surrounded by extensive morasses. The ore occurs in bed-like masses in porphyries of varying character and composition. The total length of the Kiirunavaara ore body is 15,500 feet. The width is usually 330 feet, but in one place it is as much as 840 feet. The dip varies from 45° to 60°. It is estimated that the quantity of ore available above the level of the lake at Kiirunavaara is 215,000,000 tons, and at Luossavaara 18,000,000 tons.

The Kiirunavaara ores differ widely from most Swedish ores. They are unusually hard and compact, and remarkably free from all foreign minerals except apatite. That mineral is, however, exceedingly abundant. Analyses show that ores occur with less than 0·05 per cent. and from 0·05 to 0·1 per cent. of phosphorus in such quantities that they can be mined separately. The bulk of the ore, however, contains 1 to 4 per cent. of phosphorus. The percentage of sulphur is usually 0·05, and sometimes less than 0·02. Titanium varies from 0·32 to 0·95 per cent., and manganese does not exceed 0·32 per cent. The great bulk of the Luossavaara ore is comparatively low in phosphorus, and much of it appears to be well adapted for the acid Bessemer process.

No serious attempt was made to work these deposits before 1880, when a concession was granted for the construction of a railway from Luleå to the Ofoten fjord; but the concession was withdrawn after the railway had been completed from Luleå to the iron mines at Gellivare. This year, however, the Swedish parliament authorised the construction of a railway from Gellivare, past the Kiirunavaara and Luossavaara deposits, to the Norwegian frontier; and the Norwegian parliament has authorised its being continued to Victoria Harbour, on the Ofoten fjord, a port free from ice throughout the year. The distances from the iron ore deposits along the projected line of railway are—to Gellivare, 63 miles; to Luleå, 182 miles; to the Norwegian frontier, 79 miles; and to Victoria Harbour, 120 miles. Within a short period these vast supplies of iron ore will thus be rendered available, and British ironmasters will have within easy reach sufficient ore to last for many generations to come.

ELECTRICAL STAGE APPLIANCES.

THE proposed application of electrical power for mounting plays at Drury Lane, on the lines advocated by Mr. Edwin O. Sachs, has now taken a tangible form in the completion of the first section of the stage installation in time for the impending pantomime.

Mr. Sach's present work refers principally to the stage floor and its movability in sections above and below the footlights. The total area now already movable by mechanical power exceeds 1200 square feet.

The electrical appliances just completed take the form of so-called "bridges," each working independently. Each individual section measures 40 feet by 7 feet, and weighs about 6 tons, of which about 4 tons are counterbalanced. They can travel about 20 feet vertically.

The motive power is from the ordinary electric supply mains over a four-pole motor, developing 7½ horse-power at 520 revolutions per minute. The "bridges" are suspended from cables, and these, working over the motor, allow the former to be raised with the necessary live load at rates varying from 6 feet to 20 feet per minute.

Every possible safeguard has been taken against accident, the "bridges" themselves being so constructed that in the event of derangement of current the appliances can be worked by hand gear. Automatic switches are provided so as not to be entirely dependent on the attendants, and automatic catches will work in case of rope-breaking. Special locking-gear has been installed to hold the "bridges" stationary at certain points, such as stage level, and a very large factor of safety has been allowed in apportioning the strengths and weights in the various parts of the mechanism, having special regard to the ever-increasing scenic requirements under Mr. Arthur Collins's able management.

As regards the economic aspect of the electrical installation, the initial outlay on the system adopted is about half that of continental hydraulic work. The maintenance is minimal, whilst the actual working only costs a few pence per performance. The saving in manual labour on the stage is very considerable, whilst the hygiene of the theatre is materially raised by the absence of woodwork.

METALLIC ALLOYS AND THE THEORY OF SOLUTION.[1]

THE term alloy in its technical sense is used to indicate a solid mixture of two or more metals. The earlier investigators in this field, such as Matthiesen, Richie and many others, worked mainly with solid alloys, and they endeavoured to investigate the change in properties of the alloy, such as conductivity for heat and electricity, malleability, ductility and the like, with successive small changes in composition.

This method, although well adapted to bring out properties of alloys suitable for use in the arts, has not till recently shed much light on the real constitution of this interesting group of substances. Chemists have neglected the subject because the ordinary processes by which they attack problems fail them when dealing with alloys, on account of their opacity, want of volatility and power of being separated from one another by crystallisation. Another difficulty arises from the fact that the resulting alloy has usually the same colour as the metals from which it is produced, except in a few cases, such as the rich purple alloy of gold and aluminium investigated by Prof. Roberts-Austen, and the alloy of zinc and silver noticed by Matthiesen and investigated by Neville and Heycock, which has the property of taking a superficial rose tint when heated and suddenly cooled.

During the past twelve years considerable advance has been made in the study of alloys by investigating some of their properties whilst in the liquid state, such as the temperature at which solidification commences; it is convenient to term this temperature the freezing point. Le Chatelier, Roberts-Austen, Neville, myself and others have all worked in this way. The result of this work may be very briefly stated as follows.

Solutions of metals in one another obey the same laws that regulate the behaviour of solutions of such substances as sugar in water. For example, if we take solutions of sugar of different concentrations, but not exceeding 3 or 4 per cent., we find that within these limits the lowering of the freezing point is nearly proportional to the concentration. Exactly in the same way, if we add to a quantity of molten sodium (freezing point 97° C.) some gold, we find the gold dissolves much in the same way that sugar dissolves in water. On determining the freezing point of the alloy we find that it is lowered in direct proportion to the weight of gold added, notwithstanding the fact that pure gold by itself melts at a temperature of 1060° C. It is remarkable that the effect of increasing the quantity of gold in the alloy continues to depress the freezing point of the sodium, until the alloy contains more than 20 per cent. of gold when the minimum freezing temperature 81·9° C. (eutect temperature) is reached. The case of gold dissolving in sodium may be taken as a very general one, for a large number of pairs of metals have been examined, and with but few exceptions, such as antimony dissolved in bismuth, the effect is almost always to produce a lowering of the freezing point of the solvent metal. By the solvent metal we generally mean the metal which is present in the largest quantity.

A second point in which metallic alloys resemble ordinary solutions is in the fact that the depression of the freezing point is inversely proportional to the molecular weight of the dissolved substance. Thus, if we dissolve 342 grams (molecular weight in grams) of cane sugar in 10 litres of water, and determine the freezing point of the solution, it is found to be depressed a definite number of degrees below that of pure water. But the same depression of the freezing point is produced by the solution of 126 grams of crystallised oxalic acid, or only 32 grams of formic acid, in 10 litres of water.[2] Alloys again appear to obey the same law; thus it is found that if we dissolve 197 grams of gold, or 112 grams of cadmium, or 39 grams of potassium, respectively, in a constant weight of sodium, the freezing point of the sodium will be lowered by almost the same number of degrees in each case. Now the numbers 197, 112 and 39 are the atomic weights of the metals, and it can be shown that these numbers are also probably the molecular weights of these elements. Hence we conclude that metals dissolved in each other obey the same laws as ordinary solutions.

The above facts for the behaviour of solutions of substances

[1] A discourse delivered at the Royal Institution by Mr. Charles T. Heycock, F.R.S.

[2] Although water is used as a solvent by way of illustration in these cases, it should be stated that it is by no means a suitable liquid for such experiments, owing to the changes it brings about in the substances dissolved. In making such experiments it is far preferable to use benzene or acetic acid as a solvent.