These values of t_m and t'_m are the initial stresses or circumferential tensions; and as the powder pressure p_o increases them by equal amounts, their difference is unaltered; so that $t_m - t'_m$ is the same for the initial stresses or the firing stresses; and we may calculate the shrinkage, S, by the above formula from the values of the firing stresses, or of the initial stresses; the former being chosen, as given more directly when the maximum allowable tensions, represented by t_m, are given.

(43) As a numerical illustration, let us calculate the shrinkages in the American 8-inch gun, taking the previous results of § 22, and M = 12,600 (tons per square inch) for all the coils.

Then the final contraction of the bore

$$_0S_1 = t_0 \times 2r_0 \div M = 19{\cdot}9 \times 10 \div 12{,}600 = 0{\cdot}016,$$

or 16 thousandths of an inch; and similarly,

$$_1S_2 = 12{\cdot}7 \times 14 \div 12{,}600 = 0{\cdot}014;$$
$$_2S_3 = 10{\cdot}7 \times 22 \div 12{,}600 = 0{\cdot}019;$$
$$_3S_4 = 3{\cdot}6 \times 26 \div M = 0{\cdot}007;$$
$$_4S_5 = 8{\cdot}1 \times 32 \div M = 0{\cdot}021,$$

the elongation of the external diameter of the last coil.

Lieutenant Rogers Birnie, following Clavarino ("Note on the Construction of Ordnance," No. 6), calls the *extension* or *compression* the *relative elongation* or *relative contraction*; so that the above values of $_0S_1$, $_1S_2$, $_2S_3$, $_3S_4$, $_4S_5$, must be divided by 10, 14, 22, 26, 32, to obtain his values of the relative elongation or contraction; and then, by § 37, 150 thousand times the relative elongation or contraction is the number of degrees Fahrenheit a jacket or coil must be raised in temperature to be expanded sufficiently so as to slip over the inner cylinders.

A. G. GREENHILL.

(*To be continued.*)

THE TOKIO TECHNICAL SCHOOL.

THE *Japan Weekly Mail* in a recent article describes the Tokio Technological School, situated at Asakusa, a suburb of that city. The inclosure in which the school buildings stand formerly belonged to the Shôgun's Government, and was used for the storage of rice. Several of its storehouses, which were ranged round a creek or blind canal leading off the river, still remain, and are utilized by the institution. A frame building of two stories, the chief modern portion, faces the roadway and runs at right angles to the creek. Here are the offices, showrooms, and lecture-rooms; the workshops are to be found between this building and the river. There are two great departments in the school, the Technological and the Mechanical. Of these the former is the more varied and interesting. To it are attached a dyeing shop, porcelain and glass furnaces, and technological laboratories; to the mechanical department are attached a drawing office, a pattern shop, and a foundry.

The history of the school begins with its foundation in 1882, for the purpose of training foremen and managers for manufactories, and instructors for industrial schools. It was intended that the course of instruction should include all branches of industrial education concerned with arts and manufactures. The course was to extend over three and a half years, of which the first year should be devoted to general preparatory instruction and the others to special training in some particular branch. Next year certain alterations were made, making the course one of four years, and raising the standard. In August of that year the first batch of students, numbering sixty in all, were admitted. The school was shortly afterwards brought into connection with the Imperial University, and placed under the control of that institution—a step which led to a complete change in its curriculum. The preparatory course was abolished, and a short complete course, extending over two years, was instituted. Again, in 1888, a new Imperial decree severed its connection with the University, and placed it under the direct control of the Education Department. The school set itself anew to remodel its course of instruction, abolishing the short general course and resuming the course of three years; and elective courses were established with the view of making the school more popular and generally useful to mechanics and craftsmen. The laboratories and workshops are each provided with responsible superintendents, foremen, and assistants. The general direction is in the hands of a Committee, consisting of the manager of the school, two officials of the Education Department, and two officials of the Department of Agriculture and Commerce. Candidates for entrance to the regular courses must be not under seventeen nor over twenty-five years of age, and unless they have passed satisfactorily through a normal or middle school, must undergo an examination in Japanese, arithmetic, algebra and geometry, physics and chemistry, and English translation. Students sent up by local governments need not undergo this examination. The elective courses have been instituted for the benefit of artisans and mechanics, who, having no general scientific training, are anxious to study some part of the regular course. These candidates receive this privilege only when the convenience of the school admits of it, and are allowed to study for two years, taking one or more of the subjects immediately connected with their special crafts. An elective student must be at least seventeen years of age, and must have followed, for more than one year, some trade having special relation to the subjects of instruction which he has chosen. The fee paid by these students is about 3*s.* monthly.

In the mechanical engineering section-boilers, steam-engines, force-pumps—these last happen now to be in great demand in Japan as an improvement on the clumsy well-bucket—and sawing-machines are manufactured. The shop is also prepared to execute orders for steam and hot-water heating apparatus, and has already fitted up the new Engineering College in the University grounds with a complete set of hot-water pipes and fittings. All the casting and founding required by the College are carried out at the Asakusa School. An improved pattern of perforating machine, now in use at the Imperial Printing Office, is also turned out. It is claimed for this pattern that it possesses a superiority over the one in common use in Europe for perforating stamps and other paper. Experiments are likewise in process on printing-presses, with the view of perfecting a machine for native use. The dyeing department is chiefly concerned with practical instruction in the best methods of fixing colours, rather than in any more original researches. Of late years the importation into Japan of aniline dyes has increased to such an extent that the total annual value of these imports now exceeds £35,000. Unfortunately, although these colours are very attractive to buyers, their proper use is still little understood. Silk, cotton, and other fabrics which have been coloured by native dyers do not wash well, and half the imported dye-stuffs run to waste. It is one of the chief aims of the instructors in this department to teach artisans how to fix these colours. Just now the school dye-shop is busying itself with this particular branch, and also with a series of experiments on the dyeing of mountain silk. This silk, which is soft in texture and durable in wear, refuses the ordinary dye, a circumstance attributable to the presence in it of a large amount of calcium carbonate. The pottery and glass department is associated with the name of Dr. Wagner, who has for a long series of years enjoyed the confidence of the Japanese Government. Dr. Wagner is admitted to be the best authority on all matters connected with Japanese technology, and has directed his particular attention to the fabrication of a ware known in Japan as *asahi-yaki*, and elsewhere as Dr. Wagner's faience. Unlike the Satsuma, which is also faience, but of a much harder kind, this ware receives its decoration when in its unglazed state, which is a manifest advantage. It is made chiefly from a clay found in the Enya district of the Tochigi prefecture, with slight admixture of clays from other localities. The colour of the faience when baked varies from white, having a warm brown tinge, to lightish pink. Much of the *asahi-yaki* is exported to Germany and to the United States, and a certain amount to France, but little or none finds its way to Great Britain. Artists are at work on the spot decorating the plates and other articles preparatory to the receiving of the glaze. The object which Dr. Wagner and his colleagues have in view is technological and not artistic, and consists in perfecting native potters in the manipulation of the material.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for June 1890 contains:—On the embryology of a scorpion (*Euscorpius italicus*), by Malcolm Laurie (Plates xiii.-xviii.). The develop-

ment of this scorpion, of which very elaborate details are given, would appear not to agree closely with any other Arachnid type as yet described; the development of the central and lateral eyes entirely confirms the descriptions of Lankester and Bourne, as well as those of Parker, but Patten's conclusions are shown to be without foundation. The mode of formation of the ventral nervous system is exceptional among Invertebrates, resembling rather that of Chordata.—On the morphology of the compound eyes of Arthropods, by S. Watase (Plate xix.). Reprinted, with a short introduction by the editor, from a recent number of the "Studies from the Biological Laboratory, Johns Hopkins University."—On the structure of a species of earthworm belonging to the genus Diachæta, by Frank Beddard (Plate xx.). This new species, *D. windlei*, is from the Bermudas.—On *Hekaterobranchus shrubsoli*, a new genus and species of the family Spionidæ, by Florence Buchanan (Plates xxi. and xxii.). This worm was found at Sheppey in soft mud, usually covered by an inch or so of brackish water; in addition to the figures of the anatomical details there are coloured portraits of this Annelid.—An attempt to classify earthworms, by Dr. W. B. Benham. Some idea may be formed of the progress made within the last twenty years in our knowledge of this group when we state that the author enumerates and gives analyses of nine families of Lumbricomorpha, containing thirty-two genera and over 200 species. The author wishes the following correction made:—In Fig. 39, which illustrates the anatomy of Lumbricus, the œsophageal pouch (CP) is placed in somite xi.; followed by a pair of calciferous glands in the same somite and a second pair in somite xii. The pouch (CP) should be in somite x.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 19.—"Contributions to the Molecular Theory of Induced Magnetism." By J. A. Ewing, F.R.S., Professor of Engineering in University College, Dundee.

After referring to the discussion by Maxwell of Weber's theory, which ascribes the magnetization of iron and other magnetic metals to the turning towards one direction of molecules which are already permanent magnets, and to suggestions by Profs. Wiedemann and Hughes, and lately by Mr. A. E. Kennelly (the *Electrician*, June 6 and 13, 1890), the writer describes experiments which he has made bearing directly on the molecular theory. The experiments have been made by grouping near to one another a large number of small pivotted magnets each free to turn about a fixed centre, and studying the configuration which the group assumes and the manner in which it yields when an external magnetic force is imposed. The results do not support the idea that the molecular magnets form closed chains in unmagnetized iron. They lead, however, to the important conclusion that no arbitrary conditions of directional constraint need be postulated to make the behaviour of the molecular magnets agree with what is known about magnetic quality.

In the writer's view the molecular magnets are perfectly free to turn in response to external magnetic forces, except in so far as they are constrained by the magnetic forces which they mutually exert on one another. This theory is briefly discussed in the paper in relation to the form of the magnetization curve, to the character of cyclical processes, and to the known effects of temperature, vibration, stress and so forth, and the following conclusions are stated:—

(1) That in considering the magnetization of iron and other magnetic metals to be caused by the turning of permanent molecular magnets, we may look simply to the magnetic forces which the molecular magnets exert on one another as the cause of their directional stability. There is no need to suppose the existence of any quasi-elastic directing force or of any quasi-frictional resistance to rotation.

(2) That the intermolecular magnetic forces are sufficient to account for all the general characteristics of the process of magnetization, including the variations of susceptibility which occur as the magnetizing force is increased.

(3) That the intermolecular magnetic forces are equally competent to account for the known facts of retentiveness and coercive force, and the characteristics of cyclic magnetic processes.

(4) That magnetic hysteresis and the dissipation of energy which hysteresis involves are due to molecular instability resulting from intermolecular magnetic actions, and are not due to anything in the nature of frictional resistance to the rotation of the molecular magnets.

(5) That this theory is wide enough to admit explanation of the differences in magnetic quality which are shown by different substances, or by the same substance in different states.

(6) That it accounts in a general way for the known effects of vibration, of temperature and of stress, upon magnetic quality.

(7) That, in particular, it accounts for the known fact that there is hysteresis in the relation of magnetism to stress.

(8) That it further explains why there is, in magnetic metals, hysteresis in physical quality generally with respect to stress, apart from the existence of magnetization.

(9) That, in consequence, any not very small cycle of stress occurring in a magnetic metal involves dissipation of energy.

Anthropological Institute, June 24.—E. W. Brabrook, Vice-President, in the chair.—Mr. J. E. Price exhibited parts of a skeleton found at West Thurrock, Essex.—Mr. H. H. Risley read a paper on the study of ethnology in India. This paper states the results of certain inquiries into the customs and measurements of the features, stature, &c., of some of the chief tribes and castes in India, conducted during the last five years under the authority of the Government of Bengal. Owing to the influence of the caste system, which forbids intermarriage between members of different castes, India offers a peculiarly favourable field for anthropological researches. The measurements disclose the existence of two extreme types—the Aryan and Dravidian. The Aryan type—as represented by the Brahmans, the Rajputs, and the Sikhs—is tall and fair, with a finely cut nose, and features on the whole superior to those of the average European. The Dravidians, as seen in the Kol tribes, who recently revolted against the oppression of their Hindu landlords, are short and very black, with a broad flat nose, closely approaching in its dimensions to that of the Negro. The proportions of the nose are regarded by European anthropologists—by Prof. Flower, F.R.S., of the British Museum, and Prof. Topinard, of Paris—as the best test of race distinctions. The Indian statistics bear out this opinion. They show that in Bengal caste is so closely connected with race that the social standing of a caste is in inverse ratio to the average width of the noses of its members. The lower the caste the broader and more Negro-like is its nose; and conversely, in ascending the social scale, we meet with continually finer noses, till in the higher castes European proportions are reached. The proportions of the head are of interest in connection with the theory propounded by Herr Karl Penka, of Vienna, and favoured by Prof. Sayce, that the Aryans were a dolichocephalic (long-headed) race who came originally from Scandinavia. The long-headed type is very numerous in the Punjab and North-West Provinces at the present day, and its distribution is such as to give considerable support to Herr Penka's opinions. The inquiry has also brought to light the existence in Bengal of totems such as are found among the North American Indians. Large tribes, like the Kols, are subdivided into two or three hundred groups, each of which is called after an animal, a tree, or a plant; and the rule is that a member of a particular animal group, such as the snakes, the tortoises, the eels, or the mangooses, may not marry within that group. Thus a snake man may not marry a snake woman, but must select his bride from among the frogs, the tortoises, the mango-trees, or a host of groups which include the whole fauna and flora of the district. The paper attempts to account for this custom, which the late Mr. J. F. McLennan called *exogamy*, by connecting it with the theory of natural selection. Among other interesting facts the Bengal inquiry shows that the practice of infant marriage, and the custom forbidding widows to marry a second time, are greatly on the increase, and are being adopted by the lower castes as marks of social distinction. It is feared that the spread of infant marriage will have a weakening effect on the race, and will multiply and aggravate those special diseases of women which Lady Dufferin's Fund was instituted to deal with. The increase in the number of widows is in itself a great evil. It lowers the position of women in India, and tends to lower the standard of social morality.

PARIS.

Academy of Sciences, July 24.—M. Hermite in the chair.—M. Boussinesq presented the second and last volume of his "Course of Infinitesimal Analysis," and commented upon the