black-board. The usual series of normal deflections having been recorded, tetanisation was to be prolonged for five minutes, with the result that the succeeding variations would show an increase which would gradually sink back to the normal. In the actual experiment these anticipations were exactly fulfilled.

Further experiments upon nerve in different conditions (the particulars of which cannot here be described) showed the effect of carbon dioxide as still coinciding with that of prolonged tetanisation, such effect consisting primarily in an augmentation of the negative variation; hence the conclusion is drawn that tetanised nerve evolves carbon dioxide.

In favourable conditions augmentation of the negative variation may be produced by the series of brief tetani employed in the rhythmic excitation of the nerve, when the effect closely resembles the well-known "staircase" phenomenon occurring in contractile tissue. Dr. Waller leaves it an open question whether or no the phenomenon is of carbon dioxide production in muscular as well as in nervous tissue.

Of other sub-positive considerations touched upon, one of chief interest is the surmise as to the functional and chemical relations between grey axis and white sheath in a medullated nerve fibre. The stability of nerve is that of perfect compensation, not that of slowness or absence of change; and it is probable that the investing white sheath supplies the means of rapid repair to the functional grey matter.

It is perhaps not too much to hope that an elucidation of the processes of assimilation and dissimilation will be among the gains to our knowledge of living matter brought about by this new method in the immediate future. S. C. M. S.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual Spring Meeting of the Institution of Mechanical Engineers was held last week on the evenings of Wednesday, April 29, and Friday, May 1. The President, Mr. E. Windsor Richards occupied the chair on both occasions. The meetings were held in the theatre of the Institution of Civil Engineers, lent by the Council of that body for the purpose. The new buildings, which are now being erected for the Institution of Mechanical Engineers, are fast progressing, and probably the present year will be the last during which the latter Society will be dependent for a meeting-place upon the hospitality, always so freely accorded, of the older Institution.

The agenda for the meeting contained two papers, as follows:—

(1) "Steel Steam Pipes and Fittings, and Benardos Arc Welding in connection therewith." By Mr. Samuel MacCarthy, of London.

(2) "Research Committee on the Value of the Steam Jacket. Experiment on a Locomotive Engine." By Prof. T. Hudson Beare and Mr. Bryan Donkin.

The first business of the meeting, the usual formal proceedings having been disposed of, was the reading of his address by the President. Mr. Richards, as is well known, is a prominent steel manufacturer, having held important positions in steel works both in South Wales and in the Cleveland district. As might have been expected, therefore, he dealt more with the raw material which engineers use, rather than the methods of working it up; that is, mechanical engineering proper. It would be ungracious to find fault with the address, which must have involved much labour in its preparation, but the members of the Institution could hardly but feel a little disappointed that the President did not deal more with the machinery used at iron and steel works, rather than with the form of blast furnaces and their products. Mr. Richards' wide experience would have made of the greatest value his remarks on rolling-mills, rolling-mill engines, blowing engines, and many other pieces of machinery which are strictly examples of mechanical engineering used in iron and steel works. However, he elected to confine his attention more particularly to blast furnaces, and his remarks on the subject, although perhaps more in keeping with the other technical society, of which he is a yet more prominent member, the Iron and Steel Institute, were nevertheless of considerable interest. Mr. Richards referred to the delegation organised last year, through the British Iron Trade Association, to visit Belgium and Germany, with a view to ascertaining how it was that these countries were able not only to compete with us in neutral markets, but were also able to sell their products even in our own markets. As the address said, the inquiry undertaken by the delegation involved great labour, and some of our readers may perhaps remember that at the time it stirred up some very angry feelings; the Germans specially resenting what they considered an intrusion into their country. We have not space to follow the President in his discussion upon blast furnace practice in various countries, though it may be generally stated that the Americans show an amount of intelligence and energy in their iron and steel works, which is not surpassed and hardly equalled in any other country. Indeed in blast furnace practice the United States may justly claim to take the leading position in the world, not even excepting ourselves. At the present time near Pittsburgh there is being erected an addition to the Duquesne Works, which will cost about £600,000. Four blast furnaces of a height of 100 feet are being erected, together with the necessary blast engines and other plant. A production of 500 tons of pig-iron every twenty-four hours is expected from each furnace, thus bringing the total product for the year up to the enormous amount of 180,000 tons. Quick working generally means short life in a blast furnace, as in so many other things, and it has been often contended by English iron-makers that the slower working followed in this country is more profitable. If, however, it be allowed that the lining of the new American furnaces only lasts for four years, no less than 700,000 tons of pig-iron will be obtained in that time; a quantity which, as the address pointed out, an English furnace would require fourteen years to produce. Putting aside the question of furnace lining and renewing, it will be easily seen the large advantage a system of quick working gives in respect of labour, establishment charges, and, in fact, all the items that go to make up the cost of producing pig-iron, excepting the raw material. Under these circumstances it is hardly to be wondered at that the American output in the iron trade is advancing with such gigantic strides. Mr. Richards stated that generally in America the whole labour cost per ton of Bessemer pig-iron, is from 80 cents to 1 dol., and it is expected that the new Duquesne plant will reduce that cost by nearly one-half. English manufacturers have, however, perhaps less to fear from competition across the Atlantic, than from that of continental States, and from this point of view the details given of the production of the German and Luxemburg iron districts are of great interest. We do not find the same gigantic output as in America, but "in Germany there is a readiness to adopt new methods, and to take advantage of every point in the game of international competition, which cannot but go far to ensure success." A good example of this is given in the readiness with which German steel makers have adopted the basic process. This process had its origin in England, and though taken up by a few enterprising firms of steel makers, it may be said to have been received with but cold welcome by the trade in general. English makers preferred to import the hematite ores suitable for the acid process, neglecting our own vast resources of ore not suitable for acid steel. The Germans having somewhat similar iron ores, eagerly took up basic steel making, so as to utilise native deposits, and did not rest until they had overcome those defects and difficulties in manufacture, which always attend a new process, and which were, perhaps, exceptionally formidable in this case. They have received their reward, for at the present time an enormous trade is done in Germany in basic steel which can be produced at a cheap rate, whilst the quality is sufficiently good for ordinary engineering purposes. In Belgium, too, we see the result of an intelligent appreciation of modern improvements—both by masters and men—combined with a perseverance and industry which enables advantage to be taken of the smaller details that, in the bulk, go to make success. One thing the English manufacturer has against him is railway rates, and this is very strikingly brought out in a comparison made between the facilities which English manufacturers possess, as against those of the Belgium and German producer. As regards labour cost, Mr. Richards tells us there is not much to our disadvantage, but he says that our labour has become "far more difficult to manage, is much more ready to stop work in order to obtain an increase of wages, and is constantly agitating for fewer hours of work. Every concession made renders it more and more difficult to compete with the continent in the markets of the world, but our workmen cannot yet be brought to see this, neither can they be persuaded to cease opposition to machinery devices for saving labour and reducing cost; indeed all such appliances are jealously watched, and, if possible, their success is prevented." There is much truth in these remarks of

Mr. Richards, and the only cure for the evils he enumerates is to improve the intelligence and the status of the working classes. It is with regret that Englishmen too often see continental employers superior to those of this country in regard to the thoughtful care bestowed upon their workpeople. In some cases it is true, care of the workman is forced upon the manufacturer by legislation, but in a great many instances the continental iron and steel maker has recognised the wisdom of treating his workpeople liberally. Doubtless in England we may find many large-minded employers who, either from self-interest or from motives of a higher character, pay much attention to the well-being of their workmen, but too often the "hands" are looked on as simply an extension of the plant, their sole function being to give the maximum of labour on the minimum of outlay. It is hardly to be wondered at, under these circumstances, that self-seeking persons obtain the ear of the working man in this country, and so often advise them to their own detriment and that of the nation at large.

Mr. Windsor Richards concluded his address with some remarks on technical education. Referring to the want of intelligence on the part of operatives he said, "yet the favourite remedy of this state of things is, in many minds, to spread technical education all over the country; whereas if the results they desired unhappily be attained, the last state of the trade would be worse than the first, for we should have no hewers of coal, nor makers of steel." "Technical education" is so uncertain a quantity that it is not easy to arrive at what Mr. Windsor Richards exactly meant by his expression. We think, however, that his words are likely to be misleading if not mischievous. The most hopeful solution of the labour problem, in fact the only solution, is higher intelligence on the part of the workman, and there is no better way of fostering this intelligence than by giving operatives such knowledge as will enable them to appreciate the processes in which they are engaged. Experience proves that a man does not become less efficient as a labourer, even as a hewer of coal and a maker of steel, because he is educated, although frequently he may, by virtue of his education, rise above these positions. We must, however, leave Mr. Richards' address, and turn to the other parts of the proceedings.

At the last meeting of this Institution, a paper by Mr. W. H. Patchell, on "Steam Superheating" was read, the discussion on which was adjourned until the present meeting. Mr. Patchell's paper referred to various designs of superheater, the principal one treated upon being that of McPhail and Simpson. In this apparatus steam is taken from the boiler and passed to a superheater which utilises the waste gases from the furnace. In this way the steam acquires a certain amount of superheat. It is then taken back to the boiler, and circulates in the water space of the latter by means of an internal pipe. After this it passes to the engine. The object of the invention is to obtain thoroughly dry steam without the risk of it being highly superheated, and thus cutting cylinder faces, or leading to defects which have been experienced in time past in using steam above the temperature normal to the pressure. It will be seen, of course, that this superheater, so called, is not necessarily a superheater at all; it may be, or may not be, the result depending on the quantity of heat imparted to the steam by the waste gases, and to the length of time the steam is subjected to the influence of the water in the boiler by means of the internal pipe. Supposing the steam be superheated several degrees and then returned to the boiler, it will be subjected to the influence of water at a lesser temperature than itself, for the water in the boiler is practically at the temperature of saturated steam due to the boiler pressure. The superheated steam may be reduced to that temperature, but will not fall below it. Practically, we believe, in an installation with a McPhail superheater, as usually designed, the steam finally emerges from the internal pipe at a temperature above that due to its pressure, but generally to a small extent. It will, of course, be dry steam on finally emerging from the internal pipe; though possibly, in some cases, surface radiation in the steam pipe between the boiler and the engine may deprive the steam of its superheat. It is further to be noted that the heat which the superheated steam parts with, to the water in the boiler, is not lost, but goes to aid evaporation. If the degree of superheat of the steam as t passes into the engine cylinder be small, some of the steam will be almost immediately liquefied by the usual process of extraction of heat incidental to the working of any steam engine. If the heat used for superheating be wholly waste heat, there will of course be a gain due to the adoption of the apparatus; but against this must be put the first cost of the superheater. In any case it is an advantage to get dry steam, and the McPhail device must be credited with this.

The principal contribution to the discussion was made by Prof. W. C. Unwin, who claimed that Hirn should be credited with the practical introduction of the use of superheated steam. In Alsace he said superheaters are generally in use, and are found to be of great practical value. If the apparatus were intelligently designed, it was possible to use superheated steam without any of the dangers and troubles of which so much had been heard. A few years ago superheaters were largely fitted to a large number of steamships in the form of the well-known steam chimney, as doubtless the majority of our readers are aware. The advent of higher pressures, and consequent higher temperatures, however, brought difficulties. When steam of 30 to 60 lb. pressure was used, it was possible to increase the temperature of steam above that normal to the pressure, without introducing much complication, but when temperatures rose much above those mentioned, as they speedily did with the advance in boiler practice, superheating became a more serious matter. Improvements in the packing of glands, and the introduction of mineral lubricants, now enabled still higher temperatures of steam to be used without danger. It may be as Prof. Unwin says, that we can take useful example from the Alsatian practice, and thus another era of superheating has arisen. The introduction of the water tube-boiler also may supply an incentive to marine engineers in this direction. The limited water and steam space with this type of generator make it often difficult to get dry steam, so that a superheater would fill a useful place. Another point to be observed is, that if superheating of steam be used, steam jacketing is not necessary, or at any rate not so necessary as when non-superheated steam, often containing a considerable quantity of water, is passed to the engine. Perhaps when the paper on steam jackets by Messrs. Hudson and Donkin is read, we may get further light on this subject, and it is to be hoped ample time will be given for its discussion.

Mr. MacCarthy's paper on "Electric Welding of Steam Pipes" was a valuable and interesting contribution. Higher steam pressures have brought trouble to the marine coppersmith. The old brazed copper pipes have been found, by sad experience, to be dangerous fittings, several lives having been lost by their failure. Steel pipes have been accordingly substituted where high pressures are used; and so far as the pipes themselves are concerned, there is not much difficulty in producing a trustworthy article. The longitudinal welds of a lap-welded pipe are made either by rolls or by the gas-welding system with a hammer, in a thoroughly satisfactory manner, and experience has shown how flanged junctions can be made. It is where joints, such as elbows, T-pieces, &c., are required that the difficulty arises, and it is here that electric welding has come to the help of the marine engineer. On the table of the theatre Mr. MacCarthy exhibited several very fine specimens of steam fittings of the kind referred to, a four-way branch being a notable example. These were all made by the Benardos system of arc welding. Flanges are also welded to the length of pipe in the same manner; the method of working was described by the author as follows:—

"Ordinary low-tension continuous-current lighting dynamos are used; to the terminals of these a battery of Benardos accumulators is connected, into which the current flows continuously. When the welding circuit is closed, the current flows from the dynamos and accumulators; and large resistances are used when necessary. In this way a large discharge is obtained, equal to about twice the capacity of the dynamos, and the load factor of the apparatus is high. For some purposes it is possible to work without accumulators; but when this is done, the efficiency of the apparatus is not so high, because during part of the working period no current whatever is passing, and the machinery is running light."

For attaching the flanges to the pipes, the following method is adopted:—

"The flange is stamped out under the steam hammer in such a way that a V-shaped groove is left on the inside edge, extending about three-fourths through the thickness of the metal. The flange is next shrunk upon the tube, with its flat face outwards or at the end of the tube, and is carefully set in the exact position required. The welding consists in laying small pieces of steel in the V-shaped grove, and welding them in one by one by means of the electric arc, the welds being freely hammered between

each heat. The welder makes a complete circuit of the back of the flange, and fills it up sufficiently to make a fillet of about 1½ inches radius. In this way the flange is solidly welded to the tube at the back, and about three-fourths of the way through its thickness; but the front or outer side is not yet welded. The tube is then up-ended, and the outer side of the flange is welded to the tube, the only difference being that the heat of the arc is used to burn out a cavity all round the junction of the pipe and the flange, until the depth is reached at which the two have already been united; this cavity is then welded up in the same way as the back of the flange, thus ensuring that the flange is welded solid to the pipe right through."

One point in connection with electric work, to which the author called special attention, was the length and size of the arc which is used in the welding of various kinds of work. With a short arc, the carbon point is brought down too close to the steel, and the result is inferior work, not only from the presence of the carbon, but also because the heat is concentrated upon so small a surface that the strains set up in cooling are considerable. The longer the arc, the softer and more defined is the heat; and any slight strain which may be set up can be got rid of by careful annealing. A long arc is therefore indispensable to the proper working of the system.

The reading of this paper was followed by an animated discussion in which trade interests were not altogether neglected. One manufacturer from Sheffield expressed a preference for flanges forged solid from the end of the pipe, rather than for those electrically welded on in the manner described. No doubt the electrical welding gives a very trustworthy attachment between the flange and pipe—experience has proved this; and, equally without doubt, the solid forged flange is an excellent device. The merits of the two systems are reduced to commercial considerations. The same speaker, whilst bearing testimony to the very fine junctions, bends and T-pieces shown by the author, said that recourse to electrical methods for producing these was not necessary, as they could be made equally well, and at a cheaper rate, in the shape of crucible steel castings. That, however, is also a commercial point upon which we need not enter. The question as to whether electrical welding is really welding or fusing, was also discussed by several speakers at the meeting. The problem appears very much to be one simply of names. No doubt electrical welding, as described by the author, is not welding in accordance with the forgeman's old vocabulary; but whether it be welding or fusing, so long as it gives a good and trustworthy junction of the two metals, is a matter of small importance. There is no doubt that electrical fusing, if engineering purists insist on the term, enables work to be done which could not be attempted in any other way, and it will surely take its place in times to come as an engineer's workshop process. The methods of making the longitudinal seams in steam pipes by welding were described by the author in his paper. These methods are well known now, and have been in use for some years, so we need not refer to this part of the paper, further than to state that it gave rise to a discussion on the respective merits of solid drawn tubes made from the ingot (which of course have no longitudinal weld) and lap-welded tubes. On this point Mr. Mark Robinson gave some instructive data. He had made tests with lap-welded steel tubes and solid drawn steel tubes. We will not quote the details, as they were rather voluminous, but we will simply say that the lap-welded tube showed considerable superiority. It may be stated, however, that at the present time seamless steel tubes are being made by one firm in 12 ft. lengths, the diameter being 1 ft.; this is rather a remarkable development of the industry.

The meeting was brought to a close by the discussion on this paper.

The Summer Meeting of the Institution will be held this year in Belfast, and will commence on Tuesday, July 28.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Sir G. G. Stokes, Prof. A. R. Forsyth, and Prof. J. J. Thomson are to represent the University at the celebration in Glasgow of Lord Kelvin's jubilee next month. Prof. Thomson will also represent the University at the Sesquicentennial celebration of the founding of the College of New Jersey and the inauguration of Princeton University, to be held next October.

In view of the extreme financial depression which has befallen the Colleges, the Chancellor has diminished by £3000 a year the contribution payable by them to the University in 1896–98.

The Council of the Senate has reported in favour of the affiliation of the University of Toronto and the University of Bombay.

Prof. T. W. Bridge and Mr. Charles Davison have been admitted to the degree of Doctor of Science.

OWING to the efforts of the Chairman of the District Council, it will not be long before the town of Bilston is provided with an efficient technical and art school. No less than £2400 has been locally subscribed, and it is confidently expected to bring the amount up to £2500 at least, when it will be possible to claim £1000 from the Science and Art Department, and £500 from the County Council, making a total of £4000. A Committee has been formed in connection with the workmen of the district for raising £250 towards the expenses of furnishing.

SCIENTIFIC study is given a little encouragement by the London Chamber of Commerce. Among the prizes offered for competition in the Chamber's seventh examination for junior commercial education certificates, to be held in the Hall of the Institute of Chartered Accountants, Moorgate-street, E.C., on July 6, are:—Prizes of £5 and £2 for proficiency in commercial history and geography; prize of £5 for proficiency in algebra, Euclid, mechanics, and hydrostatics; prizes of £3 and £2 for proficiency in chemistry; prizes of £3 and £2 for proficiency in electricity and magnetism; prizes of £3 and £2 for proficiency in sound, light and heat; and prizes of £3 and £2 for proficiency in natural history. There will also be awarded the "Princess Louise" prize of £35 for general proficiency, and the "Textile Section" prize of £36 15*s.* (conditions undetermined); while the Aberdeen Chamber of Commerce offer a prize of £2 2*s.* for proficiency in mathematics.

AT a meeting of the Technical Instruction Committee of the Cornwall County Council, held at Truro last week, the Agricultural Sub-Committee recommended "That in view of the Government proposals, affecting secondary education, as set out in the Education Bill now before the House, it is desirable to defer taking immediate steps to secure land and premises for the purpose of establishing a farm school in this county." The recommendation, which was proposed by the Chairman, was eventually adopted. During the discussion which took place upon the matter, it was made clear that the original intention had been to found a central institute because the only suitable efficient schools in the county were of a proprietary character, and from the provisions of the Technical Instruction Act, 1889, it was impossible to assist these. The object of deferring the question was to enable the Committee to see if, by the terms of the new Act, schools of only a semi-public character could be assisted, and also to first become acquainted with the powers of the new Educational Committee before they committed themselves to any policy.

A SHORT time ago attention was called in these columns to the low financial condition of the University College, Bristol. We now learn from the *Lancet* that the Council of the College issued last week an urgent appeal for pecuniary assistance to the inhabitants of Bristol and the West of England. The Council earnestly appeal for a capital sum of £10,000 to clear the college from debt, and for an addition to the annual sustentation fund of £700, which would restore the fund to the £1200 subscribed in 1882, not less than which is required to meet the annual expenditure and to secure the Government grant. The Council also emphasise the need of a permanent endowment, and suggest that wealthy citizens of Bristol and the West should associate their names, as in other colleges, with the endowment of professorships. The donations already promised for the capital fund amount to £5334, and to the sustentation fund about £100. We note with pleasure that, at a recent meeting of the Technical Education Committee of the Bristol Corporation, it was decided to recommend the Council to make a grant of £2000 to the funds now being raised on behalf of the college, to be conditional upon the £10,000 being obtained, and on the acceptance of two representatives of the Town Council upon the Governing Body.