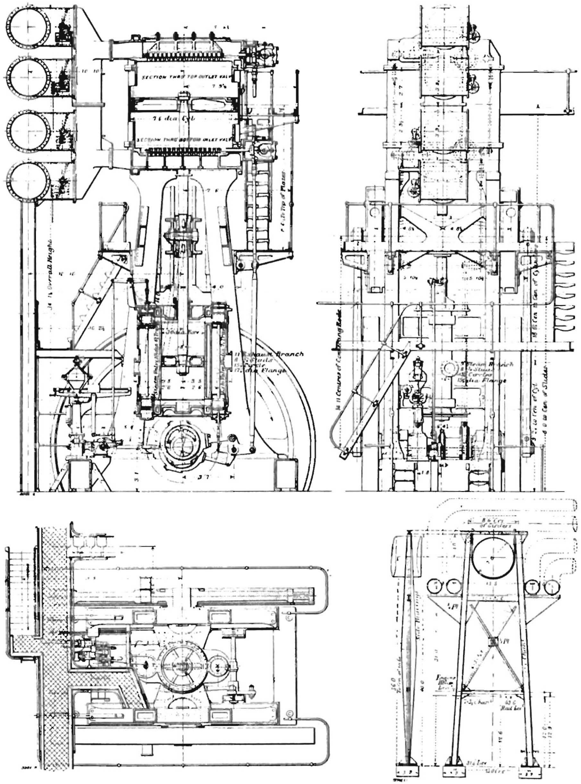

FIG. 7.

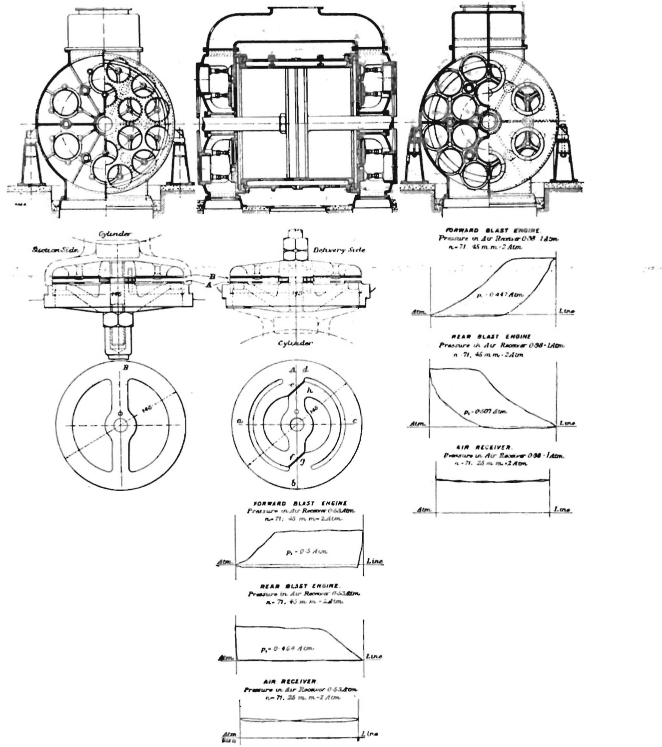
Cylinder
Suction Side
Delivery Side
FORWARD BLAST ENGINE
Pressure in Air Receiver 0.98 - 1 Atm.
REAR BLAST ENGINE
AIR RECEIVER
Atm.
Line

FIG. 8.

In Fig. 9 will be noted the round port holes right round the cylinder, in the blower in the background. The advantage claimed for this construction, is that the air completely fills the cylinder with practically no drop below the atmosphere pressure. It would appear, however, that the moving of the cylinder would absorb a considerable amount of power, as a cylinder 76in. in diameter, such as they are building, cannot be very easily lubricated.

Blast furnace gas-engine-driven blowers are finding favour in certain parts of the world, more especially in Germany, the home of the large gas engine, and members have no doubt read the many recent papers delivered by leading authorities before the British Engineering Socie-

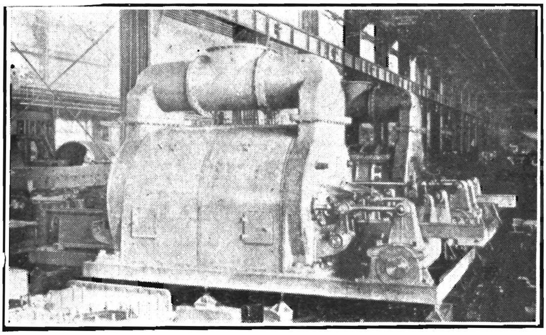

FIG. 9.

ties, and have noted the very divergent views the discussion of these papers elicited; some authors deplored the backwardness of the British Iron Masters in not at once dispensing with medium of steam for blowing power.

It is hard to credit this alleged inertia of the alert minds that control these great British industries, but up to the present no finality has been reached regarding the very important question, and to-day huge concerns continue each in their own way, to instal gas-fired boilers and steam blowing plants or blast furnace gas-engine plants. It can be very safely said, that neither of the two systems can claim every advantage.

The initial cost of the gas plant is very much higher than steam. This is very largely on account of the greater number of standby machines found necessary for a gas plant, and in such processes as we are considering, the most essential consideration is to instal machinery capable of continuous duty.

The result of a "shut down" of a blast furnace air supply is almost unthinkable, and if the value of the products recovered from the gas plant is not sufficient to meet the extra expense, then the more reliable, if slightly less efficient, steam-driven blower, is likely to hold its own.

As in all such competitions for supremacy, the result has been a very healthy one for both systems. The steam driven plant has received a greater amount of consideration than it previously did, from an efficiency point of view, and entirely new systems such as the turbo blower have been evolved, and with them the exhaust steam turbo blower, which utilises L.P. steam, that otherwise in most cases would be totally wasted.

The gas engine is having more attention paid to it, and many of the Continental designs have been improved upon, resulting in a gas engine on the lines of steam engine design, in such essential parts as valve gear, etc., which all tend to make a more reliable running plant.

The largest gas plant of this type is at the famous Lackawanna Steel Works, Buffalo, where Koerting gas engines drive the blowers; each engine is rated at 2,000 H.P., and the blowers, when driven at 60 revs. per minute, deliver 20,000 c. ft. of free air up to 30 pounds per sq. inch pressure.

Two large Nurnberg plants were recently installed at the Barrow Hematite Iron and Steel Co. Works, Barrow, for the same purpose, made by the Lilleshall Co., England.

The engine develops 1,100 B.H.P., having two double-acting cylinders each of 35in. diameter, the stroke being 43¼in., and is direct coupled to a blower of 85⅝in. diameter. When running at 90 revs. per minute, the blower is designed to deliver 26,000 c. ft. of free air per minute at 8 pounds pressure.

It will in all probability be a number of years before we see in Australia the blast furnace gas blowing plant, as it is only in ironworks of large capacities that the initial cost can be warranted.

The necessary quantity of blast furnace gas required by a gas engine, large enough to supply all the furnaces with air, is only a small percentage of the total gas available; and unless the whole, or a good percentage of the whole, can be utilised for other purposes, such as generating electricity or for general power purposes, it is very doubtful whether the necessary costly plant would pay for its installation.

Considering further the second type of plant, that is the reciprocating, as adopted for the more common purpose here in Australia, of copper and lead reduction, the capacity of such plant as required for copper smelting and converting, is relatively small compared with that for iron blast furnaces, and by far the largest plants installed in this country for this purpose, are those at the Mount Lyell Smelting Works. They consist of Turbo Blowers supplying 36,000 c. ft. of free air per minute, against a pressure of 64oz. per sq. inch, but these are only about one-tenth the capacity of the largest iron blast furnace steam blowing plants.

The chief use to which reciprocating engine-driven blowers have been put in Australia, is for copper matte Bessemerising.

The size of converter vessels is gradually increasing, but the necessary blowing power is small in comparison to that required for smelting operations, as usually (at least in Australia), one or two vessels only are converted at the same time.

A size which appears to be in favour here, is a blower capable of blowing 3500/4000 c. ft. of free air per minute against 10/15 pounds pressure, representing about 200 A.H.P., and this is found sufficient for the largest converter vessels in this country, namely, 10ft. 6in. x 7ft. 6in.

Such plants, running at moderate speed, are economical in steam consumption, and since converting is not the practically continuous operation that furnace smelting is, the air valves, etc., can be examined without great inconvenience.

The reciprocating plant in use at Mount Lyell has steam cylinders of 16in. x 24in. x 30in., the air cylinders being 30in. x 30in., speed 72 revs. per minute.

TURBINE-DRIVEN BLOWERS.

The two names to be associated with this type are Parsons and Rateau.

The steam turbine was at first developed for driving electrical machinery. Successively, it has gradually embraced all the chief engineering duties, including propulsion of ships, driving air compressing machines, and centrifugal pumps. Its latest adaption is the driving of rolling mills through double helical gearing, about which a most interesting paper was recently read in England.

The advantage of the Turbo Blower over other systems, closely follow those of Turbine plants, compared with the reciprocating engine. It possesses the advantage of the Roots type in having no valves, but is superior to it in greatly increased efficiency, and having no internal parts subject to wear, no gear wheels of any description, and can be made in sizes of any capacity desired.

Compared to the highest class reciprocating blower, it has proved itself equal, if not better, in efficiency.

The dimensions of the plant being very much less, the weight, cost and floor space required, are proportionately small.

The foundations are required only to support the dead weight of the machine, and no bolding-down bolts are necessary, since no stress whatever is transmitted to the floor.

No internal lubrication is required, as they do not contain metallic parts in moving contact. This results in a very large saving per annum.

The air flow is a perfectly steady one. This overcomes the expense of regulating receivers, which, at the best, only partially overcome the difficulty with reciprocating plants.

With Turbo Blowers, the volume of free air inhaled depends upon the speed of revolution, and the pressure against which the blower is discharging. This allows for a large range of duty, not so easily obtained with a reciprocating plant, especially in the case of the gas engine driven blower.

A large margin is always left in Turbine plants for overload, the normal speed being capable of an increase of

25%, which allows 25% to 50% more air being delivered, or an increase of 50% in pressure. This greater elasticity of the Turbo plant is one of its chief advantages.

As in the case of centrifugal pumps, no evil results to the machine if by accident an outlet valve is closed when the machine is doing full duty.

From an attendance point of view, one man can easily look after half a dozen large machines; since no oil can is required, the whole bearing and control valve system being under forced lubrication.

When Parsons first took up the manufacture of blowing plant, he adopted a horizontal flow type of machine, such as

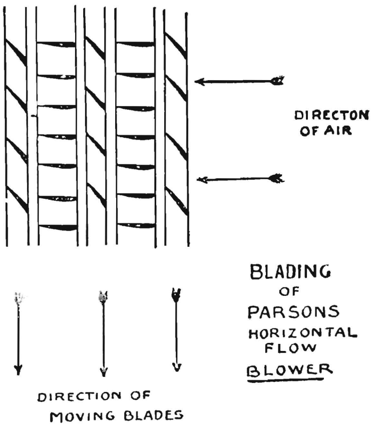

FIG. 10.

described in the paper read by the author before this Association in 1907, but which he proposed to briefly describe again.

The Turbine was direct coupled to a laminated steel drum, on the peripheral surface of which were inserted rows of vanes very similar to those in the Parsons' Turbine, excepting that instead of the working side of the blade being curved as in the Turbine. it was made flat.

Fig. 10 shows the general principle.

The first vertical row shows the rotating blades, the second the stationary air guide vanes, and so on, It will be understood that each moving row is essentially a fan, and to procure the necessary pressure, it is just a question of putting sufficient number of rows or fans in series.

Very good results were obtained from these machines in Australia, as in other parts of the world.

The first application of the principle for blast furnace work was at the Farnley Iron Works, near Leeds, this machine running at 5,200 R.P.M., and delivering 11,300 cubic feet of free air at a pressure of 3 pounds per sq. inch.

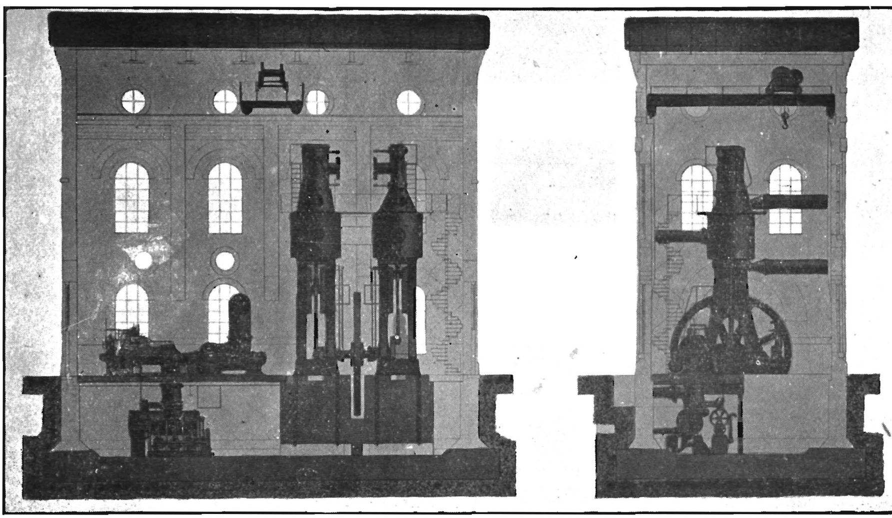

FIG. 11.

No more striking example could be found, than that illustrated in the next figure, No. 11, which shows this plant and the one it replaced. The old horizontal reciprocating engine revolved at 18 revs. per minute; was 75ft. overall in length, and 12ft. high.

The Turbo plant was 15ft. long and 4ft. in height, the flywheel of the old plant being several times the weight of the complete Turbo blower, although the latter had a duty largely in excess of the reciprocating plant.

Regarding the height of building required to house the two systems, it will be noted the height at which the crane must be placed to serve a reciprocating set compared with what is actually necessary for a Turbine plant.

Fig. 12 shows a typical Turbo Blower lay out. Fig. 13 shows a section of a Turbo plant of this design, which has been constructed in sizes of large capacity, numerous plants having been constructed to deliver 35,000 cubic feet of free air per minute against a pressure of 20 pounds per sq. inch, as a maximum, and some to deliver 50,000 c. ft. at 18 pounds, which is roughly equivalent to 4,000 air horse power.

The plant at the works of G. & C. Hoskins, Lithgow, which is the blowing plant of highest capacity in these parts, reaches a maximum efficiency figure of 56%, when delivering 20,000 c. ft. of air at a blast pressure of 22 inches of mercury.

The largest Copper Furnace Blowers in Australia are at the Mount Lyell Works, Tasmania—each machine being capable of delivering 36,000 c. ft. of free air at 64oz. per square inch pressure.

Fig. 14 gives the test figures of one of the blowers at Mount Lyell, the consumption being 23.5 pounds of steam

C. A. PARSONS & CO. TURBO BLOWER No. 1123.

Supplied to Mount Lyell Mining & Railway Co., Tasmania.

OFFICIAL TRIAL 4TH OCTOBER, 1907

Air Inlet Temperature	...	67 deg. F.
Lbs. per square inch	...	4.25
Blower Pressure	...	8.7 in. Hg.
Blower Temperature	...	145 deg. F.
Drum Pressure	...	8.5 in. Hg.
Drum Temperature	..	142 deg. F.
Orifice	...	174 sq. inches area
Quantity of free air	...	36,300 c.ft. per min.
Pitot Tube	...	7.9. in. W.G.
Revs per min.	..	3,450
Stop Valve Pressure	...	129 lbs.
P_1	...	81 lbs. per sq. inch
Barometer	...	29.875 in.
Vacuum	...	27.8 in. Hg.
Superheat	...	99 deg. F.
Steam Consumption per hour		14,360 lbs.
True Adiabatic A.H.P.	...	23.5
Equivalent B.H.P.	...	1,090
Lbs. of Steam per B.H.P. hour		13,

FIG. 14,

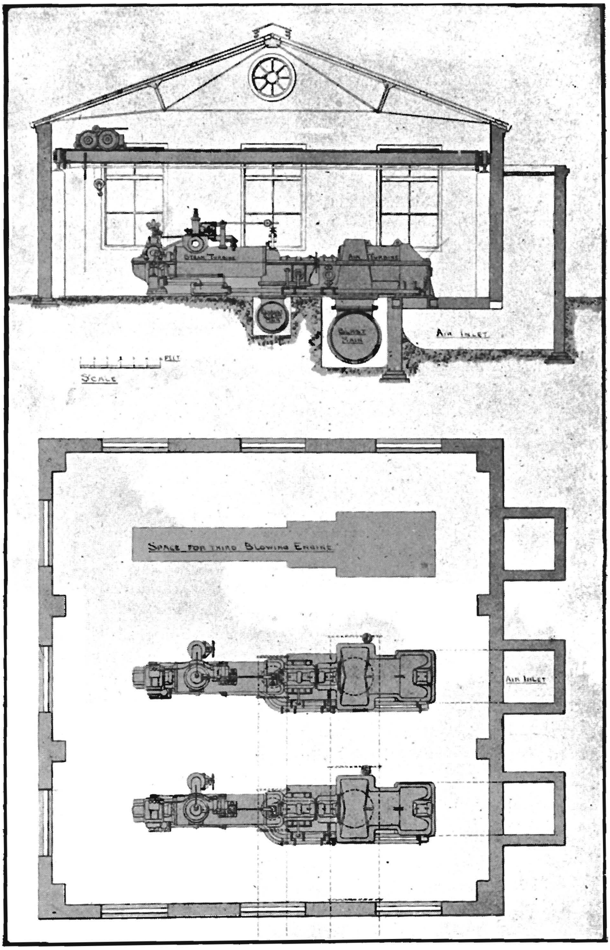
Steam Turbine
Air Turbine
Blast Main
Air Inlet
Feet
Scale
Space for third Blowing Engine
Air Inlet

FIG. 12.

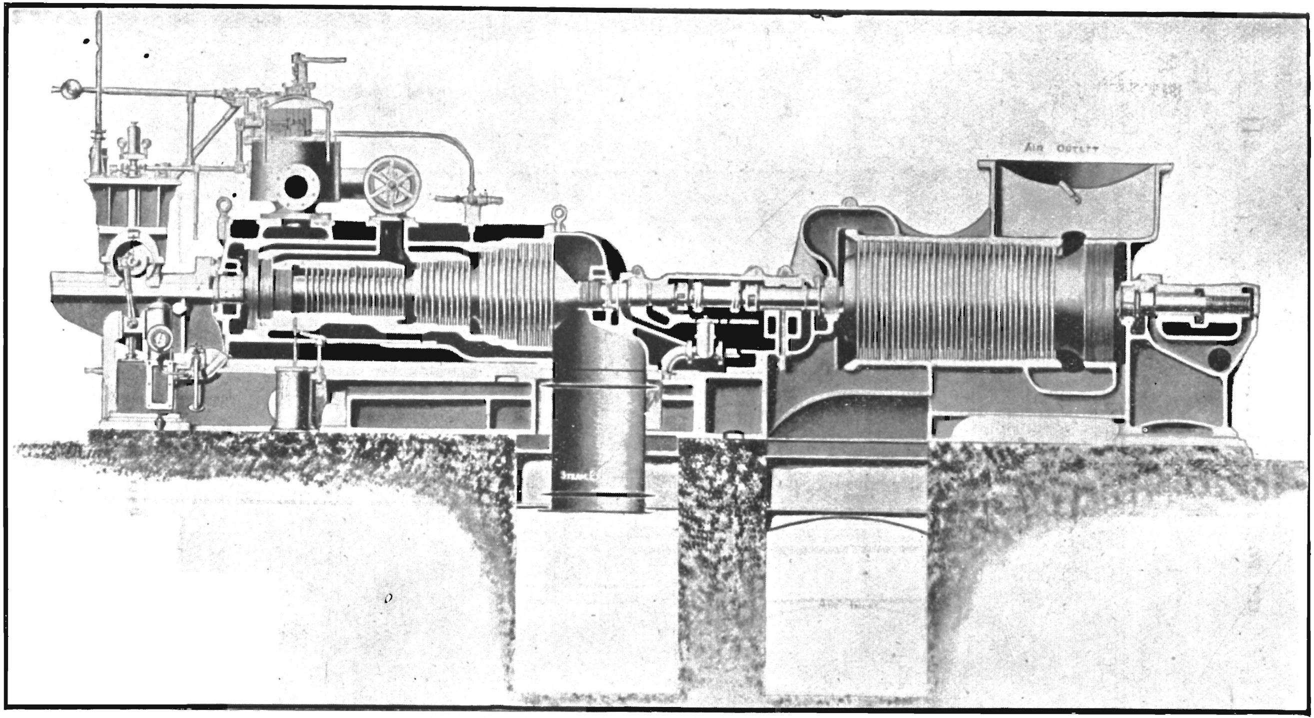

FIG. 13

per true adiabatic air horse power, the equivalent B.H.P. being 1.090, the pounds of steam per B.H.P. hour being equal to 13.

The overall thermal efficiency, according to the Rankine cycle from the above figures is equivalent to 37.5%.

The foregoing plants are of the horizontal flow type, those for blowing at 64oz. pressure having as a rule replaced the Roots type blower.

The centrifugal design is the latest, and possibly the final, type of Turbine-driven blower.

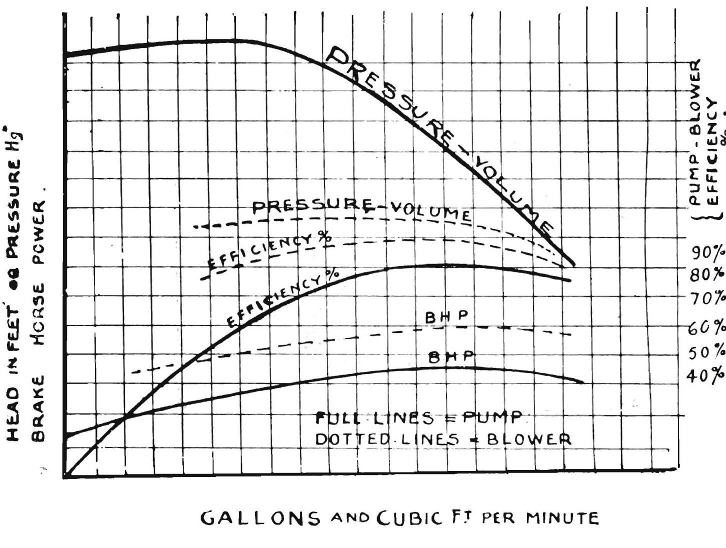

FIG. 15.

The design closely follows that of the centrifugal pump, and its characteristics are the same.

Fig. 15 shows the ordinary curves for a series centrifugal pump, and a series centrifugal blower, having the points of maximum efficiency in the same ordinate position at constant speed.

These curves are given simply to show the likeness between the characteristics of the centrifugal pump and of the blower, and no conclusions can be drawn from them as to relative efficiencies, as the two sets of curves are taken from machines for very different pressure conditions.

Naturally, constructional differences for the lighter medium in centrifugal fans, allow the rotating parts to be made much lighter.

As in the case of the centrifugal pump, when the safe stresses are reached for the material used, and the peripheral speed is not sufficient for the desired head, the series system is adopted.

On the other hand, if the volume to be dealt with be too great for one fan, two or more can be arranged in parallel.

As in the centrifugal pump, there is really no con-

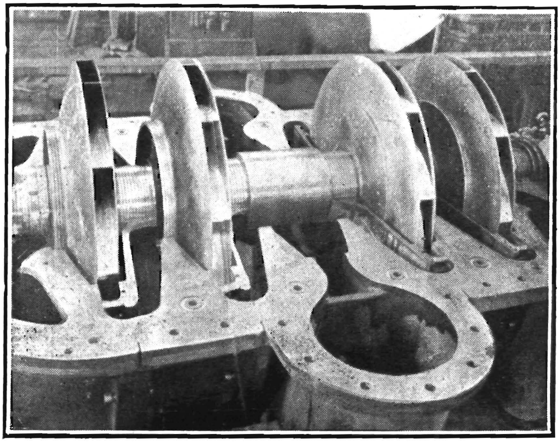

FIG. 16.

structional limit to the number of possible pumps in series, so in the case of the centrifugal blower, both Parsons and Rateau have constructed centrifugal air compressors for pressures up to 100 lbs. per sq. inch.

The centrifugal design has resulted in a great advance from an efficiency point of view, and without in any way detracting from the simplicity of the old horizontal flow machine, which in many cases are being replaced by the centrifugal type, and it is now proposed to briefly describe its construction.

Fig. 16 shows the rotor of one of Messrs. Parsons' blowers for dealing with large volumes—in this case