In the "useful" light alloys of the ternary system, however, such disintegration does not occur.

The mechanical properties found in the best of the alloys of the ternary system are remarkable. The authors suggest that alloys of copper with aluminium alone are generally contaminated with a certain proportion of alumina, formed when the aluminium is added to molten copper containing more or less oxygen; by the previous addition of manganese, which acts as a reducing agent, the formation of this alumina is inhibited and the properties of the resulting alloys are improved. It has been found that a small percentage of manganese renders the alloys more ductile without reducing their ultimate strength, while larger proportions of manganese increase the strength but lessen the ductility of the alloys. Sand-castings giving an ultimate strength of 36 tons per sq. inch with an elongation of 22.5 per cent. on 2 inches have been obtained, while in the form of rolled bars the best of the heavy ternary alloys reach an ultimate strength of 43 tons per sq. inch with 22 per cent. elongation. Perhaps the most remarkable result, however, is that obtained with one of these alloys in the hard-drawn condition, where an ultimate strength of 52 tons per sq. inch with 10 per cent. elongation has been obtained. This is probably the strongest alloy known, containing more than 80 per cent. of copper. The remarkable properties of this alloy led Dr. Rosenhain to take up the challenge recently thrown out by Sir Gerard

FIG. 4.—Micro-structure of alloy after quenching from 900° C.

Muntz in his presidential address to the Institute of Metals, to the effect that modern scientific attainments in metallurgy had not yet enabled us to produce a bronze cutting tool. By further cold-working one of these hard-drawn alloys under a powerful testing machine, a material was produced from which a chisel was ground, and with this it was found possible to incise hard stone or—with a different form of cutting edge—to cut wood so easily and cleanly that a lead-pencil could readily be sharpened with it.

A result of considerable importance has been obtained by means of abrasion tests on certain of these alloys; the test applied was one of simple wear against hardened steel rollers, the loss of weight being determined. It was found that the best of these alloys possess a very great resistance to abrasion of this kind far surpassing even the harder varieties of steel. This property, together with their very great strength and the fact that they can be machined and finished very readily, should render them of special value for the construction of scientific instruments, particularly for those parts where much mechanical wear has to be met. These alloys also possess a very great power of resisting corrosion, both by fresh- and sea-water, while tests made upon them at temperatures up to 500° C. indicate that they retain their strength up to 300° C.; these results suggest the possibility of their employment for the blades of steam-turbines working with superheated steam.

As regards the light alloys, containing more than 95 per

cent. aluminium, the properties of the ternary alloys are not markedly superior to those of the aluminium-copper alloys, except, perhaps, that in the form of chill-castings a higher tensile strength has been obtained. The presence of manganese, however, appears to protect these alloys from corrosion to a marked extent, the specimens of these alloys exposed to sea-water, for instance, becoming coated with a black patina consisting largely of oxide of manganese. Specimens of some of these alloys have retained their original brightness after more than two years' exposure in the laboratory cupboards, thus indicating a decided superiority over pure aluminium, which has hitherto been regarded as decidedly superior to its alloys in regard to corrosion.

ELECTRICAL DISCHARGES OVER PHOTOGRAPHIC PLATES.

IT is well known that when an electric discharge is allowed to take place over a photographic plate a latent image is formed which can be developed in the ordinary way. When one electrode consists of a metal plate placed at the back, and the other is a wire brought into contact with the middle of the sensitive side, a very great difference is obtained when a single spark is passed from an induction coil or Wimshurst machine according as to whether the wire electrode is the positive or the negative one. If it is positive, the figure—which is called a positive figure—consists of numerous ramifications suggesting meandering streams, while if it is negative the main lines in the figure change their directions very abruptly, and are terminated by expansions suggesting fans or palm-leaves. In each case the discharge may or may not pass to the edge of the plate; if it does, the corresponding line is very broad, with a finer, well-defined, intenser line passing midway through it. Such figures were obtained first by Mr. J. Brown, of Belfast, and have since been repeated by many experimentalists. Experiments made by Prof. J. A. McClelland and Mr. Campbell Swinton seem to render certain that the latent image is due to the luminosity of the discharge, and not to a direct electrical action.

I have recently made experiments with the object of extending our knowledge with respect to the formation of these figures, and the results have been communicated to the Röntgen Society, appearing in the society's journal for January.

My first idea was that if the paths of the discharge represent moving electricity they would be seriously modified in a perpendicular magnetic field. However, the greater part of the figure is apparently quite unchanged in such a field; the only evidence of change is in the trunk discharges that flow over the edge of the plate. These become still broader, the fine pilot spark, however, remaining apparently unshifted, and forming a sharp boundary to the trunk discharge along one edge. The direction of lateral shift is that corresponding to a wire carrying a current from the positive to the negative electrode.

A blast of air produces the same kind of effect. Indeed, if several radiating trunk discharges occur on the same plate, the effect in a perpendicular magnetic field is much the same as if a cyclonic blast of air had circulated over the surface of the plate.

The fine tracery lines in the fan-shaped expansions which terminate the lines of discharge in the case of a negative spark are very similar to the paths of the separate portions of an exploded projectile. Such paths are easily plotted by superposing a radial component of velocity, following any assumed law, upon the initial translatory velocity of the unexploded projectile. Owing to this similarity it is suggested that these tracery lines represent the actual paths of single ions or of simple groups of ions in the electrical field.

When the discharge takes place in a partial vacuum very considerable changes occur. In particular, as the exhaustion proceeds a new phenomenon appears, which reaches its most marked stage at about 17 cm. pressure. This is somewhat difficult to describe, and is shown in Fig. 1.

The wire terminal touched the plate nearly at its centre. Besides the trunk discharge ascending the plate are seen

two discharges in the shape of narrow triangles the bases of which are close to a *dark space* separating the glow surrounding them from a central rosette. The pointed ends are close to a *second dark space*, and are terminated by tuft discharges. These appearances show only imperfectly in the reproduction, but are exceedingly definite on the original negatives. The remarkable feature is the very sharp and well-defined edges which these triangles possess. It is suggested that there may be a connection

FIG. 1.—Discharge at a pressure of about 17 cm.

between these and the phenomena of *electrostriction*, but so far no definite theory has been formulated. In very many cases there is visible a *dark continuation* of these squirts on the side of their bases, which suggests that the effects seen represent a part only of the electrical effects taking place. The shape of the squirts suggests that in one region they experience a pressure from the disturbance which creates the luminous glow through which they stretch, and that this pressure is replaced by a tension as soon as the second dark space is passed. The luminous

FIG. 2.—Negative figure in coal-gas at ordinary pressure.

glow bordered by the two dark spaces suggests a single stria as seen in a vacuum tube; the phenomena of ionisation in the two cases may be similar.

When the gas in which the plate is immersed is changed the effects obtained change also. Each gas produces a negative figure characteristic of itself. *The triangular squirts above referred to are given by air alone.* The negative figure in coal-gas at ordinary pressure is shown in Fig. 2. The figure in nitrogen is also very singular.

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It is noteworthy that the positive figures in various gases present very few differences from each other.

When a small metallic triangle placed on the sensitive film forms the electrode, some striking differences are obtained according as it is made the positive or the negative terminal. When it is positive the ramifications start in the main from the corners (Fig. 3); on the other hand

FIG. 3.—Positive ramifications from corners of triangular electrode.

when it is negative a preference is shown to leave at right angles to the edges (Fig. 4).

Throughout these descriptions it has been assumed that the discharges *leave* the electrode. It must be admitted that at present there is no proof that the streamers do not represent currents that advance *toward* the electrodes.

For some further details, as well as for numerous other

FIG. 4.—Negative streamers exhibiting a preference to leave the triangle at right angles to edges.

reproductions, reference must be made to the paper in the Journal of the Röntgen Society from which the figures illustrating this article have been selected. Perhaps it should be added that these are photographic positives from the original photographic negatives.

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