would complete what he believed would be the most unique group of buildings in the world. It was intended for the higher technical education—for educating the captains of labour, and not merely the artisans, in a way that would enable them to meet the competition of Germany. The Germans had had these superior schools for years, and had been turning out a large number of expert and scientific men such as did not exist in England. They, however, hoped to make them exist in Liverpool, and he also hoped that this building would enable them to start in Liverpool many new industries that would give employment to the surplus population, and especially to females.

Speaking of the accommodation which would be afforded to the museum, Sir William reminded them that it had been founded by a bequest by the XIIIth Earl of Derby, some sixty years ago, and had been strengthened year by year by purchase. They were able to display only about one-half of their collections, and even that was so crowded that it was impossible to attempt any classification. This building would enable them to unpack and arrange scientifically the whole of their treasures, and in a short time they would have a museum unequalled out of London. When visiting Rome, Florence, Venice, and Athens, they were attracted there, not by what the Cæsars and Doges had done, not by the spoils of war, but by the monuments of art and the stores of literature which were left behind in these cities. In the same way he hoped that these buildings would tell future generations that, while they had been strenuously engaged in commerce, they had not been forgetful of the intellectual welfare of the citizens, knowing that by doing so they were promoting public morality as well as the material prosperity of the people.

ECONOMIC BOTANY IN NYASALAND.

THE following interesting notes on some of the exotic economic trees and shrubs cultivated in the Residency Grounds, Zomba, British Central Africa, are given by Mr. John Mabon, Government Botanist, in the annual report on the Protectorate for the year 1897–98 (C-9048). Accompanying the notes in the report is a complete list of exotic trees and shrubs growing at Zomba.

The collection of exotic plants grown at Zomba possessing economic value is not at present very extensive, but it is being steadily added to. The Coffee-disease Regulations in force prevent plants or seeds being imported from several tropical centres where we could obtain many valuable things, and the long journey from England hinders us from obtaining plants in Wardian cases from the Kew establishment or any of the large nurseries, except the consignment is taken in hand by some officer of the Protectorate, or the like, who is making the voyage out and sees it safely through. The authorities at Kew, having such unusual opportunities for distributing seeds, frequently forward valuable material to us, and many of the items mentioned emanated from Kew, either as seeds or plants. The list forms an interesting record of the cultural possibilities in the climate of the Shiré Highlands. There are but few countries where one can see such an essentially cool and northern type of vegetation as the Lawson cypress (which bears seed in enormous quantities) growing alongside such an essentially tropical type as the gutta-percha of Malaya (*Dichopsis gutta*). Although it is true the latter does not reach its proper degree of development, yet it is perfectly healthy, and it points to the fact that in the lower and warmer region on the Shiré River it would be a valuable culture.

Many of the items mentioned are only represented by one plant, and many of them are not old enough to have reached the fruiting period. Some of the introductions grow with surprising vigour. For instance, eucalyptus, the seeds of which were sown about six years ago, are now over sixty feet high, and would yield very capable timber if required. The well-known blue gum is not, however, a success here, but it seldom is in these latitudes below the 5000 feet level. Still there remains numerous equally good, and even better, members of this useful genus which we can cultivate with success.

Mauritius hemp (*Furcraea gigantea*) and sisal hemp (*Agave rigida*, var. *sisalana*) grow with great freedom, and while it would scarcely pay to cultivate these valuable fibres at present for the European market, yet if any textile industries arise locally there can soon be plenty of raw material at hand to supply them.

Seeds of the celebrated China grass (*Boehmeria nivea*), a fibre very much in demand now, have been ordered, and it is intended to demonstrate that it is a profitable culture that might be grown in Nyasaland with the object of exportation to the European markets. Arnatto (*Bixa orellana*) fruits with great profusion; the seeds are used in the arts as a dye, and as colouring agent for butter; the supply at present, however, from Colonies like the West African, exceeds the demand.

Fruits are a very important culture in all tropical countries, and the indications point to the Shiré Highlands being suitable for raising the fruits of many diverse countries. The mango (*Mangifera indica*) grows with much luxuriance, but as all the existing plants at Zomba have been introduced recently they have not yet reached the fruiting stage. One tree is expected to yield some fruit this year. The same applies to oranges, avocado pear, and guavas, although at present one tree of the latter is maturing fruits. (On the Buchanan estate, close to the Residency, oranges bear with great profusion, and up till recently peaches were a great success there.) The granadilla (*Passiflora quadrangularis*) fruits freely, and the fig (*Ficus carica*) seems quite at home. The grape vine grows well, and is a recent introduction; we expect to see it fruiting next year. Bananas, it need hardly be remarked, bear with great abundance. Up to the present this is practically the only fruit the native grows.

Exotic timber trees are very promising. The red cedar (*Juniperus virginiana*) and West Indian cedar (*Cedrela odorata*) do extremely well, and are important in view of the expected development of the tobacco industry, as they supply material from which first-rate cigar boxes can be manufactured. Kauri pine (*Dammara Australis*), a timber of great value and utility, promises to become a great success here, for seedlings planted a year ago have reached over three feet in height. Mahogany does very well. The good offices of Kew have been requested in obtaining for us a large quantity of seeds in order that we can grow it on a considerable scale and distribute it over the Protectorate. The splendid Mlanje cedar (*Widdringtonia whytei*) grows with unexampled vigour at Zomba, which is at least 3000 feet lower than its native habitat. It is very interesting to find it doing so well here, and points to the fact that in time the hills of Nyasaland above the 3000 feet level can be successfully forested with this excellent timber. Seeds from the trees at Mlanje have been widely distributed amongst Government officers, missionaries, and planters in the Protectorate, as well as to various parts of Southern Africa.

Perhaps enough has been said to indicate the diversity of cultures possible in the Protectorate. The Botanical Department at Zomba is very young yet, but endeavours are being made to render it of service to the country. As it is, it can demonstrate that many plants of commercial importance find a suitable home in the soil and climate of Nyasaland.

THE IRON ORE DEPOSITS OF NORTHERN SWEDEN.

OF the excursions in connection with the last meeting of the Iron and Steel Institute in Sweden, none was of greater interest than the visit to the vast mountains of iron ore at Kiirunavaara and Luossavaara within the Arctic Circle. The party of members invited by the owners of the mines was necessarily limited, and the journey was long and arduous. After travelling 820 miles by railway, the party proceeded in carriages for forty miles over a loose shingle road, then for forty miles more up the Kalix river in boats poled against the stream, and lastly for ten miles on foot. The visit to the mines was made under the guidance of Mr. H. Lundbohm, of the Geological Survey of Sweden, who contributed to the meeting an interesting paper describing the deposits. From this the following details are derived:—

The character of the country is very remarkable. The Kiirunavaara mountain consists of a steep ridge extending for about 2½ miles, divided into a series of peaks varying in height from 270 to 2450 feet above the lake Luossajärvi, which separates it from the gently sloping conically shaped Luossavaara. On the tops of these mountains the ore lies almost entirely uncovered by soil; on the sides it is covered by morainic material and beds of gravel and sand; while the mountains are

©1898 Nature Publishing Group

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.

©1898 Nature Publishing Group