrugated iron, figuring superficial area only, is 1.5, or figuring the whole surface of the iron 1.13, that is, less than an equivalent amount of glass surface. According to the engineers the explanation in that case may be that the corrugations in the iron protect the surface to a certain extent, that is, that the rate of heat transmission per square foot of actual surface through corrugated iron is less than it would be if transmitted through a flat iron surface.

Using the value obtained by Grashof's method for the glass windows, namely, 0.958, the value for the actual iron surface equals 1.19, but, in the opinion of the engineers, on the basis of this formula, there would be no reason for expecting any such difference between the iron and the glass.

Allowing for the many undeterminable conditions, it is suggested that in calculating the heat supply for buildings of this kind provision be made for a coefficient of transmission of 2 b.t.u. for the whole wall and roof area.

The coefficient of transmission through the surface of the hot-blast heater in this test was 9.41 b.t.u. per square foot per hour per degree average difference in temperature between the air and the steam, figured by the ordinary arithmetical method in which the average difference in temperature between the steam and the air is assumed to be the difference between the steam temperature and the mean of the air temperature on entering and leaving.

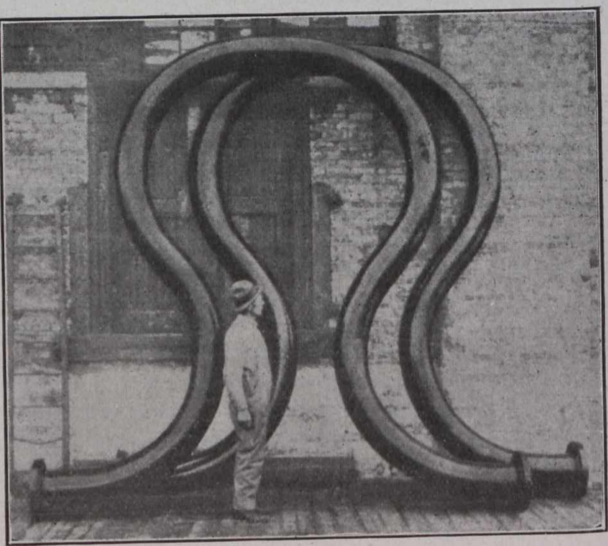
Figured according to the logarithmic formula, which takes account of the fact that the air arises more rapidly in temperature in passing over the first rows of tubes than in passing over the later rows of tubes, the value is 10. The mean physical velocity of the air through the heater was 1,210 ft. per minute.

In a subsequent test, with air entering at 72° Fahr. and leaving at 166° Fahr. and steam at 213° Fahr., in which the velocity of the air was 760 ft. per minute, a coefficient of transmission of 7.5 (logarithmic) was obtained. Ten and seven and a half are in the ratio of 0.64 powers of the respective velocities, that is, the coefficient did not vary directly as the velocity, as frequently asserted. If instead of mean velocity flow in pounds of air per minute through the heater is used, which amounts to the same thing as velocities reduced to a standard temperature, the coefficients are found to be in the ratio of the 0.62 powers of the rates of flow.

## LARGE PIPE BENDS.

The illustration shows two "N" bends each containing 34 feet of 10-inch full weight pipe, made for the city of Lethbridge, Alberta, and ordered through the Winnipeg, Manitoba, branch of Crane Co. These bends measure 11 feet 10 inches, face to face, and 10 feet 11 inches, centre to centre in height. They have a 3-foot 2-inch radius with four 10 by 17½ extra heavy No. 295 E. welded flanges. The weight of each bend is 1,570 pounds.

The bends are part of the main steam piping in the Lethbridge power plant. One bend is in a vertical position,



**Large Pipe Bends for Lethbridge, Alberta.**

supported from the roof truss; the other lies horizontally, supported from I-beams in the fan gallery. The working steam pressure of the line is 160 pounds, with superheat of 130 degrees. The engineer of the plant preferred to take care of expansion with these large N shaped bends rather than with sliding expansion joints. The specifications called for piping having a tensile strength of 58,000 pounds to the square inch, an elastic limit of 34,000 pounds per square inch, elongation of 22 per cent. in 8 inches, and a reduction in area of 55 per cent. Owing to the large size of the bends they had to be welded at the top of the bend, there being about a foot of straight pipe at that point.