century "differed much from that to-day,"[1] but a further consideration of Pepys's notes, taken in conjunction with those of Evelyn, has led him to modify his views, and he now thinks that, on the whole, there is a good case for supposing that the winters in the seventeenth century were more severe than they are to-day. Sir John Moore, it is true, maintained in a paper, "Is our Climate Changing?" read before the British Association (Section A) in 1908, that the British climate is not changing; his evidence is based mainly on observations during the nineteenth century, with some from the eighteenth; but the constancy of the climate during the nineteenth century does not seem to preclude a change having occurred since the seventeenth, nor does it follow that a change should be progressive.

There must, however, be a good deal more evidence in scattered letters or diaries that will in time throw more light on this important point. In Swift's "Journal to Stella," which extends only from 1710 to 1713, there are weather references on seventy-eight days a year. The period is short, but I think it bears out the contention that winters with little frost or snow were exceptional. On December 27, 1710, Swift writes: "Did you ever see so open a winter in England? We have not had two frosty days." This was probably a *facon de parler,* for at least two frosts are mentioned previously, and one fall of snow. By a frosty day it must be supposed that the diarists meant more than a slight morning frost of one or two degrees in the screen. If this is so, the warmth of the early winter in 1710 was not very exceptional, judged by present-day standards. December 27, it must be remembered, corresponds to January 8 new style, but in the last fifteen years during which the writer has kept climatological records there have been four, if not five, winters when there has been no frost worth speaking about until after the middle of January, in Hampshire at any rate, and these were probably as "open" as the winter of 1710.

Swift, on the whole, takes rather more interest in the weather for its own sake than does Pepys. He compares notes with "Stella" on the difference between the weather in Ireland and in London, but, of course, most of the references concern the weather as it affected him personally. There are many complaints of cold, wet, and heat, and Swift seems to have had a constitution that was much affected by hot weather. It is curious to find that bad weather is frequently made an excuse for dining with Mrs. Vanhomrigh at the time when Swift was beginning that acquaintance with her daughter "Vanessa" which was fraught with so much tragedy.

[1] Quart. Journ. Roy. Met. Soc., vol. xlvi., p. 68.

Optical Instruments in Industry.

OPTICAL instruments, which proved their worth in war, are now being more and more utilised in developing the arts of peace. A short account of some of the chief applications of these instruments to industrial requirements, especially the more recent uses, may therefore be not without interest at the present time.

Passing over the microscope with a brief reminder of its modern use, in metallurgy, for showing the structure of iron and other metals, one of the first instruments to note is the refractometer. In many chemical works this, in one form or another, is invaluable as a means of controlling the various operations, by reason of the simplicity of its manipulation and the rapidity with which the results are obtained. The refractive index suffices in numerous instances to determine the strength of chemical solutions. It is ascertained in a few minutes, and only a drop or two of liquid is required for the purpose if an instrument of the Abbe type is employed. No weighings are involved, and no calculations if the temperature is suitably controlled, so that liability to error is greatly minimised. The instrument is thus almost an ideal one for the control of works operations where the degree of strength or purity of a product is required to be ascertained by means of rapid tests, or where a process has to be stopped when the product has reached a certain stage. Specific gravity determinations or simple chemical titrations are often used in such cases, but the refraction method is always quicker, is generally more accurate, and sometimes possesses other marked advantages. Thus the strength of an aqueous solution of nicotine can readily be obtained, correct within about 0·1 per cent., by the refractometer, whereas the specific gravity method is of no value in this instance, and titration results are vitiated if other basic substances, such as ammonia, are present.

Acetic acid, acetone, ammonia, ammonium sulphate, carbolic acid, cream of tartar, glycerin, and saltpetre may be mentioned as products, made on a large scale, for which the instrument is useful. In the brewing industry the determination of alcohol, extract, and original gravity of beer is readily made by means of the refractometer. In the fats and oils industries, in the fractionation of petroleum products, in the distillation of tar oils, and in the manufacture of many pharmaceutical articles, the refractive index is a valuable aid for controlling the purity of the materials and finished products. It is useful also in the manufacture of various viscous mixtures or semi-solid pastes, in order to determine whether the constituents have been adequately mixed, and thus to obviate local excess or deficiency of the active ingredients.

The polarimeter is an instrument constantly in use for the evaluation of essential oils, whilst makers of starch products, tartaric acid, and alkaloids frequently have recourse to it, and a

specialised form of the appliance, the saccharimeter, is practically indispensable in the sugar factory.

Mention must also be made of the simple polariscope in its application to the glass industry, where it is employed for detecting strains in glassware due to faulty annealing. Not infrequently glass articles, imperfectly annealed, are destroyed on the cutting-wheel after a good deal of time has been spent on their partial decoration. Use of the polariscope to detect strains is not new; makers of optical glass have, naturally, long availed themselves of it; but as regards ordinary glassware the method has been brought more prominently under notice as a result of war conditions, and the "strain viewer" is now becoming more generally known in glass works. The principle involved is merely that of the well-known transmission of polarised light through crossed Nicol prisms when crystalline or semi-crystalline material is placed between them. Well-annealed glass leaves the field of the instrument practically uniformly dark; strained glass produces patches or bands of light, the intensity and colour of which give some idea of the amount of strain.

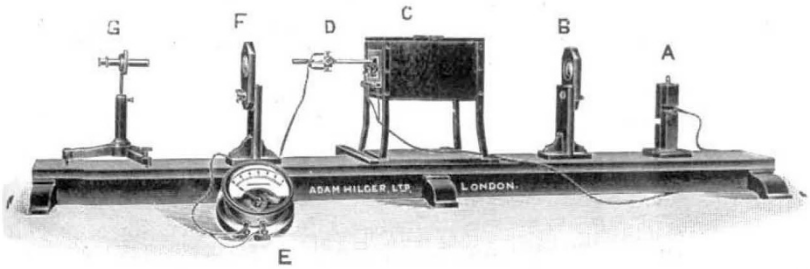

FIG. 1.—Twyman's apparatus for the determination of annealing temperatures. A, B, F, G, optical system; C, electrical furnace; D, pyrometer; E, temperature recorder.

In this connection it may also be mentioned that certain other faults in glass can readily be detected by means of X-rays. This discovery has proved very useful in making the best qualities of optical glass, by preventing the use of material in which "air-blows" had formed.

Twyman's apparatus may also be noted here. It is used for determining the annealing temperature of glass (Fig. 1). The method evolved for this purpose is applicable also to metal objects, so far, at least, as the removal of stress is concerned. Trouble during the machining of metals such as manganese-bronze, owing to distortion through stress, might often be obviated by proper annealing of the articles.

Among recent developments, perhaps the most notable is the fact that the spectroscope, in one adaptation or another, is beginning to take a definite place as an adjunct to industry. This follows upon the progress which has been made in fitting the instrument to quantitative work. In fact, it is the spectrometer, rather than the spectroscope proper, which is proving its value to the manufacturer. Hartley's work on quantitative spectrum analysis, dating from the eighties of last century, may be regarded as the pioneer investigation. He showed that the ratios of the intensities of lines in the spectrum of an element do not remain constant whilst the quantity of that element is decreased, and he introduced the term "persistency" to indicate whether a particular line appears at a definite concentration of the substance emitting it—*e.g.* 1 per cent., 0·1 per cent., and so on, of the total material under examination. This work of Hartley's was followed by that of Pollock and Leonard in Dublin, and of Gramont in France—to mention only three names out of many. Meanwhile, the earlier forms of spectroscope have given rise to the more perfect "constant deviation" wave-length spectrometer and the quartz spectrograph, with the result that it is now practicable even to carry out quantitative analyses of metals by means of their spark spectra (Fig. 2).

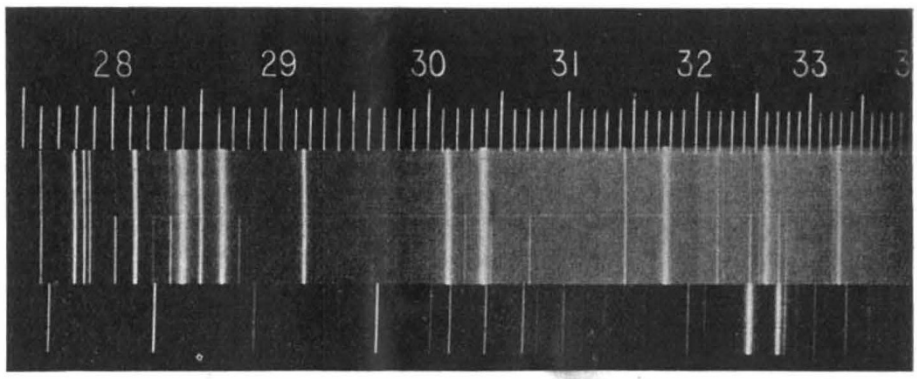

FIG. 2.—Print from negative taken on spectrograph with wave-length scale. Top strip, sample of reputed "pure tin." Middle strip, sample of commercial tin. Bottom strip, short exposure of copper spectrum. The presence of copper in the commercial tin is shown by the presence in the corresponding spectrum strip of the two copper lines at 3247 and 3274. A trace of copper is present in the "pure" tin.

Gramont uses two types of sparking apparatus (see *Comptes rendus*, 1918, clxvi., 95). In one of these the substance under examination is contained in a crater formed in one pole of the apparatus; in the second type the substance is fused in a platinum vessel, a spark being passed from a thin rod into the fused material.

This method has been used by M. Nicolardot in the chemical laboratory of the Technical Section, French Artillery, and according to Gramont it gives very satisfactory results in the control of chemical analyses. The spectrograph has also been for some time in use at the Bureau of Standards, Washington, for determining small quantities of impurities in tin and in the analysis of steel, especially as regards chromium and titanium. For estimating small quantities of elements such as niobium and molybdenum, the spectrographic method is, indeed, stated to be more trustworthy than chemical analysis.

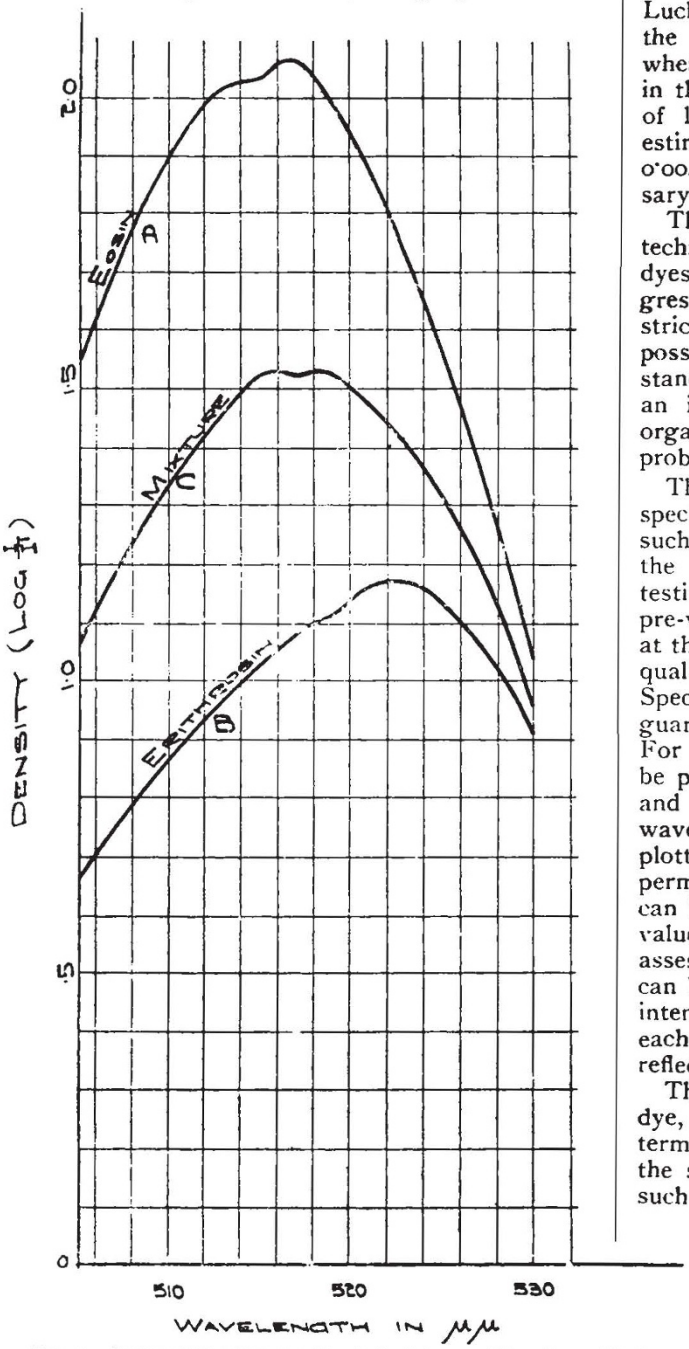

FIG. 3.—Curves plotted from results obtained in examining dyes with the spectrophotometer.

Another analytical method for metals has been described, depending upon a difference in volatility of the elements present. The authors (Hill and Luckey) use the "arc" discharge, and measure the time required for a given line to disappear when a known weight of the material is burned in the crater of the arc. Though this process is of limited application, it can be used for the estimation of lead in copper, within a range of 0·004 to 0·216 per cent., with the accuracy necessary for the work of a copper refinery.

The spectrophotometer, too, is now finding technical application, especially in connection with dyes. As the study of absorption-spectra has progressed, means for making the observations more strictly quantitative have developed also. The possibility of measuring the absorption of a substance for light of each wave-length is, in fact, an important addition to the resources of the organic chemist in dealing with certain technical problems.

The apparatus employed is a spectrograph or spectrometer combined with a suitable photometer such as the "Nutting" instrument. It is used in the control and analysis of dyes, the chemical testing of which is often a difficult matter. In pre-war days purchasers of dyes were very much at the mercy of foreign dye-makers as regards the quality and strength of dyes sent to them. Spectrophotometry can now be employed to safeguard the interests of the user in this respect. For example, a solution of known strength can be prepared from a trustworthy specimen of dye, and its colour-density determined for a series of wave-lengths by the spectrophotometer; a curve plotted from the results can then be kept as a permanent reference with which future supplies can be compared. Similarly the colour-producing value of a dye with various illuminants may be assessed by means of the instrument. Dyeing tests can be quantitatively controlled by comparing the intensity of reflected light from the dyestuff in each part of the spectrum with that of light reflected from a white surface.

The proportion of diluent substance added to a dye, or of two dyes in a mixture, may also be determined by reference to standard curves. Thus in the subjoined diagram (Fig. 3), A and B denote such curves for known strengths of eosin and erythrosin respectively, and C is a curve given by a mixture of the two substances, in unknown proportions. By taking ordinates for two suitable wave-lengths, two equations can be formulated, from which the proportions of the two dyestuffs in the mixture are calculated. From these examples the value, actual and potential, of the instrument to the dyeing industry will readily be understood.

Of other technical uses to which special instruments are applied, a brief mention must suffice. Thus in the iron and steel industry certain rapid

sorting-out tests can be made with the grating spectrometer and with the quartz spectrograph, whilst the projection comparator is a valuable aid, in engineering, for the ready optical gauging of interchangeable parts, such as screw-threads. An important development, too, is the use of radiography in the examination of metals; but this need not be dealt with here, as it was referred to in an article on "Industrial and Medical Radiology" in NATURE of February 26.

The British Sea Fisheries.[1]

THE latest book on the sea fisheries comes most opportunely at a time when everyone interested in these matters is looking for a policy. For the last two years a multitude of committees and conferences have been considering a situation that has become acute as the result of war conditions, but which was rapidly developing even in 1913. There was then a great recrudescence of interest in the longshore and inshore fishermen; there were the perennial questions of the impoverishment of the fishing-grounds and of how this might be averted; and there were indications, even then, of troublesome problems relating to the distribution and marketing of the fish caught.

The herring fleet in Fraserburgh Harbour. From "The Sea Fisheries."

There is no doubt at all that it is these latter difficulties that have been accentuated by the circumstances of the last two years. Such things as landing facilities, railroad and motor transport, market accommodation, cold storage and curing in order that gluts of fish might be utilised, cost of new construction, labour troubles, etc.—these are the matters that immediately and personally concern those engaged in the industry. The conditions are very different from those that obtained half a dozen years ago. Then there was practically no control; but one Government Department now has to do with railway facilities; another fixes wholesale and retail prices; while others again have to do with regulations of many kinds. The result is, for the present at all events, a confusion which is apparent to almost everyone.

Under our economic conditions the profit-factor in industry is still the dominant one. The bulk of the fish landed are caught in order that they may be sold so as to yield a "return" on the capital invested; otherwise no fish would be landed except the small fraction taken by individually owned boats and longshoremen who work for a living and sell their fish for whatever it will bring. How is the deep-sea fishing industry to be carried on so as to yield a sufficient profit?

[1] "The Sea Fisheries." By Dr. J. T. Jenkins. Pp. xxxi+299. (London: Constable and Co., Ltd., 1920.) Price 24s. net.