Lecture (Abstract)

The Latest Advances in Electric Welding Construction.

By Mr. H. E. Grove.

The lecture dealt mainly with developments in electric welding practice at the Construction Department of the Metropolitan Gas Company, and was profusely illustrated with slides; and a number of exhibits showed actual examples of complex welded joints at the junction of as many as eight members. Although not coming strictly under the heading of this lecture, samples were shown of various conveyor trays and links fabricated by the Department by press work at exceedingly low cost, a description of which appears further on.

The chief feature of the lecture was a description of the new coke-handling plant, which was completely designed, fabricated and erected by the Construction Department. It is shown in the isometric view in these Proceedings. It was designed to handle the coke from six retort houses, five of which are already erected; the later houses of this group are completely electric welded structures, each sustaining over four thousand tons of firebrick settings, machinery and coke bunkers, in all over eighty feet in height, with all-welded stacks of a total height of 150 feet.

The Retort Houses are arranged in two groups of three. Each block of three houses is about 140 feet by 100 feet in plan, and between the two groups there was erected, some years ago, a coal crushing and elevating plant, the structure of which consists of two towers joined at the top by a bridge 100 feet above ground. This plant is not shown in the isometric drawing. The two chain-bucket elevators deliver coal on to horizontal chain-bucket conveyors running along the top of the house, which distribute it to the bunkers. These last conveyors run the length of each house, and then descend to beneath the coke discharge level, where they return under the house to elevate the coke. A fraction of this is distributed by the top portion of the conveyor to the top coke bunkers, whence it gravitates to the producers, and there its combustion furnishes the heat for carbonising the coal which is slowly descending through the neighbouring retorts. Most of the coke, however, is tipped from the top of the rising leg
of the chain-bucket elevator on to a horizontal tray conveyor—part of the new coke-handling scheme—which conveys it to the south end of the space between the two groups of retort houses. The coke is then discharged on to a tray conveyor 185 feet long, which runs west adjacent to the south side of the western group of buildings, and slowly rises from 55 feet to a level of about 71 feet, where it is delivered on to a tipping tray conveyor running 125 feet north over the eastern end of the new coke bunkers. This conveyor discharges the coke on to a revolving screen, mounted on a travelling bridge of
lattice construction of 164 feet length and 110 feet clear span; and a part of the coke is delivered from the screen into two adjacent bunkers. The large coke falls on to a fourth tray conveyor, which distributes it over the larger compartment of the bunkers, or over the yard beyond. The coke may also be tipped directly on to the tray conveyor and distributed unscreened into bunkers. The bunkers, of 2000 tons capacity, are approximately 97 feet long, 67 feet wide, and 27 feet deep, the hopper bottoms being at a convenient level above the ground, and equipped with bag-filling devices designed and constructed by the Department. Their walls were constructed of the plate girders of the “tubular” iron Barwon River bridge, which was recently replaced by a new and heavier structure. The iron was selected for the bunkers on account of its resistance to corrosion.

The travelling bridge merits special mention. It carries the revolving screen and tipping tray conveyor. It has a clear central span of 110 feet between the travelling carriages and an overhang of 18 feet at the screen end and of 36 feet at the other, making the total length 164 feet. The structure is a rectangular lattice tube. Each chord is composed of two 4 inch by 2 inch channels welded together to form a tube of very economical section with radii of gyration 1.49 in. and 1.52 in. respectively. A conventional design for rivets of the chords would have entailed an extra four tons and another four in the remaining members. The bridge structure weighs 35½ tons, and it carries 25 tons of machinery and ten tons of gangways and chutes, etc. Similar construction was adopted for the other “tubular” trusses of the plant. All motors driving conveyors are 15 h.p., and those driving the bridge, screen, etc., are 7½ h.p. The motor switch gears are electrically interlocked, so that they cannot be operated in the wrong order and cause congestion.

Another installation of special interest referred to in the lecture was a rubber belt coal conveyor system consisting of two 18 inch belts, one 110 feet and the other 144 feet long, feeding a 24 inch rubber belt conveyor 174 feet long. The lowest public tender for this work was 80 per cent. higher in price than that of the Construction Department, which was £527s. completely erected, the Department tendering with all interest and overhead charges included. The disparity in price was owing mostly to the cheapening of construction of the structure and mechanical details by electric welding. For instance, the rollers instead of being of heavy cast iron were made from 16 gauge sheet steel; and the driving and tension drums were constructed similarly—all welded. Gearing consisting of toothed rings were bolted to steel centres. The
conveyor rollers, running on roller bearings, were mounted on trussed 2 inch pipe frames, about 12 feet 6 inches long, carrying three sets of troughing and two sets of return rollers. All was set up on jigs so that, with extreme accuracy, all frames dropped into place on erection.

An all-welded steel gas purifier was also described and illustrated. Its capacity was 2\(\frac{2}{3}\) million cubic feet per day. It consisted of a rectangular box of \(\frac{3}{8}\) inch plate with all necessary stiffeners, 76 feet long, 50 feet wide, and 6 feet deep, and was divided into four compartments each to carry two layers of oxide of iron and to resist a pressure of 216 lbs. per square foot. All necessary valves, etc., were also supplied. The boxes were supported by twelve reinforced concrete columns about 12 feet high. The plant was equipped with overhead gantry cranes, and it weighed in all when loaded about 800 tons. This plant complete, including 80 feet piled foundations, cost a little over £13,000, compared with £17,800 quoted by Alwyn Meade in his book, "Modern Gas Practice," as a fair price for erection in England on ordinary foundations.

Other interesting structures described included three pipe bridges for conveying gas over suburban creeks. The latest of these is a 30 inch pipe of \(\frac{1}{4}\) inch sheet, and 90 feet clear span—part cantilevered from the heavy concrete foundation on the south side, and by a steel and concrete structure on the north side of the Merri Creek at North Fitzroy. The pipe is fitted with a novel "concertina" expansion joint, all welded. The pipe stands alone—no truss supports it.

Coming to the conveyor, gains, the tipping trays were about 17\(\frac{1}{4}\) inches long by 30 inches wide, with 6 inch sides, and weighed about 30 lbs. Each had four square holes for bolting on cast iron lugs, and at their rear edge two nipples were pressed in to allow each tray to seat over the bolt heads of the succeeding tray. These trays were cut, stamped and pressed in one operation from sheets 22 feet long by 17\(\frac{1}{4}\) inches wide, and four ribs were raised to give stiffness. The total labour cost per tray, including getting the material to the machine, was 6\(\frac{3}{4}\) pence.

The chain links, 18 inches long, were composed of two strands with spacers. Each strand was pressed from 3 inch by 5/16 inch flat; at the same operation a 1 inch hole at each end, and two \(\frac{5}{8}\) inch holes, were punched. As the outer holes are bearing surfaces carrying the full thrust on the link, it is usual to drill them; but here was used a long stroke punch consisting, in brief, of a punch followed by a broach, and at
the inner end of the stroke the hole was burnished by the
hard, slightly-tapered shank of the punch. The total labour
cost on each of these pieces was 1\frac{3}{4} pence.

The chains for the main coal elevators were hot pressed,
and the holes were reinforced on the pressure or wearing
sides by a deposit of manganese steel from special welding
electrode. A link that had been in operation for four years
was recently taken out for inspection, and revealed no per-
ceptible wear. (It was exhibited to members).

An interesting welded joint was exhibited of a type com-
monly required in “tubular” rectangular girders, where the
chord, at a panel point, is usually fitted with two gussets, one
in the plane of each wall of the “tube,” to which are rivetted
the posts and diagonals. In the case exhibited, the chord
consisted of “starred angles,” that is where the apices are
adjacent the two arms of each angle extending outwards star-
wise; the struts coming from this chord, at right angles to it,
were also starred angles; at the same time in each plane,
angle iron ties were provided. All was welded up so that full
cross sectional strength was maintained, but no gusset was
necessary.

In conclusion, the author declared that the applications of
new methods, such as electric welding with all its consequen-
tial simplifications of workshop practice, demanded the closest
attention of all engineers, especially in view of the present
high costs of labour and of materials.
DISCUSSION

The President said members were indebted to Mr. Grove for his lecture. It was good to know that Australia had led the way in the matter of welded joints, and the Institute was to be congratulated upon having amongst its members Messrs. Keeson, Grove and Bennie. Because of the extensive experience of these members the Institute was consulted on the matter of welded joints in connection with the City of Melbourne Building Regulations.

Mr. W. Ison said the paper had been most interesting and instructive. It had been a great privilege to hear such a fine lecture.

Mr. Wm. Chas. Rowe wished to add his thanks for the lecture. Mr. Grove had placed work before the meeting which was fit to go before the engineers of the world. He would like to ask Mr. Grove if they checked by inspection the quality of the work? Could they judge from inspection whether a joint would stand?

Mr. Grove said it was a most important question. To a great extent the engineer could tell from the appearance of the weld whether the joint would stand. But it was also necessary to know the character of the welder and the quality of his work, and make tests at certain intervals of the slag from his electrodes. They had gone to considerable trouble with tests at the University, and had adopted standard safe shear and tension loads per inch of weld. For example, No. 10 electrode 16 inches long deposited on say 6 inches run would give 800 to 900 lbs. safe load per inch of length, by reducing the length of deposit a much higher shearing stress per inch would be obtained; e.g., by reducing it to 3 inches they would get 1700 to 1800 lbs. They were fortunate in that the whole of the organisation was under one control. The foremen were held absolutely responsible for everything performed in the shop. In addition to the foremen, the leading welder had to furnish returns every day recording the nature of the work being done.

Mr. A. E. Hughes wished to add his thanks to Mr. Grove for his interesting lecture. The whole thing was absolutely revolutionary as far as structural work was concerned, and the corporation that had the pluck to design structures such as they had been shown deserved every credit. They had left the beaten track, and were introducing to engineers and structural men a new class of manipulation which would probably be incorporated in most steel structures before many years. Welding of all descriptions was increasing in use, but
he thought the Metropolitan Gas Co. had been the pioneers in the use of welding for commercial purposes. There was no doubt the welded joint was much better than any other joint in use. It was refreshing to see engineers dealing with matters off the beaten track. If they could have more of that it would be better for the profession.

Mr. A. Lewis said he had listened to Mr. Grove with great pleasure. He thought it very fine that an officer of a great public utility should come forward and give the Institute the benefit of the progressive methods employed by him, as Mr. Grove had done. Some little time ago he had had the privilege of inspecting the works, and the visit had been of an educational value to him, by enabling him to see points in practice which it would be difficult to convey in a lecture.

Mr. Rigby said he was somewhat more au fait with the work shown, because he had been closely associated with welding work from the inception. He could assure them that all who had been engaged in welding had consistently met with scepticism and opposition. The best answer to the doubters and scorners was to let them pay a visit to the gas works and see the wonderful work being carried out by Messrs. Reeson and Grove, with their assistants.

Mr. J. N. Reeson said he thought the Institute had not been sufficiently favoured during the past few years by Mr. Grove and Mr. Bennie in connection with their experiences in welding and other kindred matters. He was astonished at the extent to which electric welding had been developed under the direction of Mr. Grove and Mr. Bennie. The credit was wholly due to those officers, and it spoke well for the able way in which their efforts had been supplemented by the workshop staff. He would like the Institute to pay a visit to the works, in order that they might see for themselves the work that was being done. He would like to draw special attention to the examples of welding which Mr. Grove had exhibited. The extent to which that work had been developed showed that in the near future the riveted structure would be a thing of the past. The more he saw of electric welding the more he wondered to what extent its development could be carried. He thanked Mr. Grove for his lecture, and hoped that he would be prevailed upon to supplement it at an early date.

Mr. R. J. Bennie said he had listened with great pleasure to Mr. Grove's lecture. Most of the matters dealt with were very familiar to him; but it was always a pleasure to go over old ground, and hearing things described long after the event often suggested new problems and brought back
memories. It was a pleasure to think over the successful solution of difficult problems. He would like to mention one or two things that might help members to understand the peculiar forces that came into operation in the structure illustrated in the lecture. The purifiers, which were rectangular steel tanks containing oxide of iron, had about 350 lbs. per square foot dead load of oxide of iron, and 216 pounds per square foot gas pressure. Perhaps it had been noticed that the walls of the coke bunkers were not welded. The reason was that they were built of the girders of the old Barwon River bridge, which being of wrought iron were not so subject to corrosion as in the case of steel. As an example of how they ascertained whether the work was being continuously carried out with due regard to the joints being properly welded, a recent test would serve as an illustration. They were always carrying out tests, and the staff did not know when their work was being tested. In the recent case referred to in every case the strength of the joints was equal to the strength of the plates they were made from.

Mr. W. OLIVER said reference had been made to the strength of a loaded joint, but there had been no reference to the capacity of the joint to resist shock. Also £54 had been mentioned as the cost per ton of the whole building and plant. Had Mr. Grove any information as to the cost per ton of the structure alone?

Mr. GROVE replied that he had been told by a contractor that the steel work alone could not be done under £45 per ton.

On the question of shock, he read a short extract from a published account of tests by the Westinghouse Company, showing that a typical joint of a framed building resisted shock loads longer than a typical rivetted joint.
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