question, the author says, "has been definitely answered in the affirmative."

In dealing with the copper zinc alloys, the author reminds us that it is seldom an alloy solidifies sharply or at one temperature, as water does. There are generally at least two freezing points; and in the industrial brasses, which never contain more than 45 per cent. of zinc, only three of the freezing points were referred to at first, although the scientific interest of the rest was considered later on. The chief point of interest in the paper was the consideration of the eutectic alloys. Of the several breaks in the curves of cooling points of most alloys, the first usually represents the falling out of a more or less pure metal, or some compound of the metal, from the cooling alloy. A second and sometimes a third break indicates the solidification of a eutectic alloy, that is a fusible metallic or "mother liquor," which solidifies at a definite temperature. In the copper zinc series there are several of these eutectic alloys.

Guthrie introduced the designation "eutectic" alloy to denote the most fusible alloy of two or more metals, comparing it to the mother liquor of a salt solution, which remains fluid after the bulk of the salt has crystallised out. The recording pyrometer shows that as regards alloys the case is really far more complicated. Many alloys consist, when fluid, of more than one solution; and each of the several solutions leaves, on cooling, a solid deposit and a fluid mother liquor. These mother liquors, however, do not usually unite with one another; and a complicated set of conditions is established, when the temperature has fallen sufficiently low for the whole mass to become solid. Each of these metallic mother liquors is a eutectic alloy. Some alloys—the lead-tin for instance—are of a simple character, and when fluid have only one eutectic alloy, that is, the deposits fall out from a single mother liquor. All the alloys which are used for the sake of their strength appear to be highly complicated. Thus in the alloys of copper and zinc there are at least four eutectic alloys, and in the copper-tin series there are at least six.

The composition of eutectic alloys does not in general correspond to simple atomic proportions of the component metals, and the author considers there are theoretical reasons for supposing that a eutectic alloy cannot possibly be a chemical compound. It should be noted that in the cooling curves of some alloys, solidification, as shown, takes place over a somewhat long range of temperature. The point at which one constituent begins to crystallise has been called the higher freezing point, and the temperature at which the eutectic alloy solidifies out is called the lower freezing point. These two points are indicated by separate evolutions of heat. That the lead-tin series has more than one freezing point, is illustrated in a familiar way which has considerable industrial importance. A plumber making a "wiped joint" uses a solder containing 66 per cent. of lead, and its pasty condition is due to the fact that it has two widely separated points of solidification, the alloy consisting of granules of solid lead in a fluid mother liquor.

The facts above given lead up to a consideration of the mechanical properties of brasses, and the relation of these properties to the freezing point curve. In dealing with this part of the subject, the author had recourse to a series of diagrams exhibited on the walls of the theatre. Without the aid of these it will be impossible for us to treat the matter at all completely, even from the point of view of a brief abstract. Indeed the report—which is of great length—is so full of matter that we cannot hope to do more than give a few of the most prominent facts, which may serve to afford our readers an idea of its scope. Those interested in metallurgical research will naturally go to the original for fuller information. The method of investigation pursued was to heat an alloy in a steel cylinder and squeeze out the eutectic by hydraulic pressure; the temperatures being noted, until finally a comparatively infusible residue is left. The several portions were then analysed, and the results of the analyses were given in an appendix. The results were discussed by the author in detail; the dominant fact disclosed being that the maximum strength in the series of cast brasses occurs in the alloy containing 60 per cent. of copper. This alloy has practically only one freezing point. Further additions of zinc cause a rapid diminution of tensile strength and extensibility. The explanation given was that in these alloys the compound CuZn is unaccompanied by free copper. In a series the summit of the curve representing extensibility coincides with the first appearance of the upper eutectic which falls out from the alloy that contains 71 per cent. of copper. This

eutectic probably consists of a mixture of copper with the compound CuZn. The mixture of these soft and hard substances produces great strength, as is evident from the fact that the strongest alloy of the series consists almost entirely of this eutectic; but the presence of the eutectic naturally diminishes the extensibility of a mass which contains more than a small amount of it.

The addition of small amounts of iron to certain alloys of copper and zinc (Sterro and Aich's metal) is next discussed by the author. The reason of the remarkable increase of strength thus produced has hitherto been obscure, but the facts are disclosed by a comparison of the cooling curves given in the report. The alloy selected contained 61 per cent. of copper and 39 per cent. of zinc; and in the absence of iron there was a low eutectic point in the cooling curve at about 450° C. or 842° F., evidently due to the presence of a eutectic, which constituted a source of weakness. The added iron, however, entered into combination with the eutectic, forming with it a less fusible compound; for a cooling curve then showed that the low eutectic point was absent, and that the source of weakness had been removed. Moreover, the main solidifying point of the Aich's metal was higher than that of the brass: which in itself is an indication of augmentation of strength. The facts thus established are probably of wide importance in metallurgical practice; and where strength is desired, it would appear to be advisable, whenever a cooling curve reveals the presence of a low eutectic in an alloy, to add some third metal which will diminish the fusibility of the eutectic. Aich's metal, when compared with brass of the same composition but without the 1½ per cent. of iron, is greatly superior in strength. If it owes this superiority to the fact that a eutectic alloy does not remain fluid as the mass cools, it might be anticipated that the relatively high tenacity of Aich's metal would be maintained at temperatures at which the brass would become weak.

We have not space to follow the author further in his valuable and interesting research. He shows how the action of impurities is made clearly evident in connection with eutectic points, and has some most instructive remarks on the diffusion of metals, the latter a most important section of the report. He also gives an account of improvements in the recording pyrometer by which great delicacy in recording is secured. The report concludes with a comparison of the thermo-junction with the air thermometer.

A good discussion, opened by Sir William Anderson and Sir William White, followed the reading of the report; but we have preferred to devote the space at our disposal to the report itself, as containing the most important matter. It may be said, however, that the tone of the discussion was entirely favourable to the report, its practical importance and value being dwelt upon both by the engineers and metallurgists present.

DR. YERSIN, AND PLAGUE VIRUS.

IN view of the importance which attaches to Dr. Yersin's discovery of the plague virus and its anti-toxin, the following notes on his work may be of interest.

When a youth of twenty, Yersin had the rare good fortune to obtain an entrance to the Institut Pasteur. The extraordinary ardour with which he devoted himself to his work, rapidly won for him the admiration and respect of all his colleagues. When little more than a student, Roux signalled him out to assist him in those important researches on the toxin of diphtheria which have since become so memorable, and which were communicated to the scientific world under the joint names of the master and his pupil.

While at Tonkin, in the spring of 1894, he received the request from the French Government to proceed to Hong Kong to study the plague which had recently broken out there. Yersin started off on his mission, and arrived in Hong Kong a few weeks after the plague had commenced its terrible career in that city—a career which had already claimed the lives of 300 Chinese, and which was yet to exact a tribute of over 100,000.

Yersin describes how, on reaching Hong Kong, he found the authorities busy rapidly erecting temporary hospitals, the existing accommodation being quite inadequate to cope with the widespread dimensions of the epidemic. He obtained permission to erect a small hut within the precincts of the principal hospital; and there, in a concentrated plague atmosphere, he

took up his quarters, and hastily improvising a laboratory, commenced his investigations.

So far the plague had confined itself to the insanitary Chinese quarters of the city; and Yersin mentions that the wretched cabins occupied by the natives were often not only without windows of any kind, but were sunk below the level of the ground, which, combined with the shocking overcrowding which prevailed, converted such dens into plague-incubators of the most fulsome and dangerous character.

In these infected districts, one of the first things which attracted Yersin's attention was the extraordinary number of dead rats which lay about in all directions in the houses as well as in the streets; but, on inquiry, he soon learnt that this rat-mortality was a well-known forerunner of the plague, that the latter usually attacks animals such as rats and mice, and in the country districts swine and buffalos, before it touches human beings. An examination of these dead rats showed that their symptoms differed in no way from those which characterise the plague in man, and the extreme susceptibility of these animals furnished Yersin at once with a valuable means of tracking out the virus. His first step was to make careful examinations of the bubonic material present in the tumours which accompany the disease, and here he discovered immense numbers of a short bacillus which appeared to be almost exclusively in possession of the field. These he found were readily stained, and could be cultivated with ease in the usual bacterial media. Further investigation showed that these same bacilli were invariably present in the ganglia and liver and spleen of plague patients; that they were, however, rarely to be found in the blood, and then but in small numbers, and usually only in rapidly fatal cases a short time before death.

Healthy rats and mice inoculated with pure cultures of this bacillus succumbed to the typical plague symptoms; and Yersin had thus accomplished the first step in his investigation—the identification of the specific virus of plague. Yersin was at first of opinion that rats were the principal disseminators of the disease, for healthy mice shut up with a dead plague-stricken rat, rapidly developed the disease and succumbed; but he noticed later the curious fact that, in the little room where he carried out his *post-mortem* examinations, immense numbers of dead flies were scattered about in all directions. He, therefore, determined to ascertain if this wholesale slaughter of flies had any connection with plague infection; so taking some of these insects, and first removing the head, wings and feet, he pounded up their bodies in broth. An examination later of the liquid exhibited masses of bacilli closely resembling the now familiar plague microbe; to place their identity beyond doubt he inoculated some of this broth into mice, with the result that the latter died of plague. That flies materially assisted in the spread of the disease was thus established.

With the slender accommodation and primitive means at his disposal, it was impossible for Yersin to further pursue his investigations, and prepare a plague anti-toxin, and he, therefore, forwarded cultures of his bacilli to the Institut Pasteur, and from here, in the course of the following year, was published the memoir describing the production of the anti-plague serum which is now being so urgently requisitioned for service in India. The bacillus was found to be pathogenic for not only rats and mice, but for the other animals of an experimental laboratory, rabbits and guinea-pigs.

The attempt was first made to vaccinate these animals by means of the toxin, but filtered cultures of the bacillus produced no effect whatever; so that the plan was adopted of heating cultures to 58° Centigrade, and inoculating the dead bacilli. If the latter are injected in sufficient quantities, they are capable of killing the animal; but if a smaller quantity of the liquid containing them is employed, then it acts as a vaccine, and the animal is protected from a subsequent lethal inoculation of the virus, and its serum subsequently acquires protective properties. From success with small animals the attempt was made to immunise large animals, such as horses. For this purpose virulent plague-cultures, capable of killing a mouse in two days, were employed, and the liquid containing these living microbes was injected into the horse's veins. The reaction was rapid and intense, and lasted a whole week, after which the fever abated, and the animal slowly recovered. A long interval—twenty days—was allowed to elapse before a second injection was attempted; but this time, although an equally virulent culture was employed, in the same quantity as before, the symptoms were less pronounced, and passed away more rapidly, and it was

found possible to both gradually increase the quantity and diminish the interval between the several injections. At the end of six weeks the first trial was made of the curative properties already attained by the serum, and the results were regarded as extremely satisfactory and encouraging. To confer immunity to plague infection on a mouse, it required $\frac{1}{10}$ th of a cubic centimetre of serum, administered twelve hours *before* the virus was injected; to cure animals after plague infection, 15 cubic centimetres of serum were required to be inoculated twelve hours *after* the virus had been introduced. The large quantity of serum necessary in these first experiments for curative purposes, was due to the short time during which the immunising process had been carried on. It will be remembered that in diphtheria the time required to train a horse's serum up to the proper protective pitch is a question of months, and in the case of antivenomous serum a matter of as much as fifteen months; thus a treatment of six weeks only is a very short time for the serum to exhibit immunising properties. That the most remarkable therapeutic value attaches to anti-plague serum as now elaborated at the Institut Pasteur in Paris, is shown by the success which has recently followed its application in undoubted cases of plague at Amoy, by Yersin, now Director of a Pasteur Institute at Nha-Trang in Annam.

In conclusion, it may be asked, How long is England to rest content to knock as a humble suppliant at the door of foreign institutes for assistance when overtaken by disaster, as is now the case in India? Why should Paris supply the means for relieving the suffering of our fellow-subjects in India?

The answer and reasons for that answer are, alas! but too well known to require repetition here; and we can only hope that in the future, at present dim and obscure, the barriers which now so formidably impede medical progress in this country may yield before the enlightened pressure of public opinion.

G. C. FRANKLAND.

THE "BAZIN" ROLLER BOAT.

IN NATURE of December 3, 1896, we gave a short notice of the new roller-boat the *Ernest Bazin*. From a paper recently read at the Society of Arts by M. Émile Gautier (*Journal Society of Arts*, January 22), the following further particulars are taken.

The *Ernest Bazin* was launched a few months ago at Saint-Denis, and was then taken down the Seine to Rouen, where she is being fitted with her engines and machinery. As soon as these are completed an experimental trip will be made across the Channel, and it is anticipated that the vessel will in the course of about six weeks be anchored in the Thames. This experimental vessel has a displacement of 280 tons; its length is 131 ft. 3 in., and width 38 ft. 9 in. The framework and hull are supported on six lenticular hollow wheels 32 ft. 10 in. in diameter, about one-third of which will be immersed. The engines, cargo, cabins, &c., are placed on a platform resting on a framework carried on the axles of the wheels. The engines are constructed to develop 750 horse-power; 550 of which will be used for the propeller, and 200 horse-power for driving the three pairs of wheels. With this power an ordinary steamer of a similar tonnage would not steam more than 18 or 19 knots. It is expected that the *Ernest Bazin* will attain double this speed. The principle on which the vessel is constructed is the substitution of the rolling motion of great wheels for the ordinary gliding motion of the hull of the vessel through the water, in order to minimise friction. An ordinary ship with its hull gliding through the water represents the disc pushed forward without a rotary motion being imparted to it. As it is compelled to cut the water in front of it, and to drive it back longitudinally, it would soon cease to move forward did it not receive a fresh impulsion at every moment. If, however, the vessel were supported by revolving buoys, it is contended that it would possess all the advantages of the disc, to which a rotary as well as a forward motion is given. The effort, instead of being exercised longitudinally, is exercised partially downwards, vertically, so that the resistance is reduced in a considerable degree.

As the result of calculation the rotary speed of the wheels has been made one half greater than the speed of translation.

In the discussion which followed the reading of the paper, the speakers, while declining to prophesy as to the results to be attained, seemed to be of opinion that the difficulty of construction would increase very rapidly with the increase in size, owing to the great strain which would be imposed on the