Curve Tracing and Curve Analysis.

THE review of a book on practical curve tracing in NATURE of June 9 is tantalising to one who is not in the least interested in drawing the graph of an equation, but who is frequently plotting curves from experiment, and who would like to find formulæ, not only to fit them, but to explain them. I look through most of the reviews of mathematical books in NATURE in the hope of discovering one that deals with the practical analysis of curves, and I am continually disappointed.

Can no máthematician be induced to recognise that for some of us an equation is the end, and not the beginning, of a piece of work? In innumerable cases experimental work ends with a curve, such, for example, as a hysteresis curve, and no attempt is made to find an equation to fit it.

Half a dozen rules exist, the uses of log. and semi-log. paper can easily be explained, but nobody has gathered them together with explanation of the difference between empirical formulæ and rational equations, of interpolation, smoothing, and of the legitimacy of extrapolation.

London, June 9. A. P. TROTTER.

A Brush for Collecting Mercury.

SINCE more or less mercury is always spilled around the laboratory, a simple and efficient mercury collector is of great use. I have found a very good one, and, since I have not seen it in use before, I will describe how it is made.

It is made like a paint-brush, with the difference that #40 copper wire is used instead of camel's hair in the brush part. The fine copper wire is then amalgamated with mercury. Use the brush as though painting with it. It will take up large globules and go into cracks and collect the smallest particles, so that none need be lost. Use a cup when collecting, and when the brush is full shake the mercury into the cup.

GEORGE WINCHESTER.

Washington and Jefferson College, Physical Laboratory, Washington, Pa., May 28.

LIGHT ALLOYS.

THE problem of producing an alloy which shall combine great strength with a low specific weight has been before metallurgists ever since the commercial manufacture of aluminium became an accomplished fact; more recently, however, the requirements, in the first place, of racing yachts, then of motor cars and of motor cycles, and, finally, the pressing problems of aërial navigation, have added a rapidly increasing importance to the whole question. At the present moment German manufacturers particularly are putting forth claims in regard to achievements in this direction which appear startling at first sight, and it is interesting to examine the whole state of the question.

The need for a light alloy lies in the fact that pure or nearly pure aluminium is, unfortunately, very weak mechanically. Its low specific gravity (2·71) is more than counterbalanced by the fact that its tensile strength, even in the form of rolled bars, does not exceed 7 tons per square inch. If these figures are compared with those of the best special alloy steels suitable for structural purposes, we find that some of these show tenacities up to 64 tons per square inch, with a density of approximately 7·9. Consequently, a bar of aluminium, to bear the same ultimate load as a bar of such steel having a cross-sectional area of one inch, must have a sectional area of approximately 9 square inches, and would therefore weigh about three times as much as the steel bar. A light alloy which is to compete successfully with such special steels, therefore, must either be much lighter than pure aluminium or it must combine with the density of aluminium a tensile strength of 21 tons per square inch.

So far as alloys consisting principally of aluminium are concerned, it does not appear that this tensile strength has ever been attained, except in the case of hard-drawn wires the ductility of which has been reduced to an excessively low value. It must, however, be borne in mind that the high-tension steels referred to above cannot be employed in excessively thin sections, so that in many special cases, where the scantling of structural parts cannot be reduced to minute dimensions, while the strength required is not very great, light alloys may be employed with advantage as compared with alloy steel. The same argument applies, however, to a comparison made on similar lines between light alloys and the stronger kinds of wood. These woods are all considerably weaker, per square inch of sectional area, than the light alloys now available, but when their much lower density is taken into account, as well as the advantage of larger scantlings, the result must in many cases be favourable to the employment of wood. It is for this reason that the frames of most aëroplanes are constructed of wood. When, however, an alloy of density less than 3, and possessing a tensile strength of more than 20 tons per square inch under conditions allowing of a ductility equivalent to an extension of not less than 15 per cent. on a 2-inch test-piece, becomes available, its employment will become advantageous as compared both with the best alloy steel and the best wood.

The light alloys available at the present time are somewhat numerous, and, as regards those of them which are patented or otherwise proprietary articles, it is difficult to obtain satisfactory data; it is certain, however, that extravagant claims are often advanced for such alloys, and these are not verified when samples are tried in a testing machine.

The claims of those advertising or selling such alloys must therefore be looked upon with much reserve.

Among the earlier alloys of aluminium which found a certain amount of practical application were those with iron and with nickel. One of the racing yachts engaged in one of the later races for the America Cup was built of plates rolled from one of these alloys, but the metal suffered from excessively rapid corrosion, and the presence of iron in aluminium alloys, although it undoubtedly confers considerable strength upon them, is rightly regarded as extremely undesirable. At the present time, the most completely studied of the light alloys are those in which copper is incorporated with the aluminium, either alone or with the addition of other elements, such as manganese. In the form of rolled bars and sheets, these alloys attain a tensile strength of slightly more than 17 tons per square inch, with an elongation of 15 per cent. on 2 inches; these figures apply almost equally to alloys containing about 4 per cent. of copper alone, or to those containing 3 per cent. of copper and 1 per cent. of manganese, or 2 per cent. of copper and 2 per cent. of manganese, the specific gravities of all these alloys lying close to 2·8. So far as trustworthy data are available, these figures probably represent the best available alloys of this character. Alloys of aluminium with from 15 to 20 per cent. of zinc may possibly yield somewhat higher figures, but, owing to the presence of a considerable proportion of zinc, their density is also much higher, so that they can hardly be classed among the light alloys.

The light alloys at present employed in practice are principally used in the form of more or less complicated castings, such as motor-car engine crank-cases, the corresponding parts of aërial motors, and similar purposes. When thus used the alloys cannot be compared with special alloy steels, and still less with wood, and they hold the field quite easily against cast-iron, brass or bronze of any kind. For these purposes, hardness rather than ductility is desired, and alloys containing rather more than 4 per cent. of copper, or the corresponding amount of manganese, can be employed. The casting of these alloys presents some difficulty, but a considerable number of founders are able to produce castings of this kind with regularity; the secret of their success lies largely in casting the alloy at a suitable temperature, and in the preparation of a mould having a hard and very dry surface. All the alloys of this class undergo a comparatively enormous amount of shrinkage in passing from the totally liquid to the totally solid condition, and unless due allowance is made for this contraction, faulty castings always result.

In the case of the aluminium-zinc alloys, a difficulty of another kind arises; while these alloys are less viscous when molten, and flow into the moulds more freely than the aluminium-copper alloys, they are very weak and brittle while hot, and castings made of these alloys are very apt to crack while cooling if their contraction is opposed to any considerable extent; it is probably on this account that these alloys have acquired the reputation of being "treacherous." They have, on the other hand, been employed with some success for the production of so-called "die castings." These castings are produced by means of metallic moulds, and can be made so accurate that no machining is required even for such objects as screw-threads and certain parts of instruments. On the other hand, these alloys are said to be weak under vibration, but this statement as yet requires confirmation by systematic investigation.

The question of the power of light alloys to resist corrosive influences is one of considerable importance; it has been generally accepted by those accustomed to deal with aluminium and its alloys that the pure metal is much more resistant to corrosion than any of its alloys, and, as regards some of these, this view is undoubtedly correct. The numerous "solders" which have been advocated for jointing aluminium and its alloys all suffer very seriously from this point of view. It must, of course, be borne in mind that aluminium itself has a powerful affinity for oxygen, and only protects itself from rapid atmospheric oxidation by the formation of a very thin coating of oxide on all exposed surfaces; if this coating is ruptured, as, for instance, by friction, continuous oxidation results, and the presence of an alloyed element in the form of a distinct constituent may cause such interruption. Again, the contact of aluminium with another metal, in the case of all those metals usually met with in engineering construction, leads to the formation of galvanic couples, and the consequent rapid corrosion of the aluminium. In this way also an alloyed element may intensify corrosion. On the other hand, it is equally possible that the presence of an alloyed metal may improve the protective coating of oxide formed on the surfaces of the metal, and there is good reason to believe that the presence of copper produces this effect to some extent, while the presence of manganese—as has recently been shown—facilitates the formation of a surface "patina" containing manganese oxide as well as alumina.

Even in the best circumstances, however, the protection of light alloys from corrosion is a most important matter, and this is accentuated by the difficulty of finding a suitable paint or varnish the constituents of which do not act upon aluminium—an action which generally takes the form of an interchange of oxygen between the pigment and the metal. Processes for coating the light alloys with a less corrodible metal, such as copper, tin, zinc, &c., have been tried, but these modes of protection are accompanied by the risk of an increased amount of local corrosion owing to galvanic action, if the metallic coating is anywhere broken through. A more hopeful line of thought is to be found in the development of processes for coating the alloys with an adherent layer of some inert compound of aluminium, much as iron and steel are coated with a layer of phosphate of iron in the "Coslettising" process.

Finally, some reference may be made to the possibilities of the use of magnesium and its alloys for the production of light and strong materials of construction. The fact that magnesium has a specific gravity of only 1·74 at once suggests its use for such a purpose, but the fundamental objection lies in the fact that it is much more corrodible than aluminium, and that therefore the attainment of even moderate durability in its alloys must be a problem of much difficulty. That some solution of this problem may have been found is suggested by the statement recently made that the newest German Zeppelin airship is to be constructed of an alloy known as "Elektron," said to be an alloy of aluminium and magnesium. Its density is stated as being close to 1·7, so that it must clearly consist of magnesium alloyed with only 1 or 2 per cent. of aluminium. No data as to the strength of such an alloy are available, but from the known constitution of the alloys of the aluminium-magnesium system, it appears probable that the addition of aluminium to magnesium in proportions up to 7 or 8 per cent. will materially increase the strength of pure magnesium, but the actual results cannot be predicted; it is, however, probable that pure magnesium is rather weaker than pure aluminium, so that it would be surprising to find in this group an alloy having a density less than 1·8, with a tensile strength above 10 or 12 tons per square inch. Alloys of aluminium with small proportions of magnesium are, it may be mentioned, in somewhat extensive use, particularly for certain parts of scientific instruments, under the name of "magnalium," but these alloys, although somewhat lighter, are not so strong as the best of the aluminium-copper and aluminium-copper-manganese series.

From the foregoing review of the question it will be seen that the problem of light alloys is still far from a satisfactory solution, and that there is a need for further systematic study of the alloys of the lighter metals. WALTER ROSENHAIN.

GREEK ARCHÆOLOGY.[1]

THE "Annual of the British School at Athens" still remains of the somewhat unwieldy size that it has assumed of late years. A return to the more convenient bulk of, say, vol. viii. would be welcomed by the reader; yet it cannot be said of any of the articles in vol. xiv. that any part of them might profitably have been excised. Only the fourth instalment of Dr. Mackenzie's work on "Cretan Palaces" seems rather too long. Still, no doubt the various questions raised by Dr. Dörpfeld's criticism of Dr. Mackenzie's former articles, Dr. Noack's work on Cretan buildings, and the discoveries of Neolithic prototypes of the "Homeric" palace in Thessaly, needed exhaustive treatment. So we are compelled to postpone reading Dr. Mackenzie's views on the relations of the Homeric house to the Cretan palaces until next year.

The director of the school and his assistants continue their account of the discoveries at Sparta, which have conferred such lustre upon British archæological work during the last three years. Few believed that excavations at Sparta would prove so interesting.

1 "The Annual of the British School at Athens." Vol. xiv. (Session 1907–8.) Pp. x+468; 15 plates. (London: Macmillan and Co., Ltd., 1909.) Price 25s. net.