

down of part of the machinery. There must also be a prospect of a reasonable cost of upkeep. Leaving warships out of account, oil fuel is only used on shipboard in those cases where the natural advantages render its use more economical than coal, and by vessels which trade regularly to ports where supplies can be obtained. For the ordinary cargo steamer which has to seek employment all over the globe, coal is still the necessary fuel.

The Diesel engine for marine purposes is made in three forms, viz., as a four-stroke cycle single-acting engine, a two-stroke cycle single-acting engine, and a two-stroke cycle double-acting engine. An auxiliary air compressor capable of producing a pressure of about 700 lb. per square inch is required. The author has examined the turning moment diagrams of different arrangements of cylinders, and shows that a four-stroke cycle engine with twelve cylinders, a two-stroke with six cylinders, and a double-acting with three cylinders give fairly uniform Forsion moments, the ratio of maximum to mean being not greater than 1.15. With these numbers of cylinders there is nothing further to be desired regarding steadiness of motion. The Diesel marine engine should be Diesel only as regards the cylinders and their accessories, and should be of the ordinary marine type as regards all the rest of the engine. The question of the auxiliary machinery required is fully discussed in the paper.

Dr. Diesel stated in the discussion that any kind of oil may now be used in these engines, and that the use of the two-stroke cycle may be assumed in future for marine purposes. Some 250 vessels are now fitted or to be fitted with Diesel engines, a large number of these being submarines. The use of Diesel engines in submarines has so extended their radius of action as no longer to limit their use for coast defence merely. About 1000 horse-power is the largest power obtained from one cylinder up to the present, the cylinder being of the two-stroke double-acting type. Some makers are prepared to give higher powers from one cylinder.

Messrs. Richardson, Westgarth and Co., of Middlesbrough, are now constructing a set of single-screw Diesel engines of 1000 horse-power for a 3200-ton ship to the order of Lord Furness. These will be of slow-running type. The Anglo-Saxon Petroleum Co. have on order a single-screw vessel of 4250 tons to be fitted with 1100 horse-power Diesel engines, to be built by an Amsterdam firm.

Considerations affecting local strength calculations form the subject of a paper by Mr. J. Montgomerie. It is a truism that there is no such thing in the calculations dealing with the strength of ships as an actual quantitative stress in tons per square inch. "To design a ship from first principles" is a phrase which is often used in a sense implying far too much. All calculations of the strength of ships are comparative. Structural arrangements of vessels which have stood the test of experience are taken, and are compared and contrasted with those proposed in any given case, or a corresponding arrangement is derived from them which shall be satisfactory in the case being dealt with. It is of importance to eliminate, so far as possible, errors lying at the root of the comparison. For example, the comparison of a beam of symmetrical section with another of unsymmetrical section by use of the ordinary beam formulae may produce very large errors. Again, errors often arise through want of proper consideration in cases of combined normal and shearing stresses. The effect of altered flexibility in a proposed arrangement often causes an entire change in the basis of comparison, and is generally uniformly neglected. Recent experimental work by Lilly on columns and Bach on flat plates was referred to. In connection with the latter subject comparatively little is known experimentally for rectangular plates fixed at the edges, and Dr. Thearle announced that the committee of Lloyd's Register had made a pecuniary grant to the author of the paper to assist in enabling further experiments to be carried out.

The acceleration in front of a propeller is the subject of a paper, in which Dr. R. E. Froude resists the inroad which a propulsion paper read by Prof. Henderson last year makes upon Dr. Froude's paper of 1889. The principal purpose of the latter was to prove from hydrodynamic theory that, in so far as the fluid acceleration by which thrust is satisfied may be treated as external to the propeller, one-half of that acceleration must take place

before the propeller in obedience to defect of pressure in front of it, and the other half after it, in obedience to excess of pressure behind it. Prof. Henderson's paper of last year purports to prove, also from theory, that the precedent acceleration cannot possibly contribute to thrust. In the present paper Dr. Froude reasserts his theory, together with such further considerations as appear to be called for by Prof. Henderson's paper.

Herr H. Frahm contributes a paper giving the results of trials at sea of his anti-rolling tanks. Reference has already been made to Frahm's arrangement in NATURE. When in full action, the tanks on the ss. *Ypiranga* and *Corcovado* exert a turning moment of 2790 foot-tons, thus counteracting wave impulses of equal turning moment. In order to obtain equal efficiency in damping out rolling, the same turning moment ought also to be exerted by any other anti-rolling device, such as a gyroscope, which might be fitted to these ships. It is doubtful if it will be possible to develop the gyroscope sufficiently. The ss. *General* (13,620 tons loaded displacement), of the German East African line, started on her maiden trip at the beginning of March. When crossing the Bay of Biscay, she encountered a storm which made her roll 14° on either side when the tanks were out of action. This was reduced by 7° or 8° when the small fore tank was put into action, and with both tanks in action, the rolling was reduced to 3° in either direction. A large working model was shown in the library of the Royal Society of Arts. The ship was set rolling in a tank by means of an electromotor, operating on the model by means of a very flexible flat spring. The model showed very clearly the efficiency of Frahm's tanks in reducing rolling.

Prof. E. G. Coker describes his optical method of investigating stress in plates of variable sections, and gives some applications to ship's plating. The method has been already noted in NATURE, and it may be now added that the author has developed a method of obtaining the stresses quantitatively. This may be done by subjecting a standard test-piece to such a degree of pull or push that the colour produced agrees with that at a desired point in the body under examination. Or by a method modified so as to get rid of the necessary judgment in matching colours; this modified method may be used in all cases of pull or push stresses, and consists in arranging a simple pull or push member in the same field of view as, and immediately in front of, the object under examination. To determine the stress at any point, the reference member is loaded until the original dark field produced by the optical arrangement reappears. When this happens, the stress in the reference member is the same as that at the point considered, and no correction is required for the alteration in thickness produced by the stress, since both test pieces are in exactly the same condition.

STATE SURVEYS.¹

THE true economy of executing land measurement of the highest precision as a control upon more detailed work, which can then be done more quickly and at less cost, is now generally admitted, and wherever the area is large such control work is carried out by a central administration for the use and assistance of local surveys. Methods will vary in different areas and with the special object in view, but such coordinated work on a large scale has great advantages over small scattered areas in which work is carried on independently.

(1) The operations of the Survey of India during the twelvemonth ending September 30, 1909, are described in the report which has just been issued. Primary triangulation was carried on in Beluchistan, Kashmir, and Burma over an area of 9600 square miles, besides a certain amount of building and selecting station; the average triangular of three groups completed were $0.41''$, $0.6''$, and $0.47''$. The 10-foot standard bar A having returned from Sèvres, whither it had been sent in 1908 for comparison with the international metre, was recompared with the secondary standard bar of the Survey, and the results show that it is

(1) "General Report on the operations of the Survey of India." By Col. F. B. Longe, R.E. (Calcutta, 1910.)

(2) United States Geological Survey, Washington. Bulletins 434, 437, Spirit Levelling, 1896 to 1900. Bulletin 440. Results of Triangulation and Primary Traverse, 1906-8.

improbable that any change took place in its length between the time that it left India and its return from Sèvres, so that the value of bar A, viz. 3047.996 mm. at 62° F. in terms of the international metre, is thoroughly trustworthy. Pendulum work was carried on in the western tracts of the Sâtpurâ hills and the Vindhyan plateau as an investigation of the variation of gravity in the northern portion of peninsular India, and at seven stations, situated at from 750 feet to 2100 feet above sea-level, excesses of gravity were found. At twenty-eight stations above 750 feet hitherto observed gravity has never been in excess, so that dissimilar conditions in peninsular and extra-peninsular regions seems to be indicated. Subsequent seasons' work is being extended over Rajputana and the Sâtpurâ hills to the Gangetic plain. Tidal records from nine stations, Moulmein being one which was re-established, and nearly 1100 miles of double levelling, occupied a portion of the staff, while the Magnetic Survey working in Burma completed the preliminary survey with a total of 1255 stations.

Some specially disturbed areas were surveyed in detail, and this work is being continued. Heavy prolonged rain at Dehra Dun eventually forced its way into the magnetograph room, and, rising within an inch of the top of the driving-clock pillar, necessitated the removal of the instruments on August 15, which were replaced a month later. The Topographical and Forest Surveys also completed the survey of a large area of country. In cartographic work, the results of the reorganisation of the drawing, engraving, and printing branches which was carried out since 1906 are now to be seen, and the publication of standard mapsheets has kept pace with the survey and drawing, besides there being a considerable increase in outturn. A specimen sheet of the 1 : 1,000,000 map, the strategical map of India, is given, containing the region round Bombay; roads, railways, and boundaries are strongly brought out, but the relief is shown by shading, which renders main features prominent, and by comparatively few inscribed altitudes.

(2) The Bulletins of the United States Geological Survey, which deal with higher surveying, furnish the final results of work done in the field after all corrections have been applied. The numbers stamped on the bench marks in the field represent the elevations to the nearest foot above mean sea-level as determined by unadjusted levels in the field, and those who require a higher accuracy than 2 feet must consult these bulletins or apply to the offices of the Survey. The levelling is classified as precise or primary according to the accuracy of method and precision of the instruments employed, and lines are run both forward and backward in the former case, but in one direction only in the latter. The allowable limits of error in feet are respectively $0.017\sqrt{D}$ and $0.05\sqrt{D}$, where D is the distance in miles. In the bulletins the position of each bench mark is described and its altitude given to 0.001 foot for both classes of work.

The results of triangulation and primary traverse are likewise given in periodical bulletins, which not only give the description of each station, its mark and reference mark, and geographical position, but also the azimuth, back azimuth, and the logarithm of the distance from it in metres of all points observed from it. An interesting map of the United States is included showing the astronomic location and primary control up to January 1, 1909. While much has been accomplished, large areas remain along the 101st meridian, in the Southern States, and many other parts to be completed.

THE STANDARDISATION OF COLOURS.

UNDER the title of "International Rules for the Specification of Colours," Mr. Hans-Jacob Möller has reprinted an essay by him from the Journal of the Danish Apothecaries' Association (*Archiv for Pharmaci og Chemi*, November 14, 1910) showing the importance of having an international scheme of colours so as to enable reference to be made to a definite tint on a definite scale, and recommending as the most useful and most practical scheme of the kind that drawn up by Klincksieck and Valette, a scheme based upon the original system drawn up by Chevreul. There can be no doubt that such a

colour scheme, recognised throughout the scientific world, would be of great practical value. For example, to take a very obvious instance, a large number of chemical reactions in connection with organic substances, such as dye-stuffs, depend upon colour changes, and if it was possible to describe these colour changes in accurate language, it would be of great practical value to the chemist.

When we come to the departments of pigments and of dye-stuffs, it is obvious that there, too, a definite recognised colour scheme would be of great practical value. It would, however, probably be better, if once a colour scheme was decided upon, that it should be reproduced in some permanent material such as coloured glass, so as to give a definite standard for reference at any future time, as a colour scheme which is merely lithographically printed may alter owing to fading of the colours, and if an attempt is made to repeat it, it is seldom that pigments can be twice reproduced with exactly the same tint.

On the other hand, an attempt to refer to definite lines on the spectrum is difficult in practice, as the use of the spectrum in this way for the matching of colours is not very easy, and it is not a satisfactory method. Mr. Möller does not refer to Lovibond's work on this subject and his scheme of coloured glasses. The present writer has found the Lovibond tintometer most useful and capable of very accurate matching, though the Lovibond standards are purely arbitrary. An arbitrary scheme seems the only possible one, and therefore, as Lovibond has devoted so much ingenious labour to the making and matching of his coloured glasses, there is a great deal to be said for defining tints by means of his tintometer, such a tintometer being kept as a standard of reference. Whatever may be determined, however, as the best practical solution of this question, it is certainly time that something of the nature of an international colour scheme be adopted, so that there should be no difficulty in referring to a definite scale and number in describing any colour.

A. P. LAURIE.

DIET AND DEVELOPMENT.¹

THE main impression left by a perusal of this exhaustive report upon the diets of labour convicts in Bengal jails, referred to below, is that the Indian Government has been well served in this matter, and has now in its possession advice derived so judiciously from soundly organised and ably conducted investigations as to justify what, on weaker evidence, might have seemed a parsimonious procedure, namely, some limitation of the too ample dietaries of these prisoners. The author may be said to have proved that their vegetarian diet, such as is the common food of the native population, has been provided in quantity so large as to escape digestion. No one will find reason to doubt his statement that this undigested material gives occasion to various forms of distressing trouble whilst in disordered transit through the alimentary canal of its consumers; not that this point is new, but that the condition has been very definitely shown as existing in this special and important case.

It would seem that, prior to this investigation, the diets had been arranged so as apparently to display the same "protein value" as a European diet. In the effort of imitating the heavy labour diet of English prisons with combinations of the native food-stuffs, meals of extraordinary bulk have been provided. Whereas, when added in small quantity to the varied constituents of a European meal, similar food-stuffs may yield so much as 80 per cent. of their contained protein for absorption into the tissues of the body, the author has shown that often no more than 50 per cent. is absorbed from them when found as the main constituents of a bulky meal, and this notwithstanding the fact that bulky meals are characteristic of the district, if to a somewhat smaller degree than within its jails. He has also proved that a certain ascertained diminution in this bulk, accompanied by an apparent diminution in the protein value of the diet, is always the

¹ "Investigations on Bengal Jail Dietaries, with Some Observations on the Influence of Dietary on the Physical Development and Well-being of the People of Bengal." By Capt. D. McCay, I.M.S. Pp. iv+226+15 charts. (Calcutta: Government Printing Office, 1910.) Price Rs. 2.6 on 45. 3d.

(Scientific Memoirs by Officers of the Medical and Sanitary Department of the Government of India, New Series, No. 37.)