bins of large size, where it soon becomes very hot, reaching a temperature of 60° C. (140° F.). This temperature was sufficiently high to kill or at least prevent the growth of nearly all animal and vegetable species, 50° C. being the upper limit. Upon the proper examination of this hot material one soon finds that a single species of Bacteria (*Bacillus butyricum*) is associated with the fermentation and subsequent rise in temperature. Further tests prove that it is the cause of these changes. Secondary changes are very liable to occur as the heat decreases, and lactic and acetic acid, the latter often in large amounts, are produced. Possibly alcohol is sometimes, but never as a first product of the hot material.

On the whole, this the thirty-eighth annual meeting of the American Association for the Advancement of Science may be considered to have been a successful one. Close upon two hundred papers were actually read in the various Sections, some of these of course not reflecting that "dry light" which is supposed to beat upon all scientific investigation, yet the majority of them evincing real and enthusiastic work on proper lines. One thing, however, might have been noticeable to an English ear, many of the writers seemed to possess a greater mastery over abstruseness of subject than over elegance of diction.

Many eminent men, some famous in both hemispheres, were present. The total number of persons in attendance on the meetings, and actually belonging to the Association, either as Fellows, Members, or Associates, was between four and five hundred.

Financially, the Association is declared to be in a better position to-day than ever it has been before. The annual income is at present about $6000. It has also the sum of $4500 invested at 5 per cent., the interest of which is devoted to the furtherance of original research. For the ensuing year this sum has been apportioned thus: $150 to Prof. Moseley to continue his researches on the velocity of light in the magnetic field; and $50 to Prof. Attwater for the purpose of investigating the heats of combustion of certain mineral and vegetable compounds.

Indianapolis and the third Wednesday in August were chosen as the place and time of meeting for 1890. Mr. G. L. Goodale, of Cambridge, Massachusetts, was elected President for the coming year.

The meeting was closed by a public gathering, at which many complimentary speeches were made both by hosts and guests.

ARNOLD HAULTAIN.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held last week in Paris under the presidency of Sir James Kitson. The meeting was held in the rooms of the Société d'Encouragement, and was addressed, in the first instance, by M. Eiffel, President of the Société des Ingénieurs Civils, and by M. H. de la Goupillière, President of the Société d'Encouragement. The President of the Institute, after thanking M. Eiffel and M. de la Goupillière for their kind hospitality, announced that the Council had awarded the Bessemer Medal to M. Henri Schneider, of Creusot, for his services to the iron and steel trade of France, to whom it was presented on Friday by Sir Lowthian Bell. Sir James Kitson made a brief address, referring to their last visit to Paris in 1878, under the distinguished presidency of the late Sir William Siemens, to the increase in the roll register of the Institute which had taken place since that date. He drew attention to the improvements which had taken place during the last decade in the metallurgy of steel and iron; the commercial development of the Siemens-Martin and Thomas-Gilchrist steel processes; the increased development in the manufacture of steel owing to the extension which had taken place in its applications. The Eiffel Tower was an elegant example of the scientific power and imaginative genius of French engineering, whilst the French chemical study of the processes of metallurgy had rendered great service, not only to their own industry, but to that of the world at large. The names of many eminent French metallurgists were mentioned, and the work they had done was briefly referred to.

The business of the meeting was then proceeded with, viz. the reading and discussion of the various papers which are referred to below.

Prof. S. Jordan's paper, "Notes on Iron and Steel Manufacture in France in 1887, and as illustrated by the French exhibits at Paris," the first paper read, was of a statistical character, and compared the present production of these metals with what it was ten years ago.

The Channel Bridge.—This was a paper by Messrs. Schneider and Co., of Creusot, and M. H. Hersent, Past-President of the Société des Ingénieurs Civils, descriptive of a bridge for connecting England with the Continent. The paper consists of three parts, an introductory notice, a general description of the bridge, and of the superstructure, being preliminary projects of M. Hersent and Messrs. Schneider respectively. From the introductory notice it would appear that projects have been submitted by Messrs. Fowler and Baker, but these are not published in the paper.

It is proposed that the bridge should span the Channel at about its narrowest portion—namely, between Folkestone and Cape Griznez, a distance of 25 miles, by which means also the sand-banks of Varne and Colbart can be taken advantage of, thereby diminishing the height of the piers necessary to be erected. These banks are in mid-Channel, about 3¾ miles apart, and are separated by a depression of between 80 and 90 feet deep; this is also about the depth between the bank and the British coast, whilst on the French side, between the Colbart Bank and the Cran-aux-Œufs, the bottom sinks somewhat abruptly down to 132 feet, attaining 180 feet about midway across, when it gradually rises again. In these parts the chief difficulties would be encountered in laying the foundations. As the result of frequent experiments, it is found that the blue and white chalk which forms the Channel bottom is capable of supporting a load of from 140 to 170 pounds to the square inch, and the surface of the bases of the piers has been so calculated that the foundations should not have a greater load on them than the smaller of these amounts. This would imply that no factor of safety has been allowed, which is hardly likely to be the case, as in masonry structures with a live load a factor of safety of 8 is generally recommended; on the other hand, the ordinary kinds of chalk are capable of resisting a crushing pressure of 330 pounds per square inch. The masonry piers are 190 feet in length at the base, and 140 feet above, the width depending on the columns which they have to support. The distance between the piers is fixed at 1650 and 990 feet, 1155 and 660 feet, and 825 and 330 feet, the largest spans corresponding to the greatest depths, and the smaller ones to smaller depths and the parts near the shore. Each supporting pier will consist of a block of masonry of best material, set with Portland cement, and laid on the sea bottom; the masonry will be built inside metal caissons similar to those used for ordinary bridge piers, and forced by compressed air down to the solid ground. Their surface above high-water level will form the foundation for the metal columns, which are cylindrical in shape, and vary in height between 132 and 140 feet, and on them are placed the main girders of the bridge. These girders are 200 feet above low-, and 178 feet above high-water level. This height is amply sufficient for the passage of the largest ships. The system of girders proposed to be employed is simple, unlatticed, trussed, so as to insure the proper distribution of all the stresses. After consideration it has been found advisable, instead of forming the 990 and 1650 feet spans of girders extending over the whole length of 990 feet, and extending on either side in the form of cantilevers of 825 feet, so that the junction of the two cantilevers should constitute a span of 1650 feet in all, not completely to cover the spans by means of cantilevers, but to connect these by an ordinary independent span, a saving of 17 per cent. being thus realized in each overhanging portion of the cantilever. In this manner the 1650-feet span comprises two cantilevers of 619 feet each, and an independent span of 412 feet. The metal flooring on the central span and cantilever is formed of two girders resting upon two piers 990 feet apart, and lengthened on either side to the extent of 619 feet. These girders are 36 feet high at the ends of the overhanging portions, and 214 feet high almost throughout the span of 990 feet. Each girder consists of two chords connected by bracings forming isosceles triangles. The lower ribs of the two girders have a distance of 82 feet between their axes in the central span of 990 feet, and an interval of 33 feet at the ends. The level of the permanent way is 237 feet above low water; a double set of rails is proposed, and the width of flooring proper will be 26 feet.

The paper further gives a detailed description of the foundation work, comprising the situation and dimensions of the piers, the construction, conveyance, and fitting into position of the supporting columns, and the materials and machinery required for the completion of the work; also the construction, transport, and putting into position of the metal spans, with estimates of weight, and calculations of the resistances throughout the structure. The metal required for this bridge would amount to a million tons, of which about three-quarters would be steel; the cost is estimated at £35,000,000, and the period requisite to complete the work ten years. This interesting pamphlet of nearly 100 pages will be referred to on account of the careful manner in which the subject has been brought forward, even should the building of the bridge not take place, on account either of political objections or constructive difficulties. As stated in the paper itself, each pier comprises a small lighthouse, and as about 150 of these small lighthouses will have to be erected, an injury to any one of which would close the bridge for a lengthy period, one thinks of the Eddystone Lighthouse, built by Smeaton 100 years ago, which has had to be replaced, not on account of any fault in its design or construction, but because the sea had made inroads on its foundation of rock.

On Gaseous Fuel, by Sir Lowthian Bell. The author assumes a certain quality of coal, and then compares the work that can be performed with it according as it is used in the solid state or in the condition of producer gas or in that of water gas. Producer gas is that supplied to the Siemens regenerative gas furnace; the specimen of coal used for comparison is assumed to consist of 70 per cent. fixed carbon, 16 coal gas, and 14 ash, oxygen and nitrogen, and the producer gas obtained from it of 16 parts of coal gas, 163·3 of carbonic oxide, and 222 of nitrogen, the producer gas being supplied cold at the foot of the regenerators; the calorific value of the coal is 7200 calories. 100 parts of this coal are equal to 720,000 calories, and by the combustion of the producer gas 551,920 calories are produced, showing a loss of 168,080, equal to 23·3 per cent. The method of manufacture of water gas is next explained. The fuel recommended to be employed is coke, which is placed in a cylinder of iron lined with fire-brick; the coke is rendered incandescent by an air blast. When in this state the blast is stopped, and a jet of steam passed through it. The steam is decomposed; its oxygen burns the carbon into carbonic oxide, setting free the hydrogen, the mixture constituting so-called water gas, comprising equal volumes of carbonic oxide and hydrogen. The change in producing water gas is expressed chemically by $H_2O + C = H_2 + CO$, and the heat required to tear hydrogen away from its associated oxygen is not less than that evolved when the two gases unite, or 2 × 34,200 = 68,400 calories. The weight of the combining equivalent of carbon required to effect the change is twelve times that of the two units of hydrogen, and the heat generated by this quantity of carbon being burnt to carbonic oxide is 12 × 2400 = 28,800, so that something over 14½ units weight of carbon will be required to generate a unit weight of hydrogen. But as only 6 units of carbon are being burnt per unit of hydrogen, the incandescent carbon is soon cooled down below the temperature of decomposition. When this point is arrived at, the steam is shut off, and the blast is again turned on. Using the data given in the water gas publications, water gas produces per 100 parts of carbon 682,520 calories out of a possible total of 800,000, there being a loss of 14·68 per cent.; as the coke used is produced from coal, the actual loss rises to 37 per cent. The author sums up as follows:—

(1) Coal as burnt in an ordinary furnace—

	Calories.
100 parts, yielding 7200 calories per unit	= 720,000
Chimney gases, estimated after making the necessary allowance for oxygen in the coals, 1129 units × 427° C. × ·24 specific heat	= 115,700

the loss in this case by chimney gases being equal to 16·07 per cent.

(2) Producer gas from same coal, as used in the Siemens furnaces, without the addition of steam—

	Calories.
70 of carbon or 133·33 of CO × 2400	= 391,992
16 of coal gas × 10,000	= 160,000
Sensible heat transmitted to furnace	62,411
	614,403
Heat in chimney gases, 1129 × 377° C. × ·24 specific heat	= 102,151

Loss of chimney equal to 16·61 per cent.

(3) Water gas and its accompanying producer gas—

	Calories.
Water gas, 17°·5 C. = 40·83 CO × 2400	= 97,992
Hydrogen from steam, 2·926 × 29,400	= 86,024
	184,016
Producer gas, 52°·5 C. = 122·5 CO × 2400	= 294,000
Coal gas, 16 × 10,000	= 160,000
Sum of heating-power of water gas and producer gas ...	638,016

Heat in a chimney gas assumed at same temperature as ordinary producer gas—

779·7 × 377° × ·24 sp. heat = 70,547 calories = 11·05 per cent.

These figures intimate that each 100 units of the three kinds of fuel burnt there is afforded by: coal, 83·93; producer gas, 71·14; water gas and its producer gas, 78·80.

To these figures of Sir Lowthian Bell the supporters of gaseous fuel will object that, if with the use of gaseous fuel there are 1129 units of waste gases passing up the chimney, with solid fuel there must be considerably more; whilst the employers of the regenerative gas-furnace, whilst accepting 377° C. as the temperature of their chimneys, will not allow the same for water gas, where regenerators are not used.

Another interesting paper presented to the meeting was one by Mr. W. C. Fish, on the Thomson electric welding process. The *rationale* of the process may be thus shortly described. If an inclosed circuit of inappreciable resistance be completed by the insertion and abutment of short lengths of the pieces to be welded, the passage of an electric current through the circuit will produce a transformation of electric into heat energy, and the production of this heat will take place almost entirely at the point of abutment of the metal pieces where the cross-section of the conductor is virtually of least area, and the resistance is proportionately great. If the current is of sufficient strength, a welding heat is produced at the point of abutment, and, with the aid of suitable pressure forcing together the heated extremities of the pieces, a weld is made. Various applications are given in the paper, the employment of an alternating current dynamo and a transformer being found the most effective method of working.

Mr. Alexander Siemens, in the discussion of this paper, said he was able to confirm the general results given, for in making one of the Atlantic cables twelve years ago, it was found that welding could be done more quickly by electricity than by ordinary means. An electrical machine was placed alongside of the cable machine, and they made all the joints for the sheathing of the wire by electricity. They would find that the subject had been mentioned by Sir William Siemens in his address to the Mechanical Section of the British Association at Newcastle in 1877.

Papers were also presented to the meeting on the Robert-Bessemer steel process, by Mr. F. L. Garrison, of Philadelphia; on alloys of iron and silicon, by Mr. R. A. Hadfield, of Sheffield, both being papers of a technical character. A new form of Siemens furnace, arranged to recover waste gases as well as waste heat, was described by Mr. John Head, and M. P. Pouff, of Nevers. In this furnace, instead of two air and two gas regenerators being employed, only a pair of air regenerators are used, the gas being supplied hot to the furnace. Instead of the whole of the products of combustion being passed through the regenerators, a portion is directed through a regenerator to the chimney, and the remainder through a converter producer, there to be reconverted into combustible gases, and to do the work of distilling hydrocarbons from the coal; in fact, the gas producer or converter in this furnace absorbs or utilizes the heat formerly deposited in the gas regenerators, and in doing this transforms spent gases into combustible gases. It had to be ascertained whether the products of combustion from the heating chamber would contain a sufficient amount of heat to insure their conversion into combustible gases; this has been found to be the case in practice with furnaces working for the past six months. Assuming that the producer contains only coke in the incandescent state, this coke if fed with oxygen will produce carbonic acid in the lower, and will be converted into carbonic oxide in the upper zone of the producer; if fed with hot carbonic acid instead of oxygen, one-half the fuel, comprising the lower zone, may be dispensed with, and an economy in weight of fuel to the same extent realized. In actual practice finished rolled iron has been heated in this furnace with a consumption of fuel as low as 2 cwt. per ton of iron.