February 3, 1874.

THOMAS E. HARRISON, President,
in the Chair.

THE following Candidates were balloted for and duly elected:—
JOHN CHARLES BAILEY, WILSON BELL, WILLIAM FOULIS, ALEXANDER
MONCRIEFF, F.R.S., and MURDOCH PATERSON, as Members; HENRY
BARRATT, HENRY PERCY BOULNOIS, Stud. Inst. C.E., EDWARD BRAILS-
FORD BRIGHT, MASSEY BROMLEY, M.A., Stud. Inst. C.E., WILLIAM
ARMITAGE BROWN, GEORGE HAYTER CHUBB, WILLIAM CONYERS, WILLIAM
COOPER, CHARLES COPLAND, ARTHUR LESLIE COUSINS, WILLIAM CROSS-
MAN, Lt.-Col. R.E., JOHN DOUGLAS, SAMUEL JOHN DUNLOP, Lieut. B.S.C.,
JOHN HENRY EYKYN, Stud. Inst. C.E., JOSEPH EDWARD FISHER, JOSEPH
EDWARD HANNAH, CECIL WILLIAM EDWARD HENSLOWE, ROBERT ROWAN
PURDON HICKSON, WILLIAM FREDERICK HOWARD, JOHN JACKSON, PHILIP
TOWNSHEND SOMERVILLE LARGE, Stud. Inst. C.E., JOHN EDGAR LOWE,
JAMES McRITCHIE, FREDERICK GOTHER MANN, Stud. Inst. C.E., JOHN
MENZIES, JOHN PENN, Jun., ROBERT PINCHIN, WILLIAM HENRY ROBERTS,
HENRY YOUNG DARRACOTT SCOTT, Major-General, C.B., R.E., WILLIAM
HARRY STANGER, JOHN STRACHAN, Stud. Inst. C.E., LOUIS TRENCH, B.A.,
GEORGE ALBERT TWYNAM, EDWARD HAMILTON VERNON, PATRICK
LAMBERT WEATHERHEAD, and CHARLES GEORGE WILSON, as Associates.

It was announced that the Council, acting under the provisions
of Sect. IV. of the Bye-Laws, had admitted the following Candi-
dates as Students of the Institution:—HENRY OSBORNE BALDRY,
CHARLES WALTER SCRIVEN, ARTHUR HERBERT THOMPSON, and HENRY
JOHN TINGLE.

No. 1,341.—“The Portslade Gas-works.” By JOHN BIRCH PADDON,
M. Inst. C.E.

THE site of the Portslade Gas-works was selected in consequence
of the restrictions of the Brighton and Hove General Gas Com-
pany's Act of 1866, and possession was obtained under the com-
pulsory powers of that Company's Act of 1870.

Immediately to the east of the entrance to Shoreham harbour there is a tract of shingle, between the sea and the canal forming the eastern arm of the harbour. This shingle has been arrested in its eastward movement by the original entrance works to the harbour. Since the construction of the existing western entrance, the shingle has been greatly wasted by the sea. Between 1865 and 1870, in front of the site of the gas-works, the high-water mark at ordinary spring tides advanced landwards 100 feet; and at high tides, during strong gales of wind, the waves broke over the greater portion of the land between the sea and the canal. The site of the works was the widest and most level portion of this land, with the highest average surface. To obtain a deposit of shingle along the sea front as a protection, and to prevent the lighter portions of the waves passing over the shingle bank, two groynes were constructed. In accordance with local custom, one of the three groynes was at a right angle to the shore. With groynes so built there is an invariable scour and waste on the lee side, so that a repetition of such groynes along the coast to be protected becomes a necessity. The second groyne was designed to prevent this destructive action, and was projected towards the east at an angle of 45° to the shore. The result has been satisfactory, for, soon after its completion, a large bank of shingle accumulated on the east side, where it has since remained. A breastwork was also constructed of creosoted Swedish timber; the section of the piles being 12 inches square, the waling and diagonal bracing 12 inches by 6 inches, and the planking 3 inches thick. At a depth of 14 feet the ends of the piles entered a stratum of sand and gravel of great density and holding power. Since the construction of this breastwork it has several times been exposed to the coincidence of a high tide and a strong gale of wind, and it has proved a suitable and efficient protection to the site. The uncovered surface of the ground has been raised to a height of 4 feet above high-water line at ordinary spring tides, and the floors of buildings from 1 to 3 feet above the outside ground line. The quantity of material put upon the ground for this purpose was 31,500 cubic yards.

A supply of water has been obtained by sinking an iron cylinder to a depth of 50 feet below the ground line. The water obtained from the chalk at this point holds in solution 500 grains per gallon of salts (sea water containing 2,700 grains per gallon), and is available for most of the purposes of the works, except for drinking. The water tanks over the pump-room furnish storage for 20,000 gallons of water—a quantity sufficient for

ordinary operations to an extent represented by the consumption of 100 tons of coal.

The general arrangement of the buildings is shown in Plate 12, Fig. 1. Excellent material for concrete was obtained in excavating the trenches. The foundations of the walls were extended so as to make the proportion of the weight of the superstructure to the bearing surface 15 cwt. per square foot. The concrete bed under the retort benches is 7 feet 6 inches thick.

The retort-house (Plate 12, Figs. 2 and 3) is 284 feet 6 inches long, and 80 feet wide, inside measurement. Below the floor, and in front of the furnaces, are two lines of culverts for the entire length of the house, with similar culverts in communication under the gangways. In connection with these culverts a series of 12-inch drain pipes pass under the floor from the outside of the building, by which a sufficient, and easily regulated, supply of air is admitted for the furnaces, and the chief advantage of a stage floor is obtained. The culverts also contain the pipes for supplying water to the ash-pans and cisterns, and act as drains to the floor of the retort-house. A cistern of water for coke-quenching is placed at the corners of each block of retorts. These cisterns are all connected together, and, by a float valve and cistern in the pump-room the water in them is kept, without overflowing, constantly at the same level throughout the house. From each gangway a tramway descends to the coke ground, for coke-barrows to pass over. The floor of the retort-house is paved with narrow Swanage pitchers, laid in diagonal courses. A floor of this kind was in use in the retort-house at Hove for twelve years, without receiving or requiring any repair. The cost is 7s. 6d. per square yard, exclusive of the concrete bed.

The chimneys are constructed with the lower parts of brick and the upper parts of wrought iron, and are sufficiently light to be placed on the benches, so as not to occupy floor space. They are 71 feet 6 inches high, 3 feet square at the bottom, and 3 feet in diameter at the top, the least sectional area giving 1 square inch for each lineal foot of retort used in connection therewith. The working result of this proportion is satisfactory.

The retort-house is covered by a mansard roof. From the great internal capacity of this form of roof, there is a temporary detention of the vapours arising from drawing the contents of the retorts and quenching the hot coke. The more condensable of these vapours are thereby arrested, and the quantity escaping from the ventilators is consequently less than the quantity produced; but this occasions

no practical inconvenience to the men employed at the retorts. In consequence of the exposure of the roof to storms of great violence, and to rapid corrosion from the proximity of the sea, it was considered desirable that it should be of great strength, and that its parts should be few and accessible. Accordingly, the roof was designed to sustain a weight equal to 60 lbs. per square foot of external surface, or 72 lbs. per square foot of plan covered. With that weight no part is subjected to a tensile strain exceeding 5 tons per square inch of section; the strains on the parts in compression varying from 2 to 4 tons per square inch of section. The roof consists of ten Warren trusses of 84-feet span and 14 feet deep, placed about 30 feet apart. Across the top beams of the trusses there are four lines of latticed purlins, upon which purlins the bars are laid carrying the skin of the upper portion of the roof. The lower portion of the roof is formed with the framed struts of trusses, and some lighter intermediate framed struts joined to the bars immediately over them. Thrust on the walls is prevented by a series of ties, with screwed couplings, placed between the feet of the intermediate rafters and principal trusses. The laths are of channel-shaped section, and Duchess slates are fastened thereto with screwed clips, two to each slate. Four wrought-iron rudimentary shafts, 10 feet in diameter, enclosing the tops of the chimneys, allow the smoke to escape. There is also a protected opening, $5\frac{1}{2}$ feet wide, along the ridge for its entire length, for the same purpose. The roof was constructed by Messrs. Newton and Chambers, of the Thorncliffe Iron-works, and its cost, ready for slating, was £8 16s. per square of 100 feet.

The coal stores are to the south of the retort-house, and are in connection with the system of tramways from the wharf to the retort-house. The divisional walls, which are 14 feet high, support the columns carrying the roof, and give convenient access to every part of the stock in case of fire. Under the two first of the coal stores are the tar-tanks, of a capacity together of about 200,000 gallons. The store is 180 feet long and 120 feet wide, and will hold 6,500 tons of coal without trimming. The coal storage inside the retort-house is equal to 1,500 tons. The company at present carbonise 26,000 tons of coal per annum. Of this quantity it is estimated that under ordinary circumstances 20,000 tons pass directly from the ships into the retort-house, so that the coal-stores outside are ordinarily only filled and emptied once a year. The coals are landed at a wharf in front of the middle of the site of the works. At spring tides there is a depth of 16 feet of water at the wharf, and ships of 600 tons

burden can be placed alongside. The coals are raised from the holds of the ships to the overhead tramway, or viaduct, by two steam cranes lifting 25 tons per hour per crane, and are delivered into wagons and driven to the retort-house and coal-stores. The wagons carry 10 cwt. each. A plan of the tramways is shown in Plate 12, Fig. 1. The rails are laid at a gauge of 2 feet 6 inches, and the communications with the retort-houses and the coal-stores are made by light turntables, which will be available for similar stores and a retort-house to be erected on the other side.

There are twenty-four benches of retorts. Each bench has eight long retorts, and each retort two mouth-pieces, so that there are three hundred and eighty-four mouth-pieces in all. The retorts are cylinders 16 inches in diameter and 20 feet long (Plate 13, Figs. 1 and 2); and each will carbonise 1 ton of coal per day. Allowing one-sixth of the number for reserve, the remainder will produce 1,500,000 cubic feet of gas every twenty-four hours, or 300 millions per annum. The ascension pipes are 6 inches in diameter at the bottom and 5 inches at the top. The hydraulic mains, two to each block of six benches, are of larger section than usual, and have separate outlets to the collecting main. The buckstaves are of rolled iron, with tie-rods fixed clear of the brickwork.

The gas, as it is produced, passes with the tar and liquor from the collecting pipes of the hydraulic mains, at either end of the retort-house, into 12-inch mains carried along the inside, and uniting in the middle of the south wall of the retort-house, from which point they issue by a 16-inch main to the condensers. At the end of the horizontal condensers the tar and liquor are deposited in a seal tank and led to the tar-tanks under the coal-stores. From this point the gas passes successively through the vertical condensers, exhausters, scrubbers, purifiers, station meters, and driving exhausters, into the main leading from the works to the gas-holders at Hove. The mains and connections throughout the works are 16 inches in diameter.

The condensers are shown in Plate 13, Fig. 3. The reduction of the temperature of the gas in the horizontal piping is gradual and comparatively small; but by the vertical condenser the temperature of the gas is easily assimilated to that of the atmosphere. The vertical condenser at Portslade differs from the annular condenser ordinarily used in being placed upon a ventilating chamber, in having a double set of rising pipes instead of a single set, and in being worked without open seal cups. The advantages gained

are, a control over the draught of air to the insides of the annular pipes, increased condensing surface and power, and an entire absence of smell from the liquor and tar deposited during the process of condensation.

The engine-house (Plate 13, Fig. 4) contains four exhausters, each exhauster being driven directly by an independent engine. Two of these exhausters are for the purpose of removing the gas from the hydraulic mains and driving it through the scrubbers and purifiers. A self-acting by-pass is carried from the inlet of the exhausters to the inlet of the purifiers, and each exhauster is connected with a governor, which also acts as a by-pass. Only one of these exhausters is in use at a time, the other being in reserve. The remaining exhausters are also used one at a time, and are for the sole duty of receiving the gas at the outlet of the station meter, and of delivering it into the mains leading to the gas-holders at Hove. The works are thus relieved from all pressure from the weight of gas-holders and from the resistance of the intervening mains. An hydraulic by-pass, made to resist back pressure, is placed between the meter and the main; and each exhauster is connected with a governor, whereby a slight uniform pressure is maintained at the outlet of the meter.

In the boiler-house are two of Howard's boilers each of 30 HP. The tubes are set nearly horizontal, and the boilers are entirely free from any tendency to prime. The steam from these boilers is carried through the coal-stores to the engine in the pump-room, a distance of 300 feet, the pressure of the steam being reduced in transit from 60 lbs. to 50 lbs. per square inch. A small portable steam crane in the coal-stores lifts the coals into wagons for the retort-house. Steam is conveniently supplied to this crane at whatever part of the tramways in the coal-stores the crane is required to work.

The scrubbers used at these works are the first of the kind erected (Plate 14, Figs. 1 and 2). They consist of a series of perforated discs or screens, which revolve slowly, in a tank half filled with liquor, so that the gas may pass through the portions of the screens above water. The gas is by this means divided into a series of small streams, each stream being brought equally into repeated contact with a thoroughly wetted surface. The screens being fitted at the edge with an elastic fringe, made by preference of bass, there is but little friction against the circular portion of the tank, and as no advantage is gained by a speed of more than 50 revolutions per hour, the power required to keep the

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screens in motion is very small. There is a slight difference in the heights of the bases of the scrubbers, the first being the lowest and the third the highest.

In course of working, the gas passes through each scrubber from the lowest to the highest of the set. Water enters the highest scrubber and runs through the middle and lower scrubbers to the liquor tanks, the desired strength of the liquor being obtained by regulating the volume of water admitted to the highest scrubber. These scrubbers remove 95 per cent. of the ammonia, 50 per cent. of the sulphuretted hydrogen, and from 30 per cent. to 50 per cent. of the carbonic acid existing in the crude gas. They offer no perceptible resistance to the flow of gas, and are free from the disadvantages of the vertical scrubbers in ordinary use. These disadvantages are,—The inevitable clogging up of the interstices of the scrubbing material, so that the passage eventually becomes no greater than necessary for the actual volume of gas forcing its way through. The expense and difficulty of raising to the tops of the scrubbers an adequate volume of liquor; this volume, by some authorities, being estimated at one-sixteenth of the bulk of the gas. The retention of impure deposit in contact with the gas, and the impossibility of distributing liquor uniformly to the middle and lower strata of the scrubbing material. And the necessity for the occasional removal of the contents of the scrubber to obviate the obstruction to the flow of the gas.

There are seven purifiers in a line with each other (Plate 14, Fig. 3). Each purifier is 36 feet long, 18 feet wide, and 5 feet deep, with water lutes 2 feet 3 inches deep. The covers are lifted at four points, two on each side, by a travelling lift passing on rails through the entire length of the shed. In consequence of the large surface of the covers, and the occasional heavy pressure to which they are subjected, each cover is held down by four lewis fastenings (Plate 14, Fig. 4), instead of by the usual bars and clips. The lewis fastenings are easily moved and replaced, and are not liable to accidental derangement. As the purifiers are near the high-water mark of the sea, they were placed on pile foundations 3 feet above the surface of the ground, and when the pipes and connections had been laid between the piles, the spaces under the purifiers were filled up. Tramways are laid at each side of the line of purifiers, and the purifying material is brought and removed from the oxide and lime sheds at either end in wagons. The shed covering the purifiers is of light construction (Fig. 5), and is closed on the side next the sea and open on the other side. The revivifying sheds at either end

are each 100 feet long and 50 feet wide, and are fitted with framed movable louveres. The first three purifiers are for lime, the next three for oxide of iron, and the last is also for oxide of iron, to be used as a check purifier. The collective internal capacity of the purifiers amounts to 22,600 cubic feet. They are intended for a maximum production of 3,000,000 cubic feet of gas per day, being an allowance of $7\frac{1}{2}$ cubic feet of purifier space for each 1,000 cubic feet of gas made per day. Although this proportion is rarely exceeded in large works, it may be taken for granted that the larger the purifiers the more economical and perfect will be the process of purification. The cost of removing the exhausted material from the purifiers and recharging them is 5*d.* per ton of material moved.

The station meter is one of the largest yet made. It was erected by Messrs. Parkinson and Son, to pass 100,000 cubic feet of gas per hour, and is placed next to the engine-house.

The gas-holders are all at Hove, and their tanks are about 34 feet above the level of the works at Portslade. The length of main between the works at Portslade and the gas-holders at Hove is 3,400 yards, of which about one-half is 16 inches in diameter, and the remainder 14 inches in diameter. At intervals of about 500 yards along the main, fixed receivers are provided, with a sliding disc on the top, for the removal of possible naphthaline obstructions, by sudden dislodgment under pressure from the driving exhauster at the works. Before the main was charged with gas, it was closed at the Portslade end, and a test gas-holder was connected to the other end. The main contained 12,042 cubic feet, and by forcing into it 722 cubic feet, about 6 per cent. in addition, the pressure on the inside of the main was raised to 24 inches throughout its length. With this pressure the loss was 1 cubic foot in five hours, no appreciable alteration taking place in the temperature of the contents of the main.

The testing office at Brighton is $2\frac{1}{2}$ miles from the gas-holders, and the Company's mains extend in another direction to Lancing, a distance of 10 miles. Observations for three weeks were made, as nearly as possible at the same time at each of the three places, to ascertain the illuminating power of the gas, with the following results:—

Hove . . .	14.61 candles.
Brighton . . .	14.45 ditto.
Lancing . . .	14.14 ditto.

The entire cost of the works was £72,000; and when the pro-

posed second retort-house and coal store are erected upon the site allotted for them, the total expenditure will amount to £100,000. The works will then be capable of conveniently producing 600 million cubic feet of gas per annum at a cost of £166 per million.

The Paper is accompanied by a series of diagrams, from which Plates 12, 13, and 14 have been compiled.

[Mr. PADDON.

Fig: 1.

PORTSLADE GAS WORKS.

Fig: 2.

Fig: 3.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 6.

Fig. 1.

Fig. 5.

Fig. 2.

DETAILS OF SCREEN.

Fig. 4.