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THE TECHNIC.

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THREE months of a new school year have passed, and on the whole, the times are good. Several features of the Fall's work have been especially gratifying. The Freshman class, whose numbers and appearance made a good impression at the start, seems to be one of unusual promise, both as regards school work and athletic possibilities. Thus far the various organizations which represent student activity have done well. The Athletic Association has done good work, and its recent efforts in the direction of better enforcement of the Gymnasium rules is very much to be commended. The Scientific Society, as well, deserves special mention. Its record as to the number of meetings in the past term is unique, and the officers of the Society, as well as the men who have presented papers, deserve credit for it. The Y. M. C. A, has been up to the usual standard, and what is better, has recently come to realize that this standard could be higher. From a realization of this, and an ambition to make its work a real success. much is to be expected. The Telegraph Association and Camera Club have been in good condition. It is to be hoped that this flourishing state of affairs in the organizations will be unchanged throughout the year.

And now the term has passed, and the examinations are upon us. The time has come when we are weighed in the balance. Here's hoping that in this respect, as well as in other work, most of us may be a milligram or two above weight!

IT has always been a difficult thing to define for the TECHNIC an absolutely consistant policy. As a scientific journal representing the Institute, and as a chronicle of local happenings, its functions vary widely. The trivial affairs which must be published in its latter capacity cannot but take away in some measure from the dignity which the former demands. But its duties lie in both directions, and each is important. The student body, with which it is in more immediate touch, and which furnishes so large a part of its revenue, has undoubtedly the right to a full account of the matters in which it is interested. On the other hand, the fact that so many of the standard engineering magazines exchange with the TECHNIC, and frequently reprint articles which appear orginally in this journal, shows conclusively the importance of the more serious departments.

In the past years of the TECHNIC successive editors have naturally had different ideas as to the relative importance of the two, and the variations in the space given to the local departments have been wide, Of course there is a golden mean for which each has striven according to his own ideas. If to some it seem that in the present issue too much prominence has been given to the trivial interests of college life, we are sorry, but beg that it be remembered that to the many students now in the Institute, these form a large part of the interest in what the college paper has to offer.

ONE direction in which most students have not improved their opportunities in the last few years, is that of gymnasium practice. While weather permits it is of course well that the exercises be taken in the open air, and that the gymnasium be little more than a dressing room. But with the coming on of winter, it is very desirable that systematic exercise be taken up and persevered in. Gymnasium classes are good, and ought to be well attended. We hope they will be formed. But more exercise than is afforded by these is needed. The regular exercise must not only be for the sake of present health, but with a view towards better condition and increased ability when the spring opens. We hope that there may be increased interest in gymnasium games, and that class rivalries may assist in rendering the playing of them regular and interesting.

ON the 23d of November a general assembly was called at the request of the President of the Y. M. C. A. Mr. Harry Wade Hicks, Traveling Secretary of the National College League, made a brief address to the Student Body. He was here for the purpose of building up the local organization, and of extending interest in it. He passed briefly over the history of the college movement, which comprehends today the students of many countries. As an interesting evidence of the very extended work of the organization, he exhibited publications issued by the students of the United States and Canada, England, Norway and Sweden, Germany, France, India, Australasia, Japan and China. Mention was made of the fact that the tendencies of study in a technical school, unless corrected in some way, were toward a certain narrowness of mind. The large proportion of the student's time which is required by his school duties, leaves little time for general reading or the refining influences of social life. Especially are the latter liable to neglect, and the speaker pointed out the importance of the friendships formed outside of the circle of school acquaintances. One of the best functions of the ideal college Y. M. C. A. is to encourage and help the student in this important direction. Another idea emphasized was that the organization, far from being narrow or sectarian, is intended to unite into one body all those who believe in the moral life, or appreciate the desirability of Scripture study, whatever be their beliefs.

The address was well received, and we hope its influence may be seen in increased interest displayed by the Student Body in the excellent work our Association has been doing. The Association, as well, has been encouraged to higher ambitions as to its future usefulness.

THE TECHNIC is indebted to the *Railroad Gazette* for the privilege of using the text and illustrations of the article by Professor Howe, "The First Stone Arch Bridge Built in the United States," which appears in this issue. It appeared in the above periodical a few weeks since.

THE Editor takes this opportunity of expressing his thanks to several of his fellow-students who have taken photographs for this issue of THE TECHNIC. Mr. Schwartz contributes the picture of the foot-ball team, Mr. Blair that of the new boilers, and Mr. Michel the photographs illustrating the article, "A Curious Old Book."

Storage Batteries.

By THOMAS GRAY.

THE power of the electric current to produce chemical decomposition was discovered just a century ago by Nicholson and Carlisle, who found that a current of electricity when passed from one platinum plate to another through water decomposed the water into oxygen and hydrogen gases. In the following year Gautherot noticed that if, while the electrolytic cell was being used to decompose water, the electrodes were connected together, the cell was capable of giving a current for a short time. The direction of this secondary current was opposite to that which had previously been flowing through the cell, and indicated that a kind of back pressure was set up when the water was decomposed. This back pressure, or polarization, as it has generally been called, is due to the tendency of the constituents of the decomposed body to recombine. If these constituents can be stored in contact with the plates of the electrolytic cell at which they are set free and the electrodes of the cell be connected together, a current will flow round the circuit until the substance previously decomposed has been restored. This is the fundamental principle of the modern storage cell, and hence its discovery may be said to be a century old.

As a matter of fact, no attempt was made at that early date to use these secondary currents. There was no evident need for such a cell and the subject was not developed. A certain amount of data was, however, gradually accumulated. Among other things, it was observed that the duration of the secondary current was increased if the plates used were oxidized. As early as 1837 Schoenbein found that peroxide of lead formed a good coating for a secondary cell. Similar discoveries were made by Grove, Wheatstone, Siemens and others. Faraday, in the course of his experimental researches, electrolysed acetate of lead and obtained on one plate metallic lead and on the other lead peroxide, and in the later papers he refers to the apparent high conductivity of this oxide of lead.

Probably the most interesting and important of the early storage batteries was the gas battery made by Sir William Grove in 1842. In this battery the plates were of platinum and the liquid was water acidulated with sulphuric acid. The gases obtained from the decomposition of the water were collected in glass tubes, one of which surrounded each plate. In this way the plates of the cell dipped partially in the liquid and were partially surrounded by a gaseous atmosphere by one plate being surrounded by oxygen, the other by hydrogen. When the electrodes of this cell were connected the gases recombined and an electric current was produced. With fifty such cells Grove succeeded in obtaining an arc light.

The next work of special importance was that of Planté, extending over the nineteen years from 1860 to 1879. The Planté cell consisted of two plates of lead immersed in water acidulated with sulphuric acid. When a current is passed through such a cell so as to decompose the water the oxygen set free at one plate combines with it to form peroxide of lead and hydrogen escapes from the cell at the other plate. If, after this action has been continued for some time so as to coat one plate with oxide, the current is reversed, the other plate is oxidised and the hydrogen, instead of being liberated, combines with the oxygen of the oxide previously formed, leaving lead. The plate first oxidized is thus brought back to a simple lead plate, with, however, an important difference, that the surface is soft and porous. By continued repetitions of this reversing process Planté succeeded in getting a larger and larger amount of the lead plate oxidised before the coating of the oxide became so impervious that the oxygen set free by the current could not come in contact with the lead. His cell consisted of a lead plate carrying on its surface a considerable quantity of lead peroxide and another plate of somewhat spongy metallic lead, both immersed in a vessel containing sulphuric acid and water. Such an arrangement may now be looked upon as an ordinary voltaic cell in which the opposing plates are lead and peroxide of lead. The cell is found to have the great advantage of being capable of maintaining a comparatively large current for a considerable time with only slight loss of e. m. f. due to polarization. The e. m. f. is about two volts, which is high in comparison with most voltaic cells.

It is evident that the process of the formation the Planté cell, that is, of obtaining the spongy lead and lead oxide plates above described, is tedious and expensive. This led a number of experimenters, about the same time, to make experiments on the feasibility of pasting the plates with oxide already prepared. Prominent among these workers were Metzger in Germany, Faure in France, and Brush in this country. Faure obtained broad patents on the application of oxides or salts to conducting electrodes as an aid to the formation of secondary batteries. His cells came rapidly into prominence, and in a comparatively short time the lead lead-peroxide cell became generally known as the Faure cell. As a matter of fact the various cells of this kind, and there are a great many modifications now in use, do not differ essentially from the Planté cell. The differences are in the construction and mode of formation.

There has been a good deal of controversy as to priority in the idea of pasting oxide on the plates, and claims have been made that even in this, Planté had anticipated later inventors. It is possible that some part of the difficulty in the earlier trials was due to the fact that a lead plate pasted with peroxide of lead is not the same electrically as the lead plate coated with oxide by electrollysis. A lead plate coated with commercial peroxide of lead is almost entirely inactive when used together with a plain lead plate in dilute sulphuric acid. Ordinary lead peroxide, instead of having the high conducting power referred to by Faraday, seems to be practically an insulator. The most commonly accepted view at present is that the coating formed by by electrolysis is a hydrated peroxide which, since the peroxide of lead acts as an acid, may be called a hydrogen plumbate. Such a compound formed chemically and pasted on the plate, is active in producing e. m. f.

The improvements which have been introduced since the introduction of the Faure cell in 1880 have been almost entirely in mechanical construction and in the introduction of electrochemical processes of formation. The plates of the early Faure cell consisted of sheet lead coated with a paste of red lead which were laid on top of but insulated from each other by a layer of cloth and rolled up together into a spiral form. The plates were immersed in dilute sulphuric acid and a current sent through the cell until the plate on one side became peroxidized and that on the other was reduced to metallic spongy lead. This proved a very important mode of construction because it was difficult to keep the paste firmly in contact with the lead sheet, and because fibres of metallic lead very soon formed from plate to plate through the cloth and short circuited the cell. A great many experiments were made about this time having for their object the removal of these objectionable features. Notable among these earlier experiments was a long series made by Sir William Thomson in which he tried a considerable number of porous solids as separators for the plates. In most cases the plates were flat, held firmly together side by side with porous separators between and alternate plates soldered together as in the modern cell. None of these porous separators proved satisfactory, short circuits ultimately developing in all cases.

These forms were abandoned, as was also surface pasting, on the introduction of the perforated or grid form of plate with the paste held in the perforations. The perforated plate was invented by Swan, and very soon took a large num-

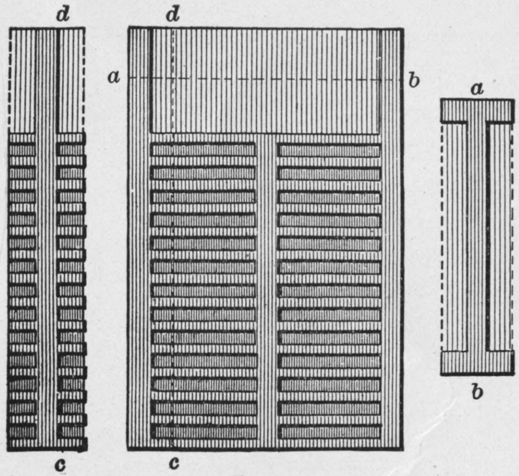


FIG. 1.

ber of forms in the hands of different inventors, A plate with grooved recesses for holding the paste, but not extending through the plate, was used about this time by Brush and is illustrated in Fig. 1. A similar form has been used in a number of other cells. It is impossible to describe in this short article the various forms of grooved and perforated plates which have been used. A general idea of one of the most widely used types of grid will be gathered from Fig. 2, which illustrates a cell of what is called the "chloride accumulator." The grid is in this and some other cases a casting about $\frac{5}{16}$ of an inch thick, the metal being an alloy of antimony and lead instead of the pure lead used in the earlier cells and still used by some manufacturers. One of the chief difficulties has been to obtain a grid which will hold the plugs of active material securely. When the bars of the grid are made thinner at the outer edges a dovetailing effect is obtained from the fact that the plugs are larger at the two outer surfaces than they are in the center. There results, however a tendency for the plugs to split into two parts and fall out. In the chloride cell, as here illustrated, the plugs are smaller at the outside surface than in the center, the process of manufacture being quite different from that of the ordinary pasted plate. In the manufacture of this cell lead nitrate is first formed by dissolving lead in nitric acid. This is mixed with hydrochloric acid and the lead chloride which is precipitated is washed and fused together with zinc chloride. The fused mixture is cast into small pastelles either round about ¾ inch diameter or square ¾ inch to the side with bevelled edges. These pastelles are then made to form part of a mould and the metal grid is cast round them. The plates so formed are packed between plates of zinc in a tank which is filled with a solution of zinc chloride. By short circuiting the cell thus formed the zinc chloride and the chlorine of the lead chloride is gradually dissolved out and a subsequent thorough washing leaves plugs of almost pure spongy lead. The oxide plates have then to be formed by the Planté process.

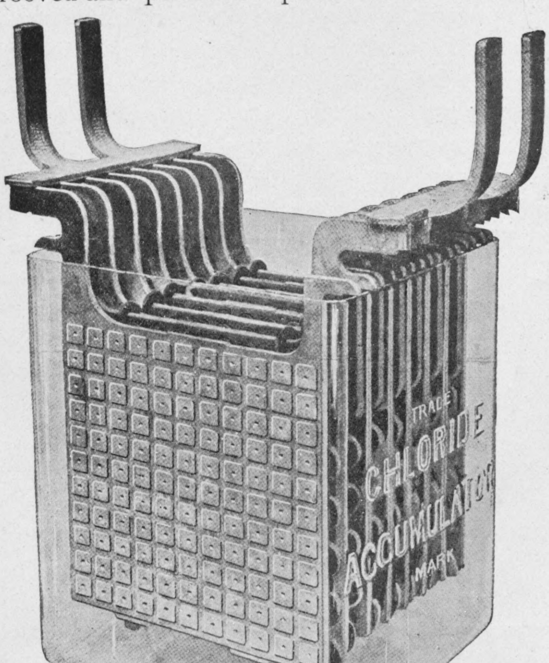


FIG. 2.

It appears that more recently the manufacturers of this cell have abandoned the above mode of forming the positive or oxide plates of their cell and now use a grid of lead antimony alloy about $\frac{5}{16}$ inch thick, having circular openings which are filled by spirals of thin corrugated lead ribbon. The oxide is formed by the Planté process as before. Several inventors have used porous lead plugs, such as spirals of ribbon, pressed blocks of fine wire tissue or powdered lead, and so forth.

In the pasted forms of plates it is now customary to use red lead for the plate to be peroxidized and to use a lower oxide, such as litharge, for the other plate. The process of formation is also in many cases partly chemical and partly electrical. For instance, in some cases the positive plates are made from lead either in corrugated or spongy sheets, which are first soaked for several days in an oxidizing solution, such as nitric acid.

The electro-chemical action of this cell during ordinary use is apparently very complex and has led to a great deal of investigation and discussion. It would seem that quite a number of secondary reactions occur during the charge and discharge of the cell and that these produce a variety of sulphates and persulphates of lead, per sulphuric acid, and so forth, besides the simple production and reduction of this peroxide, which is no doubt the most important active substance.

If we begin with a cell normally charged we have practically a lead plate, dilute sulphuric acid and a peroxide plate. The e. m. f. will be something over two volts. If it be now allowed to discharge at a moderate rate and the density and temperature of the sulphuric acid and condition of the surfaces of the plates be watched, the following, among other things, may be noticed: The density of the liquid will gradually diminish, showing that the sulphuric acid is being used up. The temperature of the cells falls slightly, notwithstanding the fact that heat is being generated by the passage of the current. The oxide is gradually reduced. Sulphate of lead is formed at both plates. During the recharging of the cell practically the opposite changes take place with such regularity that the density of the liquid may be used as an indication of the condition of the cell as to charge. The reduction of the oxide at one plate and the formation of sulphate at the other probably account for the greater part of the e. m. f. of the cell. The formation of sulphate at the oxygen plate is probably partly due to direct combination of sulphuric acid with the lower oxide formed by the partial reduction of the peroxide and partly to local action between the peroxide and the supporting grid. Neither of these latter actions add anything to the effective e. m. f. The peculiar

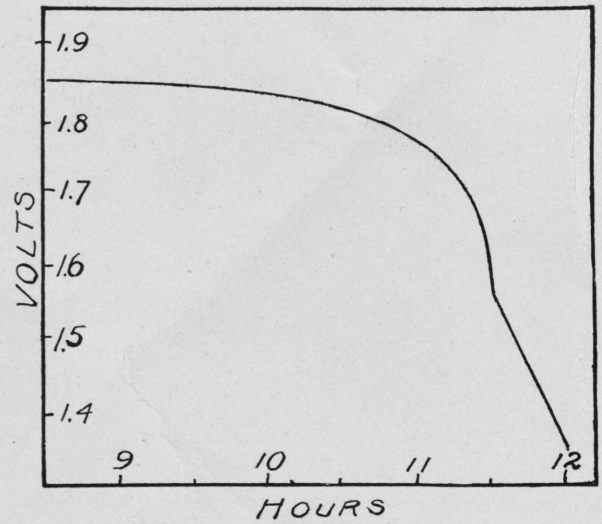


FIG. 4. This curve shows the fall of e. m. f. during the last three hours of an excessive discharge. Curves 3 and 4 are from experiments by Prof. Ayrton.

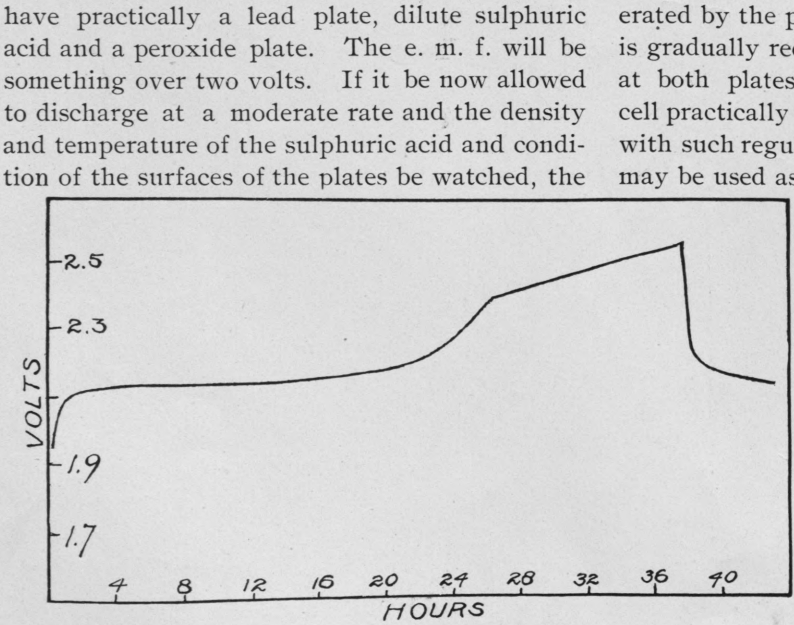
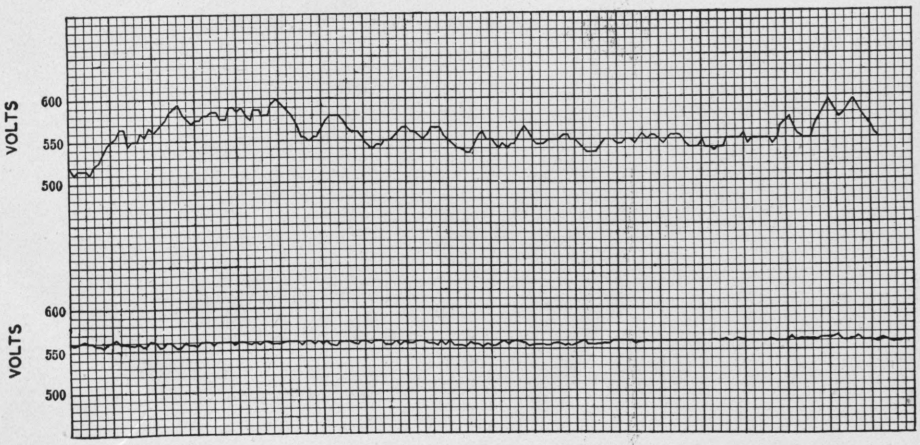


FIG. 3. This figure shows the rise of e. m. f. during charge. The charging current was kept on several hours after the cell was charged. The right hand end of the curve shows the drop of e. m. f. after the current was stopped.

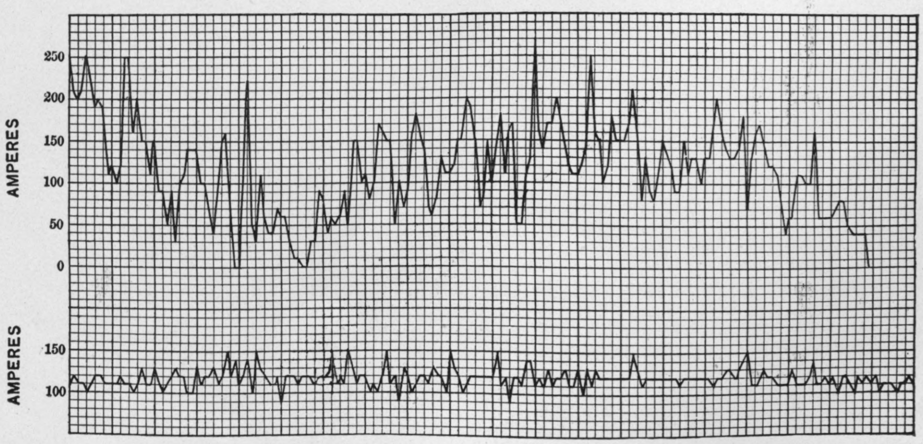
temperature changes are interesting, but are probably accounted for by the heat of solution of the sulphuric acid. Space will not permit of any discussion of the effects of the other substances formed during the charge and discharge; probably the effect of these is small unless the cell is over charged or overdischarged.



VOLTAGE CURVES IN A STATION BEFORE AND AFTER INSTALLING STORAGE BATTERIES

FIG. 5.

As to the application of these batteries, a number of attempts have been made to use them as a portable source of power for street car purposes, but with rather unsatisfactory economical results. They are used to a considerable extent in electric automobiles and if convenient charging stations could always be found, this would no doubt be a profitable application. They are coming largely into use as auxiliary sources of power in electric power stations, where they are used to keep the load on the generating plant more nearly constant and to form a kind of potential or e. m. f. governor where the fluctuations of load are large and rapid. When used to equalize the load on the generating plant they are charged when the outside demand is light and are discharged during the few hours of each day when the demand is above the average, thus assisting the generators. In some cases the battery has been made of sufficient capacity to take the whole load for a few hours when the demand is a minimum, thus allowing the machinery to be shut down. When used as a potential regulator the battery is connected in parallel with the generator and the number of cells so adjusted that a comparatively slight variation of the e. m. f. of the generator above or below the normal will cause current to flow into the battery or out of it into the line. These batteries have also been used with advantage for the equipment of substations where the area of distribution is far from the generating plant. They are then most conveniently operated by means of high potential alternate current transmission, step down and rotary transformers.



LOAD VARIATIONS BEFORE AND AFTER STORAGE BATTERY USE

FIG. 6. Figs. 5 and 6 are from an article by Herbert Loyd in the Electric Railway Number of *Carsier's Magazine*. The curves show the effect of a storage battery used as a regulator of e. m. f. and current.

The First Stone Arch Bridge Built in the United States.

BY MALVERD A. HOWE.

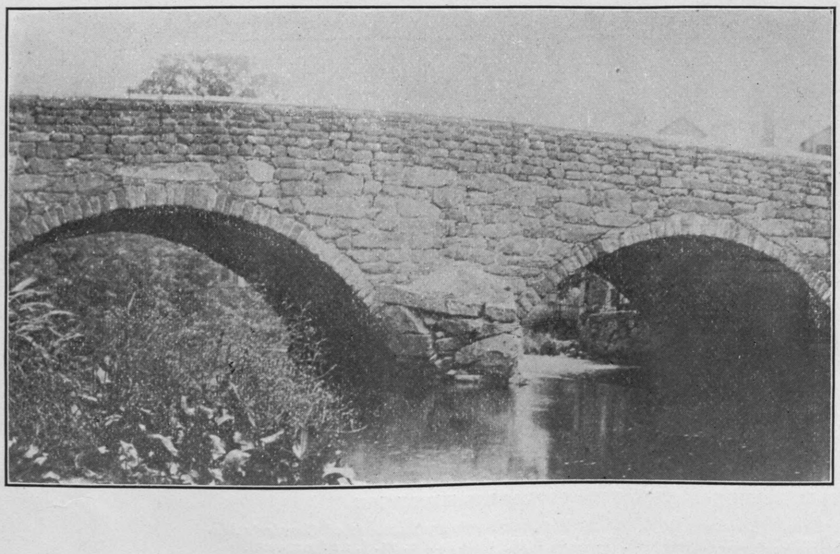
THE first stone bridge with ring stones built in the United States is claimed by the town of Ipswich, Mass. This bridge, while not of great magnitude, consisting of two spans of about 28 ft. each, has an interesting history and reflects no little credit upon its builder.

The structure is situated upon South Main street, where it crosses the Ipswitch River. The sidewalk is about 6 ft. wide and the roadway 22 ft., one side of which is occupied by a single trolley car track. In 1838 the bridge was widened 12 ft., making the original width between parapets about 16 ft. The material is granite hewn or split from boulders collected from the fields nearby. The inscription cut in a large stone at one end of the sidewalk parapet reads, "Choate Bridge Built by Town and County, 1764."

Col. John Choate, the builder, must have possessed considerable courage to attempt such a structure, for, like all innovations, it was ridiculed by many from the start. When the time drew near for the falsework to be removed public opinion ran so high against the bridge, (which was deemed unsafe by a large number of the citizens, and by some even it was contended that it would not stand under its own weight) that Col. Choate, to save his life in case the bridge failed, had his horse ready to take him out of the district. His precautions were needless, however, as the bridge did not fall and has been in constant use up to the present time. It trembles a little under a heavy team, but will doubtless give good service for many years to come.

Much of the above information has been verified through the courtesy of Mr. Charles W. Bamford, Town Clerk of Ipswich. One of the most interesting things things concerning the town which the writer learned from Mr. Bamford was that, according to the Town records Ipswich claims to be the "Birthplace of American Independence," as shown by the following vote passed at Ipswitch Town meeting, Aug. 23, 1687, in controversy to a tax levy:

"Then considering that the s'd act doth infringe their Liberty as Free borne subjects of his Majestie by interfearing with ye statutory Laws of the Land. By which it is enacted that no taxes shall be levied on ye Subjects without consent of an assembly chosen by ye Freeholders for assessing the same: They do therefore vote, that they are not willing to choose a Commissioner for such an end, without said privileges, and moreover consent not that the selectmen do proceed to lay any such rate, until it be appointed by a General assembly, concuring with ye Governor and Counsell."



For this vote the participants were promptly fined and imprisoned.

Notes on Automobile Construction.

By A. W. CLEMENT,
Supt. of Shops.

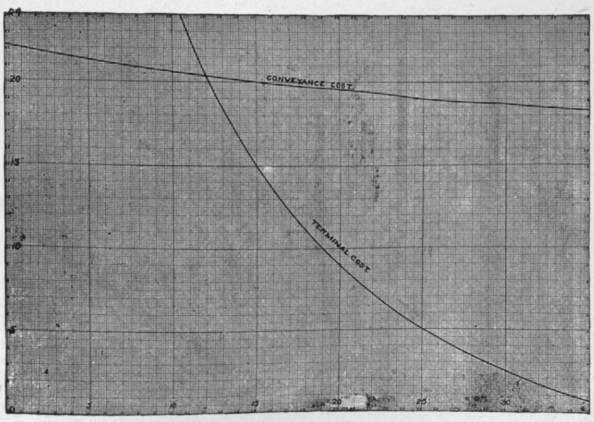
THE inventor or engineer who desires to win commercial success by supplying a want in the mechanical world should have a definite statement of the problem to be solved. He should discover whether there is wide enough demand to guarantee reward for the solution. He should review the work of others in the same field. He should have learned the laws of energy, force and motion and have sufficient confidence in them not to controvert basic principles. Then he is ready to go to work. The occasional, accidental inventor is often said to be a genius, and genius is also said to be a capacity for hard work. There is nothing contradictory in these two statements. The man *must* work hard who searches in the dark, with no method, no clue. The intelligent student has a great advantage—he gains by the *failures* of his predecessors, as well as by their successes.

In our consideration of the self-propelled vehicle we shall be rather superficial at this time, owing to our restricted limits. If any are inclined to know more of the subject, they will find not only pleasure in looking back at the efforts of early inventors but opportunities for improvement which are sure to be attractive.

The present activity in the search for a satisfactory self-propelled vehicle is not new. Steam vehicles were made and ran fairly well one hundred and twenty-five years ago. It is wonderful what they did in the early years of the 19th century. Legislation, especially in England, did much to retard their progress. The railroad was to be an enormous factor in the transportation problem and its prospects overshadowed those of the self-propelled road vehicles.

However, this has all changed, and, to-day, all classes are clamoring for them. The popular demand has become a stimulus to inventors, capitalists and manufacturers. When such a demand exists, neither the genius of the inventor nor the skill of the mechanic seems to have limits.

The interest is taking different forms with different peoples corresponding to the characteristic temperament. The French are a pleasure-loving people and found in the automobile a new sensation, a new toy, a fresh source of excitement. Legislation in France has not been unfavorable to its progress. Racing machines and pleasure carriages were early developed there. To-day our best high speed, long distance machines are built along lines developed by French engineers. The more staid Germans are making up in thoroughness what they lack in originality and inventive ability. Their love of order, neatness, cleanliness and economy is sure to be shown in their future work. The Anglo Saxon both in England and America sees more prominently the commercial side. Outside of the matter of pleasure and health, we want to know whether the thing is going to pay or not. We are more intensely practical. This



spirit has shown itself in the introduction of heavy drays for freight traffic in England.

In this country, we have taken especial interest in light express wagons, and parcel delivery wagons. The curiosity of the public is being turned to account in an advertising way. Perhaps we, more than the English, esteem the qualities by which these vehicles are made to cover considerable territory in a short time or to relieve a congested state in our stores and depots, There is an element here that does not appear in cost accounts. It is the advantage gained in being able to make more trips or transfer more goods in a required portion of the day than formerly with the horse. This element appeals to the postal authorities and also to the military man who has been limited in his operations by the will of so uncertain a beast as the army mule. more attractive. Certain inherent details of railroad work are nicely shown by a curve of terminal and conveyance costs which I first saw in *The Horseless Age*. It was used in illustrating an article by Prof. Thurston and is a graphic representation of data detailing British costs compiled by Prof. Hele-Shaw. The relation between the cost of carrying a passenger a given distance and the cost of maintaining the terminals is interesting. As the distance becomes less, the rate of terminal costs to conveyance costs becomes greater. The actual figures vary under different circumsances but the relation remains approximately constant. Switches, sidings, a signal system and all the paraphernalia employed in keeping several trains from attempting to occupy the same space at the same time would have no place in motor vehicle transportation. The

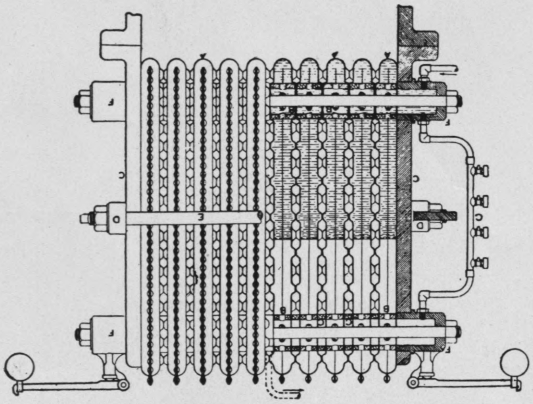


Fig. 1.

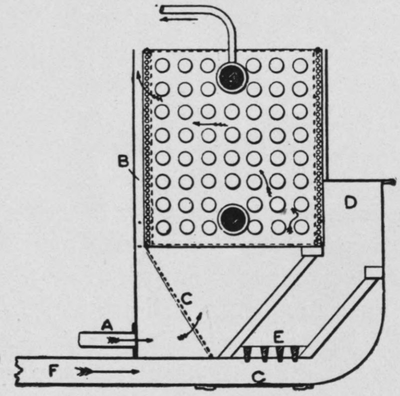


Fig. 2.

Accurate data showing comparative costs of horse versus self-propelled vehicles are not as yet easily obtained. No definite standard of construction has been evolved and the item of depreciation is unknown. The latter will always be a function of the care of the machine. When the owner learns to give as much attention to his motor as he gives his horse it will be considerably reduced. Enough is known, however, of costs to convince us, beyond shadow of doubt, that the motor vehicle has an immense field outside of considerations of health or pleasure. It is not a "fad," it has come to stay.

Capital has formerly found the locomotive portion of the curve at the left hand. i. e. for distance up to about thirteen miles in the present case shows where the automobile may successfully compete with the railroad. owing to the decreased terminal costs. Of course, in addition, there is an immense advantage in that any system, independent of rails, is infinitely more elastic. You can easily imagine how, at any time, say, when harvesting crops at different portions of the year in different parts of the country the mobility of a wagon outfit would give it increased advantage. The fact that it could be moved bodily from one district to another, or at will of its operators, connect the farmer or manufacturer with either of several railroads would make it a means of equalizing freight rates. It would help to destroy monopoly of transportation now existing in many places.

In the 23d annual report of the Indiana Department of Geology and Natural Resources, Mr. W. S. Blatchley, State Geologist, in "A Word of Suggestion to Holders of Undeveloped Coal Lands" says, "Your property is to-day, perhaps, out of reach of transportation facilities, and would actually sell for little if any more with the coal under it than it would without the coal. That will not always be so. The extensive mining of ten or twenty years from now will be carried on where to-day are only small neighborhood mines or not even that. It may be that the failure of natural gas in Indiana will result in the early development of many such regions. Suppose that five or ten years from now your land is brought within reach of the market by the introduction of a switch of a railroad. You value it at $50 an acre. Suppose there is a 5 foot bed of coal under it, what will it then be worth an acre? At a royalty of 10 cents a ton, from $500 to $750 per acre." That is, Mr. Blatchley estimates that undeveloped coal land increases in value from $50 to $500 or $750 per acre by being connected to a railroad. He also estimates that this coal will not be reached by the railroad for from five to twenty years. At a recent test in France, a wagon propelled by a gasoline motor worked at a rate of less than one cent per ton-mile, fuel cost. The possibilities are apparent.

We must not be two sanguine, however. Costs in this country will be greater than in England and France, owing to our poor roads. It is not that we cannot make good roads but that we have never had their value in dollars and cents forced upon us. I am merely forecasting probabilities. In comparing conditions here and in England we must also remember that the railroads there do not run so many spurs and branches from their main line as we do.

Leaving generalities, we will examine some of the more interesting details of construction. From 1825 to 1840 there were many steam vehicles built in England. High pressures were used, 200 pounds and more being not unusual. Much ingenuity was shown in the search for a boiler which should be a quick and rapid steamer, which should deliver dry steam and not be too heavy. Water tube boilers seem to have been tried at first by several builders but later discarded. One reason was probably that they had trouble in making the joints. The tubular construction also does not allow an easy separation of the steam from the water. In 1769 Cugnot built a steam trycycle in Paris. He mounted boiler and duplex engine on the forward wheel. Desiring to have as few moving parts as possible, he used no cross-heads but had a ratchet on the driving wheel driven by opposite pawls on radius arms direct connected to the piston rods. We do not know much of this vehicle. Indeed, it is said that details of performance of these early vehicles were most often reported at the coroner's inquest. In 1825 Hancock patented in England a horizontal water tube boiler made of 16 tubes 4½″ diam. and 4 ft. long, connected by small pipes. To keep it from priming he added a separator. He later made a boiler that was similar, except that it was vertical and that it had a 2″ smoke flue running up through each of the water tubes. He was evidently trying to increase the heating surface and improve the draught. Like others he had to abandon the water tube form on account of the many pipe connections. His next construction was novel and is partly shown in Fig. 1 and Fig. 2.

This consisted of 10 flat water chambers made of charcoal iron ⅛″ thick, shaped like a bag and riveted up the sides and across the top. These

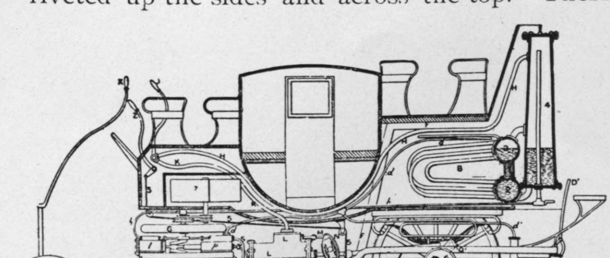


FIG 3.

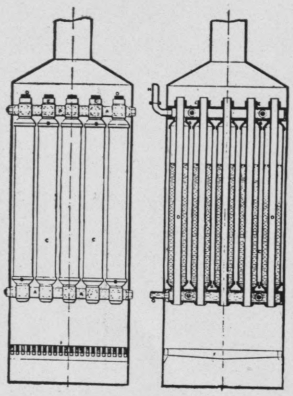


FIG. 5.

chambers were at first separated by thin vertical iron bars in order to leave passage for gases. The high steam pressure which was carried bulged out these chambers until they touched each at points between the separating bars, making the chambers mutually supporting. Hancock profited by his experience. In his next boiler he did not use the supporting bars at all. He laid the sheets on a cast iron mould and hammered the metal into concavities. Then when bent around and riveted together these bosses on the elements touched each other, leaving space between for products of combustion. Two large holes were made clear through all these chambers and stay-bolts were put through, as shown at F, Fig. 1. Pieces of perforated pipe B were placed inside the chambers and sometimes plain rings C between the chambers in order to make good joints and then the nuts on the stay bolts were tightened, combining the elements into a unit. The perforations in the distance rings B allowed for water communication below and ste m above. Heavy cast-iron plates C at the ends, formed buck stays. Transverse bars D were laid across these and drawn together by the outside bolt E. Safety valves were attached to the continuations of the steam connection. A pipe connection between the steam trunk and water trunk had four valves in it for testing water level. There was no trouble with the boiler priming. This was prevented by the small openings into the distance rings, the amount of heating surface above the water line, the large flat surfaces and the small steam pipe. No separator whatever was used with it. We have some of the figures showing dimensions and performance of one of this type of boiler as used on Hancock's coach built in 1836. In considering them, let us remember that modern ideas of construction and steam economy were unknown. There were eleven chambers about 20 in. × 30 in. × 2 in. between walls. The heating surface was about 86 sq. ft. with about 6 sq. ft. grate surface. The engines had two cylinders 9 in. dia. with 12 in. stroke and ran at same speed as the road wheels. These were 4 ft. dia. and at 10 miles an hour would make about 70 revolutions per minute. Since the pressure was anywhere from 70 pounds to 200 pounds to the square inch, according to gradeand speed, the engine may be taken to be from 14 to 20 horse power. This would give about 5 square feet heating surface per horse power at average rate and about .3 square foot grate surface per horse power. The boiler evaporated fully 10 pounds of water per pound of coke. There was no feed water heater. It evaporated about 8 pounds of water per square foot of heating surface per hour and about 130 pounds per square foot grate surface. Referring to Fig. 2, D is the hopper where the coke was put in and E was the grate. A fan was used to force air into the chamber F. All of the exhaust steam came in at A. Some of it passed through the perforated plate C and some through the fire E. The most of it, however, passed up around the boiler in the passage B and was heated and dried by the hot gases, the idea being to make the exhaust invisible. It seems that he also thought that some of the steam would be converted into water gas. There was a sliding door at C through which ashes and grate bars could be removed.

Hancock's results attracted world-wide attention and he built nine carriages. On one of them, he used a chain to transmit power from crank shaft to rear axle Previously they had all been directly connected. We may now benefit by some of his mistakes, viz: heavy fore carriage, rigid suspension of motor, oscillating cylinders, and open, unprotected machinery. These all cost him much trouble and expense. His enumeration of his trials is pathetic.

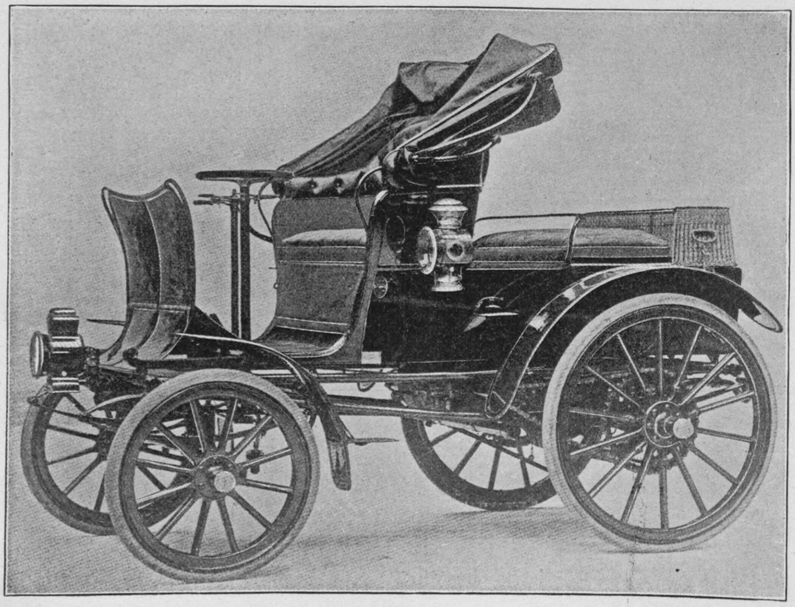
Goldsworthy Gurney was contemporary with Hancock and with the aid of Sir Charles Dance was experimenting on steam vehicles on a large scale. A longitudinal section of one of his coaches is shown in Fig. 3. His engine consisted of two horizontal cylinders, 9 in. dia. by 18 in. stroke. The driving wheels were 5 ft. dia. He used a water tube boiler at pressure ranging according to demands, from 70 lbs. to 120 lbs. It is stated that this boiler was tested to 800 lbs. per sq. in. cold. The fire was in the space B, the lower water tubes forming grate bars. The two horizontal drums, 2 and 3, extended clear across the coach. The upper drum was connected to two vertical chambers by a steam pipe, and the lower drum had a water connection to the same. These vertical chambers, 4, acted as separators. The steam was taken from the top through the pipe, 4, to a valve under the driver's seat and thence to the cylinders of the engine. This pipe passed through the upper part of the furnace, where it was heated and partially dried. A pipe vertically extending into the receivers also carried steam to two opposite cylinders of an engine on the fore carriage driving a fan which furnished forced draught. There was a flat water tank, W, under the coach. The exhaust from the main engines and from the engine driving the fan and feed pumps led into the space over this. Thus the sound was deadened somewhat and the feed water heated before going into the atmosphere. It will be noticed that there are two eccentrics, P, on the crank shaft, G′, operating valves in the steam chest, V, through rocking links, N. A cord, 5, attached to a handle near the driver was used to lift the ends of the eccentric rods to the opposite end of the rocker, thus reserving the motion. Regulation was entirely by means of throttling, there being no variable cut off. Gurney had one coach for carrying fourteen passengers, which weighed about 6,500 pounds. In driving this, it was stated that he used about ten gallons of water per mile (100 lbs.) and twenty pounds of coke, giving an evaporation of five pounds of water per pound of coke. Taking the average pressure in the cylinder as forty pounds, the power developed would be in the neighborhood of twenty-five pounds, and the steam consumption between fifty and sixty-five pounds per horse power per hour. On the whole, his outfit was not nearly as efficient as Hancock's. The heating surface of the boiler was not distributed to the best advantage. However, when we consider the date and his progress in details, viz: forced draught, water tube boilers with steam and water trunk and separator, dry steam, heated feed water, separate direct acting feed pumps, water gauge glasses, steam pressure gauge (spring loaded piston type) and fusible plugs, we must agree that he did remarkably well. In one of his carriages he so arranged his springs that the shock of starting the engine would be partly absorbed by them. In principle and effect, he thus anticipated recent patents for the spring support of electric motors on street cars. A record of the cost of fuel was kept for one of these coaches. For a total distance of 3,644 miles the average cost was eight cents per mile.

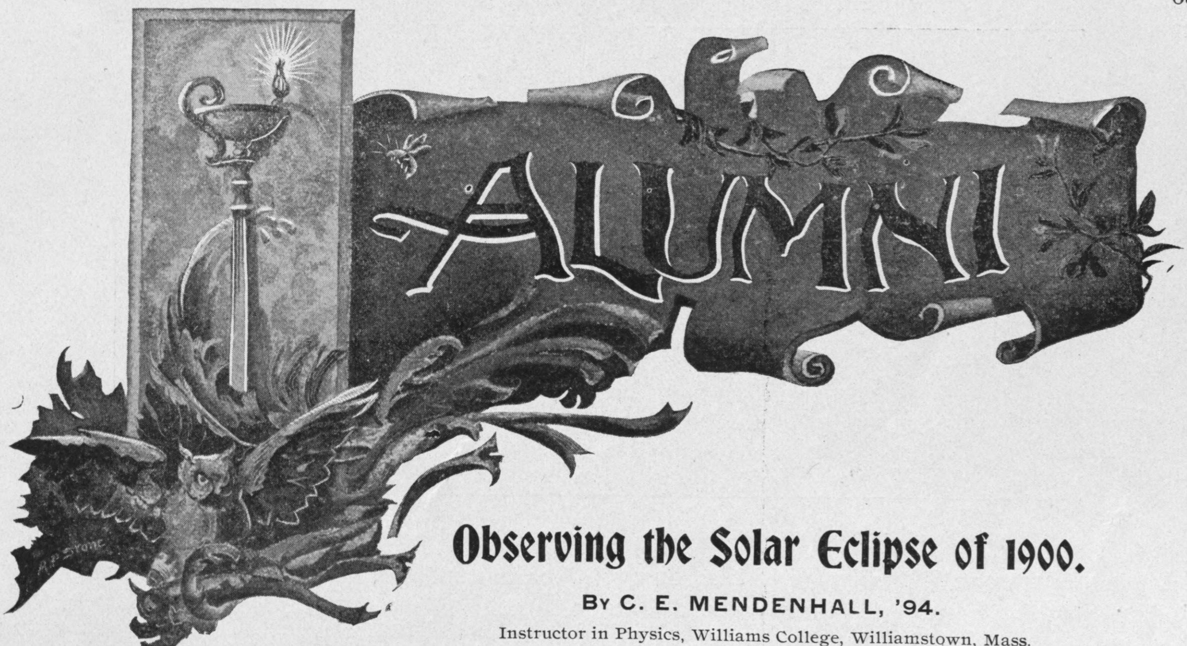
As showing the tendencies in the development of small boilers, it is interesting to briefly examine the one built by Summers and Ogle in 1830. Two views were shown in Fig. 5. It was a vertical water-tube boiler with tubes about three feet long, and had internal smoke flues, D. There were thirty of these double tubes made of charcoal iron $\frac{1}{10}$ inch thick. The ends fitted into cast iron sockets. The nuts, E, on the smoke flues were used to draw up the elements and make a joint. In plan, the boiler was $2' 4'' \times 3'$. There were six square feet of grate surface and a total heating surface of about 250 square feet. The boiler was tested cold to 364 pounds per square inch and the safety valve was set at 247 pounds. The total weight of boiler without the case was about 800 pounds. The engines used with this boiler developed normally about twenty horse power. Taking this as a basis, together with the figures which we have for an eight mile run, we may calculate that the steam consumption was about fifty-six pounds per horse power hour and about seven pounds of water was evaporated per pound of coke and 4.3 pounds per square foot of heating surface per hour. In terms of grate surface, the evaporation was 196 pounds per square foot and the consumption of coke twenty-eight pounds per sqare foot per hour.

The fact that *details* of the construction and performance of small boilers are not generally available must serve as an excuse for presenting them here. Reports of tests of such boilers are very rare. In general, we know only that the efficiency of such a small steam plant must be less than that of a large one.

James (1824) was the first to use independent engines for each driving wheel, thus avoiding the differential question altogether. Gears were not well enough made in those days to stand the rough usage. The common link chain had been used occasionally, but that also was very imperfect and entailed a loss of perhaps 15 per cent. by friction. The consequence was that the usual form was the direct-connected type, which meant slow piston speed on account of the large during wheels, and therefore large cylinders with great vibration and extravagant steam consumption.

The early engines lacked high rotative speed. Legislation checked advance in England or the small steam motors might have developed much sooner into the form now being so successfully adapted to vehicle work. However, it was in France that the first steps were taken in constructing a compact, enclosed, high speed motor. It was the internal combustion motor and to Daimler, probably, more than any other, is due credit for early discovering means to crntrol and regulate its power. In 1885 he patented the familiar type of single cylinder, enclosed crank, gasoline motor. It is known to-day under a hundred names. Improvements and modifications are the subjects for patents but the ground work is the same. Our best high-speed, long distance vehicles to-day are propelled by motors which do not diffea essentially from those built by Daimler fifteen years ago. The half-tone shows one of the modern applications which we may examine more in detail at another time.





Observing the Solar Eclipse of 1900.

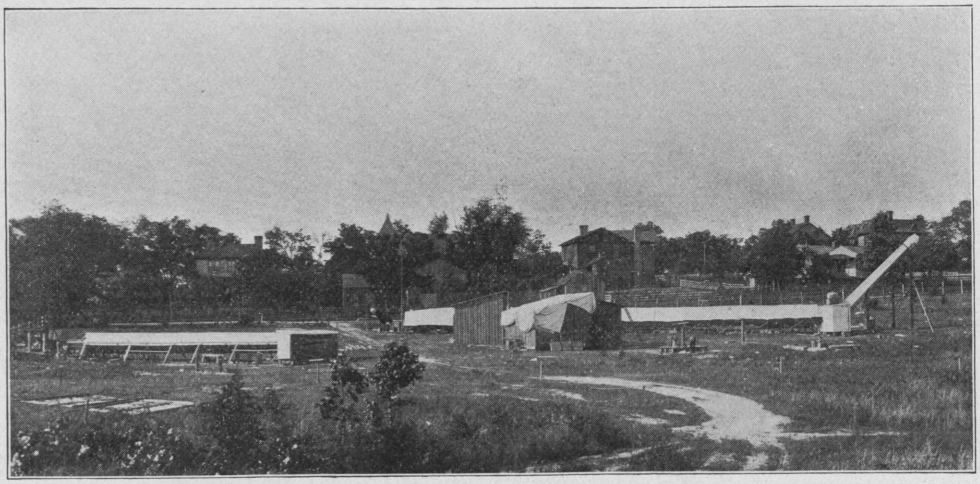
By C. E. MENDENHALL, '94.
Instructor in Physics, Williams College, Williamstown, Mass.

THE Eclipse Party of the Smithsonian Institute, under the direction of Prof. Langley and Mr. Abbot, of which I had the pleasure of being a member, was one of the best equipped of the many expeditions which observed the elipse of 1900 at various points in the southern states. Our party was stationed at Wadesboro, N. C., near the center of the path of totality. which was about 60 miles wide. Wadesboro is relatively high, and the weather records encouraged hope for a clear day on the 28th of May. As it turned out, the weather was most remarkably favorable throughout the entire path of the eclipse.

I may as well confess at once that I did not see the eclipse—that is, the spectacular part of it, totality (my work preventing)—and you will therefore be spared any vivid word-picture of the beauty and grandeur of the phenomenon. But it may be of interest to consider what were the objects of the expedition, and to describe the rather unique equipment which enabled those objects to be, on the whole, very successfully attained.

The objects were (1) photographic, (2) bolometric, (3) spectroscopic, (4) astronomic. That is to say, (1) to obtain photographs of the eclipse at various stages, to increase our knowledge of the structure, form and changes of the corona and prominences; (2) to study with the bolometer the radiant energy received from the corona in long "infra-red" waves, i. e. in waves too long to be visible; (3) to study the spectrum of the "chromo-sphere," that is, the outer gaseous layer of the sun and the "reversing layer" which produces the absorbtion lines in the solar spectrum; (4) to obtain records of the time of the various contacts—that is, of the beginning and end of totality. As might be imagined from this outline, a car load of apparatus was required, and weeks were spent in mounting and adjusting it.

The most striking feature of the camp was the telescope, 135 feet long, having a twelve inch objective, belonging to Prof. Pickering. This was mounted, as is the one at the Paris exposition, with its tube horizontal in a general east and west direction. The tube in this case was of canvas, on wooden supports, and it terminated at the image end inside a dark room, in which photographic plates could be safely manipulated. The beam of light from the sun was sent in a fixed direction down the tube by a large plane mirror, which was given the proper motion by

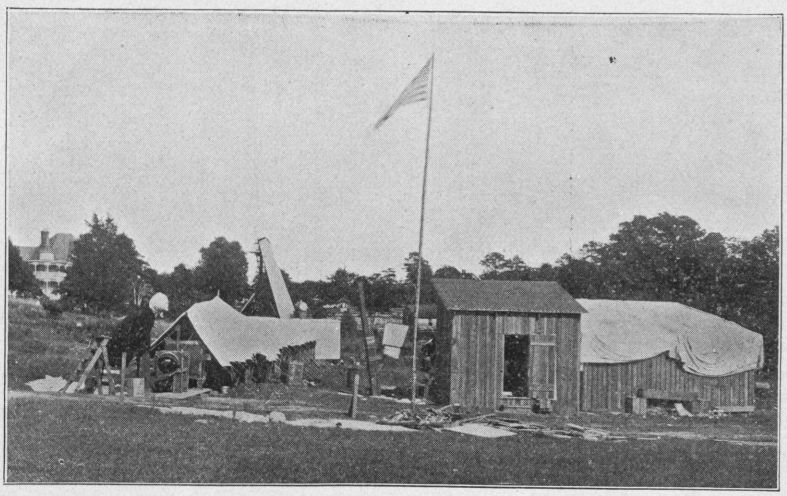


General view of Smithsonian and Yerkes Observation Camps; the latter to the left, partly dismantled.

suitable clock work. The image of the sun on the photographic plate (or of the moon's disc at the time of the eclipse) was in this case about 16″ in diameter—the approximate relation being in .01 diam. of image for every inch of focal length, i. e. $\frac{135\times12}{100}=16$. The plates used were about $30''\times30''$, so that only the inner corona come on the plate; for the entire corona extends at least several dimaters of the sun from the edge of the disc. What was desired on these plates was as much as possible of the detail or structure of the inner corona and the prominences; the latter being great eruptions of luminous gases projecting from the chromosphere, which become visible when the sun's disc is obscured by the moon. A number of plates were exposed during the time of totality, which lasted less than 90s.

Another telescope of about 38 ft. focus, mounted with its tube fixed, and requiring therefore a moving plate, gave a greater extent of corona. The brightness of the corona of course diminishes as the distance from the sun increases, so that a plate properly exposed for the outer faint corona would be over exposed for the inner corona. No one plate can therefore show both the detail of the inner corona and the greatest extent of the outer corona. Partly on this account I presume, no photographs of the corona which I have seen equal in variety and complexity the descriptions of competent eye observers. There were other telescopes, two of 11 ft. focus, two of 3 ft., one of 6½ ft. arranged with plate holders for photographic purposes, and all mounted so as to be moved in the proper way to keep the image fixed on the plate during the time of eclipse. The shorter focus ones, giving the smallest image of the sun, and the largest field around the sun, were specially intended to secure the presence of possible intra-mercurial planets, which could neither be seen nor photographed under ordinary circumstances on account of the glare of the closely adjacent sun. Examination of these plates has, I believe, already shown the existence of several such bodies.

This is the first time that any elaborate attempt has been made to study the invisible, so called radiant heat of the corona during an eclipse—though Prof. Brackett made some experiments in that direction a number of years ago. Our apparatus was quite elaborate. The instrument used to detect the presence of the invisible rays was the Bolometer, invented by Prof. Langley, the essential part of which is a slip of platinum, perhaps .002 m. m. thick, 1 m. m. wide, 10 m. m. long, which forms one arm of a wheatstone's bridge. If the bridge is first carefully balanced, any change in temperature of the platinum strip, which will produce a corresponding change in its resistance, will produce a deflection of needle of



On the right is Prof. Hale's bolometer house, and beyond, the Smithsonian bolometer house.

the galvanometler connected to the bridge, which will be proportional to the change in temperature of the strip, other things remaining constant. The strip being blackened on one side, will very largely absorb any radiant energy falling on it; and being very thin, a given amount of radiant energy will produce a correspondingly great change in temperature.

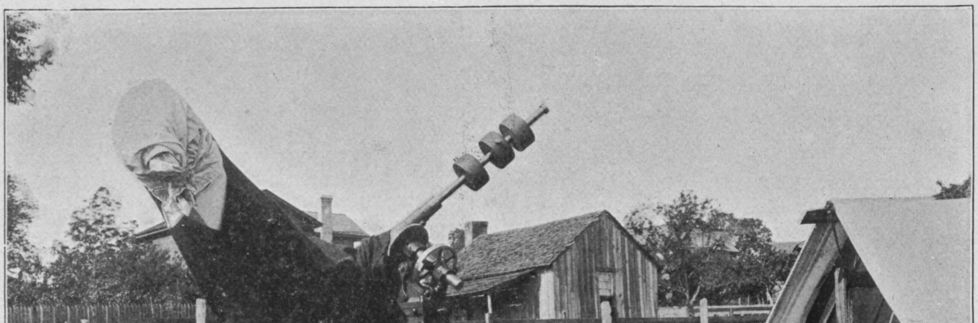
By using an extremely sensitive galvanometer, it is possible to detect a change in temperature of the strip of $\frac{1}{100000000}$ of 1 degree Cent.—and to detect the radiation from a candle at a distance of several thousand meters. Being concerned with such small differences of temperature, it is necessary that the balometer and accessory apparatus should be very carefully protected against all temperature change except that brought about by the radiation examined. Accordingly all the apparatus was in a double house, and the most sensitive parts, the platinum strip, the coils forming the other arms of the bridge, and the "sliding bridge wire" used for balancing were inclosed in a water-jacketed cylinder and protected from air currents. A plane mirror outside, given the proper motion by clock work, sent a beam of sun light through an opening in the side of the house upon a concave mirror 18″ in diameter which formed an image of the sun about $1^{c.m.}$ in diameter upon a screen containing a small slit. The light passing through this slit was, by another system of mirrors, brought to a focus on the platinum bolometer strip. By moving the first concave mirror, the relation between the slit and the sun's image could be changed at will. During the eclipse the image of the moon's disc was first set on the slit, and later moved so that the slit was nearly tangent to an edge of the image, so that, therefore, light from the inner corona passed through the slit to the bolometer. The corresponding deflections at the galvanometer indicated the relation between the radiation from the dark moon and the corona.

It was found that the radiation from the corona was greater than that from the dark moon, but less than that from a screen at about 20° C. Mr. Abbot suggests that this points strongly to the conclusion that the corona is gaseous matter under the influence of an electrical discharge, somewhat as in the case of a Crooke's tube.

I assisted Mr. Abbot in the bolometer work, being at the galvanometer while he manipulated the mirrors. Those who have had experience with a sensitive galvanometer can better appreciate the excitement attendant upon taking a number of readings in 90 seconds, when it was known all the time that there would probably be no chance to repeat the observations for many years. We both of us had more or less of an attack of "buck fever," in spite of previous rehearsals.

The spectroscopic equipment was relatively limited, consisting merely of one arrangement of apparatus used in connection with the 135 ft. lens. The horizontal tube of this telescope was double—one arm leading to the dark room as before noted, the other branching off at an angle of some 10° or 15°. A large glass prism of rather small angle was arranged so that it could be swung in and out of the path of the beam just after it left the lens; when the prism was in the path, the beam was dispersed and deviated until it passed down the branch tube and was brought to a focus at the far end, where a series of exposures of a photographic plate was automatically made. Just before totality, and immediately after totality, the narrow crescent of the sun visible around the edge of the moon, served as the slit of this spectroscope; during totality the prism was swung back so that photographs of the corona could be taken as before described. Unfortunately no results were obtained with this spectroscopic apparatus, the plates being entirely fogged.

To get the time of the contacts there was an ingenious mechanism, actuated by a break-circuit chronometer, which made an exposure each second on a moving photographic plate, giving a series of "snap shots" of the relative positions of sun and moon. Knowing the time when the series began, one could determine with an accuracy dependent on the sharpness of the negative, the time when the various contacts occurred. Eye observations were also made by Prof. Langley, and Mr. G. R. Putnam, R. P. I., '90, made a chronographic record of the times of contacts and directed the giving of signals for the guidance of the various observers. Several "rehearsals" were held on the two days just preceding the eclipse, one being a "full-dress" rehearsal at the corresponding time on May 27th, at which the moon was the only delinquent. In spite of this, I think every one admitted that the shortest 90 seconds ever known were those during which the sun was eclipsed on May 28, 1900.



One end of 135 ft. telescope; showing fixed lens, prism (swung to one side) and plane mirror moved by Brashear collostatt. The latter also carries a camera of 6 inch aperture and 7½ ft. focus.

SOME ALUMNI STATISTICS.

Location by States Where Alumni are Professionally Engaged.		*States from which Students have Entered the Institute.*	
Alabama	3	Alabama	8
Arlzona	1	Arkansas	5
Arkansas	5	California	5
California	3	Colorado	1
Colorado	1	Connecticut	2
Connecticut	1	Dakota	3
District of Columbia	6	District of Columbia	9
Georgia	1	Florida	2
Illinois	39	Georgia	3
Indiana	46	Idaho	1
Iowa	5	Illinois	74
Kansas	4	Indiana	376
Kentucky	11	Iowa	23
Louisiana	1	Kansas	12
Massachusets	4	Kentucky	66
Michigan	6	Louisiana	3
Minnesota	4	Massachusetts	4
Missouri	10	Michigan	15
Montana	2	Minnesota	5
Nebrnska	4	Mississippi	2
New Mexico	3	Missouri	18
New York	30	Montana	2
North Carolina	2	Nevada	2
New Jersey	1	New Mexico	1
Ohio	25	New York	12
Pennsylvania	29	North Carolina	2
Rhode Island	1	Ohio	99
South Carolina	1	Oregon	2
Tennessee	2	Pennsylvania	11
Utah	1	Tennessee	4
Wash ngton	3	Texas	10
Wisconsin	6	Utah	5
West Virginia	2	Vermont	3
Mexico	3	Washington	2
British Columbia	2	West Virginia	4
Japan	1	Wisconsin	5
England	1		
			801
Total, 33 States, four foreign countries.		Total, 36 States.	
Total number of graduates	275	Japan	1
		Canada	2
		South America	2
		England	1
			6
		Four foreign countries.	
		Total students	807

GRADUATES.	Per cent
Engaged in engineering work proper	80 2
As managers of business for which an engineering educalion is essential	11 3
Professions for which an engineering education is advantageous	2.3
Professors of Science and Mathematics	3.2
Miscellaneous	3.
	100.

H. F. Madison, '00, is with the Columbia Iron Co., Johnstown, Pa.

Larson, '00, has taken a position with the E. P. Allis Co., Milwaukee.

A. P. Stone, '99, is with the Forest City Steel and Iron Co., Cleveland, Ohio.

H. B. Stilz, '98, who is in the Navy Department at Washington, is at 908 Fifteenth street, N. W.

R. A. Philip, '97, is with the Seattle Electric Co., at Seattle, Wash. His address is 923 James street.

A. D. Kidder, '99, is in the General Land Office at Washington, D. C. He is engaged in examining the returns of public land surveys.

G. W. Phillips, '95, who has been with the Liquid Carbonic Acid Manufacturing Co., is with the Pennsylvania Malleable Iron Co., McKee's Rocks, Pa.

G. R. Putnam, '90, has left for Manila, Philippine Islands, to engage in work connected with the U. S. Coast and Geodetic Survey. His December TECHNIC will will be the first one to visit the new possessions.

The Electric Controller and Supply Co., of Cleveland, have recently issued a folder announcing that they had secured the services of Mr. A. C. Eastwood, and giving a short but very flattering outline of his previous work.

Harry J. McDargh, '96, leaves this month for British Columbia, where he will make surveys and plans for the purpose of developing water power for the West Kootenay Power and Light Co , at Bonnington Falls, B. C. He expects to be gone about three months. Upon his return he will resume the work of The Dayton Water Works. Mrs. McDargh will accompany him on the trip.

Butler = R. P. I.

THE football team met the biggest surprise of the season when it played Butler College at Indianapolis, Nov. 10. The boys went to Indianapolis with the intention and confidence of winning, as Butler had not won a game this season against a college team, and in fact had not scored. However, previous to the game, Butler worked in five men, who are attending the Indianapolis Medical School, and these five men defeated Rose. One of the five was France, who played guard on Michigan in '97 and was selected for the All Western team of that year, and he was a team in himself. Out of the five men who did the best work for Butler three were Indianapolis men. Notwithstanding the disadvantage, Rose had the best of the argument all the way through and had the ball in Butler territory the entire game, with the exception of the first part of the second half, and at one time had the ball on Butler's 5 yard line and were unable to score. At two other times the ball was on Butler's 15 yard line and place kicks were attempted, both of which were blocked.

It was a cold, damp day, and there were only a few people on the grounds when the game was called. Butler won the toss. Immediately after the kick off, Rose obtained the ball and carried it down the field to the 15 yard line, but was held for downs and Hadley attempted a place kick. The kick was blocked, Riggs falling on the ball. Butler then got the ball on downs and carried it up to within ten yards of the center of the field and were held on downs, and the Rose men carried the ball to Butler's 15 yard line again and were held for two downs. Hadley attempted his second place kick, which was again blocked, Rose getting the ball. During the remainder of the half the ball remained in Butler territory and the Rose line was not in danger at any time.

In the second half France kicked off. The ball lit directly in front of Uhl and in bouncing hit his knee and then rolled over the line. Uhl, thinking the ball had not touched him, let it lay while Wallace, of Butler, fell on it. The Butler referee at first averred that the ball did not touch Uhl, but that it was a touchdown nevertheless, and when the rules were shown him he immediately retracted his statement and stated that the ball did touch Uhl, and allowed the touchdown. Mehring attempted to adjust the ball before kicking the goal and Rose prevented the kick on the ground that two men had touched the ball.

After the next kick off the ball was carried and punted from one end of the field to the other, Huffaker returning a number of yards on every kick before being downed. When he punted the Butler man was downed in his tracks. The game ended with the ball on Butler's 20 yard line in possession of Rose.

The team lined up as follows:

Rose.	Position	Butlere
Fishback	left end	Mac.
Hadley	left tackle	Patton
Hampton	left guard	Morgan
Brannon	center	Compton
Peck	right guard	DeVaney
Peker	right tackle	France
Oglesby	right end	Anthony
Riggs	left half	Mehring
Uhl	right half	Edson
Jumper	quarter back	Butler
Huffaker	full back	Wallace

Officials—Referee, Simons; umpire, Robertson; timers, McCracken and Helmer; linemen, McGaughey and Keene.

VINCENNES, 0; R. P. I. 2d, 6.

The game which was to have been played with Wabash Thanksgiving was cancelled by Wabash on Wednesday afternoon, and the first team did not play on that date. The second team, re-enforced by the first team subs and several of the first team men, went to Vincennes and defeated the strong Vincennes University team. This team has not been defeated in three years, with the exception of a defeat administered by Indiana University, Not only that, but they have not been scored on in two years, and they played seventeen games last season. So, taking it all in all, the boys deserve a great deal of credit for the work they did on Thanksgiving.

The teams were very evenly matched, with Vincennes having a trifle the best of it in weight, The weather was crisp and clear when the teams lined up before an estimated crowd of 1,500.

Warren kicked off to Vincennes' 25 yard line. Before Rose's men had settled down Vincennes rushed the ball up the field by brilliant work until they reached the center of the field and were held for downs and compelled to punt to Pfleging on Rose's 25 yard line. The Rose men then rushed the ball up the field by line bucks, using mostly the guards right and left formation, which is a product of the second team this year, until Uhl was pushed across the line for a touchdown, and the only one of the game. The work of the team was very much to be commended, as the ball had been carried by line bucks 100 yards for a touchdown, and that without losing the ball at any time. Warren kicked goal.

Vincennes kicked off to Rose on the 30 yard line, and the ball was not advanced any notable distance the remainder of the half, the ball being in Rose's possession on their 38 yard line when time was called.

In the second half Vincennes kicked off to Pfleging on the 10 yard line. Rose advanced the ball by line rushes, but was hindered in end runs by the crowd on the field. The runs would have been good ones on a clear field, as the man was stopped by the crowd time after time with a clear field before him. Vincennes obtained the ball on their 35 yard line and carried it to Rose's 50 yard line, where they were held for downs. Immediately afterward Rose was held for downs and punted to Vincennes' 35 yard line. Vincennes had carried the ball to Rose's 37 yard line when time was called.

The line-up was as follows:

Rose (Second Team).	Position	Vincennes.
King	center	Like
Hommell	r. guard	Williams
Krieger	r. tackle	Neidifer
Kellogg	r. end	Purcell
Hampton	l. guard	Fairhurst
Brannon	l. tackle	Davis
Pine	l. end	S. Johnson
Jumper	q. back	C. Robinson
Uhl	r, half	E. Johnson
Warren, Capt	l. half	Bays
Pfleging	f. back	R. Robinson, Capt

Time of halves, 20 and 25 minutes.

VINCENNES 18; R. P. I. 2d, 0.

Bacon kicked off for Vincennes to McCormick, who fumbled the ball to Vincennes, Then a series of short line gains, followed by two long runs by Aydelotte scored a touch down in about two minutes of play. Bacon kicked goal, score 6 to 0. Hills kicked off for the Poly and Vincennes was immediately held for downs. Warren punted twenty yards and Robinson was downed in his tracks. Robinson immediately punted to Rose who fumbled the ball to Robinson, who ran twenty yards before he was downed. Vincennes was held for downs and then punted twenty-five yards over the goal line. The ball was brought out and kicked off by the Poly from the twenty-five yard line. Vincennes then brought the ball back to the twenty yard line and time was called.

In the second half Hills kicked off forty yards and Johnson fell on the ball. Line and end plays gained for a little and then the ball went to Poly on downs. Three times the boys tried to get through the line and then Warren punted thirty-five yards to C. Robinson who came twenty. Steady end and line plays with tandem interference and long individual runs by Aydelotte made another touchdown for Vincennes, Johnson carrying the ball. Bacon kicked goal. Score, 12 to 0. Hills kicked to Aydelotte who came back ten yards. He then made a run of 15 yards but was called back because in the formation there were six men back of the line. Steady line bucks brought the ball to the goal line and Aydelotte carried it, over Bacon kicking the goal and the score 18 to 0. Hills kicked to Aydelotte and the Vincennes men were compelled to punt fifty yards. Jacob got the ball and fell on it. Poly line plays made ten yards and then lost on downs. Time was called as the ball changed hands on the Poly's ten yard line.

The line up was as follows:

Rose Second Team.	Position.	Vincennes
Powell	left end	Hillman
Hills	left tackle	Neideffer
Williams	left guard	Fairhurst
Shaley	center	Like
Williams	right guard	Baker
Krieger	right tackle	Martin
Brentano	right end	Bacon
Knight and Jacob	quarter	C. Robinson
Pfleging	left half	Aydelotte (Capt.)
Warren (Capt.)	right half	Johnson
Ingle	full back	R. Robinson

Substitutes—Hunley, Jacob and Cohn; Williams, Buck and Davis.

Referee—Wilder; Umpire—Harold Bays, of Sullivan; Timers—Lindenberger, of Rose, and R. A. Yelton, of Vincennes; Linesmen Fitzpatrick and Buck; Touchdowns—Aydelotte (2), Johnson (1); Goals—Bacon (3). Time of halves, twenty-five minutes each.

And now the foot ball season is over and it is time to commence talking about a team next year, and also about a base ball team for next spring. The foot ball team for next season ought to be a good one, as only five men on both teams will be lost this year by graduation—Huthsteiner, Riggs, Hadley, King and Pfleging. King and Hadley are the only line men, so that a very good line ought to be expected. Huthsteiner will, of course, be a big loss back of the line, but this will not be felt as much as Riggs', as Huthsteiner has not played in the last three games. Riggs and Hadley will probably be the greatest loss to the team.

The season as a whole has been disastrous in regard to the number of games won, but even more so in the number of men who were compelled to quit playing during the season on account of injuries. Brannon is the only man who has played in every game this season.

The second team has not been entirely successful, either, this season, but still they cannot be blamed, as man after man has been taken from their ranks to supply the vacancies on the first team. Oglesby, Pine, King, Jumper, Nicholson and Fishback were all members of the second team at the beginning of the season and were taken to supply places on the first team.

However, in the face of all these disadvantages of this season, let us still be hopeful of a successful one next year, and let every man be ready for foot ball when the season opens.

Locomotive Shop Practice.

J. R. RIGGS, '01.

TO the outside world little is known of the methods obtaining in the large manufacturing establishments of our country. Notwithstanding the fact that access is generally to be obtained to the factories and shops, by those interested, yet from a rapid visit and cursory examination of a plant, not much idea of anything but the general work can be obtianed. Of the perfected organization by which each workman knows exactly what to do and when to do it, and by which a machine can be taken entirely to pieces and its many parts scattered to as many workmen and places, and then again assembled without any loss or friction, little is known.

In locomotive repair, the engine is entered in the erecting department, its number and the "shop order" number placed on a card, also the date of entrance and date for complete repair are recorded. On the latter date the engine is entirely restored; its broken parts renewed, and bright with fresh colors, it leaves the shop propelled from a boiler of compressed air.

The first workmen on an engine entered for repair are known as the strippers. They remove the cab, running boards, hand rails, side rods, grates and all other parts not left to special workmen, and raise the engine on jacks preparatory to taking out the wheels. The number of the engine is painted on all these and each goes to its department for repair. In taking down the steam chests, guides and eccentrics, the parts, such as bolts, etc., are small and the number is cut with a die, together with an L or R to indicate the side of the engine from which it came. The bolt holes are similarly marked, so that each piece can be put in the proper place when reassembled.

The bolts and nuts go to the polishing room and return later as bright as new. Those which had the threads battered in removing are sent to apprentice lathe boys to be recut if still serviceable. Steam chest covers are planed for a new joint and new cylinder rings turned, as in nearly all cases the old packing is broken in many pieces, often being worn as round and smooth as gravel.

Cylinders have frequently to be rebored, and this is about all the repair work that is done in the room where the engine is dismantled, as the cylinders are never taken apart from the frame except when new ones are to replace them. Work on the frame or cylinders consists in reaming the holes for new bolts to attach the boiler to cylinder saddle, and reaming the holes when the frame is taken apart for new cylinders. The cylinder saddle bolts in the case of Mogul engines are thirty-six in number, about one and a quarter inches in diameter and four to five inches long. They are very hard to remove, as they have been made taper fit and driven the last quarter inch with a sledge. The nuts below have often to be split off with a chisel and the bolts driven out with a pneumatic hammer.

When the boiler is again replaced it is set in lead putty and all the holes reamed out with a taper reamer, each hole being fitted with an individual bolt. The importance of these can be seen when it is known that they practically hold the boiler and frame together, for, on account of expansion of the boiler when fired, the back end has to be placed so it can slide relatively to the frame. It is kept from lateral movement by what are termed pads, being flat pieces of iron held to the boiler by from twelve to sixteen steel bolts.

In putting new cylinders on the engine the work of lining them with the frame must be very carefully done. The cylinders come from the works where the engine was probably first built and are made according to the original specifications. The only work besides adjustment is chipping the saddle so the boiler will correctly fit. The frame of engine is generally made with its four main members continued in front by separate parts. These parts are removed, the cylinders placed, and a line running through the center of front and back end passed to the rear of frame. The frame is then moved so that it is equidistant on each side from these lines, and the extensions of the frame are put on and bolted to the main frame with new bolts in newly reamed taper holes. Now the cylinders are drilled through so that long bolts, four or more in number, pass from top to bottom.

For finding the distance down to which the saddle must be chipped, a temporary wooden frame is mounted above the saddle and the distance from center of boiler to center of cylinder is struck off from each side. This gives the exact position of center of boiler on the frame. Next, with a radius equal to radius of boiler, an arc is struck along the front and back edge of the saddle, down to this line the iron must be removed. This chipping would be very laborious if performed by hand, but much time and labor are saved by the use of an air hammer driving an ordinary cold chisel fitting in a socket, the whole not weighing over six or eight pounds.

In general, all the drilling and reaming on the frame is done by air motors. The use of air in this connection is a valuable adjunct and cheap, for the tools can be operated with 70 or 80 pounds pressure and the time saved over hand work is very great. Especially in boiler work are they of service. The sides and top of fire box and surrounding part of boiler are mutually supported by bolts passing from one to the other. These bolts or braces are screwed in, and the holes for them are threaded by taps driven by air motors.

The ends of the tubes through the boiler are put in from the smoke box in front, passing through the front of fire box behind. After coming through the holes in the fire box they are enlarged, and the edges turned over with a V shaped tool driven by a pneumatic hammer. This makes a perfect joint, but before an engine leaves the shop the boiler is filled, oil fires used for getting up steam and all the leakages noted and properly fixed.

All the joints between different sections of the steam pipes are ground so no steam can escape during its passage from steam dome to cylinders. The joints are made by brass rings, a section of which approximates a quadrant of a circle. It is ground with oil and emery paper on one side and then the other until when it is placed between two sections of pipe and the latter are lifted together, a perfect union is made. In the same manner the joints for the stuffing boxes are made, metallic packing of three or four rings being used in nearly all cases.

When the guide yoke is paced across the frame it occupies the same position it originally had, and the guide hangers are bolted back with the same bolts in the same holes, and even turned in the same direction in the holes. It would seem from this that the guides would occupy the same position when fastened to the hangers, but they may have been planed or polished so that they do not allow the cross-head to move exactly in line with the piston. The work of "lining up" the guides is done by passing a line through the exact centers of front and back end of cylinders and fastening it just behind the hangers. Now the guides are placed, and by putting them level and equidistant from the line just mentioned they are correctly adjusted. This is accomplished by putting tin strips, called "liners," between the guides and the supporting projections from the back cylinder head. Then, if the piston rod is connected to the exact center of cross head, all will move well. The cross heads are generally provided with adjusting screws on the flanges so that the last operation is easily performed.

Valves are planed to a true surface and the valve seat filed so it makes a perfect joint with the bottom of the valve. Around the four sides of the top of the valve are rectangular grooves. Into these are placed springs and on top of the springs, four rectangular bars fitting into the grooves, but held up by the springs against the cylinder cover. This prevents the steam from exerting a downward pressure on valve, which would call for a good per cent of the power to overcome the resulting friction on valve seat.

In the top and bottom of the steam chest is a groove running entirely around the four sides, and into this a soft copper wire placed so that when the nuts on the thirty or more stud bolts are drawn the wire is mashed and a steam tight joint made. Copper wire of a smaller size is also placed in the same manner between stuffing boxes and the parts against which they fit.

The setting of valves, or rather the setting of eccentrics to properly move the valves, is a very important and difficult task and entrusted to a skilled mechanic of long service in this branch of the work. The first part of the operation is to mark the points on the guides to which the cross head comes when the front and back steam ports are just beginning to open. After this the cylinder covers can be put on and no more attention paid to the valve itself. Next, two small wheels mounted to just clear the rails are placed before and back of the drivers, to the axle of which the eccentrics are fastened. These little wheels have corrugated surfaces and to one of them a lever is attached, so that when the frame of the wheels is drawn together, the driver is raised from the rail and may be rotated by the lever. By turning the drivers after the eccentrics have been temporarily secured, and tramming from a fixed point on frame to circumference of drivers, paying attention at the same time to the position of the cross head, the adjustment is made. This fixes the position of the valves, for the corresponding positions of valve and cross head have been center punched on the guides. By these means the valves are given the right amount of lead, or none at all, as is becoming quite common of late.

Of the management of the shop forces by which the work can be so systematically carried on, a word might not be amiss. After the Superintendent of Motive Power, and Master Mechanic, with his chief clerk and numerous office clerks, we come to the shop proper. Here the work is divided into about twenty-five different departments. Each of these is under a foreman chosen for his especial fitness for the work in hand, who has generally risen from the ranks and is thus familiar with every feature of the work.

The workmen in the various departments are divided into gangs in charge of a gang boss.

These gangs have only a certain kind of work to do, and perform it on all engines entered for repair. For instance, in the erecting department a certain gang of four or five men do all the work connected with taking apart, and later putting together, the main steam pipes. Now the boss in charge, from long service, is perfectly familiar with the work and knows exactly what to do in every case. In any event he has the department foreman whom he can advise with. Thus the work is regularly and systematically carried on, reported to the foreman and by him to the main office.

All work is paid for by the piece. Thus it is worth so much to remove a stud bolt, so many cents an inch for reaming or drilling a hole, so much for lining the guides, etc., etc. This scale of wages for work was originally made out so that the average mechanic can make his limit of wages per hour by employing his time industriously. The boss of the gang reports at the end of the day the work done and the amount due therefor, also the number of hours each man has worked.

It does not follow from this that a man could take the work paying the largest proportionate prices and by extra energy outstrip his fellows, for the machinist, the machinist helper, apprentice, etc., all have a limit of wages placed on them. All work over this goes to the company, and if the laborer or mechanic does not do his work he is not paid his limit. The latter is rarely the case, however, for the scale is a just one and fixed so the average mechanic can earn by piece work as much as his fellow at another place earns by day work. This is as it should be—fair to company and fair to employee.

As an employee of the Vandalia Railroad Company during last summer's vacation, the writer had abundant opportunity to appreciate and admire the management of a successful shop.

For any erroneous statements, of which it is hoped there are none, he asks the pardon of the officials and workmen, whose kindness and interest were at all times marked.

SCIENTIFIC SOCIETY.

Three meetings of the Scientific Society have been held since the last report was made. On Saturday, November 24, William Hadley delivered an interesting paper on "The Measurement of High Temperatures." He sketched briefly the older methods, and then proceeded to describe in detail the two forms of apparatus now most used for the purpose. He showed the Wiborg Air-thermometer and the Siemens Electrical Resistance Thermometer, and described the method of using them. He will contribute a similar article to THE TECHNIC shortly.

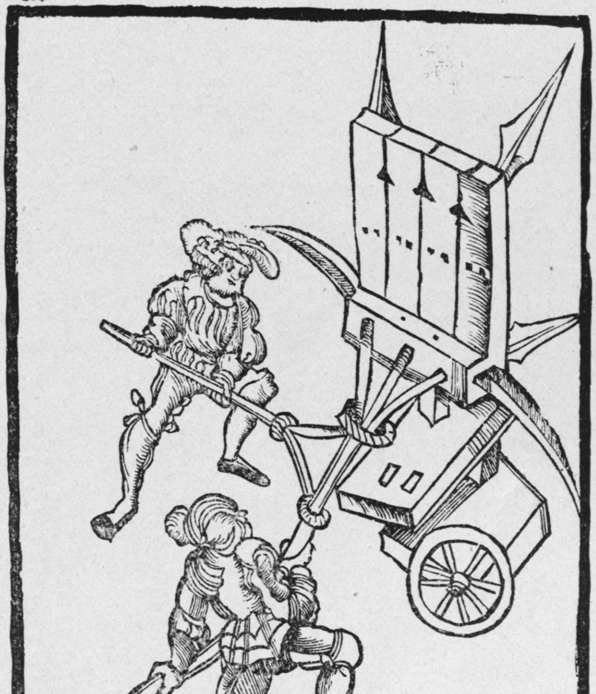
On the 8th of December Robert C. Warren spoke on "Smoke Tests on a Locomotive." The paper was a good one, and was illustrated with lantern slides.

Mr. A. W. Clement, on December 15, gave a lecture on "automobile Construction" before the Society. The paper was a very practical one, and Mr. Clement's extended experience in this direction gave his statements an especial weight. An article on the same subject appears in this issue of THE TECHNIC, by Mr. Clement. As the field is an extremely wide one for treatment in a single, short article, the author will contribute a second paper in some future issue.

THE NEW BOILERS, JUST AFTER COMPLETION.

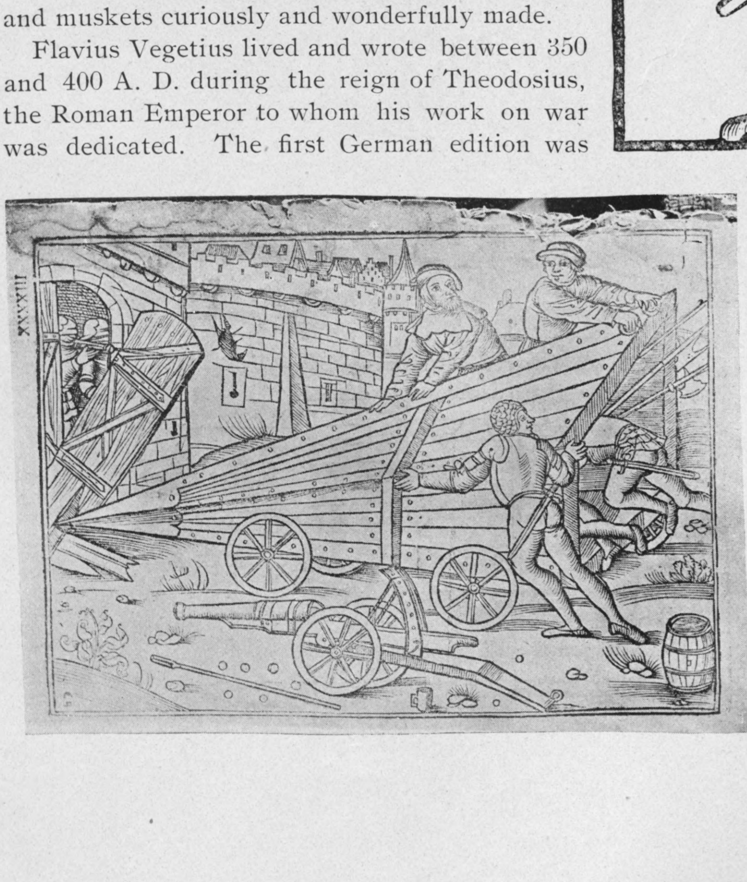
A CURIOUS OLD BOOK.

CX



The accompanying illustrations are taken from one of the oldest and most interesting books in our library. The title to the book supplied by the antiquarian is "Engravings on Wood, Illustrating the Epitome of the Art of War, by Flavius Vegetius Renati, published by Hans Knappen, at Erfurt, 1511." It is a folio volume of 195 full page wood engravings. The binding is of pigskin with leather bands across the back to which the contents are securely stitched with strong thread. One feels on opening the book very much as if he were entering a sepulchre. The musty, yellow covers, the weather eaten margins, the age-stained and worm-eaten leaves unite with the quaint and crude illustrations in telling of a departed age. All the old instruments of war are depicted—battering rams, catapults, long spears, javelins, movable towers, bridges, ladders, hooks for leveling walls, and many others. There are also several cannons and muskets curiously and wonderfully made.

Flavius Vegetius lived and wrote between 350 and 400 A. D. during the reign of Theodosius, the Roman Emperor to whom his work on war was dedicated. The first German edition was published at Ulm about 1475, with a few wood-cuts attributed to Zainer. The next edition appeared anonymously with the following title: "Flauii, Vegetii, Renati vier bucher der Ritter-schaft, zu de allerdurchleichtigesten groszmechtigeste furste vnd hern Maximilian Romische Keyser. . . . Erfurt durch Hans Knappen 1511." Rendered into English the title is "Four books (chapters) on Chivalry by Flavius Vegetius Reniti (dedicated) to the most illustrious and potent prince and lord Maximilian Roman Emperor. . . . Erfurt (printed) by Hans Knappen 1511." The book which we have belongs to the commentary to



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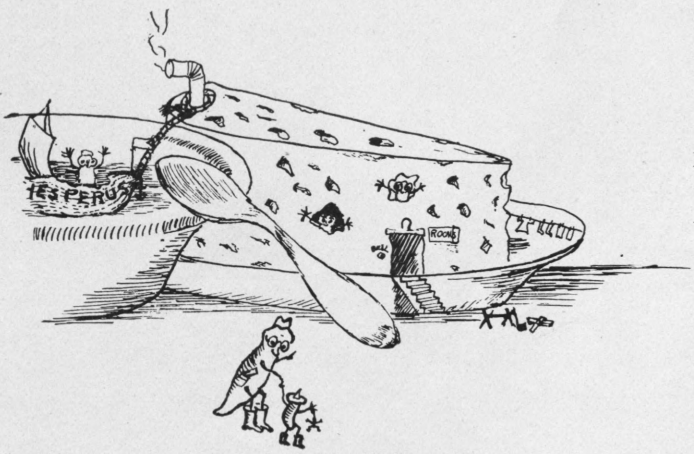
this edition and was printed a short time after the above date. Concerning the artist nothing is known definitely. Several monograms occur which cannot be identified with any known artist of the period. The monogram H K appears several times, suggesting that the publisher may have been an artist also.

ALBERT FAUROT.



It was the good ship Hesperus,
She sailed the wintry seas;
And the skipper had taken his little daughter—
To inhabit the boarding-house cheese.

Marshall did it.

Uhl says that the conductor was charged plumb full.

A new cement floor is being laid in the boiler room.

Several students enjoyed Thanksgiving dinners at home.

Marshall—"Go on away with that stationary magnet."

The last issue of the TECHNIC came out on November 15.

Warren claims to think very "quickedly" in a foot-ball game.

It is said that Schwartz has quit making those "goo-goo-eyes."

"Little Benny" left a broken heart in Vincennes, they say.

Jones:—"I didn't know you could measure angles in inches."

Koffend:—"Of what metal is a silver gulden made, professor?"

Dr. J. has discovered a "geographical" method of solving problems.

Dave Meriwether paid the town a visit during lhe Thanksgiving holidays.

The Doctor was heard inquiring about "Little Bennie Pine's" *manly beard.*

Burt, '03, was heard in the laboratory asking for "a great big desecrator."

Dr. J.:—"The effect of the induction-effect,—no, it wouldn't do to say that."

Uhl says that two equal currents in opposite directions countermand each other.

Brosius, contemplating a test tube:—"This surely contains water or something else."

Prof. Hathaway has told the Sophs a method of remembering anything if they forget it.

Prof. Wickersham says they have dry weather streams and wet weather streams out west.

Oglesby:—"The blacksmith docked me an hour because I took a bolt out of the shop."

Dr. J.:—Now, these two quantities are by no means the same, but—well, they're identical.

Prof. McCormick says that Wrai, '04, may be an X-Wrai before Xmas. Ominous for Wrai.

Jumper says that the signal So sent over the telegraph line means that the line is not working.

Some of the students became very popular on Thanksgiving,—those who received boxes from home.

Prof. Wickersham to Brentano, reading, "Are you sure you have the right page, Mr. Brentano?"

Ijams wanted some "Commonium" (cadium). Have not heard yet whether he found it under that title.

Wickersham, "Now take the letter "W." As to its sound, take for example, "Wicky," as you boys call me."

Brentano translates, "Paul and Marie have passed fifteen days on board the ocean."

Burt, experimenting, discovers a slight difference bet veen the taste of Na O H and lemon juice.

After Dr. Gray had developed several partial equations, and then combined them into one complete equation, Rochester expressed his pleasure in the fact that the doctor, as well as he, considered it a "fool" equation.

The landlady who used the expression, "A little of this goes a very long ways," in pointing out shortcomings to a tableful of boarders, has since had occasion to hear the same thing in connection with her particular variety of biscuits.

Huthsteiner, in "Poleconomy:"—The difference is that the one who's taxed is really the one who's taxed.

Prof. Howe, to Marshall (who is always asking questions): "Now just supposing you had a pipe-line," etc.

If you happen to find Warfel trying to open the front door, show him that one should pull it, instead of pushing.

Prof. W. asks Lyon to translate a passage in German. Lyon:—"Why, I have n't got the words written in, even."

Hammel interrupts a language class with these words, spoken very loudly, "I would n't fight with you in Wicky's room."

Charleston center, after trying to dive through Shaley's legs, whereupon Bismarck sat down on him: "Je, but you're heavy!"

A Sophomore, seeing Marshall coming up in the rain with his books in a sack:—"Say, who is that Normalite coming up the walk?"

"Careful there! or you will get the penalty for off side playing," comes the warning from Prof. Hath, as the Sophs make a rush for the door.

Disgusted Soph.:—"Oh! I cant get this to neutralize."

Austin:—"Of course not, that is nit realization.

Hills to Professor Wickersham just before a quiz, "Well, Professor, I'm going straight up." Wicky, looking up, "What's that, Mr. Hills?"

TECHNIGRAPHS—III.

It speaks for itself.

Prof. after explaining first problem—"Are there any others to be explained?" Soph. (waking up)—"I would like to see number one."

In paying his fare recently, Michel was seen to take a new street car ticket-book from his pocket, tear out a ticket, and hand the book to the conductor.

In setting the hands to the clock, Flory got one hand an hour fast. The cause of this was that he had lost his glasses just before the christening.

We hear that a descriptive problem involving the revolution of Cohn into the H plane, and his projection on the same plane, was successfully solved.

"Some one has lost a conscience and I have found a cent," remarked Prof. Hathaway after failure to locate the student so reckless with his money.

The Junior class has appropriated the song, "Of course you can never be like us, but be aslike as you're able to be." They seem to believe in the sentiment.

Professor Hathaway smoked a cigarette at reception recently. Dr. Gray seems to think that it is the influence of some of his pupils that is demoralizing the professor.

Prof. Faurot:—"They are exactly alike in every respect.

Arnold, S. F.—"Then what is the difference between them."

It is a fact that a certain member of the second team stopped the game at Charleston to take a chew of tobacco.

Dr. Noyes told Miller that he wouldn't get home until early Wednesday morning. Everyone was horrified until the Doctor explained that he was on the election board in his precinct.

Someone poked Hammel.

Hammel—"Say, let that alone ; it isn't yours."

Someone—"Whose is it?"

Hammel—" It is hers."

Someone—"Which Herz?"

Everyone laughed and Hammel looked worried.

The wearing of old-rose and white by members of the "Burgomaster" troupe was evidently greatly appreciated by those occupying the front seats at the performance. It was perhaps the first time the foot-lights had heard the R. P. I. yell so close.

On the Friday evening following Thanksgiving the Y. M. C. A. invited the students to their headquarters for an informal apple party. The attendance was good, and the large supply of apples was pretty well disposed of. A drawing contest was the chief feature of the evening's entertainment.

Dr. Blanchard arrives in the stock-room of the chemical laboratory, where a small crowd of students are examining the mass of powders and broken bottles which indicate an explosion in the organic case: "Is anything broken?"

Oglesby:—" No, a slight fracture."

The small crowd showed its appreciation.

Under the management of Superintendent Hommel, the Telegraph Co.'s line has been rapidly getting in its connections. The year promises well. The officers elected at a recent meeting were as follows : G. Davies, Pres.; V. Hommel, Supt.; E. L. Jones, Sec.; C. A. Cohn, Treas.

Brettner:—"Bob, if you want to fix your "pipe line" ask him about it." "No? Well, I guess my "pipe line" needs repairing, so here goes." "Professor, isn't that the same thing as determinants?"

Professor (enjoying the joke:)—" Yes, I have been lecturing on determinants for an hour."

Dr. Noyes, at beginning of lecture, "Mr. Rochester, Hammel and Perkins absent." He folds up his paper and begins, "Mr. Perkins, what is the first method," &c.

LEVITIES.

" McF. uses liquid tooth-powder."

" S.'s voice was the only person I recognized."

"Oh, Professor, where can I find some foaming Hydrochloric acid?"

On seeing some one pulling up a dried cornstalk in a field: "Don't spoil the poor farmer's crops."

Jealous contemporaries claim to have heard the same gentleman inquiring at a drug store for some alkili that would restore the holes eaten by acid in his trousers.

Second step in the direction of reconciliation between R. P. I. and I. S. N.—Mr. Levi, of the Sophomore class, lends his opera-glasses to a Normalite in the gallery. He gets them in time to take them home with him.

The Power Quarterly Vol. 1, No. 1, Gas Engine Edition, 25 cents. The Power Publishing Company, New York.

THIS is the first edition of a new publication issued by a firm with an established reputation. The constantly increasing importance of the gas engine is shown by the demand which is continually growing, and by the numerous responsible manufacturers who are now engaged in the manufacture of gas engines on a large scale. In this country, however, the practice has until recently been confined to small engines and, in fact, at present but few large engines are in successful operation. On the continent, however, the manufacture of exceedingly large units has been undertaken and from what it is possible to glean from information which the continental manufacturers treasure highly they have been exceedingly successful. According to the author the manufacturers of the large 1,000 H. P. units are decidedly choice in their remarks about the details of their engines, occasionally condescending to give snch information as that "the cylinder is round and made of iron, nice iron, etc." We do not care to discuss the ethics of such a procedure but if all manufacturers were as careful of their information progress in this particular line would certainly be hindered not a little.

One of the most important fields for the gas engine and one which will no doubt soon be developed is the utilization of blast furnace gas in place of natural gas or gasoline. The exhaust gas from the blast furnace has been utilized in numerous ways but this will probably prove the most profitable. The blast for the furnace can be furnished by from one-third to one-fourth of the power developed by the engines from the furnace gases and consequently a large proportion of the power is available for other purposes. The larger engines all employ the Otto cycle with a possible explosion every fourth stroke; the most of them also using the hit and miss system of regulation. With blast furnace gas these engines develope about .7 of the power which they are capable of developing with natural gas.

In the above mentioned publication is collected in convenient form many details of construction of large and small gas engines, as well as many details of oil engines as manufactured by the continental and American firms. A comparison of these details is made and many important conclusions reached. Many useful tables for the design of gas engines are included, with explanations of their uses.

The "Practical Engineer" Pocket-Book for 1901. Leather, gilt. 462 pages and Diary, 1s. 6d., net. The Technical Publishing Co., Limited, Manchester, England.

THIS is, as its name signifies, a pocket book for practicing engineers, and is of most convenient size and shape. It comprises in an exceedingly small space a volume of most useful information, all tabulated in such form as to be easily accessible. Mechanical engineers will more especially appreciate this publication as it deals in a concise and still explanatory manner with the problems confronted by that profession. To the civil and electrical engineers it will not be so important a work, although it contains some information frequently required by followers of these professions. Usually, however, such information may be found in pocket books arranged especially for such use. On the whole the work is excellent, and the fact that it is a revised issue and thoroughly up-to-date makes it all the more valuable.