Structural Steels of High Elastic Limit.

THE demand for stronger, but still relatively cheap, steels in shipbuilding, and in bridge and boiler construction, etc., gives considerable importance to a paper on the subject recently presented by J. A. Jones to the Iron and Steel Institute.

It is well known that it is possible to increase the elastic limit and tensile strength of the steel by an increase in the carbon content, but a comparison of steels with identical maximum strengths shows that this method of securing high-tensile properties is much less satisfactory than by increasing the amount of manganese present. A higher carbon steel, with a given maximum strength, has a lower elastic limit, yield point, and elongation, and a much lower impact value than a lower carbon steel of similar tenacity obtained by the addition of more manganese. Its fatigue range is also lower than that of a low-carbon high-manganese steel, and it is, further, much more affected by slight departure from the most suitable conditions of normalising.

The improvement in the properties of these steels by the addition of manganese is very marked, but the amount present must be limited to a figure which varies with the carbon content. With 0·2 per cent of carbon, a suitable maximum percentage of manganese is 1·8 per cent, which falls to 1·5 per cent when the carbon content is increased to 0·35 per cent. These figures apply particularly to sections $\frac{3}{4}$ in. thick; the limits of manganese content being rather lower for thinner sections. A small amount of nickel increases the ductility of low carbon steels, but at least 3 per cent of this element is required to produce a steel belonging to the high elastic limit class, and it is suggested that the use of a small amount of chromium at a lower cost would appear to be more promising.

The influence of silicon in raising the elastic limit and tensile strength of mild steel has been known for a long time, and much interest has been shown in Germany lately in a steel containing about 0·1 per cent of carbon, 0·5 to 1·5 per cent of manganese, and 0·6 to 1·5 per cent of silicon. The tensile strength of this material is from 30 to 35 tons per square inch, but with a higher carbon content, increased tenacity may be obtained. The test results given show clearly that silicon raises the fatigue range and the ratio of the fatigue limit to the tensile strength to a greater extent than does manganese. With a silicon content of 1·5 per cent, however, a marked lowering of the impact figure occurred, and no silicon steel was found with all-round properties superior to those of a plain manganese steel containing 1·5 per cent of that element. Further, the higher silicon steels present certain difficulties in manufacture. The steel pipes deeply, involving a high percentage of discard, higher temperatures are required for annealing and rolling, and greater care must be exercised in reheating, in order to avoid cracks.

Owing to these difficulties in the production of silicon steel on a large scale, a new structural steel is being developed, containing approximately: carbon 0·15 to 0·18, silicon 0·25, manganese 0·8, copper 0·5 to 0·8, and chromium 0·4 per cent. The amount of scrap produced is small, and in spite of the additional cost of the special elements, the steel can be produced more economically, and with more reliability than can the silicon steel. It has a lower tensile strength than the steels considered in Mr. Jones's paper, but an increase in the carbon with an adjustment of the copper and chromium contents might lead to the development of a high quality steel with a high limit of proportionality and good ductility.

On the whole, it is concluded that of the materials examined a steel containing 0·3 per cent of carbon, 1·3 per cent of manganese, and 0·9 per cent of silicon yields the best mechanical properties. Normalised at 860° C., this steel gave the following test results:

Elastic limit	26·8 tons per square inch.
Yield point	29·8 ,, ,, ,, ,,
Maximum stress	45·6 ,, ,, ,, ,,
Elongation	30 per cent.
Reduction of area	63 ,, ,,
Brinell hardness	200
Izod impact value	44 ft.-lb.

F. C. T.

Scientific Uses of Gramophone Records.

THIRTY years ago, the possible use of gramophone records in phonological studies was realised and discussed at a meeting of the Vienna Academy of Sciences. Since then, large collections have been formed of records of all the European languages and dialects and of the speech and music of many of the primitive peoples. In archives are preserved at Vienna some 3000 records, at Paris 4000, at Berlin 10,000, and collections of similar size are to be found at important centres in all parts of the world. The first use of gramophone records in the exact sciences was in a rather premature attempt to analyse the physical nature of vowel sounds. Enlarged tracings of the grooves were obtained by a lever system from the slowly rotating record and were assumed to represent the original sounds.

Until quite recently no systematic research had been carried out upon the gramophone, but during the last few years the new electro-mechanical acoustics has been applied and has made possible the preparation of records of special value for many electrical and acoustical laboratory measurements and experiments. The Parlophone Co. has issued a set of three sound test records[1] prepared under the direction of Drs. E. Meyer and H. Salinger, of the Hertz Institute, Düsseldorf. The first record gives on one side when rotated at a speed of 80 revolutions per minute an almost pure sine wave output beginning at a frequency of 6000 and steadily gliding down to 100 Hertz (1 Hertz = 1 vibration per sec.). To overcome the difficulty of the stationary waves set up when such a record is used to obtain acoustical response curves with fixed apparatus in an ordinary room, the other side of the record is prepared to give a 'gliding howling' tone the frequency of which varies about 10 times per second by ± 50 cycles, whilst the mean frequency decreases as before steadily from 6000 to 150 cycles. The system of nodes and antinodes in the room is, therefore, continually shifting. The other records of howling tones give a frequency band which is traversed about 10 times per second, whilst the mean frequency remains constant at a selected one of eight possible values.

The Gramophone Co. (H.M.V.) also issues a list of fifteen double-sided 12-in. constant frequency records, which, when rotated at a speed of 78 revolutions per minute, are capable of giving any one of 100 different frequencies of 50 seconds duration, of which the lowest is 25·5 and the highest 8460 cycles. Many possible uses of these special records are indicated in the technical press, the Parlophone Co.'s leaflet,

[1] Sound Test Records. Three 12-in. d.s. with album and instructions. Obtainable only from Parlophone Co., Ltd., 85 City Road, E.C.1. 42s. net.

and in certain German publications referred to therein. In general terms one may say that, provided the records are used with carefully designed apparatus, they are capable of forming an inexpensive standard source of either acoustical or electrical vibrations over the very wide frequency range of some eight and a half octaves.

In conclusion, it may be noted that in the ordinary commercial electrical record now made to be played upon a mechanical gramophone, the grooves represent fairly accurately the original sound over a frequency range from 60 to 6000 vibrations per second, and especially so over the range from 200 to 4000 vibrations per second. This achievement is largely due to the comprehensive acoustical researches carried out in the Bell Telephone Laboratories, New York, and details will be found in the important paper by Maxfield and Harrison, "Methods of High Quality Recording and Reproduction of Music and Speech based on Telephone Research" (*Jour. Am. Inst. El. Engineers*, **45**, pp. 243-253; 1926).

W. H. GEORGE.

Marine Biology in Ceylon.

THE Administrative Report of the Marine Biologist for 1927, Part IV. Education, Science, and Art (F.), by Dr. Joseph Pearson, November 1928, Ceylon, includes reports by the assistant marine biologist on the pearl fishery, Gulf of Mannar; window pane oyster fishery; chank fishery and trawling survey with statistics, and by the second assistant marine biologist on field and laboratory work with notes on fishes and fishery problems. The work was done under the supervision of the marine biologist, Dr. Joseph Pearson, who contributes the introduction and reports on the research vessels *Nautilus* and *Violet*, with suggestions for suitable fishery vessels and a fishery base.

The report on the pearl fishery is very interesting, showing how quickly conditions change, and that whereas in 1926 in Donnan's Muttuwarattu Paar, which was specially investigated, the oysters were much on the decrease, in the spring of 1927, owing to supplementing of the original stock by drift oysters, they were in much greater numbers, again decreasing in the autumn. A discussion relative to the age of these oysters shows that they seldom live so long as five years, and that they should be fished at three and a half years on this particular paar, and probably on others. This is a very low age estimate compared with that of previous workers.

The chank fishery is apparently peculiar in that there is no substantial diminution in the yearly yield however much it is fished. No details are known with regard to the rate of growth and habits of this animal, and more research is needed.

The important and valuable fishing banks known as the Pedro and Wadge Banks up to 1927 had no charts of any kind. The trawling survey was begun in August 1927, and a Petersen grab is on order for bottom sampling. The figures for the analysis of the trawls are not quite correct, but an average of 207 fish per hour is taken as a low estimate, only fish of first-class edible quality being included. Assuming 20 hours trawling per day, this would give a daily catch of 4140 lb., or approximately 36 cwt. A much larger average is probably possible. Two important features are (1) that the catches are made up of a restricted number of species, which are of a convenient size both for storage and for market, and are equal in edible qualities to any tropical fish now marketed, and (2) there is very little waste. *Lethurus* (sea bream) comes first in numbers, 29 per cent, and *Lutianus* (snapper) second, 23 per cent.

The trawling investigations made by the Department in the seas around Ceylon are promising, particularly on these two banks described. These are the only trawling grounds so far discovered in Indian waters which show promise of successful exploitation. A fish-trawling company was floated in 1926, and during the year under review the company laid down one trawler which was expected to arrive in Ceylon about the middle of 1928. Twenty-seven per cent of the capital of this company has been subscribed by the Sinhalese.

It is a difficult matter to devise suitable boats for the inshore fishermen. This problem is now under consideration.

Much more research is needed into the economic problems, especially on the habits and life-histories of the principal food fishes, and there is abundant room for many more workers.

Theoretical Investigations of Ocean Currents.

THE mathematical investigations of Prof. V. W. Ekman into the dynamics of ocean currents have been directed chiefly to the study of 'type problems'; in these, friction is taken into account, but simplifying assumptions are made as to differences of density, the extent of the field, etc., so that his methods do not lead to quantitative results. He has now given us a non-mathematical account of his later work ("A Survey of Some Theoretical Investigations of Ocean Currents." *J. du Cons. Perm. Internat. pour l'Exploration de la Mer*, **3**, No. 3, p. 295, 1928), in which he shows what modification of his earlier results is necessary.

Starting from the well-known pseudo-force due to the rotation of the earth, which acts on a moving particle directly as its mass and velocity if the latitude is constant, he shows that, conversely, a particle which is acted upon by a constant force and is not otherwise constrained, will move at right angles to the force *cum sole*; its velocity, the 'normal velocity', and not the acceleration, will vary directly as the force. The original theory of the 'pure drift current' is modified by no longer assuming that the 'coefficient of virtual viscosity' is invariable, but no important change results; the spiral is still developed, but it is no longer equiangular, and the angle of surface deflection is not exactly 45°. Unlike the drift current, a slope current extends to the bottom, so that it is necessary to assume a layer in which bottom friction is effective; its thickness is the 'lower depth of frictional influence', corresponding with, but not equal to, the 'upper' depth. It is only in this lower layer that any transport of water in the direction of the slope takes place.

Out of this arise Prof. Ekman's recent investigations into the 'deep current' which lies above the bottom layer, and the effect on it of the topography of the bottom. A deep current running in the direction of increasing depth will experience a rotation *contra solem*. Further, since the velocity of the deep current increases from the pole to the equator, it will experience a rotation *cum sole* when directed towards increasing latitude.

These conclusions require some modification, the