SCIENTIFIC AMERICAN SUPPLEMENT. No 1468

Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1904, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. LVII No. 1468.

NEW YORK, FEBRUARY 20, 1904.

Scientific American Supplement $5 a year.
Scientific American and Supplement $7 a year.

ASIATIC LOCOMOTIVES CONSTRUCTED IN GERMANY.*

By Frank C. Perkins.

The two Asiatic locomotives shown on this page in Figs. 1 and 2, were constructed in Germany for Asiatic service.

The engine noted in Fig. 1 is a tank locomotive, with cylinders 13.38 inches in diameter and a stroke of 19.68 inches. It has six driving wheels coupled together, each having a diameter of 36.61 inches. The boiler has a heating surface of 709.88 square inches, and a fire grate area of 13 square feet. The engine was designed for a gage of 41.33 inches, and has a total weight when fully equipped and ready for operation of 30.4 tons. The water tank for this locomotive has a capacity of 925 gallons of water, and the coal bunkers will hold 2,425 pounds of coal. The shortest curve on which this locomotive is designed to operate has a radius of 295.29 feet.

The locomotive noted in Fig. 2, for the "Kleinasiatische Schmalspurbahn," was also constructed at Cassel for a gage of 41.33 inches, and was designed for operation on curves of not less than 295.29 feet radius. This engine has eight coupled driving wheels, and one bogie truck in front. The cylinders of this engine measure 15.94 inches in diameter, and the stroke is 19.68 inches in length. Each of the eight driving wheels is 40.94 inches in diameter, and the engine is designed to be operated with a tender carrying the coal and water. The boiler of this locomotive has a total heating surface of 1,342½ square feet and a fire-grate surface of 208½ square feet. The total weight of this engine without the tender is 45 tons, and it is provided with two headlights, as in the case of the engine in Fig. 1, one in front of the smokestack and the other below, on a level with the lower part of the boiler shell.

A large number of locomotives have been constructed at the Lokomotiv und Maschinenfabrik at Cassel, not only for use in Asia, but also in Africa by the Egyptische Staats-Eisenbahnen, also for the Daenische Staats-Eisenbahnen and for the Moskau-Kasan-Eisenbahn in Russia.

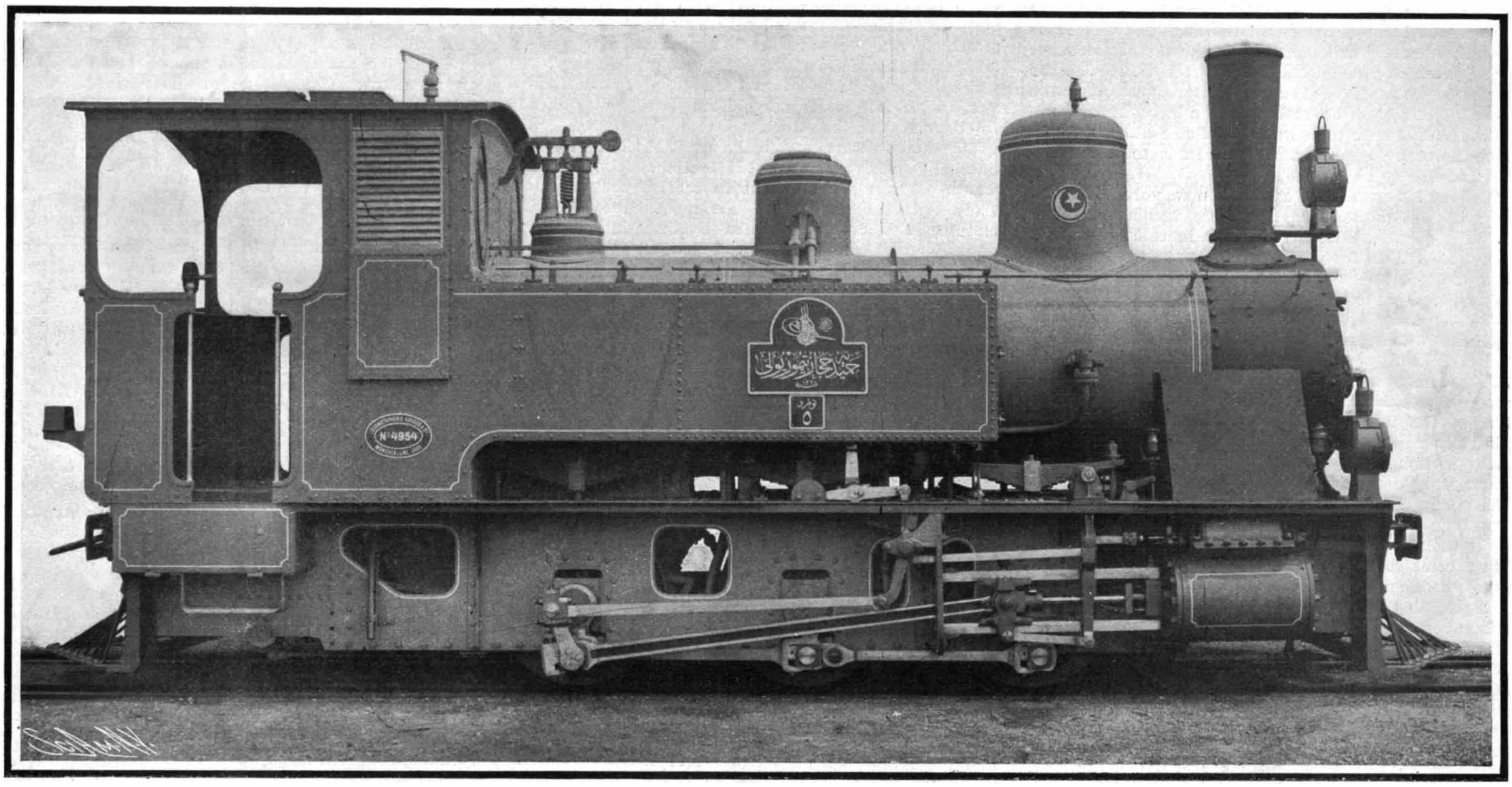


FIG. 1.—ONE OF THE TURKISH LOCOMOTIVES.

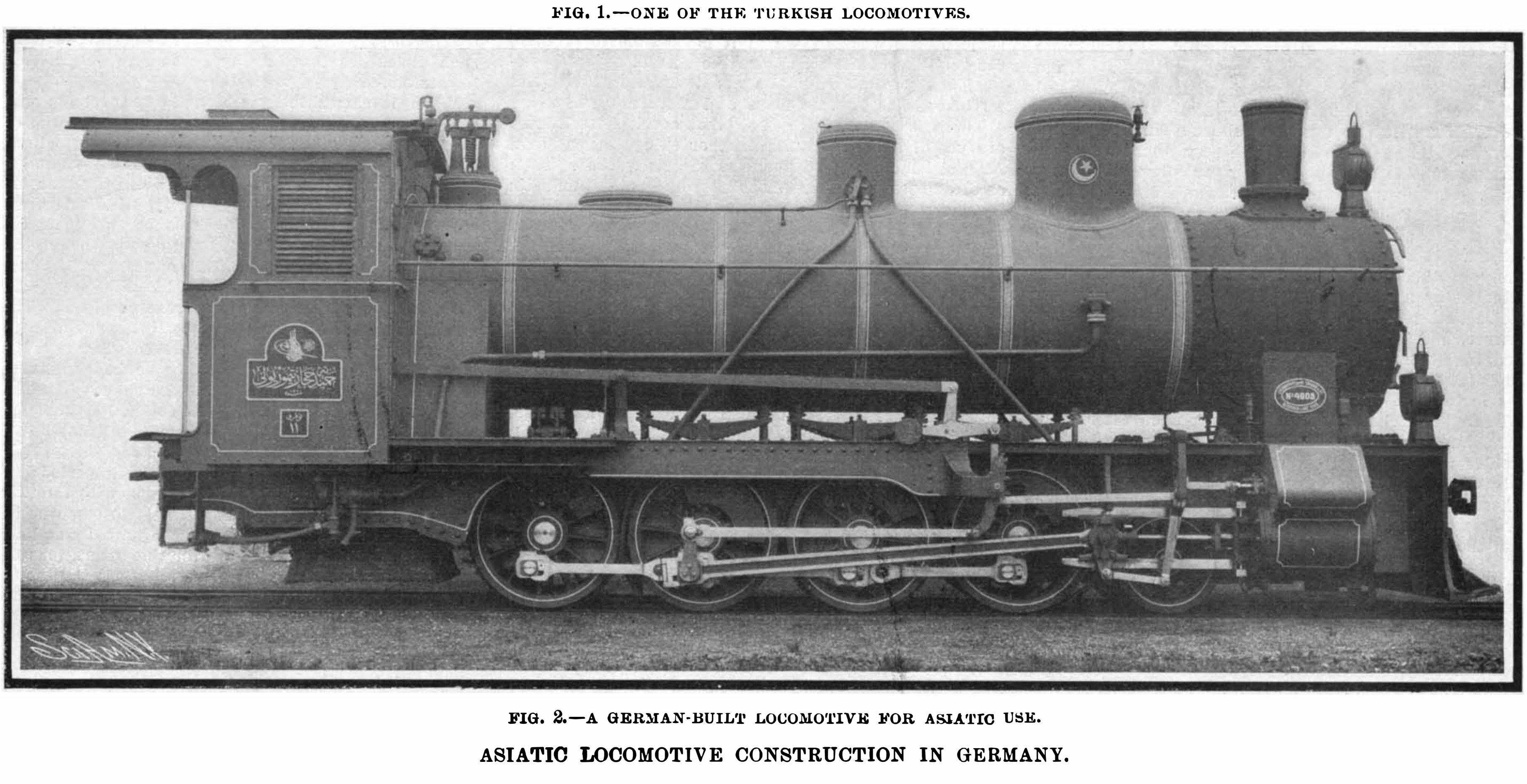


FIG. 2.—A GERMAN-BUILT LOCOMOTIVE FOR ASIATIC USE.

ASIATIC LOCOMOTIVE CONSTRUCTION IN GERMANY.

* Specially prepared for the Scientific American Supplement.

SCIENTIFIC INVESTIGATION AND PROGRESS.*

At the weekly services of many of our churches it is customary to begin with the reading of a verse or two from the Scriptures for the purpose, I suppose, of putting the congregations in the proper state of mind for the exercises which are to follow. It seems to me we may profit by this example, and accordingly I ask your attention to Article I. of the Constitution of the American Association for the Advancement of Science, which reads thus: "The objects of the association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness."

The first object mentioned, you will observe, is "to promote intercourse between those who are cultivating science in different parts of America;" the second is "to give a stronger and more general impulse and more systematic direction to scientific research;" and the third is "to procure for the labors of scientific men increased facilities and a wider usefulness." Those who are familiar with the history of the association are well aware that it has served its purposes admirably, and I am inclined to think that those who have been in the habit of attending the meetings will agree that the object which appeals to them most strongly is the promotion of intercourse between those who are cultivating science. Given this intercourse, and the other objects will be reached as a necessary consequence, for the intercourse stimulates thought, and thought leads to work, and work leads to wider usefulness.

While in 1848, when the association was organized and the constitution was adopted, there was a fair number of good scientific investigators in this country, it is certain that in the half century that has passed since then the number of investigators has increased very largely, and naturally the amount of scientific work done at present is very much greater than it was at that time. So great has been the increase in scientific activity during recent years that we are apt to think that by comparison scientific research is a new acquisition. In fact there appears to be an impression abroad that in the world at large scientific research is a relatively new thing, for which we of this generation and our immediate predecessors are largely responsible. Only a superficial knowledge of the history of science is necessary, however, to show that the sciences have been developed slowly, and that their beginnings are to be looked for in the very earliest times. Everything seems to point to the conclusion that men have always been engaged in efforts to learn more and more in regard to the world in which they find themselves. Sometimes they have been guided by one motive and sometimes by another, but the one great underlying motive has been the desire to get a clearer and clearer understanding of the universe. But besides this there has been the desire to find means of increasing the comfort and happiness of the human race.

A reference to the history of chemistry will serve to show how these motives have operated side by side. One of the first great incentives for working with chemical things was the thought that it was possible to convert base metals like lead and copper into the so-called noble metals, silver and gold. Probably no idea has ever operated as strongly as this upon the minds of men to lead them to undertake chemical experiments. It held control of intellectual men for centuries and it was not until about a hundred years ago that it lost its hold. It is very doubtful if the purely scientific question whether one form of matter can be transformed into another would have had the power to control the activities of investigators for so long a time; and it is idle to speculate upon this subject. It should, however, be borne in mind that many of those who are engaged in this work were actuated by a desire to put money in their purses—a desire that is by no means to be condemned without reserve, and I mention it not for the purpose of condemning it, but to show that a motive that we sometimes think of as peculiarly modern is among the oldest known to man.

When the alchemists were at work upon their problems, another class of chemists were engaged upon problems of an entirely different nature. The fact that substances obtained from various natural sources and others made in the laboratory produce effects of various kinds when taken into the system led to the thought that these substances might be useful in the treatment of disease. Then, further, it was thought that disease itself is a chemical phenomenon. These thoughts, as is evident, furnish strong motives for the investigation of chemical substances, and the science of chemistry owes much to the work of those who were guided by these motives.

And so in each period as a new thought has served as the guide we find that men have been actuated by different motives, and often one and the same worker has been under the influence of mixed motives. Only in a few cases does it appear that the highest motives alone operate. We must take men as we find them, and we may be so thankful that on the whole there are so many who are impelled by one motive or another or by a mixture of motives to take up the work of investigating the world in which we live. Great progress is being made in consequence and almost daily we are called upon to wonder at some new and marvelous result of scientific investigation. It is quite impossible to make predictions of value in regard to what is likely to be revealed to us by continued work, but it is safe to believe that in our efforts to discover the secrets of the universe only a beginning has been made. No matter in what direction we may look we are aware of great unexplored territories, and even in those regions in which the greatest advances have been made it is evident that the knowledge gained is almost insignificant as compared with that which remains to be learned. But this line of thought may lead to a condition bordering on hopelessness and despondency, and surely we should avoid this condition, for there is much greater cause for rejoicing than for despair. Our successors will see more and see more clearly than we do, just as we see more and see more clearly than our predecessors. It is our duty to keep the work going without being too anxious to weigh the results on an absolute scale. It must be remembered that the absolute scale is not a very sensitive instrument, and that it requires the results of generations to affect it markedly.

On an occasion of this kind it seems fair to ask the question: What does the world gain by scientific investigation? This question has often been asked and often answered, but each answer differs in some respects from the others and each may be suggestive and worth giving. The question is a profound one, and no answer that can be given would be satisfactory. In general it may be said that the results of scientific investigation fall under three heads—the material, the intellectual, and the ethical.

The material results are the most obvious and they naturally receive the most attention. The material wants of man are the first to receive consideration. They cannot be neglected. He must have food and clothing, the means of combating disease, the means of transportation, the means of producing heat and a great variety of things that contribute to his bodily comfort and gratify his esthetic desires. It is not my purpose to attempt to deal with all of these and to show how science is helping to work out the problems suggested. I shall have to content myself by pointing out a few of the more important problems the solution of which depends upon the prosecution of scientific research.

First, the food problem. Whatever views one may hold in regard to that which has come to be called "race suicide," it is certain that the population of the world is increasing rapidly. The desirable places have been occupied. In some parts of the earth there is such a surplus of population that famines occur from time to time, and in other parts epidemics and floods relieve the embarrassment. We may fairly look forward to the time when the whole earth will be overpopulated unless the production of food becomes more scientific than it now is. Here is the field for the work of the agricultural chemist who is showing us how to increase the yield from a given area and, in case of poor and worn-out soils, how to preserve and increase their fertility. It appears that the methods of cultivating the soil are still comparatively crude, and more and more thorough investigation of the processes involved in the growth of plants is called for. Much has been learned since Liebig founded the science of agricultural chemistry. It was he who pointed out some of the ways by which it is possible to increase the fertility of a soil. Since the results of his investigations were given to the world the use of artificial fertilizers has become more and more general.

But it is one thing to know that artificial fertilizers are useful and it is quite another thing to get them. At first bone dust and guano were chiefly used. Then as these became dearer, phosphates and potassium salts from the mineral kingdom came into use.

At the Fifth International Congress for Applied Chemistry, held at Berlin, Germany, last June, Dr. Adolph Frank, of Charlottenburg, gave an extremely interesting address on the subject of the use of the nitrogen of the atmosphere for agriculture and the industries, which bears upon the problem that we are dealing with. Plants must have nitrogen. At present this is obtained from the great beds of saltpeter found on the west coast of South America—the so-called Chili saltpeter—and also from the ammonia obtained as a by-product in the distillation of coal, especially in the manufacture of coke. The use of Chili saltpeter for agricultural purposes began about 1860. In 1900 the quantity exported was 1,453,000 tons, and its value about $60,000,000. In the same year the world's production of ammonium sulphate was about 500,000 tons, of a value of somewhat more than $20,000,000. Of these enormous quantities about three-quarters finds application in agriculture. The use of these substances, especially of saltpeter, is increasing rapidly. At present it seems that the successful cultivation of the soil is dependent upon the use of nitrates, and the supply of nitrates is limited. Unless something is done we may look forward to the time when the earth, for lack of proper fertilizers, will not be able to produce as much as it now does, and meanwhile the demand for food is increasing. According to the most reliable estimations indeed the saltpeter beds will be exhausted in thirty or forty years. Is there a way out? Dr. Frank shows that there is. In the air there is nitrogen enough for all. The plants can make only a limited use of this directly. For the most part it must be in some form of chemical combination as, for example, a nitrate or ammonia. The conversion of atmospheric nitrogen into nitric acid would solve the problem, and this is now carried out. But Dr. Frank shows that there is another, perhaps more economical, way of getting the nitrogen into a form suitable for plant food. Calcium carbide can now be made without difficulty and is made in enormous quantities by the action of a powerful electric current upon a mixture of coal and lime. This substance has the power of absorbing nitrogen from the air, and the product thus formed appears to be capable of giving up its nitrogen to plants, or, in other words, to be a good fertilizer. It is true that this subject requires further investigation, but the results thus far obtained are full of promise. If the outcome should be what we have reason to hope, we may regard the approaching exhaustion of the saltpeter beds with equanimity. But, even without this to pin our faith to, we have the preparation of nitric acid from the nitrogen and oxygen of the air to fall back upon.

While speaking of the food problem, a few words in regard to the artificial preparation of foodstuffs. I am sorry to say that there is not much of promise to report upon in this connection. In spite of the brilliant achievements of chemists in the field of synthesis it remains true that thus far they have not been able to make, except in very small quantities, substances that are useful as foods, and there is absolutely no prospect of this result being reached within a reasonable time. A few years ago Berthelot told us of a dream he had had. This has to do with the results that, according to Berthelot, are to be brought about by the advance of chemistry. The results of investigations already accomplished indicate that, in the future, methods will perhaps be devised for the artificial preparation of food from the water and carbonic acid so abundantly supplied by nature. Agriculture will then become unnecessary, and the landscape will not be disfigured by crops growing in geometrical figures. Water will be obtained from holes three or four miles deep in the earth, and this water will be above the boiling temperature, so that it can be used as a source of energy. It will be obtained in liquid form after it has undergone a process of natural distillation, which will free it from all impurities, including, of course, disease germs. The foods prepared by artificial methods will also be free from microbes, and there will consequently be less disease than at present. Further, the necessity for killing animals for food will no longer exist, and mankind will become gentler and more amenable to higher influences. There is, no doubt, much that is fascinating in this line of thought, but whether it is worth following, depends upon the fundamental assumption. Is it at all probable that chemists will ever be able to devise methods for the artificial preparation of foodstuffs. I can only say that to me it does not appear probable in the light of the results thus far obtained. I do not mean to question the probability of the ultimate synthesis of some of those substances that are of value as foods. This has already been accomplished on the small scale, but for the most part the synthetical processes employed have involved the use of substances which themselves are the products of natural processes. Thus, the fats can be made, but the substances from which they are made are generally obtained from nature and are not themselves synthetical products. Emil Fischer has, to be sure, made very small quantities of sugars of different kinds, but the task of building up a sugar from the raw material furnished by nature—that is to say, from carbonic acid and water—presents such difficulties that it may be said to be practically impossible.

When it comes to starch, and the proteids which are the other chief constituents of foodstuffs, the difficulties are still greater. There is not a suggestion of the possibility of making starch artificially, and the same is true of the proteids. In this connection it is, however, interesting to note that Emil Fischer, after his remarkable successes in the sugar group and the uric acid group, is now advancing upon the proteids. I have heard it said that at the beginning of his career he made out a programme for his life work. This included the solution of three great problems. These are the determination of the constitution of uric acid, of the sugars and of the proteids. Two of these problems have been solved. May he be equally successful with the third! Even if he should be able to make a proteid, and show what it is, the problem of the artificial preparation of foodstuffs will not be solved. Indeed, it will hardly be affected.

Although science is not likely, within periods that we may venture to think of, to do away with the necessity of cultivating the soil, it is likely to teach us how to get more out of the soil than we now do, and thus put us in a position to provide for the generations that are to follow us. And this carries with it the thought that, unless scientific investigation is kept up, these coming generations will be unprovided for.

Another way by which the food supply of the world can be increased is by relieving tracts of land that are now used for other purposes than the cultivation of foodstuffs. The most interesting example of this kind is that presented by the cultivation of indigo. There is a large demand for this substance, which is plainly founded upon esthetic desires of a somewhat rudimentary kind. Whatever the cause may be, the demand exists, and immense tracts of land have been and are still, devoted to the cultivation of the indigo plant. Within the past few years scientific investigation has shown that indigo can be made in the factory from substances, the production of which does not for the most part involve the cultivation of the soil. In 1900 according to the report of Dr. Brunck, Manag-

* Address of the retiring president of the American Association for the Advancement of Science, St. Louis meeting.

ing Director of the Badische Anilin- und Soda-Fabrik, the quantity of indigo produced annually in the factory "would require the cultivation of an area of more than a quarter of a million acres of land (390 square miles) in the home of the indigo plant." Dr. Brunck adds: "The first impression which this fact may be likely to produce, is that the manufacture of indigo will cause a terrible calamity to arise in that country; but, perhaps not. If one recalls to mind that India is periodically afflicted with famine, one ought not, without further consideration, to cast aside the hope that it might be good fortune for that country if the immense areas now devoted to a crop which is subject to many vicissitudes and to violent market changes were at last to be given over to the raising of breadstuffs and other food products." "For myself," says Dr. Brunck, "I do not assume to be an impartial adviser in this matter, but, nevertheless, I venture to express my conviction that the government of India will be rendering a very great service if it should support and aid the progress, which will in any case be irresistible, of this impending change in the cultivation of that country, and would support and direct its methodical and rational execution."

The connection between scientific investigation and health is so frequently the subject of discussion that I need not dwell upon it here. The discovery that many diseases are due primarily to the action of microscopic organisms that find their way into the body and produce the changes that reveal themselves in definite symptoms is a direct consequence of the study of the phenomenon of alcoholic fermentation by Pasteur. Everything that throws light upon the nature of the action of these microscopic organisms is of value in dealing with the great problem of combating disease. It has been established in a number of cases that they cause the formation of products that act as poisons and that the diseases are due to the action of these poisons. So also, as is well known, investigation has shown that antidotes to some of these poisons can be produced, and that by means of these antidotes the diseases can be controlled. But more important than this is the discovery of the way in which diseases are transmitted. With this knowledge it is possible to prevent the diseases. The great fact that the death rate is decreasing stands out prominently and proclaims to humanity the importance of scientific investigation. It is, however, to be noted in this connection that the decrease in the death rate compensates to some extent for the decrease in the birth rate, and that, if an increase in population is a thing to be desired, the investigations in the field of sanitary science are contributing to this result.

The development of the human race is dependent not alone upon a supply of food but upon a supply of energy in available forms. Heat and mechanical energy are absolutely essential to man. The chief source of the energy that comes into play is fuel. We are primarily dependent upon the coal supply for the continuation of the activities of man. Without this, unless something is to take its place, man is doomed. Statistics in regard to the coal supply and the rate at which it is being used up have so frequently been presented by those who have special knowledge of this subject that I need not trouble you with them now. The only object in referring to it is to show that, unless by means of scientific investigation man is taught new methods of rendering the world's store of energy available for the production of heat and of motion, the age of the human race is measured by the extent of the supply of coal and other forms of fuel. By other forms of fuel I mean, of course, wood and oil. Plainly, as the demand for land for the production of foodstuffs increases, the amount available for the production of wood must decrease, so that wood need not be taken into account for the future. In regard to oil, our knowledge is not sufficient to enable us to make predictions of any value. If one of the theories now held in regard to the source of petroleum should prove to be correct, the world would find much consolation in it. According to this theory petroleum is not likely to be exhausted, for it is constantly being formed by the action of water upon carbides that in all probability exist in practically unlimited quantity in the interior of the earth. If this be true, then the problem of supplying energy may be reduced to one of transportation of oil. But given a supply of oil and, of course, the problem of transportation is solved.

What are the other practical sources of energy? The most important is the fall of water. This is being utilized more and more year by year since the methods of producing electric currents by means of the dynamo have been worked out. There is plainly much to be learned before the energy made available in the immediate neighborhood of the waterfall can be transported long distances economically, but advances are being made in this line, and already factories that have hitherto been dependent upon coal are making use of the energy derived from waterfalls. The more rapidly these advances take place the less will be the demand for coal, and if there were only enough waterfalls conveniently situated, there would be no difficulty in furnishing all the energy needed by man for heat or for motion.

It is a fortunate thing that, as the population of the earth increases, man's tastes become more complex. If only the simplest tastes prevailed, only the simplest occupations would be called for. But let us not lose time in idle speculations as to the way this primitive condition of things would affect man's progress. As a matter of fact his tastes are becoming more complex. Things that are not dreamed of in one generation become the necessities of the next generation. Many of these things are the direct results of scientific investigation. No end of examples will suggest themselves. Let me content myself by reference to one that has of late been the subject of much discussion. The development of the artificial dye-stuff industries is extremely instructive in many ways. The development has been the direct result of the scientific investigation of things that seemed to have little, if anything, to do with this world. Many thousands of workmen are now employed, and many millions of dollars are invested, in the manufacture of dye-stuffs that were unknown a few years ago. Here plainly the fundamental fact is the esthetic desire of man for colors. A colorless world would be unbearable to him. Nature accustoms him to color in great variety of combinations, and it becomes a necessity to him. And his desires increase as they are gratified. There seems to be no end to development in this line. At all events, the data at our disposal justify the conclusion that there will be a demand for every dye that combines the qualities of beauty and durability. Thousands of scientifically-trained men are engaged in work in the effort to discover new dyes to meet the increasing demands. New industries are springing up and many find employment in them. As a rule the increased demand for labor caused by the establishment of these industries is not offset by the closing up of other industries. Certainly it is true that scientific investigation has created large demands for labor that could hardly find employment without these demands.

The welfare of a nation depends to a large extent upon the success of its industries. In his address as president of the British Association for the Advancement of Science given last summer Sir Norman Lockyer quotes Mr. Chamberlain thus: "I do not think it necessary for me to say anything as to the urgency and necessity of scientific training. . . . It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. . . . It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals." In another part of his address Sir Norman Lockyer says: "Further, I am told that the sum of £24,000,000 is less than half the amount by which Germany is yearly enriched by having improved upon our chemical industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since, but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness, the nation would now be much richer than it is, and would have much less to fear from competition."

But enough on the purely material side. Let us turn to the intellectual results of scientific investigation. This part of our subject might be summed up in a few words. It is so obvious that the intellectual condition of mankind is a direct result of scientific investigation that one hesitates to make the statement. The mind of man can not carry him much in advance of his knowledge of the facts. Intellectual gains can be made only by discoveries, and discoveries can be made only by investigation. One generation differs from another in the way it looks at the world. A generation that thinks the earth is the center of the universe differs intellectually from one that has learned the true position of the earth in the solar system, and the general relations of the solar system to other similar systems that make up the universe. A generation that sees in every species of animal and plant evidence of a special creative act differs from one that has recognized the general truth of the conception of evolution. And so in every department of knowledge the great generalizations that have been reached through the persistent efforts of scientific investigators are the intellectual gains that have resulted. These great generalizations measure the intellectual wealth of mankind. They are the foundations of all profitable thought. While the generalizations of science belong to the world, not all the world takes advantage of its opportunities. Nation differs from nation intellectually as individual differs from individual. It is not, however, the possession of knowledge that makes the efficient individual and the efficient nation. It is well known that an individual may be very learned and at the same time very inefficient. The question is, What use does he make of his knowledge? When we speak of intellectual results of scientific investigation, we mean not only accumulated knowledge, but the way in which this knowledge is invested. A man who simply accumulates money and does not see to it that this money is carefully invested, is a miser, and no large results can come from his efforts. While, then, the intellectual state of a nation is measured partly by the extent to which it has taken possession of the generalizations that belong to the world, it is also measured by the extent to which the methods by which knowledge is accumulated have been brought into requisition and have become part of the equipment of the people of that nation. The intellectual progress of a nation depends upon the adoption of scientific methods in dealing with intellectual problems. The scientific method is applicable to all kinds of intellectual problems. We need it in every department of activity. I have sometimes wondered what the result would be if the scientific method could be employed in all the manifold problems connected with the management of a government. Questions of tariff, of finance, of international relations would be dealt with much more satisfactorily than at present if the spirit of the scientific method were breathed into those who are called upon to deal with these questions. It is plain, I think, that the higher the intellectual state of a nation the better will it deal with all the problems that present themselves. As the intellectual state is a direct result of scientific investigation, it is clear that the nation that adopts the scientific method will in the end outrank both intellectually and industrially the nation that does not.

What are the ethical results of scientific investigation? No one can tell. There is one thought that in this connection I should like to impress upon you. The fundamental characteristic of the scientific method is honesty. In dealing with any question science asks no favors. The sole object is to learn the truth, and to be guided by the truth. Absolute accuracy, absolute fidelity, absolute honesty are the prime conditions of scientific progress. I believe that the constant use of the scientific method must in the end leave its impress upon him who uses it. The results will not be satisfactory in all cases, but the tendency will be in the right direction. A life spent in accordance with scientific teachings would be of a high order. It would practically conform to the teachings of the highest types of religion. The motives would be different, but so far as conduct is concerned the results would be practically identical. I need not enlarge upon this subject. Unfortunately, abstract truth and knowledge of facts and of the conclusions to be drawn from them do not at present furnish a sufficient basis for right living in the case of the great majority of mankind, and science can not now, and I do not believe it ever can, take the place of religion in some form. When the feeling that the two are antagonistic wears away, as it is wearing away, it will no doubt be seen that one supplements the other, in so far as they have to do with the conduct of man.

What are we doing in this country to encourage scientific investigation? Not until about a quarter of a century ago can it be said that it met with any encouragement. Since then there has been a great change. Up to that time research was sporadic. Soon after it became almost epidemic. The direct cause of the change was the establishing of courses in our universities for the training of investigators somewhat upon the lines followed in the German universities. In these courses the carrying out of an investigation plays an important part. This is, in fact, the culmination of the course. At first there were not many following these courses, but it was not long before there was a demand for the products. Those who could present evidence that they had followed such courses were generally given the preference. This was especially true in the case of appointments in the colleges, some colleges even going so far as to decline to appoint any one who had not taken the degree of doctor of philosophy, which is the badge of the course that involves investigation. As the demand for those who had received this training increased, the number of those seeking it increased at least in the same proportion. New universities were established and old ones caught the spirit of the new movement until from one end of the country to the other centers of scientific activity are now found, and the amount of research work that is done is enormous compared with what was done twenty-five or thirty years ago. Many of those who get a taste of the work of investigation become fascinated by it and are anxious to devote their lives to it. At present, with the facilities for such work available, it seems probable that most of those who have a strong desire and the necessary industry and ability to follow it find their opportunity somewhere. There is little danger of our losing a genius or even one with fair talent. The world is on the lookout for them. The demand for those who can do good research work is greater than the supply. To be sure the rewards are not as a rule as great as those that are likely to be won by the ablest members of some other professions and occupations, and as long as this condition of affairs continues to exist there will not be as many men of the highest intellectual order engaged in this work as we should like to see. On the other hand, when we consider the great progress that has been made during the last twenty-five years or so, we have every reason to take a cheerful view of the future. If as much progress should be made in the next quarter century, we shall, to say the least, be able to compete with the foremost nations of the world in scientific investigation. In my opinion this progress is largely dependent upon the development of our universities. Without the opportunities for training in the methods of scientific investigation there will be but few investigators. It is necessary to have a large number in order that the principle of selection may operate. In this line of work as in others, many are called, but few are chosen.

Another fact that is working advantageously to increase the amount of scientific research done in this country is the support given by the government in its different scientific bureaus. The Geological Survey, the Department of Agriculture, the Coast and Geodetic Survey, the National Bureau of Standards and other departments are carrying on a large amount of excellent scientific work, and thus helping most efficiently to spread the scientific spirit throughout the land.

Finally, two exceedingly interesting experiments in the way of encouraging scientific investigation are now attracting the attention of the world. I mean, of course, the Carnegie Institution, with its endowment of

$10,000,000, and the Rockefeller Institute, devoted to investigations in the field of medicine, which will no doubt be adequately endowed. It is too early to express an opinion in regard to the influence of these great foundations upon the progress of scientific investigation. As both will make possible the carrying out of many investigations that would otherwise probably not be carried out, the chances of achieving valuable results will be increased. The danger is that those who are responsible for the management of the funds will be disappointed that the results are not at once of a striking character, and that they will be tempted to change the method of applying the money before those who are using it have had a fair chance. But we who are on the outside know little of the plans of those who are inside. All signs indicate that they are making an earnest effort to solve an exceedingly difficult problem, and all who have the opportunity should do everything in their power to aid them.

In the changes which have been brought about in the condition of science in this country since 1848, it is safe to say that this association has either directly or indirectly played a leading part. It is certain that for the labors of scientific men increased facilities and a wider usefulness have been procured.—Ira Remsen.

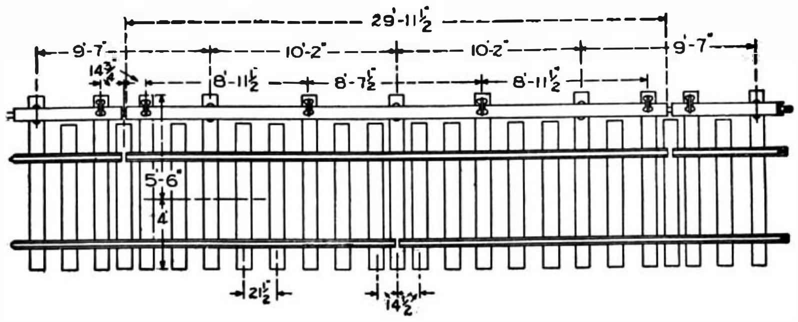
AN EXPERIMENTAL ELECTRIC RAILROAD.

In the development of electric traction apparatus the knowledge gained from experiments conducted under practical operating conditions is of special value. To provide a suitable plant for such experiments, the General Electric Company, in 1896, constructed a railroad along the bank of the Erie Canal opposite the Schenectady Works, which road has been in constant use ever since. When a new railway motor, control system, or other item of railway equipment has been designed and built, it is thoroughly tested and perfected before it is finally put on the market—the test often extending over several months. The General Electric Railroad thus affords the means of detecting and eliminating defects which might appear in practical operation, besides enabling new ideas to be investigated and developed under actual operating conditions.

The railroad consists of a car shop, in which cars are stored and equipped, together with a switching yard, and about 1 1-3 miles of single track, standard gage, composed of 85-pound rail laid in stone ballast.

The line is equipped so as to enable power to be supplied either by continuous or alternating current. For the testing of apparatus using continuous current, power is brought from the works' power-house to a switch-house beside the track, in which is installed a recording wattmeter for measuring the energy supplied to the apparatus being tested. Thence it passes to feeders running the whole length of the track, connected at intervals to a third-rail from which current is drawn by the apparatus under test, and returned to the power-house through the track rails.

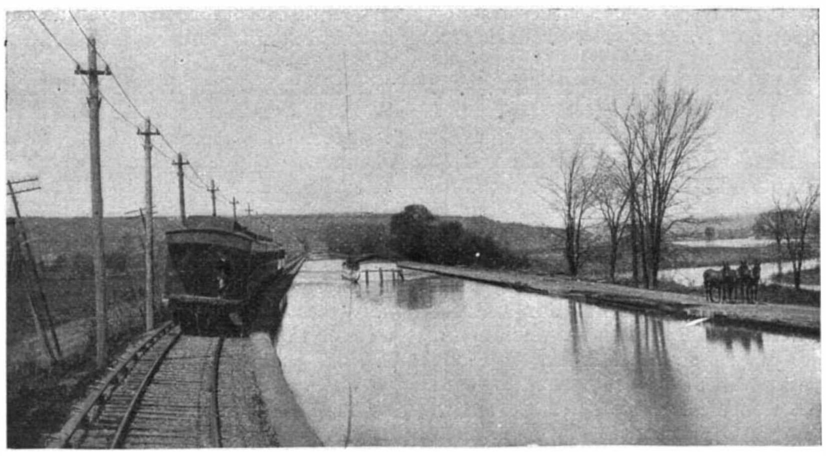
The third-rail has a protective covering throughout its length. The rail is of rectangular section rounded at the top, weighs 80 pounds per yard, and is mounted on insulating blocks of artificial stone. The covering is a suspended channel iron. Along the greater part of the track, the conductor consists of a 30-pound T rail mounted on insulating blocks of wood, and protected by a strong wooden cover, erected in substantially the same manner as the channel iron covering in the yard, the only difference being that a wooden plank replaces the channel iron used in the yard. The rail has been in operation during severe winter weather without accident or trouble from ice deposits.



DETAILS OF PROTECTED THIRD-RAIL AND SHOE.

Top of third-rail is 3 inches above top of running-rail.

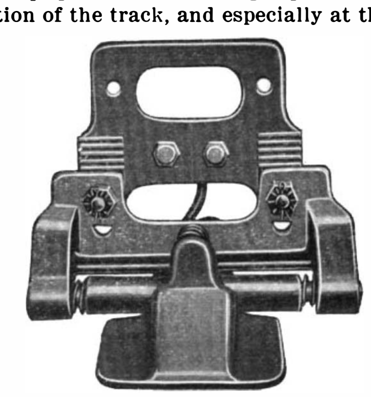
The form of protection used possesses the advantages of simplicity and low first cost, while being very effective for every purpose for which protection is needed. It guards the third-rail from deposits of ice, affords protection against shocks to persons crossing the tracks, or to employes working on the line, and reduces to a minimum the possibilities of short circuits due to the careless handling of track tools. The third-rail is located with its center 28 inches from the gage line of the nearer track rail, and with its top 3 inches above the track rail. This position has been chosen as it is often essential that steam locomotives should run over the tracks of an electric road, consequently it is desirable to recommend, as standard, a position which will provide the necessary clearance for even the large low-pressure cylinders of compound steam locomotives. The channel iron or plank protection is 6 or 8 inches wide and is attached to brackets, screwed to the ends of extra long ties which support the covering about 2½ inches above the rail—a slight gap being left between the ends of each length, when of metal, to separate them electrically.



A VIEW ON THE EXPERIMENTAL ROAD.

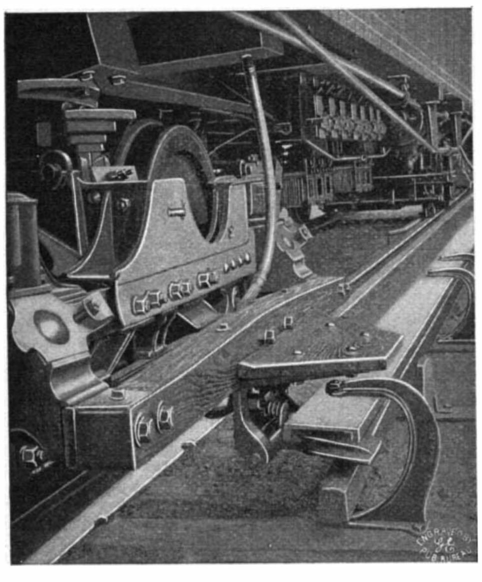
The third-rail shoe has been specially designed to work on such a form of rail, passing with ample clearance under the protective covering. It consists of a cast iron plate hinged at the point of support and kept in contact with the rail by means of a spring. This is carried by brackets adjustable for height to allow for wear—the brackets being bolted to an insulating timber attached to the truck journal boxes. The third-rail may be located on either side of the track as convenient, and since gaps in its continuity are necessary at switches and crossings, each truck is equipped with two shoes, one midway on each side, so that a double truck car carries four of these shoes. At specially complicated slip switches it may be found difficult to locate the third-rail so that the gap may be spanned by the shoes, and for other reasons it may at places be impracticable to continue it beside the track. In such cases a short length of rail or wire may be installed overhead, current being collected by means of an extra shoe on the top of the car. An example of this construction can be seen in the car barn, where it has been put in for the purpose of moving cars out.

For testing and developing alternating current apparatus there are installed throughout the length of the line three overhead trolley wires, insulated sufficiently to permit of their being worked up to 10,000 volts pressure. For the greater part of their length these lines hang from parallel steel span wires which are attached to 10,000-volt insulators at the cross arms of the poles. This catenary suspension forms a simple, inexpensive, and efficient means of securing a highly insulated trolley wire, which is especially suitable for the equipment of the straight part of the track. Over a portion of the track, and especially at the curves, the trolley wires are carried by porcelain lined hangers so designed that the wires are freely suspended but cannot approach one another.

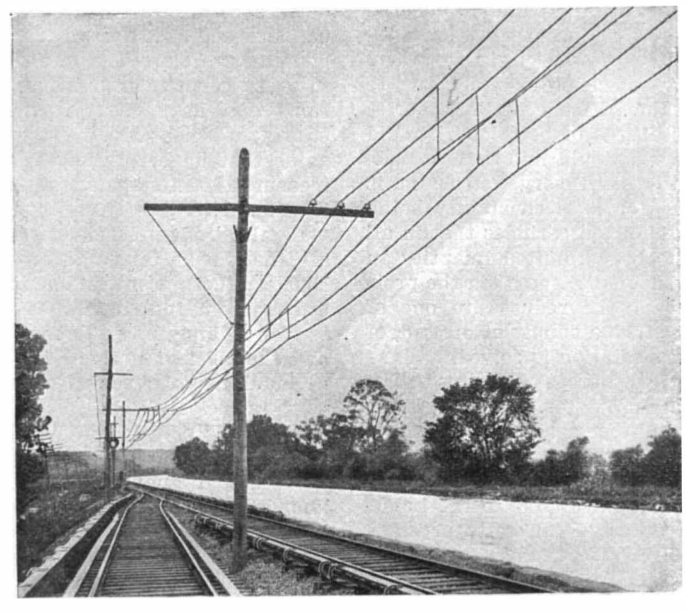


THIRD-RAIL SHOE.

A portion of the track is provided with the necessary equipment for supplying power through surface contact studs, and here different types of switches and studs are given service tests. In the General Electric Surface Contact System, there are two rows of contact studs between the tracks, but only one is connected to the high potential side of the line. From the studs of this row the current is taken by means of a sliding shoe, and after passing through the motors is returned by means of a second shoe to the studs of the other row. From these it passes to the track rails through the energizing coils of the switches which connect the high potential studs to the feeder. Thus none of the studs are alive except those which are beneath the car when the motors are taking current from the line. At starting, the switch corresponding to the contact stud under the shoe is operated by a small storage battery carried on the car and thrown in by the act of starting. Succeeding switches are operated by the motor current. The battery is kept charged by passing a portion of the motor current through it, and in addition to operating the contactors, it serves to light the car. The switches corresponding to about 200 yards of track studs are



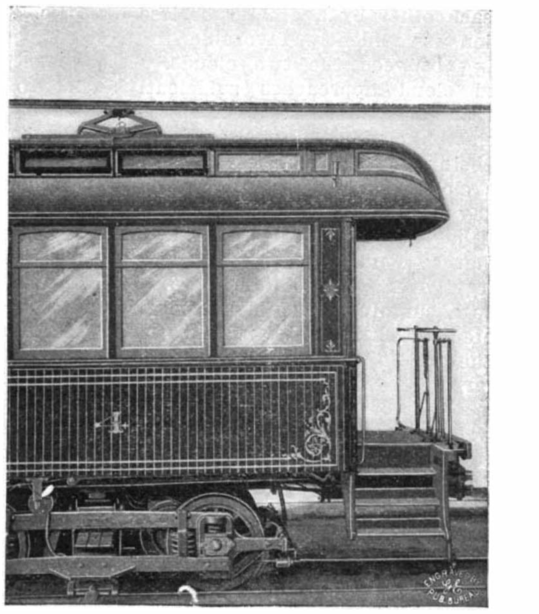
SHOE ENTERING PROTECTED THIRD-RAIL.



THREE-PHASE LINE WITH CATENARY SUSPENSION.

collected together in a vault to which the main and track feeders are brought. On the General Electric Railroad the vault is represented by a shed, equal in size and shape, in which the switches are located.

The tests are almost as varied as the apparatus used in railroad work, and comprise operating tests on electric locomotives, heat runs on railway motors, tests of controllers and control systems, tests of train resist-



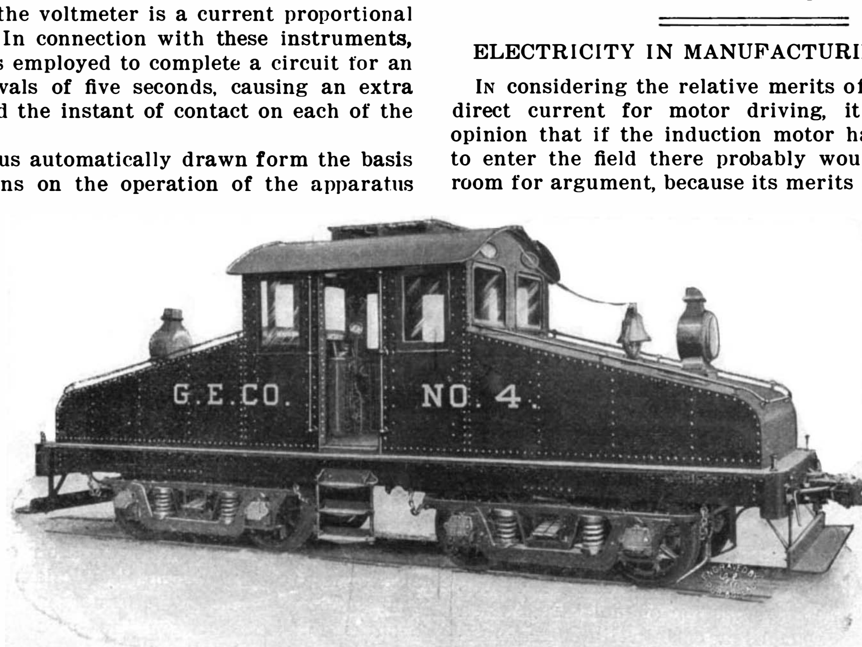
CAR EQUIPPED WITH OVERHEAD CONTACT DEVICE.

ance and wind effect, tests of the possibilities of electric apparatus for securing high acceleration, etc., besides investigations of the causes of troubles that have arisen in practical operation. Ample power is available for any test that may be required, so that there is no difficulty in completely realizing service conditions. Some interesting comparative tests were recently made to determine the relative merits of steam locomotives and electric motors for heavy traction work. These tests showed that the electric motor could accelerate a train more quickly than a steam locomotive with the same weight on drivers, on account of the longer sustained draw-bar pull of the electric motor in comparison to the decrease in draw-bar pull of the steam locomotive due to changing cutoff.

The cars on which apparatus is usually mounted for test, are six in number.

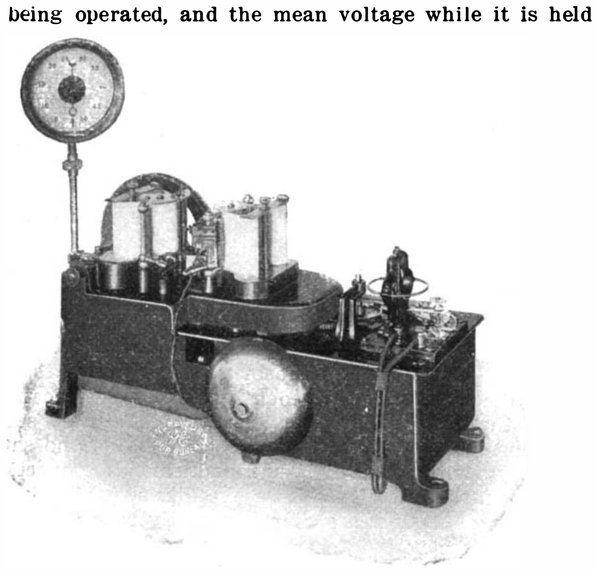
The particulars of the operation of a train or motor are accurately recorded by automatic instruments specially designed for such work. A Boyer speed recorder is driven from one of the train wheels, and draws a curve showing the speed after running any distance. To this has been added a second drum, motor driven to feed the paper at a uniform rate, on which is drawn the speed in terms of the time. An automatic voltmeter records the electric pressure, on paper driven at a uniform rate, and thus shows the variation of voltage with time; and a recording ammeter in the same way draws a curve between current and time. The two latter instruments are similar in construction, action and appearance. The force to actuate a light and well-damped recording pen is obtained in both instruments by a uniform current in a movable coil and a current in the fixed coils which, in the ammeter, is the main current, and in the voltmeter is a current proportional to the voltage. In connection with these instruments, a chronometer is employed to complete a circuit for an instant at intervals of five seconds, causing an extra marker to record the instant of contact on each of the record papers.

The curves thus automatically drawn form the basis of all calculations on the operation of the apparatus



YARD LOCOMOTIVE.

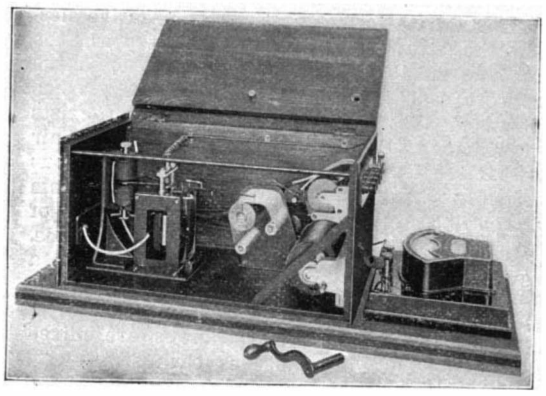
under test. Let it be the performance of a train with a given equipment and making a given schedule that is required; then the curves give all there is to be known about the acceleration, velocity, current, and energy taken from the line, while from them the motor losses are immediately obtained, whence their temperature rise after a period of service on the schedule is deduced. The train characteristics are directly copied from the recorded curves, the ampere scale depending on the number of motors in parallel on the line. The energy expended in the coils of the motors is deduced from their resistance and from the average value of the square of the current, which average is obtained by replotting the current curve on polar co-ordinate paper, so that the radius at any point is proportional to the motor current, and the angular distance from the beginning of the curve to the time. The area of the curve so plotted is proportional to the energy lost in the copper circuits of the motor during the run. From the mean motor current while the controller is being operated, and the mean voltage while it is held



BOYER AUTOMATIC SPEED RECORDER.

on a running point are obtained the two portions of the core loss curve, since the loss in the iron for any particular voltage and current is always known from special tests on the motor. Thus the average rate at which energy has to be dissipated in the motor is determined.

If the motors are of a new type the schedule may be repeated until the temperature is steady, and a succession of such heat runs enables curves to be plotted from which the heating when making any particular schedule is deduced.



AUTOMATIC RECORDING VOLTMETER.

Such information, obtained under actual operating conditions, is indispensable where the performance of a piece of apparatus has to be predetermined from a knowledge of the service it is required to stand.

ELECTRICITY IN MANUFACTURING PLANTS.*

In considering the relative merits of alternating and direct current for motor driving, it is the writer's opinion that if the induction motor had been the first to enter the field there probably would have been no room for argument, because its merits are so great that there would have been little incentive to develop anything else. It happened, however, that although alternating current was the first, as it is the natural product of any machine without special commutating devices, it was some time before a commercially practicable alternating current motor appeared, and the direct current motor, being first in the field and being undoubtedly meritorious, acquired the vogue which always comes to that with which people are familiar.

Mechanically the induction motor appeals at once to every practical man as the better device. The coils of wire are entirely stationary, while the rotating part consists of disks of sheet steel inclosed by massive composition end rings, which latter are connected by stout bars of copper bedded in slots in the steel sheets. The direct current motor, on the contrary, has its coils movable as well as stationary, and, while these do not often give trouble, they are not so simple and mechanical as the rotating part of an induction motor. The direct current motor has an additional feature which is entirely absent in the alternating current motor—the commutator and brush holder. These are the parts requiring most attention and the ones most liable to give trouble, although the modern methods of design and manufacture have reduced this to a minimum. The efficiency of the induction motor is fully equal to that of the direct current motor and indeed is slightly better over most of its range of capacity.

Thus far it might seem that everything is so greatly in favor of the induction motor that there could be no room for choice; but this type has one defect, namely, it is a constant speed motor, and many of the foremost advocates of individual tool driving want a motor whose speed can be varied through a wide range. While it is entirely possible to make an induction motor whose speed can be varied, the extreme simplicity of the first type is lost on account of the slip rings, which are used to enable the variable speed to be obtained by throwing resistance into the circuit. These, while not so liable to derangement as the commutator of a direct current machine, do add a slight additional complication. Before going on to explain some of the different methods by which variable speed is obtained with direct current motors, it may be mentioned that in the New York Shipbuilding Company and also in the steam engineering plant at the Brooklyn navy yard, the simplest type of induction motor is used, and the variable speed is obtained by means of belts and cone pulleys. In the opinion of the writer this method is entirely satisfactory and gives an adequate range of speeds with extreme simplicity.

It may be well to mention, in speaking of direct current motors, that apart from crane service, the type of motor almost universally used in industrial plants is the shunt motor, so called because the field circuit is

THE PROTECTED THIRD-RAIL.

a shunt from that of the armature. The shunt motor is inherently self-regulating, and within moderate limits the speed remains constant without regard to the load coming upon it. One of the simplest methods of varying the speed is by varying the field strength, which can be done by introducing a suitable rheostat in the field circuit, and as only a small portion of the current goes through this circuit anyhow, the loss is immaterial. The speed can also be varied by introducing resistance in the armature circuit to cut down the E. M. F. acting upon the armature, but this is objectionable on account of the large amount of energy wasted as heat in the resistance.

Another method which has been used with decided success and simplicity is the three-wire system from a single generator in connection with field regulation, which enables the speed of the motor to be varied sufficiently to meet all practical purposes. The three-wire system is obtained by utilizing a special generator somewhat resembling a rotary converter; that is, in addition to the brushes and commutator furnishing direct current, leads are brought out from the armature winding to two or more slip rings placed upon the armature shaft. From these slip rings alternating current is taken, and if this is passed through an auto-transformer, and a lead is tapped from the middle of the transformer coil, this lead will always have a potential midway between that of the terminals on the direct side of the machine, thus securing at the motor two voltages, one equal to twice the other. By field regulation the speed can be varied through a ratio of about one to three, so that with this variation combined with the two voltages of the three-wire system we get a range of six speeds, which, in general, will be amply sufficient.

Another system, known as the multi-voltage system, has also been used to some extent with direct current motors, consisting of a number of circuits working at different voltages. Suppose that, commencing with a negative wire, the voltage rises to 60 at the second wire, 140 at the third, and 250 at the fourth, thus giving intervals of 60, 80 and 110 volts. It is obvious that we can get any of the three voltages by the intervals, and by varying wires we can get in all six voltages. If the field of the motor is constantly excited at, say

* Abstract of paper by Walt r M. McFarland before the Society of Naval Architects and Marine Engineers.

250 volts, the several voltages applied to the armature will give as many different speeds, and the gaps between may be filled in by slightly varying the field excitation. The objection to this system is the complication of the generating apparatus and of the wiring.

Still another system is that called, after the name of its inventor, the Ward-Leonard system, which depends upon supplying a current of varying voltage to the motor by varying the field strength of the generator, the field of the motor being constantly excited from an independent constant potential circuit. This is the system employed for turret turning on board naval vessels, where it has worked very successfully, and it was described in detail some years ago in a paper before the Society, so that we need not go into it further here. It will be seen that the objection to this system is its enormous complication when attempting to apply it to so large a number of motors as would be found in a manufacturing establishment.

An advantage of the induction motor is that from its construction there is no danger from a short circuit, because the bars in the rotating part are purposely short-circuited. Further, this motor will stand being brought to a full stop for a moment with the full current upon it without any resulting damage, while such an occurrence with a direct current motor would certainly burn out the insulation, if not doing still greater damage. As a result of this it is not necessary to fit circuit breakers or fuses to take care of these motors. In the small sizes the motor can be started up by simply closing the circuit by means of an ordinary switch, and in the larger sizes practically the same thing is done, as a two-throw switch is used in connection with an auto-starter, which is simply a small transformer arranged to give half the line voltage in starting up. The object is not so much the protection of the motor itself as to avoid the demand for a large amount of current from the generating system, as the starting current without the transformer would be somewhat more than twice full-load current. In the case of the direct-current motor it is, of course, necessary to start through the rheostat, so that the full voltage only comes on when the motor is up to speed.

In regard to individual and group driving some engineers go so far as to say that they would have a motor for each tool, even if it involved going to sizes as small as one-quarter horse power, but the writer is inclined to believe that the judgment of more conservative engineers is favorable to individual driving where the power required will be, say, from five to ten horse power and upward, and for group driving where the individual tools would require less than those amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group driven a moderate-sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and materially reducing the first cost of the installation.

ELECTRONS AND ATMOSPHERIC ELECTRICITY.*

ONE result of the development of the new theory of electrons is likely to be a great addition to our knowledge of the causes and phenomena of atmospheric electricity.

Elster and Geitel have made numerous experiments to ascertain the rate at which an electroscope loses its charge in different localities and in different states of the weather. They found that the rate of leak was greater at high altitudes than at low ones, and that on the tops of mountains negative electricity escaped faster than positive. The latter phenomenon is evidently due to the fact that the negative charge of the earth accumulates at the mountain peak and repels with greater intensity the negative charge of the electroscope. The experiments made in different states of the weather showed that the rate of leakage was much smaller in mist and fog than when the weather was bright and clear.

Investigations into the nature of electric conductivity in gases, have shown that electricity can only pass through a gas when it is carried by means of free positive or negative ions or carriers. The positive ions are usually uncombined atoms or positive electrons, and the negative ions are the so-called negative electrons, or corpuscles, whose mass is only about one-thousandth part of the mass of an atom of hydrogen, though their negative charge is equal in quantity to the positive charge of the positive electron. One consequence of this is that under the influence of an equal electric force the negative electron moves much faster than the positive electron.

The rate at which a charged electroscope loses its charge, is thus a measure of the percentage of free electrons in the atmosphere. Another method of measuring the percentage of free electrons in the atmosphere has been devised by Prof. Ebert, of Munich. In his apparatus an aspirator driven by clockwork draws a definite quantity of air through the annular space between the two coaxial cylinders, the inner cylinder resting directly on an electroscope, while the outer is connected to earth. If the capacity of the system and the quantity of air drawn through it in a given time are known, then one can (from the number of volts indicating the loss of potential during the time) calculate in absolute measure the quantity of electricity contained in a cubic meter of air, and from that deduce its charge of free electrons.

Determinations made with this apparatus in Switzerland showed that the charges of electrons found at the surface of the earth depended on changes going on in the higher strata of the atmosphere. Thus, during the Fohn (a violent south wind), the charge of electrons was not only absolutely very high, but the normal preponderance of negative electrons was changed to a decided preponderance of positive electrons. Experiments in balloons have shown that the charge of electrons in the atmosphere increases rapidly with the altitude. There is consequently a higher degree of conductivity of the air about mountain peaks, and as the negative charge of the earth accumulates at these peaks, both the mobility of the negative electrons and the force acting upon them are great. The negative electrons are consequently driven away, and a great excess of positive electrons is left in the air surrounding mountain peaks. When the south wind blows over the mountain crests, the air, charged with positive electrons, is driven down into the valleys.

This changing of the electronic content of the atmosphere appears to have a specific effect on the human organism. Czermak, who has studied this phenomenon in the Fohn region at Innsbruck, is disposed to connect the increase in the density of positive electrons with the so-called Fohn sickness which attacks sensitive persons, and for which, up to this time, no satisfactory explanation has been found. In this connection, the results of the Monte Rosa expedition, for the investigation of mountain sickness, recently reported on by Caspari, are very interesting. It was found that the electronic content attained a very high figure in hollows, caves, and chasms which communicate with the open air, but at the same time contain a considerable quantity of quiet, stagnant air. Now, according to the experience of mountain guides, it is in such partially inclosed spaces that the complex phenomena of mountain sickness are most apt to occur, even where altitude offers no predisposing cause for this effect. In a passage on Monte Rosa, notorious for its mountain sickness, Caspari found with the Elster-Geitel apparatus an enormously large charge of electrons.

The normal distribution of positive and negative electrons at different altitudes may be greatly disturbed by vertical air currents, such as are produced when the surface of the earth is greatly heated by the sun in the summer time. The ultra-violet element in sunlight causes the earth to freely discharge negative electrons into the stratum of air in contact with the earth's surface, and this when heated carries its charge of electrons to considerable heights. Recently it has been discovered that a peculiar stratification exists in the air which so subdivides the whole column of air above us that the temperature and amount of aqueous vapor suddenly change their value in passing from one stratum to another. These stratifications are of the greatest importance for the formation of clouds. Now it is noteworthy that with each entrance into a new stratum there has been observed a sudden change in the electronic charge and also in the proportion in which the positive and negative charges are mixed in these strata. Therefore, just as each stratum is characterized by a certain temperature and moisture, so it is also characterized by certain electrical properties which seem to be conditioned chiefly by its origin.

In the stratum of cumulus clouds about 2,000 meters above sea level, Ebert repeatedly found charges of electrons more than four times as great as those on the earth's surface.

At the earth's surface, under normal conditions, there is a charge of one to three electrostatic units per cubic meter of free electronic electricity, there being a slight excess of the positive charge over the negative. With increasing altitude the positive and negative electronic charges become more nearly equal, but the total number of free electrons increases. At an altitude of 3 kilometers there is a total charge of more than 4 electrostatic units per cubic meter. Conrad has estimated from Elster and Geitel's determinations that the amount of electricity in 1 gramme of the water of a cumulus cloud amounts to 1-36 of 10^{-8} of a coulomb. Within a dense cloud there was, according to Conrad's measurements, 5 grammes of water per cubic meter. There was consequently an electric charge per cubic meter of the cloud of about 1-7 of 10^{-8} of a coulomb. This approximates very closely to the charge of 4 electrostatic units, i. e., 4-30 of 10^{-9} coulomb found by Ebert to be the free electronic charge in the air at a height of 3 kilometers, and the electronic charge appears to have been entirely absorbed by the moisture of the cloud.

The explanation of this phenomenon is to be found in the experiments of C. T. R. Wilson, who found that in slightly supersaturated air free from dust, electrons acted as nuclei for the condensation of moisture. When the supersaturation reaches a certain limit, the particles of moisture form first round the negative electrons. If the supersaturation is still further increased, the particles of moisture are formed round the positive electrons. If the air is not free from dust, the particles of dust act as nuclei for particles of moisture before the negative electrons. Thus, if a stratum of air contains dust particles and both positive and negative electrons, the first result of a gradually increasing supersaturation is a condensation of moisture about the particles of dust. If this moisture falls as rain, the rain will be electrically neutral. The second condensation takes place round the negative electrons, and this may result in a shower of rain with a negative electric charge. The third condensation, if the supersaturation goes far enough, will be about the positive electrons, and the shower of rain which may result will be positively electrified. The neutral, negative and positive showers of rain following each other in succession have been observed by Elster and Geitel. The particles of moisture formed may not be large enough to fall as rain, and the process described above may only lead to the formation of positively and negatively charged clouds separated from each other by a greater or less distance. This condition is evidently favorable to a discharge of lightning between the two clouds. If a negatively charged cloud approaches sufficiently near to the earth's surface, a discharge of lightning takes place between the cloud and the earth. This discharged cloud being now at the earth's potential will discharge clouds behind, and the thunderstorm may in this way gradually spread over an extensive region. Conrad has shown that the potential difference created by a charged cloud is quite sufficient to cause lightning discharges over great distances. If, for instance, we suppose a cumulus cloud of spherical form of only 1 kilometer radius to rest with its center 3 kilometers from the earth's surface, then it will by its own internal charge cause a decrease of potential at the earth's surface of 11,000 volts per meter of vertical distance. Such values have actually been observed in thunderstorms at the earth's surface. For such a gradient a point in the air 500 meters above the earth would show a difference of potential of 5½ million volts with respect to the earth's surface, and such pressures are quite adequate to bring about a discharge of lightning.

Thus the theory of electrons appears to give a more satisfactory explanation of the origin of atmospheric electricity than any of the numerous hypotheses that have already been proposed. There may be more than one cause at work bringing about the dissociation of the neutral molecule into its positive and negative elements. The ultra-violet constituent of sunlight is known to be an effective cause. Another cause has been suggested by Schuster, namely, the presence of radio-active substances in the earth. The particles projected from radio-active substances are known to be powerful ionizers of air. There has been a growing tendency of late to believe that the sun emits cathode rays or negative electrons, which penetrate the upper strata of our atmosphere. It has also been suggested that the heat of the sun is due to the presence in its mass of radium in high percentage. Both cathode rays and the emissions from radium are powerful ionizers, and they may, therefore, contribute largely to the production of free electrons in our atmosphere.

The free negative electrons, as stated above, are more mobile, on account of their smaller mass, than positive electrons. A consequence of this is that, when near a conductor like the earth, they are attracted by induction and absorbed in greater quantity than the positive electrons. But this attraction of the negative electrons will only take place to any extent in hollow parts of the earth's surface, such as chasms and caves, because in these the repulsive force of the negative charge of the earth is neutralized. On mountain peaks, on the contrary, the repulsive force of the earth's negative charge is exaggerated and free negative electrons are driven off into the upper air.

The result of these opposite actions on the negative electrons is to leave an excess of positive electrons in the atmosphere near the earth's surface, both in deep valleys and on mountain peaks. There is no doubt an intermediate curvature of the ground where the percentage of the two kinds of electrons in the air remains practically equal.

The theory of electrons has placed a new instrument in the hands of the meteorologist to unlock the mysteries of the weather, and no observatory in future will be complete without its electronometer.

* From the Electrical Review, London.

THE EARTHING OF ELECTRIC TRANSFORMERS.

WHEN the report of a committee on the protection of electric plants against atmospheric electricity was being discussed in a recent meeting of the Berlin Elecktrotechnische Verein, Mr. Rosenberg drew attention to a peculiar fatal accident. Monophase currents are sent by an overhead line of several miles length to a transformer station, from which a district is illuminated. The power station is provided with horn lightning arresters, the transformer station with plate arresters. In accordance with the Austrian law, the transformer was insulated; only when underground conductors are used, the transformers must be earthed in that country. Several hours after a violent thunder storm, two men were killed in their own houses when attempting to turn on the electric lamps. It was found that in one of the transformers a short circuit had been established between the primary and secondary line; the latter, low tension, is arranged on the three-wire system, which is not earthed either. An inspection of the plate lightning arresters showed that they had operated. The lightning had played about the arresters, and possibly failed after a time; it may also be that a branch current found its way into the transformer. One transformer coil was burned, and the flame had penetrated to the core, which was, as we stated, insulated from the earth. One of the two fuses of the primary high-tension current had blown, the other not; the transformer remained under high-tension currents, therefore, both in the primary and secondary circuits. The wiring in the houses was very carefully insulated, because the ceilings were of wood; the floors were

stone, so that the people standing on the stones with their damp wooden shoes would form a fairly good earth connection. To avoid similar accidents Mr. Rosenberg had recommended to earth the neutral wire of the low-tension circuit, and to earth the transformer. There are, of course, objections to both those proposals. Mr. Rosenberg himself admitted that dangerous tensions might arise in an earthed transformer Such cases are best met by tension interrupters inserted in the low-tension branches. The earthing of the neutral wire is in itself commendable, provided that it does not cause disturbance in telephone circuits.

A RÉSUMÉ OF RECENT PROGRESS IN THE STUDY OF RADIUM AND RADIO-ACTIVITY.

THE position of radium in the periodic system as determined by its spectrum has been made the subject of an investigation by C. Runge and J. Precht, the results obtained having been published in the Phys. Zeitschrift.

By means of their behavior in the magnetic field the authors selected the lines in the radium spectrum, which form the first pair in the principal and the first and second subordinate series respectively. These lines correspond exactly to the similar lines in the spectra of magnesium, calcium, strontium, and barium. It is well known that the frequency differences of all the pairs of the two subordinate series and the first pair of the principal series are all equal. Now this frequency difference is nearly proportional to the square root of the atomic weight for the elements of one chemical family. This is not strictly true, and the authors state the law as follows: The atomic weight is proportional to a power of the frequency difference, or the logarithms of the atomic weights are a linear function of the logarithms of the frequency differences. These frequency differences for magnesium, calcium, strontium, and barium are 91.7, 223, 801, and 1691; on plotting the logarithms of these numbers against the logarithms of the atomic weights a straight line is drawn through the points and is extrapolated to find the atomic weight of radium, taking its frequency difference as 4858.5. In this way the atomic weight is found to be 257.8. This value does not deserve more consideration than that experimentally determined by Mme. Curie as 225, but it must be remembered that barium and radium bromides are isomorphous, and therefore very difficult of separation. An incomplete separation would tend to lower the atomic weights as determined by chemical means. The value 225, on the other hand, fits in with the periodic system much better than 257.8.

R. Blondlot, by observing the action of Röntgen rays on a small electric spark, has obtained indications which show that the rays have a plane of action. They act as if they possessed different properties on different sides or are *polarized*, using the word in the widest sense. The plane of action appears to be independent of the orientation of the anti-cathode used; it is always the plane which passes through the Röntgen ray and the cathode ray producing it. The spark, being put in the plane of action, on changing its orientation in this plane, the action of the Röntgen rays upon it is a maximum when it is normal to them, and zero when it is parallel or nearly parallel to them. Quartz and sugar appear to rotate the plane of polarization in the same direction as does light. Rotations of 40 deg. have been observed.

With some photographic papers, notably collodio-chloride and other printing-out papers, L. Zehnder notes the following curious effect: By exposure to cathode rays part of the paper is darkened, in this case to a brown color; on further exposure, this time to daylight, the previously unaffacted parts become blackened, while the portions affected by the cathode rays become paler. The result is to turn what, after exposure to the cathode rays, was a negative into a positive. If the darkening due to the exposure to the rays be too great, a reversal does not take place. Radium radiation has the same effect as cathode rays in some cases, but apparently differs when certain bromide papers are employed. Canal rays or ultra-violet light are also found to be efficacious. A comparison with Goldstein's work on the coloring of certain salts in a similar manner is of interest.

Prof. Curie, in Comptes Rendus, gives the results of his experiments of the action taking place when radium is placed in an inclosure maintained at 450 deg. C. or at —180 deg. C. He finds that the law of de-activation is still the same throughout this range of temperature, that law being the exponential one—

$$I = I_0 e^{-\frac{t}{\theta}}$$

where I = intensity of the radiation from the walls of the inclosure and $\theta = 4.97 \times 10^5$ seconds; the intensity diminishing by one-half in four days. Some interesting speculations as to the nature of radio-activity are given. The energy within the inclosure, which produces the activity of the walls, decreases with the time according to a law which is independent of the temperature between —180 deg. and +450 deg. Curie has previously shown that the law is equally independent of other very varied conditions. He suggests that the energy produced by each atom of radium dissipates itself by radiation or by conduction in fluid bodies. Experiment shows that in gases the energy transmitted by conduction is stored up in a special form, and dissipates itself according to an exponential law on provoking the radio-activity of material bodies. Rutherford supposes that thorium and radium emit a radio-active emanation which excites the radio-activity of the bodies on which it fixes itself. It is this emanation which produces the induced activity in an activated closed vessel. Rutherford seems to believe in the material nature of the emanation, and thinks it probable that it is a gas belonging to the argon group. The author considers that there is not sufficient evidence to admit the existence of an emanation of matter under its ordinary atomic form. He and Debierne have vainly sought for new rays in the gases extracted from radium. Moreover, the emanation disappears spontaneously in a sealed tube. He considers also that it is not probable that the effects which accompany the existence of the emanation have their origin in a chemical transformation—no chemical reaction is known whose velocity of reaction is independent of the temperature between —180 deg. and +450 deg. Curie intends to use the convenient term emanation, and defines it as the radio-active energy emitted by radio-active bodies in the special form under which it is stored up in gases and in a vacuum. This special form of energy in the case of radium is essentially characterized by the time constant of the exponential law according to which it dissipates itself. The radio-activity of the solid walls constitutes another form of this radio-active energy, which dissipates itself according to a different law.

Curie gives the following theory of radio-activity: Radium of itself does not send out Becquerel rays, it only emits the emanation. In the solid salts of radium, the emanation, not being able to escape, is transformed on the spot into Becquerel radiation. In the case of a solution placed in an inclosure, the emanation spreads itself throughout the inclosure and excites the radio-activity of the walls, the radiation is "exteriorized." What is the support of the energy which constitutes the emanation? One explanation is that of Rutherford, viz., that radium emits a gas which serves to transport the emanation. Again, the support of the emanation may be due to the gas existing in the space concerned, but on this hypothesis it is difficult to explain why the nature of the gas, its pressure and temperature, have no influence on the properties of the emanation. A third hypothesis consists in supposing that the emanation has not ordinary matter for its support, and that there exist centers of condensation of energy, situated between the molecules of the gas, which can be carried along with it.

Prof. H. Becquerel, in Comptes Rendus, gives proofs that the α-rays from radium and the radiation from polonium are identical. It was previously pointed out that the degrees of absorption of the two kinds of rays were quite analogous. They are now shown to behave similarly as regards deviability. A photographic method of experiment being adopted, the two proofs—the feeble one of polonium and the intense one of radium—appeared superposable. The direction of the deviation of both kinds of radiation was the inverse of that of the cathode rays. The different kinds of radiation emitted by active bodies may be thus classed: (1) Uranium emits only radiations charged with negative electricity and very penetrating. (2) Polonium emits only rays charged with positive electricity and very penetrating. (3) Thorium and radium emit both these kinds of radiation. Radium sends out besides very penetrating non-deviable rays. The nature of these is unknown, but they exhibit various characteristics which are also found in the case of Röntgen rays.

A. Debierne, the discoverer of actinium, has observed that the behavior of actinium differs in some respects from that of radium as regards inducing or exciting radio-activity in neighboring bodies placed with it inside an inclosure. The time constants of the decay of the activity produced allow of distinguishing between the different substances. The activity induced by actinium dies away very rapidly; hence the effect is observed only in the immediate neighborhood of salts of actinium. The activating centers of energy, according to Curie's hypothesis (called the emanation by Rutherford), are extinguished in the case of actinium before they get far from the source. With radium these activating centers are exhausted slowly.

R. J. Strutt in Nature shows that the nature of the walls of the vessel, in which electricity from a charged wire leaked across air, influenced the rate of leak. From this it would appear that the observed ionization of air is due to Becquerel rays from the containing vessel. The comparative values of the rate of leak with various materials surrounding the charged wire is given in a table.

Prof. P. Curie and J. Danne in Comptes Rendus state that solid bodies exposed to the action of radium in a closed vessel all become active in the same way. Withdrawn from the inclosure, and thus removed from the action of the emanation, they cease to be active somewhat rapidly according to a definite law. This law is the same whatever the duration of the exposure to the emanation, provided this exposure has lasted sufficiently long (over twenty-four hours). In general, the result is independent of the nature of the body placed under the same conditions. All substances gain and lose activity in the same fashion.

The activity diminishes by one-half in twenty-eight minutes. The law of the diminution of activity is considered as characteristic of the form in which the radio-active energy is stored up at the surface of solid bodies. The intensity of radiation at any moment is represented by the difference of two exponentials. The radio-active energy disappears much more rapidly when it is under the form in which it appears on an activated solid body than when it is in the form of an emanation. In the last case it diminishes by one-half in four days. When the duration of activation is less than twenty-four hours the law of de-activation during the first hours is much altered. For an activation lasting five minutes, the intensity of radiation after a quick fall passes through a minimum (t = 8 min.), increases then to a maximum (t = 40 min.) and then decreases regularly. In all cases the law of de-activation becomes finally at the end of two hours thirty minutes the ordinary exponential law. Whether the material becomes active or is de-activated, the radiation tends toward its limiting value according to the same law. Perhaps it is in the presence and in the transformation of a certain quantity of emanation that it is necessary to seek for the explanation of the singularities of the curves at the commencement of the de-activation. While in general the law of de-activation does not depend on the nature of the activated bodies, yet, for certain substances which have undergone long activation, the final exponential law of de-activation no longer applies. After some hours the activity only decreases very slowly, and requires sometimes many days to decrease by one-half. This phenomenon is especially manifest in the case of celluloid and of caoutchouc. Paraffin and wax show it to a less degree; it is also observed in the case of alum and of lead.

CAISSON DISEASE.

FIVE cases of trouble in consequence of working in compressed air in a bridge caisson have been reported in this city within the last few months. In one of these it is possible that a previously existing weakness of the heart may have been chiefly instrumental in producing the observed effects, but the others were doubtless caisson disease, or diver's palsy, pure and simple. The disorder has long been recognized by the medical profession. It is not of frequent occurrence, fortunately, because only a limited number of engineers and workmen are engaged in the actual operations of driving a tunnel. Still, a singularly large proportion of these suffer to a greater or less degree. Out of sixty-four men employed in a caisson on the banks of the Loire in 1884, sixteen had severe attacks, and it was necessary to discharge twenty-five on account of sickness. Two cases resulted fatally. Very often, when life is not lost, the ensuing paralysis is permanent. Such was the penalty paid by Washington Roebling for his devotion to duty in the construction of the first bridge over the East River.

Several theories have been advanced to account for this curious malady. It has been suggested that the seat of the mischief may be the brain and spinal cord, to which the blood is driven by increased external atmospheric pressure. Inasmuch as these parts of the body are inclosed in rigid walls, they cannot yield to distending influences, as the heart or other organs can. Other investigators imagine that the trouble results from an effervescence of air or other gases in the blood and soft tissues. Paul Bert advanced this idea some thirty years ago, and confidence in its correctness was expressed only a few weeks ago in the Journal of Hygiene by Dr. Leonard Hill, of London, and Prof. J. J. R. MacLeod, of Western Reserve University, who have recently co-operated in experiments of their own. To the lay mind the second explanation will doubtless seem the more satisfactory of the two, because the more serious symptoms usually develop not while the subject is under pressure, but after he is liberated. The unpleasant sensations felt in the ears and the temporary deafness when first confined are, of course, practically harmless. It is when the compressed air with which the whole system has become saturated (like a bottle of soda water, charged with carbonic acid gas) has a chance to expand that the gravest consequences are noticed.

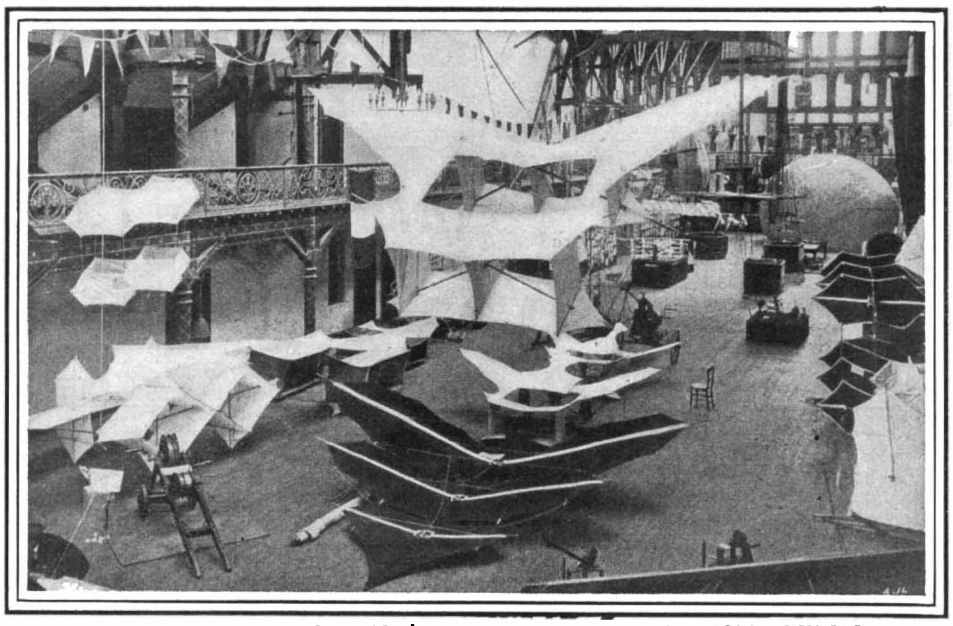
A number of precautions are suggested in the Journal of Hygiene article. The selection of men not over twenty or twenty-five years of age, tough and wiry in their build and abstemious in their habits, is recommended. Before they are permitted to go on duty they should be tested with light pressures and rejected if they feel any ill effects. Unduly sensitive subjects having thus been weeded out, the utmost attention should be given to one other safeguard. After men who are about to begin work have entered the "air-lock," that is always interposed between the outside atmosphere and the chamber in which excavation is carried on, the necessary increase of pressure may go on rapidly. Ten or fifteen minutes will usually suffice. When the men are coming out they should be detained in the antechamber much longer. "Decompression" should be more gradual than compression. Even when the pressure under which they have been working is not over thirty pounds to the inch, it might be wise to take from half an hour to an hour for the reduction. For higher pressures "decompression" should be still more protracted.

The amount of pressure in a caisson or tunnel depends upon the depth of the latter below the surface of the water. The fluid is excluded by the air. Dr. Hill and Prof. MacLeod think that it will prove practicable to go fully two hundred feet below water level, and to use air pressures of more than one hundred pounds to the square inch, if picked men are employed and if two hours are devoted to the liberating stage. Such an assurance it gratifying, because no one knows exactly how far down it is safe to go in engineering operations of this class. Depths never before reached may possibly be attempted in the near future. The most immediate bearing of the paper here quoted, though, is upon enterprises now in progress. It reveals the importance of taking ample time for the release of men who are to-day working in compressed-air chambers.—N. Y. Tribune.

THE CODY KITES.

AFTER several previous fruitless attempts, S. F. Cody succeeded in crossing the Channel in a boat drawn by one of his kites. Mr. Cody had been waiting for many days for a favorable wind. When at last it came, he started without fear or hesitancy. The exigencies of having to consider the tide compelled him to delay until afternoon was coming on, and then, alone in his little boat, harnessed to a kite far up in the air, he started, and quickly left behind the pilot boat, which saw him out of Calais harbor. Soon he was alone in mid-channel under the stars. He could only observe the position of his great kite by seeing the stars blotted out below or above, according as it rose or fell. There is something impressive in the thought of the lonely and intrepid experimenter right out in mid-channel with his lantern, and his frock coat rolled up under a seat, in the neighborhood of the treacherous Goodwins, which he twice passed without a single boat or vessel of any kind to render assistance, controlling a means of traction which had never been successfully harnessed to a boat before.

Mr. Cody's successful experiment is a contribution to a certain extent to the problem of flight, but it is premature at present to estimate its value. Here we have a system, composed partially of an aeroplane guided by a trail rope and sea anchor (the boat) which maintained itself in varying equilibrium, successfully, for a period of some thirteen hours, which is an aeronautic phenomenon. Mr. Cody has shown the power of his kites to lift at least a single man. In the present experiment the man was in the boat, but there is no inherent reason why he might not have been up in the kite, at any rate for a large part of the time. It suggests that further experiments may possibly be made at an early date with mechanically-propelled aeroplanes, obtaining stability from a trail rope with a sea anchor or small boat attached to them. This would render the system less dependent on the wind in the first instance, and might enable useful data regarding the manipulation of a motor-propelled aeroplane in mid-air—under somewhat different but still analogous conditions to those with which the Brothers Wright have successfully experimented—to be obtained.



VIEWS OF SEVERAL OF MR. CODY'S KITES AT THE AERONAUTICAL EXHIBITION.

It was a kite of one of these types which successfully drew his boat across the Channel.

PLATINUM AND OSMIUM.

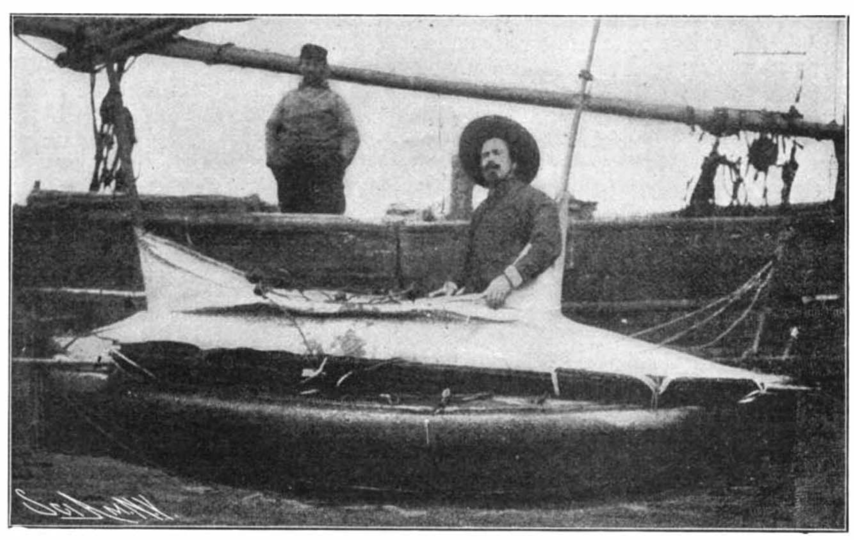
ACCORDING to Prof. Kemp, platinum deposits occur in three forms: (1) In placers, as exemplified by those in the Urals, Colombia, Brazil, and British Columbia. (2) In veins, as at Tilkerode, in the Hartz; Minas Geraes, Brazil; Santa Rosa, Cal.; Beresovsk, Russia; Gualdalcanal, Spain; and the Rambler mine, Wyoming. (3) Disseminated in eruptive rocks, in two ways; (a) in sperrylite, with the copper-nickel ores in uralitized norite, Sudbury, Canada, and (b) as a native metal in basic eruptive rocks, especially peridotites, frequently intimately associated with chromite.

The demand for American platinum has been somewhat increased in the last few years by the discovery of a use for osmium, which occurs to a considerable extent in American platinum as the mineral osmiridium. Its presence formerly interfered very seriously with the sale of the crude platinum product, as it is a heavy, hard, refractory mineral, that made the treatment of the platinum very difficult. Osmium is now required for the manufacture of the filaments of the new Auer incandescent electric lights, so that American platinum, both on its own account and on that of its heretofore despised attendant, osmiridium, has become wholly desirable.

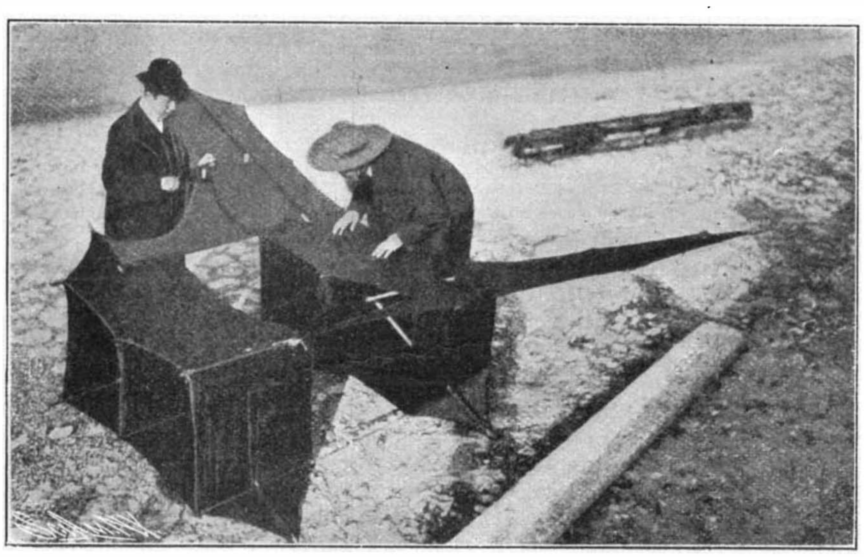
MAGNETISM OF BASALT.

A PAPER, entitled "On the Magnetism of Basalt and the Magnetic Behavior of Basaltic Bars When Heated in Air," was contributed by Dr. G. E. Allan to the proceedings at the meeting of the Physical Society of London on November 23, 1903. In the experiments carried out by the author, bars cut from basalt obtained from Rowley Regis and from Linz, Germany, were tested by means of a magnetometric method to determine their magnetic properties at temperatures from 15 deg. to 800 deg. C. Hysteresis curves are given in the paper, and the temperature permeability curves show that while the English basalt has, in general, a maximum permeability near 500 deg. C. followed by a minimum at about 550 deg. C., the maximum temperature permeability in the case of the German basalt lay in the neighborhood of 50 deg. C., there being a subsequent gradual loss of strength with rise of temperature. Sections of heated and unheated rocks are also given, showing evidence of chemical change in some of the rock constituents, and a table of values of susceptibility of the specimens is appended. Prof. W. F. Barrett made an interesting written communication on the paper, in which he stated that several years ago he examined the magnetic properties of various specimens of columnar basalt which had been taken from the Giant's Causeway in County Antrim, and a note on the result of this investigation was published in the Proceedings of the Royal Dublin Society for December, 1889. Each block was found permanently magnetized with a strongly marked north and south pole, the magnetic axis running diagonally through the block, and inclined to the horizon approximately at the angle of dip. As the blocks formed part of vertical columns in the causeway, their magnetization was undoubtedly due to the earth's magnetic field, the concave end of each block—for the ends are not plane, but slightly concave or convex—was (in all the blocks examined) found to be a north-seeking pole, and must therefore have been downward when *in situ* at the causeway. The weight of the blocks varied from 24 kilogrammes to 37 kilogrammes, and the specific gravity of a fragment of one of them was found to be 2.86. With such large irregular and feebly magnetized masses only a very approximate estimate of the magnetic moment was possible by the ordinary method. This was, however, attempted, the blocks being placed on a turntable with their centers 60 centimeters distant from the reflecting magnetometer. As might be expected, the magnet moment per gramme was found to be very small, and almost alike in each case. The volume of the blocks being known, their permanent intensit[illegible]

MR CODY SENDING UP THE KITE.



MR. CODY IN HIS KITE-DRAWN BOAT.



PREPARING THE KITE FOR ITS LONG FLIGHT.

NEARING THE ENGLISH COAST.

S. F. CODY AND HIS NOVEL KITES.

of magnetization was found to be less than that estimated by Everett for the earth, regarded as a uniformly magnetized body, viz., 0.079. Nothing could be inferred from this, as the blocks had been removed a long time from the causeway, and had been lying about in different magnetic positions to that which they originally occupied. The long retentivity of the direction of their original magnetization, in spite of rough usage, was, however, somewhat remarkable.

MAKING THE SOUTHWEST PASS OF THE MISSISSIPPI A SHIP CHANNEL.*

A LITTLE over a quarter century ago, construction of the Eads jetties made a permanent channel through the South Pass of the Mississippi sufficient to accommodate the ocean commerce of New Orleans for the time.

At the present time an even greater work is under way at the river's Southwest Pass, one that will rank as one of the conspicuous engineering undertakings of the decade. The preliminary work on blue paper has been done, and the actual labor of constructing the jetties has begun. In three years, if all goes well, the Mississippi will have an entrance worthy of its great volume of trade and capable of accommodating the largest ocean steamers. Congress has appropriated $1,750,000 to prosecute the undertaking, and has authorized contracts to be entered into for further work, not to exceed in the aggregate $1,750,000, making a total of $3,500,000. The estimated cost of completing the work, according to the report of official engineers, is $6,000,000. The plans call for the construction of jetties on either side of the Southwest Pass for a distance of between three and four miles, extending from the already navigable channel of the confine its energies to maintaining a navigable channel. The Southwest Pass has been selected for exploitation because that outlet offers the greatest volume of water. Once the jetties, or artificial banks, have been constructed, the river itself will be expected to do much toward keeping the channel clear. The government engineers say that systematic dredging may be necessary, as in the case of the South Pass, but the chief reliance is upon the scouring effect of the current, once that current is confined within proper bounds.

At a period when the largest vessels in the world drew but twelve or fifteen feet of water, the natural channels of the river presented no especial difficulties; but with the enormous increase in size that has been effected in ocean-going craft within the past three decades, the navigation problem has been an absorbing one. The demand for cheaper freight rates has led to the building of larger and still larger vessels, until to-day the ocean liners and tramp freighters are of a tonnage ten times that of the large craft of thirty years ago.

As the ships increased in size, they began to get stuck in the mud at the mouth of the river. After years of agitation Congress was forced to take action; and in 1875 it authorized the Eads Company to construct jetties at the South Pass. At that time Mr. Eads, in common with other experts, held the opinion that the work should have been projected at the Southwest Pass instead of the South; but the latter was chosen by the government because of less expense involved, and because the project was at that time more or less experimental. The specifications in the South Pass work called for a depth of twenty-six feet of water; but, as a matter of fact, a depth of thirty feet has since been maintained at the government's own the Mississippi will be the most extensive in the world, and in that fact lies their claim to distinction.

It will require the labor of 300 men for not less than three years to complete the work. Beginning at the solid banks of the river, the jetties will be extended in slightly converging lines into the Gulf. The total length of the pass is fifteen miles. It extends from the Passes Light to the Gulf at East Point, where the east bank of the Pass ends, the west bank being about 6,000 feet in advance of the east. The actual work will thus cover a stretch of four miles on the east bank and three miles on the west, the jetties extending across the bar and well into the Gulf, in order to secure the required depth of thirty-five feet.

The process of construction consists in building up tiers of willow mats firmly held in place by rock ballast and frames of wood. Within the wooden frames of yellow pine the willows are laid in such manner as to break joints, the tiers of mats rising one upon another in the form of a pyramid. Each successive tier is weighted by stone, and the top tier is capped with cement, in order to withstand wave action. The concrete capping is to be twelve feet wide at the bottom, eight and a half on top, and four and a half in thickness. The slope of the pyramid may be comprehended when it is stated that the foundation mats are to be from 100 feet to 150 feet in width.

The mattresses are to be built in lengths of not less than 200 feet, and will be from two to five tiers deep, according to depth of water. It is estimated that 960,000 square yards of mattresses, 213,525 tons of riprap stone, and 65,606 cubic yards of concrete will be required. In the course of time, the bottom tiers will sink into the mud, and the whole structure, by virtue of its immense weight of ballast, will become as firm as the natural banks of the river, and even

THE SOUTH PASS JETTY, SHOWING THE METHOD OF CONSTRUCTION.

river, through the bar and out into the Gulf of Mexico. The depth of water to be maintained must be thirty-five feet.

For many years the mouth of the Mississippi River has given navigators trouble. Like every other silt-bearing stream, the Mississippi tends to choke itself at its conflux with the sea. Much of the vast quantity of sediment carried by the water is precipitated upon the bottom, forming bars and resulting in an outlet, the enlarged expanse of which prevents any considerable depth of channel. The natural slope of the land is so insignificant that the "scouring" process observed in swift-running streams is here rendered abortive. Land is formed across the river's mouth; and the stream, when not confined by jetties, is diverted into several useless channels.

For untold centuries the Mississippi has been engaged in this land-building process. Geologists say that the spot now occupied by New Orleans, 110 miles from the river's mouth, was once beneath the waters of the Gulf, and that the same is probably true of the whole territory as far up as the Red Hills, which begin at Baton Rouge. At all events, within the brief period covered by authentic record the old town and fort of Balize, situated on a branch of Pass a l'Outre, was formerly on the Gulf, but it is now some miles inland. Scientists declare that the whole Delta is of extremely recent geological formation, and that it is to this land-making tendency of the mighty stream that one of the richest agricultural sections of the world owes its origin. Having repeatedly erected dams across its own mouth, the river has simply followed the lines of least resistance, establishing three main passes or outlets, known as Pass a l'Outre, South Pass, and Southwest Pass.

Congress has decided, however, that no matter what the mission of the Mississippi may have been in the past, it shall in the future drop land-building and expense. The work was completed in 1879, and from that time until the present all large vessels entering the Mississippi River have used that pass.

Twenty years ago, even fifteen years ago, a channel twenty-six to thirty feet deep was considered sufficient for the very largest steamers. To-day that requirement has been exceeded, and Mississippi Valley merchants have in consequence considered themselves handicapped in the struggle for commercial supremacy. The vessels of greatest carrying capacity, those offering the lowest freight rates, have been shut out of the river by lack of water over the bar. Consequently, there ensued years of agitation and the beleaguerment of Congress.

The growing interests of New Orleans forced the issue. Delegation after delegation appeared before the House Committee on Rivers and Harbors, appealing for a new channel through the Southwest Pass, with the final result that, on June 19, 1902, Congress authorized the improvements, the actual work upon which has just commenced.

It was not only a lack of depth in the South Pass that caused the clamor for a new channel to the Gulf, but the lack of breadth as well. The present channel is so narrow, that should a large vessel sink there and be thrown crosswise by the current, as might easily happen, the whole Mississippi River might be closed to navigation seaward until such time as the wreck could be removed. The Southwest Pass, on the contrary, will offer no such difficulty. It will be 3,500 feet wide at the narrowest point, as compared with 650 feet in the South Pass.

The construction of jetties is now no experiment. Similar engineering works have been built at Sabine Pass and Galveston, Texas, and at Fernandina, Florida. The jetties at the Sulina mouth of the Danube are of world-wide fame, and other Old World rivers have been flanked by the curious mats of willow, cement, and stone. Those now under construction at the mouth of firmer. The top layer on either side of the channel will rise only a few feet above the surface of the water. In time the jetties may become totally submerged, without any sacrifice of utility. The whole lower section of the Delta is settling at the rate of 0.05 foot in twenty years, and in certain sections much more rapidly. At the Jetties Light of the South Pass, for instance, the subsidence has been one foot in three years. The mud at the mouth of the river is so soft that if a man were to venture upon it, he would sink out of sight before help could reach him. The scheme of jetty construction in its entirety may be defined as the building of artificial river banks, and by so doing man simply discounts Nature by so many years.

The movement that resulted in securing the Southwest Pass improvements is recognized to be an open fight on the part of New Orleans to secure the commercial supremacy of the United States. That port ranks only second to New York in volume of exports, and it is the leading cotton and grain exporting city of the world.

In a comprehensive statement made before a Congressional committee several years ago by M. J. Sanders, agent at New Orleans of the Leyland Line and president of the New Orleans Progressive Union, it was pointed out that the immediate result of the improvements on the South Pass was to decrease cotton freights between New Orleans and Liverpool from $7.90 per bale to $3.90 per bale, and that this reduction affected the whole country, since every other exporting port must of necessity be in strict competition with the Crescent City. In 1896 the rate fell still lower, reaching $1.95 per bale. To-day the rate per bale of 500 pounds between the ports named is about $1.75, but the latter drop has been due not only to the great increase in the number and size of vessels, but to the demoralized condition of grain freights as well. On grain the saving effected by river improvements was even more pronounced. Between the years 1880 and

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

1896 the rate from New Orleans to Liverpool fell from fourteen and one-half cents a bushel to eight and one-half cents. During the period mentioned the saving to shippers of grain alone amounted to the enormous sum of $207,000,000. The total saving on all exports since the construction of the South Pass jetties has never been computed.

The vast area of the Middle West is vitally interested in deep Mississippi River channels. The difference of but one cent per bushel on transportation of grain means millions of dollars annually to the farmers of the West. There are at present a large number of ocean-going vessels trading at New Orleans that are forced to leave that port and look for employment elsewhere when light freights such as cotton are unobtainable. Of course, all such loss of capacity is sooner or later borne by the producer, and not the shipowner. The problem in brief is this: Large steamers carry freight cheaply; small steamers, dearly.

Liverpool to-day is carrying on harbor improvements at an expenditure of $17,000,000, in order to accommodate vessels of 900 feet length, 90 feet beam, and 40 feet draft. It is estimated that such vessels would have an economy probably three times as great as the majority of those now trading at the port of New Orleans. When it is remembered that ocean freights exert a tremendous influence in the regulation of railroad freights, the total saving to Western and Southern farmers to be secured by the admission of such steamers to the Mississippi assumes really imposing proportions.

There is another phase of the situation usually less dwelt upon, but none the less important. At present there are few harbors where the larger vessels of the United States navy could seek refuge in case of overpowering necessity, particularly in the Gulf. With the completion of the Southwest Pass improvements, New Orleans might easily be made one of the great bases of naval operations, since the river itself affords a harbor that can accommodate in single file something like 1,500 vessels. At low water there is ample depth for 200 miles above the Passes, and being landlocked this immense harbor could easily be rendered impassable to any foe. Moreover, it is a fresh-water harbor, and vessels may lie there for years without being subjected to the destroying influence of barnacles and other marine growth.

The effect of the development of the new pass upon the city of New Orleans will be of tremendous importance. Experts in commercial affairs are wont to allude to the tremendous possibilities to be opened up to that port through the contemplated Isthmian canal. Predictions are freely made that, with really deep water to the Gulf, the city will yet occupy the proud position of first exporting port in the United States. These seers of commercial visions find their inspiration in these facts: That the city's railroad facilities are already matchless, with even greater under contemplation; that the port is every year being more and more regarded as the natural outlet of the great West; that deeper water at the mouth of the river will cause such a reduction in ocean freights as to place New Orleans in a class by itself in the shipment of all food stuffs and other Middle West products to countries across the sea.

The first step in the realization of this dream of commercial greatness is the notable engineering feat now under way at the Southwest Pass. In order that the forty-five millions of people in this country directly affected may enjoy a greater degree of prosperity, and that, incidentally, Europe may have cheaper food, one of the greatest rivers in the world has been commanded to mend its vagrant ways, and to occupy in larger measure than heretofore its true position in the nation's marvelous development.

THE SWEDISH ANTARCTIC EXPEDITION, 1902-3.

By Dr. Otto Nordenskjöld, Commander.

It was on the 21st of February, 1902, that the "Antarctic" left our winter party for the last time—six men, absolutely cut off from the world, standing on the shore to see the mast tops sink below the horizon. We had already had some experience to show that, though our station lay far to the north, we should not have to meet smaller difficulties than in the inner Antarctic regions, and it is easy to understand what our feelings were at that moment. But well it was that none of us could then anticipate that two long winters would pass before we should again see a human being, and that our faithful steamer would never again be seen by any of us.

During the first weeks all the members of our little party were busily occupied in constructing our houses and observatories, and in arranging everything so that we should be prepared for the winter. Already in February we had experienced a number of severe gales and storms with temperatures as low as —12 deg. C. (10 deg. F.), a "summer" temperature scarcely to be expected in a latitude of only 64½ deg. S. We had, however, occasional fine days, and it was during such a period, about the middle of March, after we had finished all the most important arrangements and had started the scientific observations, that I decided before the new ice was formed to go out on a boat trip southward intending to reconnoiter the southern parts of Admiralty Inlet and to lay down a depot for use in the future.

We started on March 11, but soon found that it was already too late in the season for expeditions of this kind. The ice-pack, moving in the narrow straits with the strong tide-currents with irresistible force, kept our boat in imminent danger, and as soon as the water calmed new ice was formed between the ice-floes. However, we ascertained that Admiralty Inlet is really a strait, dividing Seymour Island and that on which the winter station was situated from the mainland; and also that Cape Lockyer is situated on a separate island. After two days we had to leave the boat at the edge of the fixed land ice and use our sledge in order to push on as far as possible with the supplies for establishing a depot. We were only just back to the boat when a storm started blowing, reaching during the first hour a velocity of more than 60 miles an hour, the thermometer being as low as —16 deg. C. (3 deg. F.). Still we could sleep in our bags until in the morning we were awakened by the water running into the tent. The ice had broken up, and the sea was washing over our tent—five minutes more and we should have been swallowed by the sea. As it was, in a second we were out of the bags, and soon had our boat and other things brought further in on the ice. But the gale was blowing terribly, and we could not see 100 yards around us; so the whole day we had to walk about, keeping watch until we could the next day proceed on our way homeward, though the wind was still rather too strong.

For further excursions outside our own island we had now to wait until the sea was solidly frozen over. For this several weeks were required, and even in May violent gales could break it all up in a few hours. So we settled our winter routine. The meteorological observations were divided between Dr. Bodman and Lieutenant Sobral, though during the night watches the work was shared by the whole scientific staff. Dr. Ekelof was busily occupied with bacteriological investigations, and I myself used every opportunity to collect fossils and prepare the map of our surroundings.

In this way the time passed tolerably well. We were all very glad to have as much to do as possible, as we were very closely confined to our winter quarters, and the space was rather small. As a matter of fact, no one had anticipated that we should be compelled to remain so much within doors. It is true that from the reports of the "Belgica" and "Southern Cross" expeditions it was well known that the winter in the Antarctic is both severe and stormy; but who could imagine that we in our station, situated six or seven degrees farther from the pole, should meet with a considerably lower temperature than the first of the above mentioned expeditions, and almost as low as the second, and at the same time should experience gales that, in persistence, if not in strength, far surpassed those encountered by the expeditions referred to. But so it was. April was the best month during the winter, but with the beginning of May there commenced a period of storms which, with short intermissions never exceeding three days, lasted five months, until the end of September. During the whole of this time the average velocity of the wind was 23 miles an hour, and once, during a whole fortnight in May and June, it averaged 45 miles.

It is difficult to give an idea of these terrible gales. Our house was continually shaking like the cars in an express train, and in fact there is a certain likeness between the two; if our house had been moving with the same speed as the wind rushed past when at its height, in less than 24 hours we would have reached the pole. Everything not solidly fixed was carried away, and after every storm we had to look for lost things. A large whaleboat lying on the shore was carried off hundreds of yards and crushed against the rocks. But what made the wind specially objectionable was that these strong gales from the southwest brought with them the lowest temperatures that we experienced—a feature in a measure peculiar to the region. Thus during the period mentioned in June the thermometer varied between —25 deg. and —32 deg. C. (—13 deg. and —26 deg. F.), and our stormiest day (mean velocity 63 miles an hour) was also one of the coldest (mean —31 deg. C., or —24 deg. F.). At such temperatures it was absolutely impossible to stand up against a wind of that force, and even in the daytime it became quite a difficulty to go as far as the observatories.

So it came about that we had to pass a very long time indoors, more even perhaps than many expeditions wintering in the darkness of the night far nearer to the pole. Our house was small but pretty comfortable, with one large room 8 feet by 14 feet in the middle and four smaller on the sides, one for the kitchen and three sleeping rooms for two men each. Over the whole house was a roomy loft, used as a store room. It was generally not difficult to keep the house warm, though we had hoped to get some snow to pile up round the walls, which, however, was never possible. Seals' blubber as fuel proved far superior to coal.

I made during the winter several short sledge trips, though I was never absent for a long time. From the beginning of August, however, a good part of the time was occupied in preparations for a longer sledge trip southward, which I had already contemplated before landing. We carried for the purpose a pretty good equipment of necessaries, and it was only in one point that we were seriously handicapped—viz., the number of dogs at our disposal. In this respect we had always met with bad luck. Of the dogs I brought from Greenland, all except four died on the way out, those four, however, being exceedingly fine animals. A number of pups born on the ship were frozen to death in a gale a few days after our landing before we had been able to arrange for them. The dogs I brought from the Falkland Islands proved not altogether unsuited to our needs, but most of them, and first of all the strongest and most courageous, had soon been killed by their ferocious Greenland companions. So for the expedition I could only use in all five dogs, a quite insufficient number remembering that it was impossible, by reason of the smallness of our company, for me to arrange so that an auxiliary party should follow us with fresh supplies.

My companions on the trip were Lieutenant Sobral and the sailor Jonasen. I took two sledges, the one to be pulled by the dogs, the other by two of the men. Though it was possible to load the latter sledge much more lightly than if we had had to pull the whole outfit ourselves, still the pace of our march was that of the men pulling, and a few dogs more would have allowed us to move much more quickly. We carried provisions for 45 days, but calculating that we should go on the sea-ice, and that our load was already rather heavy, I took only about 20 days' food for the dogs. At this time of the year I considered it almost certain that we should find seals and penguins on our way.

After a long delay, caused by the storms, we started from the station on September 30. During the first ten days we were favored by exceptionally fine weather, but after October 10 the storms commenced again, violent as before, and combined with a cold that was felt all the more after the preceding mild period. Before that date, however, we had passed out of Admiralty Sound and discovered a great inlet extending northward from Cape Foster; I believed it to be a large channel opening into the Erebus and Terror Gulf and separating an archipelago of islands from the mainland. This mainland, the hitherto unknown connection between Louis Philippe Land and King Oscar Land, is formed by a high range of mountain peaks separated by large glaciers and further inland passing into a level ice-covered plateau. Passing along this coast, though at a distance, we arrived at Christensen Island, which may be considered as an extinct volcano. My plan was in the further trip to travel southward as near the main coast-line as possible, and, as already mentioned, I had reckoned to make this journey on the sea-ice. I was therefore very much surprised to meet at Christensen Island a high ice wall extending inward in a westerly direction as far as I could see. If we did not care to go outside of the whole archipelago, where we had already once passed with the "Antarctic," and where nothing could be seen of the inner land, we had to pass over this ice. We decided to attempt the task, and during the whole time until we turned back we passed over level ice, rather low and almost without crevasses when we were at a distance from land, but rising rapidly and at the same time full of large, deep, impassable crevasses as soon as we approached the land. These extensive ice-plains, unlike anything I know of in aspect and formation, except, perhaps, the region inside Ross's great ice barrier, where the "Discovery" has had its winter quarters, were a great obstacle to our advance, in so far that with them every hope of finding seals for dog food vanished, and when I turned back on October 21 it was much earlier than I had expected. But then we were encircled by deep crevasses that could only be passed on narrow snow-bridges, and we had every reason to fear that if a thaw should set in we could not pass them at all. The last week had been a continual series of gales, the wind blowing straight against us. Our tent was in a deplorable condition, having been severely damaged by the wind, and already we had to feed the dogs out of the pemmican brought for ourselves. Of killing the dogs there could be no question, as this would have spoilt every hope for future sledge trips.

At this time we had arrived at lat. 66 deg. S., long. 62 deg. W., somewhat more than 200 miles from the station. On the southernmost point I climbed a high summit affording a good view of the surrounding mountains and ice plains. My intention was to find a way back much nearer to the coast. But here we met with crevasses which were almost impassable unless we were prepared to lose far more time than we could spare during this period of alternate storms and snow fog. So we had to go further off, and thus had very little opportunity for mapping the details of the coast line. On November 7 we were back at the station, having been absent 34 days, of which, however, only 22 or 23 were such as could be used for traveling.

Though there was still no change to be seen in the ice we already began to look for the returning of the "Antarctic." During the whole month I was busily occupied with work in the neighborhood that I wished to finish before going on board. About December 1 I made a sledge trip to Seymour Island, principally for geological studies, but also for collecting eggs for our table during the summer. It was during an excursion to the northern point of that island that I made in one day two important discoveries. On a ridge of hills I collected numerous fossil bones of vertebrate animals, some of them of great size, and a little further south I found a layer rich in plant remains belonging to numerous species. And so there seems to be no doubt that in those remote regions, where now the vegetation is as much inferior to that of Greenland or Spitzbergen as that is compared with an English forest, the climate was once mild, and that there existed then large forests of leaf-bearing trees where birds sang and strange large animals fed on the herbage. That this has been the case in the north has long been known, but it is the first time it has been proved in the south.

The ice on our east coast was at this time covered by deep melting water and very difficult to pass, and we

had every reason to believe that it would soon break up. Unfortunately, during the summer the strong gales of which we had formerly had such an abundance were almost completely wanting, and the year came to an end without any perceptible change in the ice. Then for the first time we began to be uneasy about our relief, and we started preparations to collect birds and seals for meat, as well as blubber, in case we should have to stay for another winter. The temperature was unexpectedly low and easterly winds with fog and snow very common. Though there were many open lanes in the ice, and a blue water sky was almost constantly to be seen far into the north, we were never really anxious about the fate of the "Antarctic" just because the sea was never open enough for us to expect her arrival.

For our principal food during the winter we intended to kill a number of penguins, but in hope of relief, and also because we did not want to do their young more harm than necessary, we delayed this as long as possible. The ice had now opened so much on the east coast of the land that when, on February 6, we were ready to start for the rookery on Seymour Island, we could make the trip by boat. We killed about 400 birds, which proved fully sufficient for our winter. However, to our taste, seal meat is much better than penguins, and it is specially to be remarked that it is impossible to get, even from a great number of penguins, grease enough to serve as fuel during winter.

It was during those days that the ice-conditions were the best that summer. Much open water was seen in all directions on our east coast, and several times we imagined we saw the ship among the ice. But the winter was already setting in; strong gales, alternating with snow and snow fog, were blowing from all directions, sometimes with temperatures as low as —10 deg. C. (14 deg. F.); and a few days later, again nothing but ice was seen all round the horizon, and everybody was forced to acknowledge that we were going to pass another long winter in our old quarters. None of us knew that during those stormy days the "Antarctic" had fought her last fight with the ice.

From this time commenced for us the second winter. We had good stores of provisions brought from home, except meat, which, as already mentioned, was got from the game of the region. Of course, we had to change our menu in respect of several more or less important items of food. But the only real difficulty was the isolation, which seemed the greater now that we had once considered the relief to be so near. With some letters and newspapers, some new books, or, far better, some new fellow-workers, if that could have been, I think we should all have been comparatively satisfied. And we were anxious also about the future; if there was ice one year there could just as well be ice for two or three, and would a relief expedition come if anything had happened to the "Antarctic"? And the worst of all was that we all knew that by ourselves we could do nothing for our safety.

But I never heard a complaint from any of my companions, and, in fact, our great consolation was that this second winter would give us far more ample opportunity to work for science than we could ever have expected. Especially it was clear that as our meteorological observations had given so many new and unexpected results, a second year would be of great importance, particularly if the others taking part in the international undertaking continued their work, as was the case with the British expedition and the Argentine station. All the members did their best to find new ways to complete their researches.

Fortunately this winter was far better than the former, not so much with regard to the temperature as to the gales, which were neither so strong nor so persistent as before. A few short sledge trips were made during the winter, but as my intention was to make several long expeditions in the spring I spared our efforts for that time. But before describing the only trip executed, it may here be appropriate to give a short summary of the scientific results obtained during the two years of wintering.

The principal object was the magnetic and meteorological observations. About the former nothing can here be recorded, the observations not yet having been worked out. An interesting though negative result was that in those two years we did not observe a single aurora australis. Of the meteorological results the most interesting is the unexpectedly cold climate of the region visited. The mean temperature for the first year was about —12 deg. C. (10.2 deg. F.), the same as in Hudson Strait or in Jakutsk, the two coldest places in the north, situated in more or less the same latitude as our station; at the same time it is several degrees lower than the temperature experienced by the Belgian expedition six degrees further south (14.7 deg. F.). It is possible that this year was colder than usual, but as already stated the second winter was not very much warmer. What seems to be certain is that the summer was exceptionally cold; with a mean temperature of —2.2 deg. C. (28.2 deg. F.) it is the coldest known until now on the earth. In connection with this are to be considered the exceedingly bad ice conditions, that were so disastrous for us.

Interesting, too, are the great average velocity of the winds (the first year 20 miles an hour), their generally southwesterly direction, and the strength of the gales in the winter as compared with the summer.

As of geological interest, I have already mentioned the discovery of fossil plants and vertebrates, but besides this the island where the station was situated, as well as neighboring islands, are very rich in fossils, all belonging to Mesozoic or Tertiary formations. Also our researches on the ice have yielded several results as to the causes of stratification, the temperature and the movement of the ice, etc. It was a surprise to find that, while in the winter all snow was carried away by the gales, the surface of the ice keeping constant, there was in the summer time on the glacier at the level of the sea a great accumulation of snow. The bacteriological work has also given several new results, observations on the tides have been taken, and several other studies executed. To the results of our cartographical work I will return later.

For the sledge trips of the second year I could dispose of six Greenland dogs, two of them born on the station. This time it was my intention to study the region north and northwest from the station up to Bransfield Strait, and as I knew how much easier it is to travel and how much faster the speed when the whole load is pulled by dogs, I decided to take only one companion and to divide the work into two expeditions of moderate length.

Taking provisions for us and the dogs for 30 days I started with the sailor Jonasen on September 29. This time the weather was quite the reverse of that of last year. On the second day we encountered a severe gale, so that our tent was broken, and we had to go back for a day to get it repaired. At first we followed the same route as last year; but, arriving at the western end of Admiralty Sound, we turned to the north into that great inlet discovered during the previous expedition. Though for several days we were confined to the tent, because of wind and dense fogs that made the mapping work impossible, the weather was comparatively favorable and was growing better and better. Soon we found that we were in a large channel presenting the grandest scenery. On one side was the magnificent range of King Oscar Land; on the other a large archipelago forming a remarkable contrast to the former and made up of tufaceous volcanic rocks, with sounds, glaciers, and promontories, all dominated by the shining blue-white prominent peak of Mount Haddington, probably formed by a mighty crater.

Through this channel we passed until October 12. At that time we had advanced near to Cape Gordon and we had before us Erebus Gulf, a blue streak in the sky showing that there was open water near at hand. We were surrounded by islands, which I believe had never been seen by man, and our last camping-place had been at the foot of one of those islands, a high precipitous volcanic cliff. We were traveling rapidly toward a dark promontory, perhaps the Cape Corry of the charts. For a moment I fixed my attention on some dark objects near to shore, but only to consider them as probably large boulders. Then suddenly Jonasen shouted to me, asking if I could see what it was. Stopping and examining them a little more closely, I said: "Yes, they look like people, but of course that cannot be; perhaps it is some large penguins." But we were both seized by a peculiar emotion, and a few seconds later I had the glasses again to my eyes and saw that it was really two men coming to us. Who could they be? Numerous conjectures floated before my mind, but were all rejected. It was not probable that they were either some of my companions from the winter station, or that the "Antarctic" had returned and had already sent out a relief party.

Meanwhile we had turned, and both parties were rapidly approaching one another. Every second my astonishment was greater. I saw two men, their faces coal-black, the eyes protected by rude wooden pieces; their black hair was hanging to the shoulders; their clothes were blackened and of an unknown shape. Even at the moment we met I had no idea who they were, and their first question, "Have you heard anything from the 'Antarctic'?" could not explain the situation.

But it did not take long for me to hear their story. It was Dr. Andersson, the leader of the expedition during my absence, and Lieut. Duse, who had, together with a sailor who was now preparing their dinner a little nearer the land, left the "Antarctic" at the end of December, the previous summer, when it became exceedingly dubious whether the ship could reach the station during that season. Their intention was to reach our station with a sledge, pulled by themselves over the ice. Their starting place was a bay near to Mount Bransfield, and they were to induce us to retire there in case the ice conditions were not better. For this eventuality there had been put on shore a small depot, but, as the ship was to return under any conditions, this contained only the things necessary for the summer. However, they soon found that it was impossible at that time to reach the station owing to the state of the ice, this being in many places broken up at the shores and covered by deep water. So they turned back to the starting point and here they passed the time agreed waiting for the ship.

But as the months passed without any notice, they began to grow anxious and prepare for winter, and in the beginning of March they moved into a small, low, stone hut. Here they passed seven long winter months. The construction of the hut was a difficult task, as the ground was frozen and they had no tools. They killed about 500 penguins for winter food, depending for fuel exclusively on the seals, which they had all the winter through in sufficient numbers, though not greater than necessary. They had no books, and even if they had had they could not have read them by the feeble light of their blubber lamp. The temperature inside was generally below freezing point, and by reason of the gales they were for long periods confined to their berths composed of the bags and the few articles of clothing carried for the summer.

Notwithstanding this, their sojourn had not been without results. Mr. Duse had made a map of the surroundings so that there is now, including the work of the "Antarctic" in the Orleans Channel, and my own work and that of Mr. Duse on our sledge-trips, a complete map of the whole coast from the southern end of the Gerlache Channel, on the west coast, to the turning point of our first sledge expedition in latitude 66 deg., on the east. Dr. Andersson had found interesting proofs of the former greater extension of the glaciers, and what was more important, he had found a rich fossil flora of a very different type from that of Seymour Island and belonging to an older geological epoch.

Now they were on their way to the winter station, having started from their hut the same date as we had left our place. Without dogs and with a heavy load they had to move rather slowly, and their speed was not increased by the fact that two of the three had recently had their feet rather badly frost-bitten.

It is difficult to say which of the two parties rejoiced the most. For us they were bearers of news from that outer world we had almost forgotten, but for which we were nevertheless always longing—news that was just as interesting even if it were a year old. For them we represented a kind of civilization, and we had good reason both of us to be grateful that the members of both parties were all well and in full working capacity.

This meeting changed all my plans, though for the moment I would have turned back even had it not happened. As, according to their observations, the open water came rather near to Cape Gordon, we turned and went on through an inner strait connecting the channel with Sidney Herbert Bay; this strait had been discovered by Andersson and Duse during their first trip. We here met with much snow, and owing to the heavy load—all the most important things having been transferred to our sledge, after which the other was left on the shore—our advance was not very fast. Still, on October 16, exactly two years after the expedition left Sweden, we were again at the station. As it proved afterward this was not too early, the ice opening so much during the next few days that we should have found it rather difficult to pass the last cape.

Naturally for the time our principal interest centered about the "Antarctic" and about the chances for our relief. So much was soon evident that there would not be any hindrances this year of the same kind as in the last year. Before the end of October the ice was more open than it had at any time been during the last summer, and as a proof of the difference between the two years it need only be mentioned that while in 1902 the mean temperature for the latter half of October was at 0 deg. F., it was in 1903 +30 deg.

By reason of the ice conditions, we could not think of any long sledge expeditions, but we made a number of short trips and interesting studies among the islands round the station.

During this time it was seldom that we were all assembled at the station, and thus it happened that on that memorable day of the expedition, November 8, two of us were out on a visit to Seymour Island to bring home the first penguin eggs of the season. They were expected home that day, and when we saw at a distance some moving objects on the ice, we believed it to be they. But a few minutes later a second look showed us four persons, and, without even taking time to arrange our clothing, we were in a moment all out on the ice to meet the party. After waiting so long, at last the relief had come, and so early in the year we could not expect any other ship but our own "Antarctic." We were prepared to greet the newcomers with a cheer, but, coming nearer, a doubt took hold of us and our pace rather slackened. Soon we could greet our visitors—Commander Irizar, from the Argentine steamer "Uruguay," and another officer, accompanied by our own two companions. Even now our first inquiry was for the "Antarctic," and everybody will understand our feelings when we heard that there was no news from the ship. Alas! the probability that all the men on board were lost, together with the ship, was all too great.

However, we could not but be glad to accept the invitation from the Argentine commander to embark on his steamer, which was next to go out on a search for the lost members of the expedition. While we were following our guests to the house, hundreds of questions were put, and we also now heard that a Swedish relief expedition had been fitted out, though lately no news had been heard of its progress.

At night the officers returned to the ship, driving on the dog-sledge and accompanied by some of our men. It was late, but none of us was thinking about going to bed. We had all to work at the preparations for the start, and I was busily occupied in writing a report to be left in the house. Suddenly the dogs started howling, and somebody told me that there were several men outside. Naturally we thought the commander had sent some men from the ship's crew to assist us in the preparation, and we were all too busy to go out and meet them.

When nothing further was heard, Dr. Bodman went out to look who it was. A moment later we heard him crying and screaming, the only words to be caught being cheers and "It is Larsen!" And again in a second we all huddled out. It seemed too marvelous, too impossible even to believe in our eyes, but there they were, Capt. Larsen, Mr. Andersson, and four men

from the "Antarctic," coming just at the right moment, the same day that we had for the first time despaired of their fate.

And here I will give a short report of the voyage of the "Antarctic" from November 6, 1902, when she left Usuaia for the last time, and of the fate of the members of the expedition after the steamer had sunk. When far west of the South Shetlands, they had met with dense pack ice, amid which they had to struggle for several days. After having passed this ice they found Bransfield Strait and its surroundings comparatively free from ice, and here they worked for some time, obtaining a very interesting series of soundings as well as collections of animals and plants unexpectedly rich even compared with what we had seen the first summer. At the same time, as already mentioned, a chart was made of the Orleans Channel as far as where this passes into the Gerlache Channel.

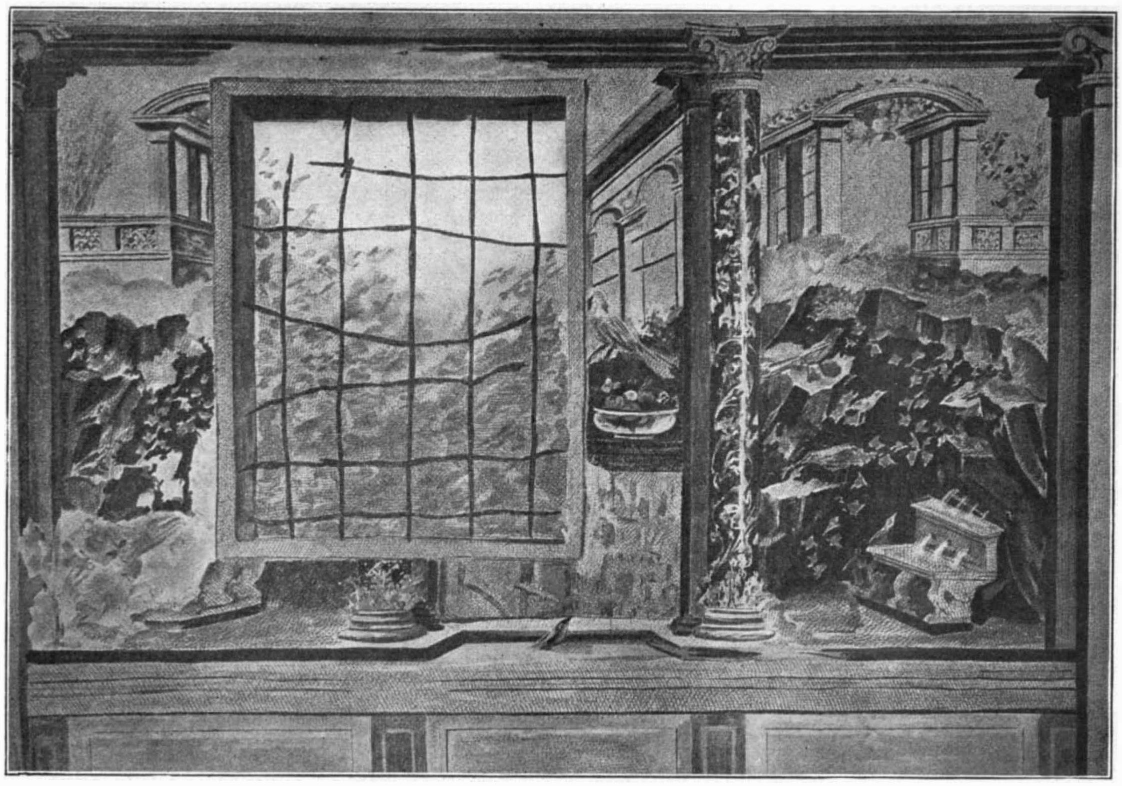
This work having been finished, the intention was to proceed to the winter station, but now the difficulties really began. They soon found that the whole of Erebus Gulf was filled with ice, and when they tried to pass eastward of Joinville Island they were caught by the ice and drifted with this as far north as Elephant Island. Eventually, however, by dint of hard work, they got free of the ice and, trying again to find a way through the strait west of Joinville Island, they there passed Christmas, with the nearest land in sight, though at a distance of about 60 miles. It was now that Dr. Andersson and Mr. Duse decided to make the sledge trip, the result of which has above been related. During this time the "Antarctic" had to try her luck another time eastward of the land.

It was now late in the summer, and, though the ice conditions were clearly hopeless, there was nothing else to be done except to press on. Struggling hard, they passed round Joinville Island, during the first days of the new year, and through a narrow opening in the ice they could advance several miles to the south. But here they were again caught by the ice, and drifted north until, on January 10, a strong gale from the south commenced, filling the bay and setting the ice rapidly against the northern shore. The steamer was at that time fast in the ice about 20 miles south from Dundee Island. The storm keeping on, the ice began to press very heavily, lifting the ship about four feet. The situation was most perilous, and the disaster came with a big ice-floe, with strong pressure-ridges, rising high out of the water. From this ice emerged a large ice-foot which, catching the steamer from underneath, broke the rudder and the keel, bent the axle of the screw, and tore up the bottom of the ship, fixing the vessel at the same time solidly in its embrace.

Only after three weeks' hard work was it possible to release the steamer from the grasp of this ice-foot. The pumps were working all the time, and when the ship got free the leak proved too great to be managed with the resources on board. For another week the vessel drifted in the ice without finding a way out. Had it only been possible to bring the ship to the beach while still afloat, the stores and provisions, as well as all our valuable collections, could have been saved. But even this proved impossible, and the same head gales in the beginning of February that raised our hopes in the station were disastrous for the ship. On February 12 the "Antarctic" was abandoned, and an hour later she was buried in the sea.

The question was now to bring the men and as many as possible of the most important things over the drifting pack-ice to the land selected for winter quarters, the small, volcanic island of Paulet, known to be rich in seals and penguins. This, under the admirable direction of Captain Larsen, was executed during the following sixteen days. Three boats were carried, used as sledges and pulled by the party, to take the outfit. The advance was very difficult, and many times in the morning the whole party found themselves carried away by the strong currents much farther from their goal than before the whole work of the foregoing day. Gradually more and more of the things were lost, and at last, when they arrived at the open land at the foot of the island and had to put out the boats, only a small part could be saved. The travelers were barely on the shore when a storm broke out, carrying off the ice and making it impossible to think of returning to bring on shore the part of the outfit left on the ice.

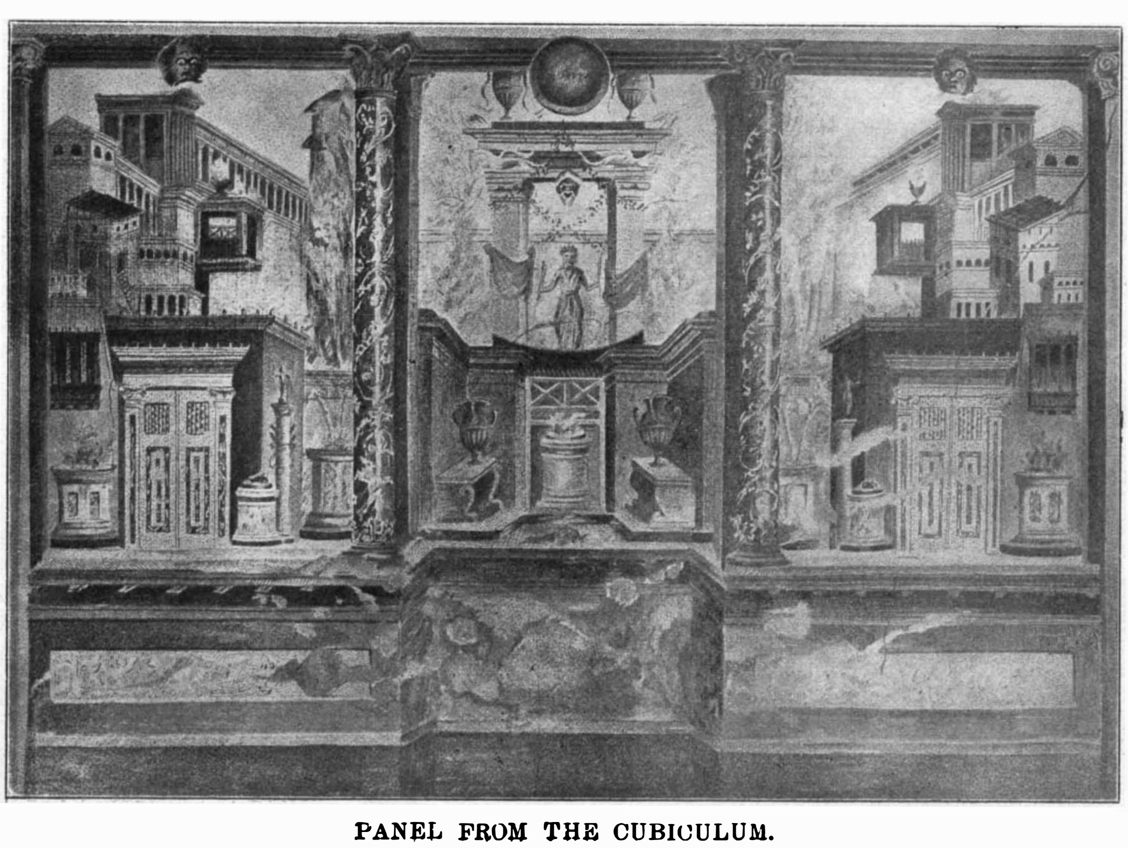
It was a great pity, and, to the scientific staff on board, I believe the greatest sorrow was to lose so many valuable collections, including almost all the photographs taken during the summer. Happily all older collections had been lodged safely before the steamer started, and even now they managed to bring on shore several of the most valuable specimens. This is so much the more creditable as the provisions and other outfit were very scarce and the prospects of the future were nowise bright, especially as it was impossible to know at what time assistance might come. Here also a stone hut was built, and in this the twenty men passed the winter, using for food the meat of seals and penguins that could be obtained, and also catching a good number of fish, which proved a very welcome change. What was most scarce was fuel, as the seals were by no means numerous during the winter. It was a hard life, but happily all were in good health, except the young Norwegian seaman Wenersgaard, who died of heart affection in the middle of the darkness and the gales of the winter on June 7. It had long been arranged that a small party should start for the winter station to bring us news of the fate of the "Antarctic" as soon as the ice would allow. On October 31 they started, and, passing the site of the winter hut at Mount Bransfield, where they learned the news of how that party had spent the winter, they arrived at our station just at the last moment when we were going to leave definitely the place and the region.



PANEL FROM THE CUBICULUM.

And now came the last great event in the story of the expedition. After having embarked on the "Uruguay," the 10th, we passed very early the next morning Paulet Island, awakening its involuntary inhabitants with the steam whistle of our ship. The effect was instantaneous—in a second the beach was alive with men, still unable to understand their luck. The change was too great, after all their privations, with the dark prospect of the future, to be suddenly awakened out of their sleep, placed in the midst of civilization, and at the same time know that all their companions from the two other winter stations were well, and all this to happen so early in the year, when no relief could have been expected.

It was undoubtedly a great proof of the awakened interest of the Argentine nation and of the capacity of its navy to send this expedition, and to us the stay on board has only bright remembrances, for we were received as, I believe, has rarely been the lot of a shipwrecked expedition. Passing the winter station of Mount Bransfield to pick up the collection left there, we arrived at the port of Santa Cruz on November 22, and during the following hours the telegraph announced to the world the news of our return.—London Times.



PANEL FROM THE CUBICULUM.

THE BOSCOREALE FRESCOS.*

The recent acquisition of the Boscoreale Frescos and a magnificent *biga* or double-yoke chariot said to have been found at Norchia, a village on the site of an Etruscan town, by the Metropolitan Museum of Art of New York city, is the most noteworthy event in the recent history of the museum and enables it to take rank among the great museums of the world.

The frescos are from a Pompeian villa, near the little city of Boscoreale, which was buried in the year 79 A. D. beneath the ashes of Vesuvius. They were unearthed in 1901. The modern city of Boscoreale, situated in the province of Naples and at the foot of Vesuvius, has for several years been celebrated in archæological annals. The beautiful collection of silverware executed by Greek artists of Alexandria, at present at the Louvre thanks to the munificence of Baron Edmond de Rothschild, the important find of gold coinage of the reigns of Galba, Otho, and Vitellius, and the rich set of household furniture acquired by the Museum of Berlin had already brought the city into prominence, when a find still more important came and added a new *éclat*.

The Deputy Vincenzo de Prisco, to whom the success of former excavations was due, continued in 1900 explorations in the vicinity of the villa Pisanella, and after arduous efforts was rewarded by discovering at several meters below the surface of the ground the wonderful wall-paintings which we have to-day.

The villa Pisanella was one of the most luxurious and most artistic of that ancient epoch. It stood on the beautiful slope of Vesuvius and commanded one of the most delightful nooks of the incline near the peaceful little city of Pompeii. It was very natural that the rich patricians of the time seeking in the quiet of the country a relaxation from the busy life of the city should be seduced by the happy situation of this hill at the base of Vesuvius—a verdant hill which opened up a wonderful panorama to their eyes.

By a refinement of luxury due to the conquests of the Romans in Asia, the paintings which ornamented the walls of this sumptuous villa represented the best examples of the art of that time. We do not know the name of the patrician who built this house of allurement, but the paintings found there readily suggest that he was a lover of music and also of games such as wrestling. Many of the paintings represent musicians and athletes and upon one fresco can be seen a table loaded with prizes for the games, among them being crowns of gold.

* This article, taken from Current Literature, is based largely upon a French monograph entitled Les Fresques de Boscoreale, published recently in Paris and written by M. Arthur Sambon, docteur ès lettres de l'université de Naples. The illustrations were furnished through the kindness of the Director of the Metropolitan Museum of Art in New York.

Barnabei and Sogliano have searched with rare patience all the documents which might throw some light upon the history of this house. Tablets show that it was sold at auction on the ninth of May, in the twelfth year of the Christian era, under the first Consulate of Germanicus. Another tablet found in the *villa rustica* bearing the name of P. Tannius Synistor led one to think that the last owner was thus named. But a bronze seal found later suggested another name, that of Lucius Herennius Florus, who was probably the last owner of the house.

The paintings belong to two different epochs. The most ancient (severe architecture, imitation of precious marbles and large figured panels) date probably from the first years of our era; others more *rococo* in treatment are certainly of later date than the sale of the house in the twelfth year of the Christian era.

It is not necessary to recall the rôle of the Pompeian pictures. The archæologist and the historian find in them the best elements for the reconstruction of furniture and products of industrial art, the explanation of the religion and customs of the Roman people, the illustration by image of the literary works of the last century before Christ and the first of our era. The paintings of the villa of Lucius Herennius Florus are among the most interesting with all these points of view in mind. The instruction which one derives from them and the admiration which they arouse are considerable. On an artistic side, too, their worth is immeasurable. These paintings are the reflection of Alexandrine art—an art both spiritual and sentimental. Up to this time Alexandrine art has not been the object of especial study. It is not necessary to examine closely into the number of mediocre examples which belong to the long and fatiguing decadence of this art under the Roman Empire, but one should surely examine the creative force of the artists of the glorious Ptolemaic epoch, the third century before Christ, during the literary spring and florescence of that exquisite pastoral poetry whose echo we find in more than one of the Boscoreale paintings.

The frescos obtained from the villa Pisanella are largely from the *cubiculum* (bed-chamber), *triclinium* (banquet hall), and *tablinum* (room containing family records and hereditary statues). The latter are far more important and represent in a peculiarly good condition the best examples of ancient art.

The "Zitherist" is the most noteworthy of the panels, and is from the *triclinium*. It represents a young woman of the classic style of beauty and is considered by some the most beautiful portrait in colors which antiquity has left us. The artist has sought to express the soul of his model and has left in the work the imprint of his emotion. She is seated upon a chair, painted and carved, and with a high and straight back (*la cathedra*). Her garment, the *stola*, is the long flowing robe so loved by the ancient Romans. She holds a gilded zither, while behind the chair stands a little girl. The red background brings out the blue gown and white mantle to perfection.

Next in importance comes the picture of two seated figures. A man, undoubtedly an athlete, is seated upon a long chair and seems proud of his manly and energetic beauty. His hands rest upon a staff. Beside him is seated a woman, her head enveloped in a mantle. She fixes her eyes upon her companion, but with the vague regard of a dreamer. The artist probably grouped them with the intention of representing a legendary subject whose meaning it is difficult to comprehend.

The woman holding a shield, while less artistic, is nevertheless interesting. She stands almost full-faced, the head turned a little to the left, while her gaze is turned upward. She holds, partly resting on her knee, a shield. Her robe is white with a blue mantle.

The *tablinum* was almost square in form. The walls were ornamented with plates imitating marbles of different colors. Upon these walls were painted heads of young bulls adorned for the sacrifice, masques and garlands of fruits and greens. Four panels, well preserved, have been taken from it.

The third wall of the alcove of the *cubiculum* offers a decoration full of charm. The eye reposes with pleasure upon a garden in which there is an artificial grotto known as *musaea*. Creepers of ivy cling to the rocks carpeted with moss. Birds of gay plumage dart from rock to rock. Above the grotto is a large passage

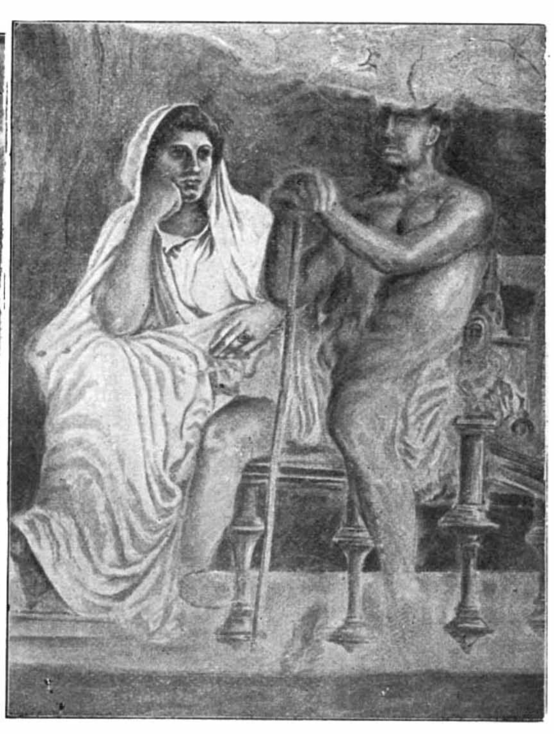
PANEL FROM THE TRICLINIUM.

(*gestatio*) bordered with a balustrade. To the left is an open window with bars.

Another panel from the *cubiculum* represents a row of Corinthian columns resting upon a wainscot. These columns support a *cymatium* decorated with masques of satyrs. In the first section arises a temple with an altar and a column surmounted by a winged goddess (Artemis) holding two flambeaux. In the distance are houses, terraces, porticos, balconies, and hanging gardens. In the second section a marble support holds a gold *hydra*. In the center is an altar, below which is an offering of fruits. Behind rises an edicule decorated with greens, a masque of Silenus and draperies. It supports on the cornice a shield and two gold vases. The statue is of Hecate or Diana, who is the guardian of the house. The third section is a reverse presentation of the first. Another panel from the *cubiculum* represents a sacred inclosure encircled by a portico of a double row of Corinthian columns. In the center a circular monopteral temple of twelve columns arises. The principal entrance to the portico faces the spectator. In front of this entrance is an altar loaded with offerings.

In all these paintings there is a woful lack of perspective, and the drawing is careless. But the color sense of the artists who painted them was keen, and the fine Pompeian reds still hold their wonderful tone.

THE ZITHERIST PANEL FROM THE TRICLINIUM.



PANEL FROM THE TRICLINIUM.

The great panels of the figures of the zitherist and of the athlete belong to great art. They are living portraits, the most beautiful that antiquity has transmitted. The panels from the *peristyle*, the *tablinum*, and the *triclinium* are in a noble and severe style which commands admiration. The panels from the *cubiculum* are among the most interesting of the decorative paintings of Pompeii. One thing is remarkable in these paintings—the law of perspective is a *melange* of realism and fantasy.

Although the relatively low artistic worth of these paintings may detract somewhat from our enjoyment of them, still as evidence of the skill of the Pompeians, in an age when art had not reached the heights it did later, they are exceedingly valuable.

These Pompeian paintings seem like dreams—dreams of riches and of pleasure. In them we recognize the very soul of the epoch which they represent and the refined voluptuousness of the Romans of the great empire. They are the best translation of an Horatian ode.

CHINESE MEDICINE.*

By James M. Flint.

The Chinese trace the origin of medicine to an emperor named Shen-nung, who is said to have reigned about 2700 B. C. He first experimented on the medicinal qualities of herbs and their application in the treatment of disease, and to him are ascribed the earliest writings on the subject. The principal one of his medical works is entitled "Shen-nung Pen ts'ao king." The statements in regard to the origin of this work, both as to authorship and time, are exceedingly doubtful, the probability being that its precepts were traditional until, after a long period, they became incorporated in the writings of a more modern author. It can hardly be doubted, however, that a system of medical practice was established in China long before any now known to have existed among western nations.

Concerning the theories of disease held by the Chinese, and the *rationale* of their modes of treatment, the information at hand is indefinite and perplexing. According to Cleyer,† their theory of disease is based on the existence of two radical principles, Yin and Yang, translated as "heat" and "moisture," which give life and movement to all things. Health depends on the maintenance of an exact balance of these two elementary principles, any disturbance of the proper relations between them producing all the phenomena of disease. Others interpret Yin and Yang to be two principles or powers in nature, male and female, ever active in producing the physical, chemical, and vital phenomena which appear within and around us. When these principles are equalized there is repose or a state of health. If the male principle is in the ascendant there is disease and it is inflammatory; if the female principle predominates the disease is of a typhoid character.

In addition to the rationalistic theories of disease and its treatment, superstitious and religious notions concerning them prevail very widely. Magical rites and charms occupy a large place in both preventive and remedial medicine and temples devoted to the worship of medical divinities are numerous and much frequented. In these temples are images representing eminent physicians of history and tradition who have been deified and to whom worship is paid. In particular there are ten celebrated doctors of special sanctity often referred to, but no two lists of their names are exactly the same. It would seem that some of these divinities have lists of numbered prescriptions, and by means of correspondingly numbered bamboo sticks the patient draws by lot the prescription suited to his disease.

In the examination of a patient the Chinese doctor determines the diagnosis, prognosis, and indications for treatment chiefly from the condition of the pulse, the appearance of the tongue, and the facial aspect. For medical convenience the human body is divided into three regions: (1) the superior region, from the head to the epigastrium; (2) the middle region, from the epigastrium to the umbilicus; (3) the inferior region, from the umbilicus to and including the pelvis. For each of these regions there is a distinct pulse which may be felt at different positions along the radial artery at the wrist, about half an inch apart. These pulses mark the condition of certain organs in the different regions according as they are felt on the right or the left arm. Thus the superior pulse on the right arm marks the state of the heart; on the left arm, of the lungs. The middle right pulse indicates the condition of the stomach and spleen, the middle left pulse the state of the liver. The lower right pulse is controlled by the right kidney and large intestine; the lower left by the left kidney and small intestine. The delicate variations in quality, force, and rhythm of these pulses which the Chinese doctor claims to detect are not evident to the ruder touch of the foreigner.

Examination of the bodies of the dead never having been allowed or practised, the knowledge of anatomy is necessarily crude. A general idea of the internal organs of the body, and their location, has been forced upon them by the accidents of war and peace, but for the rest imagination has supplied the place of demonstration. A theory of a double circulation is held, by means of which the "spirits," which are the vehicle of the radical principle Yin (heat, or the male principle), and the blood, which conveys the Yang

* Specimen Medicinæ Sinicæ.

† From Smithsonian Miscellaneous Publications.

(moisture, or the female principle), are distributed throughout the body. This circulation begins in the lungs at three o'clock in the morning and completes its round in twenty-four hours. For the accommodation of this circulation they count twelve principal canals—six passing from above downward, and six from below upward. There are also accessory canals or vessels, eight of which run transversely and fifteen obliquely.

The materia medica of the Chinese is extensive and is used with prodigality by both the sick and the well. The classical authority for the use of drugs is a sort of dispensatory called "Pen-ts 'ao kang-mu"—"A Synopsis of Ancient Herbals"—compiled by one Li-Shi-Chen in the latter part of the sixteenth century. The last reprint of this work was in 1826, and it appears in forty-three quarto volumes, the first three containing over 1,100 rude wood cuts of the minerals, plants, and animals treated of in the body of the work. Drugs are classified in three kingdoms and fifteen divisions, as follows: (A) Inanimate substances—water, fire, earth, metals, and stones. (B) Plants—herbs, grains, vegetables, fruits, trees. (C) Animals—insects, scaly animals, shelly animals, birds, quadrupeds, man. Comprised in these divisions, and described in the "Pen-ts 'ao," are 1,892 distinct drugs. These, in various combinations, are presented for use in about ten thousand formulæ. All drugs are considered as having certain inherent qualities of heat, cold, warmth, or coolness, and these are noted. But in spite of the mystical and utterly unintelligible explanations of their actions given by Chinese authors, it is probable that medicines are administered, in China as elsewhere, principally as specifics, that is to say, "good" for the disease.

THE MICROSCOPE USED AS A MAGIC LANTERN.

By WALTER BAGSHAW.

THAT few amateurs can stand the strain upon the eye when using the microscope for any length of time is due partly to over-illumination which rapidly produces fatigue. Experienced workers, of course, guard against this, and consequently can pursue their inspection for a considerable period; but prolonged or continuous observation is not usually necessary except when fugitive or changing objects are being examined, such as, for instance, animal and vegetable moving objects usually found in pond water, or the formation of crystals during evaporation.

Sometimes, however, a microscopist would like not only to avoid this fatigue, but to show his slides to others, though this becomes a tedious matter when the focus has to be adjusted for each individual, and it also produces a feeling of weariness upon those who have to wait probably ten minutes between the changes of slides. There is no difficulty in exhibiting enlargements of minute objects before large audiences either by ordinary lantern slides, or through the projection microscope attached to an optical lantern, neither of which, in all probability, does the amateur possess; yet absolutely no extra apparatus is needed by the owner of a microscope in order to show his slides to a small number of persons at one and the same time, since the microscope itself can readily be turned into a magic lantern by using it in a horizontal position. In this way, infusoria, diatoms, water fleas, and the larger inhabitants of stagnant water can be shown in motion, and very entertaining it is to watch their movements over the screen.

The brilliant and ever-changing colors of polariscope objects can also be shown, though the largest and most effective pictures are got from stained sections of plants, insects, and similar slides.

To those who care to make the experiment a few hints may be of service: First, get a sheet of stout white cardboard about 12 inches square to act as a screen, and place it in an upright position against a few books piled up behind it, taking care to leave room for free movement to and from the microscope. Now place the microscope in its horizontal position about a foot away from the screen, first having swung the mirror on one side, and removed the substage condenser. Put in the A eyepiece and a 2-inch objective for a start, and focus on to a suitable slide. Then lower the room lights and bring round the oil lamp and bull's-eye and adjust them so that a set of parallel rays is projected on the slide. A disk of light will immediately appear on the cardboard, but probably brighter in one part than another, in which case the light or the bull's-eye, or both, should be slightly moved till the illumination of the disk is perfectly uniform in brightness.

Having got this effect, see that the object is in the center of the field, when a little focusing will bring it into sharpness and make it visible to all.

If the substage condenser and a higher power be used, the cardboard may perhaps have to be brought nearer to the eyepiece, and a sheet of ground glass between the light and the substage condenser will often make a wonderful difference in securing even illumination.

A simple cell for showing pond life may easily be made on a glass slip, 3 inches by 1 inch, having a thin cement ring in the center with a cover glass fixed on. This cover glass, it must be observed, must have a small bit snipped off the top edge for insertion of the liquid through a pipette.

Most troughs sold for this purpose are too wide, and therefore allow the insects to get out of focus, whereas a cell made as described will generally keep objects in focus and in view all the time. The operation of taking a picture in photo-micrography is really the same as the method now explained, but the focusing screen of a camera is used to receive the enlargement instead of the cardboard.

The writer has sometimes shown a small insect enlarged to 12 inches across, and heard microscopists express wonder why they never tried this simple method of showing their slides.—Nature Study.

ENGINEERING NOTES.

The largest steel plates ever made in America have been rolled by the Worth Brothers Company, Coatesville, Pa. The plates are to be used in the construction of marine boilers, and are 139 x 181 inches in size and 66-100-inch thick. They were rolled on the company's new 152-inch mill, which is the largest as well as the most modern plate mill in the country.

The long railroad which the Russians are building in Asia south of Siberia from Orenburg southeast to Tashkend, where it will connect with the Asiatic Midland, whose sole outlet now is by the Caspian Sea, has been making good progress through the grazing country south of Orenburg, and trains have been running a considerable distance during the summer and fall. It is reported that the authorities purpose suspending the train service during the winter on account of the obstructions from drifting snow in a very thinly peopled country, which naturally needs very few trains; but the Orenburg people protest that this may cause a famine on the Kirghise steppe, where the grain crops failed this year, as they frequently do in semi-arid countries. The remarkable thing about this is that a country which for all time has been dependent upon its own resources should in a few months become dependent upon railroad transportation.

Two of the remarkable alloys discovered by Dr. Guillaume in his study of high nickel and iron compounds are now made on a commercial scale. The first, to which the trade name "Invar" has been given, contains 37 per cent of nickel, and after special heat treatment is practically unalterable in length between the ordinary ranges of atmospheric temperature, the dilatation per degree Fahrenheit being only 1-36 inch per mile. This is coming into use for standard bars, wires for base line measurements, and other geodetic purposes, as well as for the pendulum rods of astronomical clocks and the compensation balances of chronometers. The alloy containing 46 per cent of nickel, known as "Platinite," has the same coefficient of expansion as glass, and may therefore be substituted for platinum in the manufacture of incandescent electric lamps. It has also been used in Appert's armored glass, in which a wire network is inclosed between two plates of glass. A valuable memoir on the magnetic and other properties of these alloys has lately been published by Louis Dumas of the Commentry Fourchambault Company.

The experimental section of the North-Eastern Railroad of Great Britain, which has been reserved for tests with the Hall electro-automatic signaling installation, has been completed. The installation has been laid down by the Hall Signal Company of this city (New York). The locality chosen for the experiment is a stretch of trunk road between Alne and the Green Lanes Box, Thirsk, a distance of about eleven miles, where the lines converge from three or four running parallel to one up and one down track. On this stretch of track there have hitherto been six signal boxes, but with this new system several of these will be abolished. With the new signaling the track will be divided into fifteen sections, each about 1,200 yards in length, so that by this means the carrying capacity of the railway will be more than doubled. By the adoption of the new system, in addition to shortening the block sections of their railway, the North-Eastern Railroad will be able to dispense with a considerable amount of the manual labor involved in the present system. The motive power of the signals is a new invention, by which carbonic acid is used to operate the semaphore arms.

The time is past when a man is considered to be qualified to run machinery whose only recommendation is that he can start and stop the same. Machinery must be intelligently cared for if continuous and efficient service is expected of it. In many cases, mines and mills are remote from large shops, thus requiring many repairs to be made on the ground in event of a sudden breakdown, if a prolonged idleness of the whole plant is to be avoided. It is often necessary to carry on extensive mining and milling operations with a class of labor that is unused to handling machinery and which is ignorant of the simplest mechanical principles. In such cases the valuable suggestion is made that a "handy man" be employed who can handle ordinary problems in connection with the machinery and "leaven" the whole mass of unskilled native labor. A large amount of mining, milling, and general engineering work is progressing or contemplated under adverse circumstances—in such districts as the Rand, where labor is very inadequate to the requirements, and largely the native black element—or in tropical countries where the action of the climate has such a destructive tendency to all iron or steel. Under such conditions the care of machinery is most important. Without the use of the most approved mechanical appliances, some properties would prove valueless, and in all cases where the most up-to-date devices are employed in mining operations, more than ordinary knowledge is required to keep all the machinery running smoothly.—Mines and Minerals.

ELECTRICAL NOTES.

Presiding at a dinner of the New Vagabonds' Club, Mr. Marconi said he was bold enough to forecast the day when his wireless system of telegraphy would make communication between the nations of the world very much cheaper than with the submarine cables. Speaking of his recent achievements, and the progress of the system, he stated that at present there were 50 Atlantic liners using wireless telegraphy for communication with 48 land stations along the British and Irish coasts, and 64 British and 24 Italian warships fitted with the apparatus.

J. E. Taylor, in Roy. Soc. Proc., refers to disturbances noticed during experiments on wireless telegraphy for the British Postal Telegraphs. The noises are distinct from the ordinary telegraphic and inductive disturbances. They are more frequent in summer than in winter, most in evidence for a few hours about sunset, and herald the approach of a storm or gale. The noises recall flowing and bubbling water, further, crackling and rocket discharges; these latter the author ascribes to the passage of meteors which set up electric discharges in the upper rarefied atmosphere. The other noises he connects with the ionization of the air; disturbances are caused when the ionization is dissipated by an electric field. There are also high-frequency effects noticeable only on the coherers or other forms of Hertzian wave receivers.

Prof. R. Threlfall exhibited and described at a recent meeting of the Physical Society the following instruments which he has used in the testing of electric generators by air calorimetry: (1) A "hot-wire voltmeter" accurate to 1-100 volt. The wire in this instrument is very fine, and special precautions are taken to keep the tension on it constant, so that the elongation measured is due only to the expansion of the wire caused by the heating effect of the current. (2) A "pitot tube" for the measurement of air velocity, the velocity being proportional to the square root of the pressure produced in the tube. (3) A "manometer" for determining pressure differences in pitot tubes with accuracy. This consists essentially of two bottles containing colored water, which are connected by a syphon, and the air space of each bottle is put in communication with its appropriate tube. The readings are taken by setting a pair of needle-points just to touch the liquid surface, and then measuring how they differ in level by micrometer screws, or by calipering suitable jaws. The instrument is reliable to 0.01 mm. of water pressure. (4) A multiplying pressure gage in which the motion of a float or ball is used to operate a finger moving round a dial. The dial is divided in such a manner that the square roots of the pressure differences are read off. Air velocities are therefore given directly.

The idea of transmitting Mr. Chamberlain's last speech from Birmingham to London by telephone and electrophone was distinctly smart, and the conductors of the Evening News (London) may fairly be congratulated on their enterprise, quite apart from any considerations of a fiscal, financial, or political character. Unfortunately the scheme, though well laid, went somewhat "agley," for a number of ludicrous mistakes crept into the text of the oration as printed—mistakes indeed so palpably absurd in some cases as to suggest that the "copy" could neither have been sub-edited nor read by the correctors of the press attached to the staff of the paper in question. One of the funniest instances of garbling was in the passage in which Mr. Chamberlain was made to say:

"Mr. Cobden said that the United States of America, if free trade were adopted, would abandon their premature manufactures (loud laughter), that the workmen in their factories would go back to the land, and (now I am quoting his exact words) 'they would take the hoe and plow for us.'"

Of course, neither Mr. Cobden nor Mr. Chamberlain ever supposed or said that plowing is done with a hoe, for the former was a practical agriculturist, I believe, and the latter is also sufficiently familiar with the ancient industry of the husbandman to know how furrows (lonely or otherwise) are turned.

It was on September 25, 1895, that the first power was delivered to a consumer by the Niagara Falls Power Company. This first power went to the Pittsburg Reduction Company, which company to-day take 3,000 horse power from this development. The largest customers of the Niagara Falls Power Company are the Union Carbide Company, the amount taken being 15,000 horse power. In all, 57,365 horse power is sold by the Niagara Falls Power Company in Niagara Falls. To Niagara Falls, Ont., 1,900 horse power is sent; to the Tonawandas, 3,699 horse power, and 1,500 horse power goes to Lockport. The International Railway Company take 1,000 horse power for their Lockport-Olcott line, and 63 customers in Buffalo take 23,421 horse power. The largest consumers of Niagara power in Buffalo are the Buffalo Railway Company, who take 7,000 horse power, while the Buffalo General Electric Company come next, using 6,000 horse power. All told, the International Railway, which company operates the electric lines of Buffalo, Lockport, Niagara Falls, and between these cities, uses 12,000 horse power. An outlay representing $13,000,000 has been made by the Niagara Falls Power Company, and on a total assessed valuation in the city of Niagara Falls, this company pays about one-fifth of the total taxes paid. The longest distance Niagara power is transmitted is about 39 miles, on the Olcott line of the International Railway.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Advice to Firms Exporting to the Philippines.—The following article, taken from the Manila Daily Bulletin of recent date, may be of interest to United States exporters:

"Catalogues should be in Spanish, and should always give the telegraphic addresses and codes employed. Prices should be given. Confidential discount sheets should give the prices current; the importer then can judge prices from his own commercial journals. Weights and dimensions of articles are of great value in a catalogue.

"The reputation of a house often depends upon the manner of packing as much as on the merchandise itself. Goods for Manila should be packed with special care. The port is unprotected and the sea is often very rough, making unloading at such times impossible. Transfer is made by natives in small boats from a point two miles distant. These boats are tossed about by the slightest agitation of the water.

"Documents ought to accompany the merchandise. Firms should choose for their representatives persons of great experience. The customs officials of Manila are guided by fixed laws, from which they do not deviate. The Philippine tariff laws in regard to the different classifications should be carefully studied, and persons should draw up their documents in accordance therewith. Manufacturers should not place small samples in their shipments unless they mention them as such in their invoices, otherwise they will be compelled to pay duty thereon, and, perhaps, an additional amount.

"Every package should bear the name of its destination and its particular marks, and should also show gross and net weight in pounds and kilogrammes.

"Invoices should be prepared in regular form. Some important rules of the Philippine customs service follow:

"1. Each package should be specified in the invoice, with marks and numbers.

"2. The contents of each package should be indicated in detail, in regard to price and destination.

"3. Packages containing goods of different classification should be so entered.

"4. The weight declared should include the wrapper, since the wrapper pays the same duty as its contents.

"5. As the wrapper is destroyed, the invoice should show net and gross weight.

"6. Invoices should always be made in triplicate, two for the customs and the third for consignee.

"If bills of lading are not payable at sight, a second but non-negotiable bill should follow, in order to give the consignee information as to freight.

"It is preferable to insure in companies having legal representatives in Manila."

American Manufactures in Bamberg.—Of American goods, cotton is the only article which reaches this consular district by direct importation from the United States, all other goods coming by way of Hamburg, Berlin, and Frankfort. Small as the direct trade for American goods seems to be in this district, one cannot go into a large manufacturing plant without finding a fair percentage of American machinery, and every up-to-date farmer uses agricultural implements made in the United States; enter a fine office or counting house and one will almost surely find American desks —all the office furniture American, in many cases; while hardware stores handle a number of American tools and household goods.

Much could be done toward increasing the sales of American goods if the different emporiums handling the same were nearer to the consumers. American shoes, although more expensive than those of German make, are well liked on account of their superior shape and workmanship, but few people care to have them sent to them from a distance. The dealers in American shoes in Berlin, Frankfort, and one or two other large cities may be reporting a successful business, but what they sell are fine and high-priced goods. It is safe to predict that the dealer in American shoes who can supply the masses in their homes and at fair prices will do a large business.

Sending catalogues and price lists, even the visits of commercial travelers from the United States, cannot compare with the establishing of branch houses at easily accessible points. If the American manufacturer wants to sell his goods in Germany to advantage, the goods will, as a rule, have to be where they can be had when wanted. Ordering by sample may be done successfully in a few instances. To make satisfactory sales, the goods must be brought within easy reach of consumers.

Far from being prejudiced against our goods, the Germans give them very fair consideration and do not hesitate to buy them, if, in their judgment, they offer advantages, which in many instances they unquestionably do.—W. Bardel, Consul at Bamberg, Germany.

Outlook for American Trade in Bulgaria.—Mr. John B. Jackson, United States Minister to Greece, Roumania, and Servia, and also diplomatic agent in Bulgaria, sends the Department of State, under date of September 24, 1903, the following information relative to trade relations with the United States:

At present essence of roses is almost the only article exported to the United States from Bulgaria, and agricultural machines are almost the only direct imports from the United States.

Recently Bulgaria has been doing a great deal to develop its Black Sea ports at Varna and Bourgas, and new railway connections have been made between the interior and certain ports on the Danube. Bulgaria has considerable mineral resources, and there are quantities of coal of very good quality near Tirnova. With proper development of the mines this coal could easily compete with the English and other coal which finds a market in large quantities at points on the Danube.

In spite of the fact that foreign capital is greatly needed, foreign companies have not received liberal treatment, and persons wishing to obtain concessions should be very careful in ascertaining the exact conditions, not only as to how they may carry on the enterprise in question, but with regard to the possible withdrawal of the concession itself.

It has long been the wish of the Bulgarian government to establish closer commercial relations with the United States, and the Prince of Bulgaria has expressed the belief that Americans could do a great deal toward the industrial development of his country, and that a market there could be found for many American products.

German Beet-Sugar Production.—For the thirteen months ended August 31, 1903, the German sugar refineries consumed in the manufacture of sugar 12,381,552 tons of raw beets. During the same period in 1901-2 the consumption of raw beets amounted to 17,614,152 tons, snowing a decrease of 5,232,599 tons in the year ended August 31, 1903. The amount of sugar produced during the thirteen months ended August 31, 1903, was 1,663,193 tons, as compared with 2,246,237 tons during the thirteen months ended August 31, 1902, a decrease of 583,044 tons. The kind and quantity of sugar produced in the comparative periods were as follows:

	Year ended August 31.	
	1903.	1902.
Description.	Tons.	Tons.
Crystallized sugar	583,127	587,774
Granulated sugar	15,748	15,220
Sugar candy	136,116	145,172
Loaf sugar	228,107	213,045
Flat bar and cubical sugar	30,983	26,390
Lump and crump sugar	350,651	327,818
Refined and powdered sugar	52,420	56,833
Farine (moist sugar)	2,860	2,174
Liquid refined sugar, including sugar goods	1,594,560	1,576,896
Syrup	6,062	5,984
Other sugar products	478,615	563,718

The compilation of these statistics has been made for thirteen months, because, owing to the new regulations for taxing sugar, the business year has been changed from the 1st of August to the 1st of September.—Talbot J. Albert, Consul at Brunswick, Germany.

Flanders-American Trade.—The increase in the volume of trade between the Flanders and the United States during the fiscal year 1903 was in about the same proportion as in former years. Exports to the United States increased $367,252 in value, and imports, of which there are no detailed figures for this district available, but of which there is daily evidence in the shipments of machinery, flour, raw cotton, petroleum, pitch pine, hardware, canned goods, and shoes which enter this city, the distributing center for the Flanders, must be large. Agencies exist for American typewriting machines and cash registers.

Direct importations are made generally to Antwerp, Brussels, France, and England, and from there American wares and goods find their way into this district. This results from the fact that American exporters do not send representatives here in person to solicit trade, as do English, French, and German dealers. On the other hand, many Belgian exporters have their representatives in the United States, and American importers come or send their agents here annually to buy the merchandise they require. It seems strange that the importers in the United States should show more practical interest in this trade than the American manufacturers and exporters.

There are excellent steamship facilities for the transportation of merchandise between American ports and this district via Antwerp, which is only about an hour distant by train from Ghent. Tank steamers were the only ones arriving direct from the United States during the year.—Frank R. Mowrer, Consul at Ghent, Belgium.

Plaster Industry in Amoy.—Plaster of Paris is not an article of commerce here. It is imported only in small quantities by the two foreign hospitals for surgical purposes.

Gypsum, which is said to be quarried near Shanghai, is imported in moderate quantities and, strange as it may seem, is said to be used by the Chinese principally as a medicine. The imports of gypsum in 1901 amounted to 129,276 pounds, valued at $1,134.

The annual consumption of calcined plaster and wall plaster cannot be estimated, but it is very large. Most Chinese houses are built of cheap brick, and are plastered both inside and out. Large quantities of plaster are also used for the making of Chinese graves, almost all of them being entirely covered with it.

The lime used in building, etc., is entirely of local manufacture. In this locality it is procured by burning oyster shells. In the interior of the province it is made from limestone. It sells in this port for about 75 cents per 100 pounds.

For the better class of houses and graves it is customary to use one-third each of earth, sand, and lime, with a varying amount of Portland cement. This is imported from Hongkong, usually in barrels of 375 pounds each. This cement, which comes from Green Island, near Macao, is increasing in use for graves on account of its durability. The imports for 1901, the latest data available, amounted to 121,562 pounds, valued at $1,133.—Carl Johnson, Vice-Consul, in charge at Amoy, China.

Opening for Mill Machinery in Warsaw.—There is a knitting mill for the manufacture of cotton hosiery in process of erection here, and an opportunity for American manufacturers of machinery thus presents itself. The machines with which they are familiar here are of two kinds (both of German manufacture), viz., (1) machines which knit the stocking down to the sole and (2) machines for knitting the sole. These machines have the following faults: (1) They produce too small a quantity; (2) are constantly in need of repair; (3) it requires two machines to knit one stocking; and (4) the ends of the stocking have to be sewn together on a separate machine. A machine which knits ribbed and ornamented stockings is manufactured in the United States. This machine, if properly represented here, should find a ready sale. In the projected mill cotton yarn will be used, and either gas or electricity will be the motive power. Our manufacturers should address M. Greynetz, No. 25 Dluga, Warsaw, in either the Polish, Russian, or German language.—Clarence Rice Slocum, Consul, Warsaw, Russia.

Plauen Woolen Goods for the United States.—A large number of factories for the production of woolen dress goods, cloths, zibelines, shawls, flannels, and other similar goods are located in the district of Plauen, and while some of their product still reaches the United States the declining tendency in the export of these goods has never been checked, and it is not likely that at our present rates of tariff the manufacturers here will ever again be able to largely compete with those in the United States, except it be in certain qualities of high-grade ladies' cloth; though some manufacturers express the hope that by intelligently adapting their goods to the American taste they may be able to regain some of their lost trade in henrietta cloths and shawls.—Hugo Muench, Consul, Plauen, Germany.

Americans and American Investments in Chihuahua.—Since my last annual report (printed in Commercial Relations for 1902) the Kansas City, Mexico & Orient Railroad has built and is operating 40 miles of its line eastward from this city. The Parral and Durango Railroad has built about 8 miles of extension west of Parral, and is building westward into the Sierra Mountains to reach the timber lands. It may be safely estimated that $2,000,000 of American gold has been invested in this district, chiefly in mines, machinery, and development work. There are now in the district and engaged in regular business, or as employes, about 600 Americans, many of whom have their families with them.—W. W. Mills, Consul, Chihuahua, Mexico.

Automobiles in Cuba.—From a report recently sent from the Belgian Commission in Cuba to the Department of Foreign Affairs in Brussels, an item concerning the use of automobiles in Cuba may interest our manufacturers and exporters of automobiles. Cuba is regarded by the commission as an excellent market for automobiles on account of their constantly increasing use. The kind of carriage most in demand is the vehicle known as "voiturette," run by gasoline or steam. The commission calls especial attention to the poor condition of the roads in Cuba, and recommends a strong, well-built automobile, of about ten horse power, and moderate in price, as being the most likely machine to meet with quick and profitable sale.—George W. Roosevelt, Consul, Brussels, Belgium.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

TRADE NOTES AND RECIPES.

Production of Caoutchouc Sticking Plaster.—Fuse 20 grammes of gutta-percha, cut in small pieces at a temperature of almost 150 deg. C., add 20 grammes of liquid paraffine, and heat until the gutta-percha has dissolved. To this is added 960 grammes of lead plaster. Heat the mixture until liquid, whereupon it is allowed to cool with stirring.—Phar. Revue.

Mineral Pigment.—A method has been proposed for making various metallic oxide pigments by setting fire to the waste vapors of the metals which escape during reduction in the electric furnace. Different ores give different colors, according to whether the vapor escaping is that of a simple metal or a mixture of the vapors of two or more metals. It is claimed that besides saving waste, the method gives a great many different colors and shades of pigment, and produces it in an extremely minute state of subdivision, so that not only is grinding unnecessary, but a degree of fineness unattainable by grinding is secured. The vapors are of course burnt in special flues, from which the pigment resulting is removed from time to time.

Production of Sprinkling Borax.—Borax being rather expensive, there is prepared in workshops where considerable soldering is done, a so-called sprinkling borax, which is not only cheaper, but also dissolves less in soldering than pure borax.

The borax is heated in a metal vessel until it has lost its water of crystallization, and mixed with calcined cooking salt and potash—borax 8 parts, cooking salt 3 parts, potash 3 parts. Next it is pounded in a mortar into a fine powder, constituting the sprinkling borax.

Another kind of sprinkling borax is prepared by substituting glass-gall for the potash. Glass-gall is the froth floating on the melted glass, which can be skimmed off.

The borax is either dusted on in powder form from a sprinkling box, or stirred with water before use into a thin paste.—Neueste Erfindungen und Erfahrungen.

Fireproof Paint.—Fireproofing paints of effective quality are now prepared in different ways, of course no oily or greasy substances entering into their composition, the blending agent being simply water. One of the standing paints of the class, says a contemporary, is described as consisting of 40 pounds of powdered asbestos, 10 pounds of aluminate of soda, 10 pounds of lime, and 30 pounds of silicate of soda, with the addition of any non-resinous coloring matter desired, the whole thoroughly mixed with water, that is, enough of the latter for producing a perfect blend and rendering an easy application. Two or more coats of this is the rule in applying it to any wood surface, inside or outside of building. Another formula involves the use of 40 pounds of finely ground glass, a like amount of ground porcelain, and similarly of china clay or the same quantity of powdered asbestos, and 20 pounds of quicklime. These materials are ground very fine and then mixed in 60 pounds of liquid silicate of soda, with water, as in the preceding formula. Two or more coats, if necessary, are given. Each of these paints is applied with a brush in the ordinary way, the drying being accomplished in a few hours, and, if coloring matter is desired, the above proportions are varied accordingly. Further, if used one after the other, the following solutions are effectively fire-resisting, namely, a solution of silicate of soda in water and then a mixture of quicklime, asbestos and some white lead.

Metallic Powders as Conductors on Molds in the Galvanoplastic Art.—To add conductivity to the molds by the use of metallic powders is, in some cases, preferable to graphite or even to metalizing them by the well-known wet process. The metal or bronze powders are, according to Langbein, only finely divided metals, of which for galvanoplastic purposes, at least, only pure copper or brass powders have any interest. In cases where these powders are to be used for metalizing, since they do not adhere well to the waxed or stearine-covered objects, it is better to coat the molds first with varnish, and just before the varnish is completely dry, dust over them some of the powder from the bag, or sprinkle them with it after any convenient method. When the varnish is hard, the molds may be gone over with a soft brush dipped in the dry powder to perfect the finish, thus imparting to it an even, smooth conducting exterior; any excess of powder may be removed under a gentle stream of water.

It is possibly known that, without the bother of making the deposit on single parts and afterward soldering them together, large objects can be readily reproduced in this manner; that the cores after metalizing can be composed as a whole, and the galvanic deposit obtained in one piece. To this end Lenoir made use of a kind of coating of platinum wire which was introduced into the interior of the completed form, and gave to the higher and lower parts a sort of profile, so that the deposit could form with equal thickness upon all parts. This process requires, however, an opening in the upper part of the form to permit of the escape of the hydrogen gas which collects at the cathode; it requires also a sufficient insulation of the platinum wires inserted in the mold, which Lenoir suggests may be accomplished with glass tubing.

Planté substituted lead wires for the expensive platinum, and consequently made the Lenoir system a practical process; nevertheless, it demands some knowledge to put it to advantageous use, and only in practised hands does it afford perfect results.—Translated from Neueste Erfahrungen und Erfindungen.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of The Supplement, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of The Supplement can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

Combined Rates.—One copy of Scientific American and one copy of Scientific American Supplement, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.