

Quick speed driving pinion, 20 teeth.  
 Slow speed wheel on countershaft, 66 teeth.  
 Quick speed wheel on countershaft, 58 teeth.  
 Spur pinion on countershaft, 13 teeth.  
 Spur wheel on main axle, 52 teeth.  
 Driving wheels, 5 ft. 6 in. in diameter by 16 in. on face.  
 Leading wheels, 3 ft. 6 in. in diameter by 9½ in. on face.  
 Main axle, 5 in. in diameter.  
 Countershaft, 3½ in. in diameter.  
 Front axle, 3½ in. in diameter.  
 Slow travelling speed, 1.32 miles per hour.  
 Quick travelling speed, 2.64 miles per hour.  
 Maximum working steam pressure, 150 lbs. per sq. in.  
 Grate area, 6.5 square feet.  
 Total heating surface, 150 square feet.  
 Amount of coal carried, 10 cwt.  
 Amount of water carried, 140 gallons.

#### WORKS OF THE BETHLEHEM IRON COMPANY.

By A. L. HOLLEY and LENOX SMITH.

In the present article it is proposed to briefly describe the two new blast furnaces, Nos. 5 and 6, in some detail, excepting their compound blowing engines.

These furnaces differ in many details from the usual type of furnaces of their class in the United States, and they combine many valuable results of experience. They were designed by and constructed under the superintendence of Mr. John Fritz, who is a famous authority abroad as well as at home, in connexion with the iron manufacture.

Fig. 4 is an elevation, partly in section, of the pair of stacks and of the stoves, boilers, &c. Their position, as well as that of the blowing engines *a, c, d, e, f, g, h*, and the pumping engines *i, j, k, l*, are shown by Fig. 5 on the present page. The compound engine *a* is not yet completed. The two furnaces, and also No. 2, are run by the compound engine *c* and the two engines *d* and *e*, all of which are of the same power. The air cylinders are 80 in. by 80 in., and the revolutions are 24 per minute.

The peculiarities of general arrangement, such as widely separating the stacks (225 ft.) and putting the engines on the other side of the stock house, have been well studied. The stacks are separated in order to get the stoves *m, p*, Fig. 5, and the boilers *r, t*, close to them in a convenient manner, and also in order to have the supplementary stoves *n* and the supplementary boilers *s* convenient to both furnaces. The

intention was also to get the necessary stock floor around each furnace in a long house (451 ft. by 61 ft.) running, with its straight railways, parallel to the line of furnaces, rather than to get this room less centrally by a narrow house running, with its necessarily curved railways, in the other direction. The stock hoists at *u* and *v* command within a very short distance a large floor space, under two railways. The stacks are also separated in order to keep the casting-houses far apart for the sake of ventilation, and to make better space for the boilers. The heat of a double casting-house, where stacks are close together, is a serious matter in a warm climate. The gas connexions from the stacks to the stoves and boilers are not longer than they would be under other usual arrangements.

The furnace stacks are of the following dimensions: No. 5 is 70 ft. high and 17 ft. 2 in. in diameter at the bosh. No. 6 is 70 ft. high and 18 ft. 6 in. in diameter at the bosh. It will be observed (see Fig. 4) that instead of being enveloped by an outer shell of plate iron the stack is enclosed by a system of rings and vertical bars of iron which have a uniform width of 9 in. throughout; the lower courses are 1 in. thick, and the courses decrease in thickness toward the top to ½ in. The vertical bars are also similarly reduced in thickness toward the top of the furnace, their thickness at the bottom being 1 in. The joints of the rings and bars are 2 ft. apart from centre to centre at the base of the furnaces. This forms a stronger system of bracing than an exterior shell of plate iron of equal weight, as it does not, like the latter, tear apart in detail; besides which it possesses important advantages in other respects over a plate-iron shell, especially in respect of the facility with which repairs may be made. The outer walls of the furnaces are ventilated by means of two holes situated in each of the spaces between the bracing, and which extend through the masonry surrounding the loam lying next to the lining. The outer walls are similarly traversed by vertical holes. By this means overheating of the outer walls, and consequent straining of the bracing, is prevented, and the exact point where gases may be escaping is readily detected. In case the lining of the furnaces becomes thin, the outer masonry may be cut into between the bracing, and the damage quickly and effectually repaired at the least possible cost.

The arrangement of the tuyeres also combines some novel and practical features. Besides the four or five working tuyeres, auxiliary or "fighting" tuyeres are placed about 16 in. or 18 in. above the former, and fitted in embrasures specially intended for them. These tuyeres are ready for

immediate use in case of need, and derangements in the working of the furnaces are thus provided against. The furnaces also have spare cinder notches, which are fitted with Lurman's closed front, and may be used at a moment's notice in an emergency.

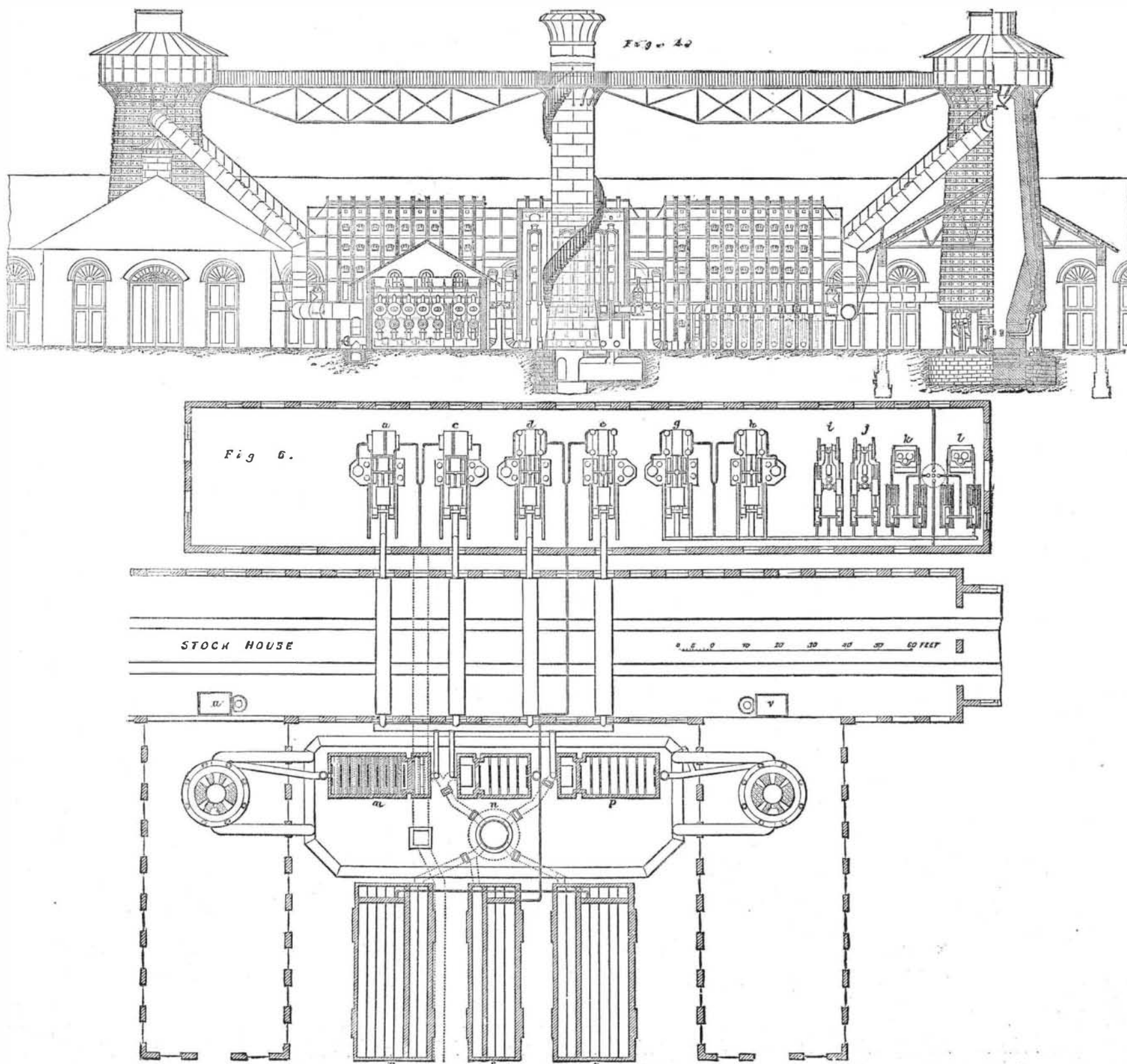
The engines are placed far away from the dust of the furnaces, and are separated by a tight wall from that of the stock house, in order to save the excessive wear which always accompanies dirt. Carrying steam this long distance in 16 in. pipes thoroughly lagged results in very slight condensation and reduction of pressure. The air pipes from the engines to the stoves are made large enough to form the air reservoirs—a convenient and cheap arrangement in every respect.

The boiler and boiler-house are shown in longitudinal section by Fig. 6, and in cross section by Fig. 7, and the boiler-house in side elevation by Fig. 8. The boiler setting is peculiar, and it is perhaps the only one that completely provides for expansion in every direction without subjecting the boiler to injurious strains. Each boiler is suspended by sixteen brackets, and these are upheld, as shown in Figs. 6 and 7, by four equalising beams which rest on two heavy girders extending across the building. The two main batteries *r* and *t*, Fig. 7, contain seven boilers each. The upper shells are 70 ft. long by 40 in. in diameter. The lower shells are 30 in. in diameter. The supplementary battery *s* consists of five boilers.

Each main hot-blast stove has 80 pipes, the supplementary stove has 50. The pipes are 20 ft. high and 8 in. inside diameter. They are made circular in cross-section instead of being flattened, since at a good heat and at the least pressure, often over 10 lb. per inch, necessary for anthracite, they tend to become circular, and hence they last better if so made at first. The general arrangement of the stove and its bracing is shown by Fig. 4 and Fig. 9.

The chimney shown in Fig. 4 is one of unusual size, being 176 ft. high and 11 ft. in diameter, the base being 16 ft. in diameter. The stack is lined with inferior firebrick 9 in. thick, and is cased with a shell of plate iron ½ in. thick at the base of the stack, and ⅜ in. thick in the upper portion.

Those who are familiar with the difficulties of working anthracite furnaces on irregular ores will appreciate the manner in which the Bethlehem furnaces are run, when it is stated that the No. 1 furnace was run seven years without blowing out, and made 70,000 tons of pig on one lining.—*Engineering.*



BLAST FURNACES OF THE BETHLEHEM, PA., IRON WORKS.