warranty would be on stock vendors. The breeders and feeders are certainly more to blame for disease and its non-detection than butchers; they should, therefore, be held more responsible. By eliminating the butcher's claim for compensation measures of control are simplified, because we then may deal with all stock and all claims under the Animals Diseases Act, which would provide assistance to the owners of stock and compensation for all notified disease.

Compensation at the rate of £3 for all animals below the value of £8 and compensation at a higher rate on all over that value would probably reach a cost of £100,000 in the first year and a constantly decreasing sum every year afterward until no disease existed. This is less than is now paid every year for the attempts to stamp out swine fever.

For this payment, what should we receive? A guarantee against human infection from animals, and a gradual but rapid suppression of disease among stock.

I have now laid before you arguments in favor of legislative action. I have shown what danger and loss the disease causes. I have offered an estimate of the probable cost of proper control.

I hope I have been able to prove that voluntary effort is insufficient, and that the protection of human life will be most effectively undertaken by measures which apply to all animals, and not to those only which are in the hands of butchers and cowkeepers. The cheapest and best method is the one which is effective; the most costly is that which the Royal Commission well described as "temporary and uncertain palliatives."—*Journal of the Society of Arts.*

INSTRUMENTS FOR MEASURING SMALL TORSIONAL STRAINS.*

By E. G. COKER, B.A., B.Sc.

THE advances made within recent years in the scientific testing of engineering materials have caused great attention to be paid to the design of instruments for measuring small strains. By far the greater number of such instruments have been devised for measuring the small strains of extension or compression in bars subjected to a direct pull or push, and but little attention has been paid to instruments for the use of engineers in the measurement of the small strains in a bar subjected to twist.

The object of the present paper is to describe two arrangements of apparatus intended for use in engineering laboratories and testing houses for measuring such strains and for the determination of the modulus of rigidity.

Each instrument is wholly supported by the test bar, being secured thereto by screws, which grip the bar at two transverse sections separated by a known interval, and the relative angular displacement between these two sections is measured directly. The instruments are adapted to measure both large and small strains, and are self-contained, while they can be used in a horizontal, vertical, or inclined position.

One form of the apparatus is shown by Fig. 1, and consists of a graduated circle, *A*, mounted upon a chuck plate, *B*, provided with three centering screws adjust-

FIG. 1.

ble by hand. A ring, *C*, secured to the test bar by set screws at a known distance away, carries a swivel arm, *D*, in which slides a tube, *E*, so that the contact ball, *F*, at its outer end can be brought into position touching the center of the faced end of a screw micrometer gage, *H*, provided with a divided head. This micrometer screw is mounted upon a vernier plate, *J*, of the graduated circle, and can be clamped in any position, the final adjustment being effected by a screw, *N*.

A silk-covered wire connects an insulated binding screw, *K*, upon the ring with the contact ball, and this wire is joined up in circuit with a simple form of galvanometer, *L*, and cell, *M*, to a second uninsulated binding screw on the ring. If the contacting pieces are touching, a circuit is completed through the test bar, and the galvanometer needle is deflected. If now a twisting movement is applied to one end of the test bar, the contacting pieces are separated, and the micrometer screw must be advanced until the circuit is again completed, as indicated by the galvanometer needle. The number of divisions through which the screw has been turned affords a measure of the angular displacement, and it only remains to calibrate these readings in terms of angular measurement. The calibration is effected by reference to the graduated circle and vernier plate.

The micrometer screw is set tangentially to the radial arm, and, therefore, its indications are nearly proportional to the tangent of the angle moved through; but if the faced end of the screw is always maintained at or about its central position, the error introduced by taking

the readings as directly proportional to the angular displacement is relatively small compared with the quantity under measurement, and may be neglected. To calibrate the instrument, it is, therefore, only necessary to measure the number of divisions corresponding to a small angular displacement of say 10', and this is easily accomplished by setting the instrument in position with the circuit complete, and afterward following up a known angular displacement of the vernier plate by the micrometer screw.

A single form of detector galvanometer, in circuit with a single dry cell, has been found to be a convenient arrangement for indicating when contact takes place, and the feeble current required does not injure the contacting surfaces. It is essential that the graduated circle be set accurately upon the bar, with its plane perpendicular thereto, and its center coinciding with the longitudinal axis of the bar. An arrangement has been devised to effect this, consisting of two similar and equal clamp bars, the eyed ends of which take over outwardly projecting cones arranged diametrically upon the chuck plate and ring. Each main piece has one degree of freedom with respect to the clamp bars, and, therefore, two degrees of freedom with respect to the other; these degrees of freedom are suppressed by projecting plates fitting against corresponding projections on the main pieces, and this connection makes the apparatus a rigid whole. The bar is now inserted and the screws adjusted by hand as accurately as possible. The clamp bars are afterward removed, leaving the two main pieces accurately spaced on the bar, while the graduated circle remains perpendicular thereto, and very approximately centered. The light contacting arm is then clamped in position and the bar may now be set in the testing machine. An improved clamp described with reference to the second form of apparatus may be used instead of the arrangement described above, and the hand-operated chuck plate may be replaced by a form of self-centering chuck described below. An example of tests made with this apparatus is given below. The test bar was adjustably secured at one end and a balanced lever of fixed length secured upon the free end and hung from the arm of a scale beam. The load was applied by placing equal weights in the suspended pans of the balanced lever and scale beam, so that bending movement was as far as possible eliminated. Before making a reading, the torsion arm was brought to a horizontal position by aid of a spirit level. The mean of the calibration tests gave 18.6 divisions of the micrometer screw as corresponding to an angular displacement of one minute of arc. Turned bar of Bessemer steel, length under measurement = 10.25 inches, diameter = 0.747 inch, torsion arm = 15 inches, a constant.

The second form of apparatus differs from the preceding in employing a reading microscope to observe the relative angular displacement of a radial line upon the vernier plate. The edge of a thick wire is a very convenient line for observation, and has been used with notable success in an extensometer designed by Prof. Ewing. (Proc. Roy. Soc., May, 1895.) The instrument is shown by Fig. 2, in which *A* is the graduated circle mounted upon a chuck, *B*, and furnished with a vernier plate, *J*, an arm, *O*, of which carries a wire, *P*. A reading microscope is carried in the sleeve, *R*, of an arm, *S*, mounted upon the short cylinder, *C*, which latter is gripped upon the test bar by screws. The reading microscope has an eye piece, *T*, provided with a

FIG. 2.

glass scale, and a right-angled prism, *U*, is interposed between this and the objective, *W*, so that readings can be easily taken. The tube, *Q*, is free to slide or rotate in its guide, *R*, but in order to readily focus the wire this latter is carried in a frame, *X*, pivoted upon the vernier plate, *J*, and adjusted by a screw.

The microscope arm, *S*, is secured to the cylinder, *C*, by a divided collar, the two halves of which are pivoted on one side and the free ends are clamped by screws. If it is desirable that the telescope be turned round or released altogether, the screw may be thrown out of engagement. Since the difference between an arc and its corresponding chord is an infinitely small quantity of the third order when the arc is an infinitely small quantity of the first, the readings of the microscope scale may be taken as directly proportional to the angular displacement, and the calibration is effected by mov-

FIG. 3.

ing the wire through a definite angle of 10', and noting the equivalent reading of the microscope eye piece.

This instrument is furnished with an improved form of clamp—Fig. 3—consisting of a pair of divided collars,

a, the halves being pivoted together at *b* and secured by nuts, *c*. The collars are wedge-shaped in radial section to engage with corresponding wide-angled grooves upon the chuck plate and cylinder, only the angled sides being in contact, so that the collars are readily fixed when required. The lower halves, *d*, of the divided collars are connected by one or more distance pieces, *e*, so that when the former grip their respective grooves each piece has one degree of freedom with respect to the clamp, and this can be suppressed by a pin or by the frictional grip of the collars, thereby causing the parts to act as one rigid whole for setting the instrument on the bar. The graduated circle of this instrument is carried by a self-centering chuck of somewhat novel form, and a section through this is shown

Fig. 4.

by Fig. 4, while a perspective view of the arrangement is shown by Fig. 5.

There are three centering screws, *A*¹, the outer cylindrical ends of which are supported in guides, *B*¹, and prevented from rotating by pins, *C*¹, engaging with slots, *S*¹, cut in the screws. The screws work in rotating nuts, *D*¹, provided with bevel pinions, *E*¹, gearing with a hand-operated bevel ring, *G*¹, so that all the screws are advanced or retracted together. An additional pinion, *H*¹, is provided, operated by a key fitting on its squared spindle, *J*¹, so that the screws are firmly gripped upon the bar. The inner ends of the nuts have a collar bearing, *K*¹, so that the stresses are borne by the body, *L*¹, of the chuck, and the bevel ring is prevented from seizing by bearing plates and an adjustable ring, *M*¹, at the back. This bevel ring can be slid back to allow any screw to be separately adjusted.

FIG. 5.

Other modified arrangements of the chuck have been tried, in which the guide pins have passed bodily through slots cut through the inner ends of the screw, and the screw pairs have been inverted, but these modifications have not answered well.

An example of tests made with this form of apparatus is appended, the same Bessemer steel bar being used: Mean value of calibration test, one minute of arc corresponds to thirty-six divisions of scale. Length under measurement, 8 inches; diameter, 0.747 inch; torsion arm, 15 inches, a constant:

Load, Pounds.	Reading.	Differences.
0	800	41
1	759	41
2	718	41
3	677	41
4	636	40
5	596	41
6	555	42
7	513	42
8	471	41
9	430	41
10	389	40
11	349	40
12	309	42
13	267	42
14	225	42
15	183	40
16	143	40
17	103	40
18	62	41

* British Association, Section G.

And we have for this test bar $C = 11,850,000$ pounds per square inch.

A second test gave very approximately the same result. Angular displacements of one inch can be measured with this form of apparatus. As the overhanging arm carrying the microscope is necessarily heavy to afford the requisite stiffness, the length under measurement is limited. For the purpose of making the angular displacement visible to an audience, a magnifying arrangement is used, consisting of a tilting mirror supported upon a tripod. Two legs of the tripod are supported by a hole and slot carried upon the vernier plate, and the third leg is supported upon a plane attached to the other main piece. The spot of light reflected from the mirror is caused to move over a fixed graduated scale, and the angular displacement is thereby made visible.

We are indebted to The Engineer, of London, for the article and illustrations.

THE USE OF MUSICAL VIBRATIONS AND CHROMATOSCOPIC FIGURES—A CONTRIBUTION TO THE THERAPEUTICS OF EMOTIONS.

In a recent number of The Medical Record there is an important article by J. Leonard Corning, A.M., M.D., of New York, entitled "The Use of Musical Vibrations Before and During Sleep—Supplementary Employment of Chromatoscopic Vibrations—A Contribution to the Therapeutics of the Emotions."

The method of treatment outlined is so novel and interesting that we give an abstract of certain portions of Dr. Corning's paper. To make a just estimate of the propositions constituting the burden of the paper entails some acquaintance with the psychology of the affective life. The feeling of the waking state, the psychology of sleep and of dreams are treated, then finally the author comes to his method of employing musical vibrations during sleep.

In the first place, he made a kind of hood of canvas

presence of the cap is sufficiently unusual to retard sleep at first. This difficulty may be readily overcome by giving the patient some appropriate hypnotic, fifteen or twenty minutes before retiring, or his power of attention may be exhausted by causing him to look fixedly at a bright object rapidly revolved and illuminated by a light so screened as to leave all else in complete obscurity. A disk of tinfoil rotated by clockwork behind a dark sheet of cardboard, perforated by an orifice sufficiently large to disclose about a square inch of tinfoil, answers every purpose.

The method to which he gives preference is the projection of chromatoscopic images, which possesses the advantages of the foregoing methods as far as fixing the attention is concerned, and has the added virtue of making a much more powerful appeal to the affective life of the subject.

The subject is placed upon a low divan and the acoustic hood is applied; a tent-like arrangement shutting in the divan, both above and at the sides, excludes the light completely. At the foot of the dark chamber thus simply constructed is a white screen stretched upon a frame. Outside of the curtained inclosure is a small stereopticon of short focus. Only the tube of the instrument protrudes through a small aperture in the drapery. Various chromatoscopic slides may be successively introduced into the slot of the lantern, and it is evident that accurate focalization makes it possible to project many-hued images upon the little screen at the foot of the couch—images whose ever-changing form and capricious beauty hold the attention with an ineffable enchantment. A small electric motor rotates the mechanism of the slide.

Harmonic vibrations are derived from an Edison phonograph placed in communication with the earpieces of the acoustic hood. Most of the music to be had in the shops is quite worthless for the purpose, but special cylinders can be made. The phonograph should always be operated behind closed doors in an apartment adjoining that occupied by the subject. The communication between the hood and the phonograph may be had by passing the conducting tube

a striking example of how great discoveries may frequently result from accident. Picric acid was discovered in 1771, and for more than a century was used as a dye for wool, silk, and leather, without its explosive powers being suspected. Some ten years ago a fire occurred at a chemical work in Manchester, and spread to a shed containing a quantity of this acid. Being melted by the heat, the acid flowed until it came into contact with a quantity of litharge stored in the same building. A terrible explosion followed, and subsequent investigation revealed the fact that under certain conditions picric acid behaved as a powerful explosive. Further experiments have made clear the necessary conditions; and at the present time picric acid bids fair to outrival all other explosives for the purpose of filling shells.

Before proceeding to describe the manner in which this body is caused to liberate its explosive power, it will be advisable to give a brief account of its manufacture and common properties, in order that the sequence may be made clear. Pure phenol, or carbolic acid (the common disinfectant obtained from coal tar), is placed in a vessel with an equal amount of strong oil of vitriol (sulphuric acid), and the temperature raised to the boiling point of water. Strong nitric acid (aqua fortis) is then allowed to flow into the mixture, after which the whole is cooled, leaving a solid mass of yellow crystals in the vessel. The crystals are filtered and drained, and afterward washed with cold water—when the residue is pure picric acid. The crystals so obtained have an intensely bitter taste, and for this reason have been largely employed on the Continent for the adulteration of beer. If handled, picric acid stains the fingers a golden yellow. If heated gently, it melts quite tranquilly, and may be poured from one vessel to another. If strongly heated, it chars with a slight fizzle; if hammered on an anvil, no detonation occurs, as in the case of most other explosives. A cursory examination, such as the foregoing, gives no indication of its latent powers, and it is therefore a matter of little wonder that they should have remained undiscovered for more than a century.

The shock necessary to explode picric acid in all its forms is furnished by a class of bodies known as "detonators." These are sensitive bodies which explode with great violence; and if placed in contact with a large mass of picric acid, the shock to which their explosion gives rise causes the whole charge to detonate, an extremely small quantity of the detonator sufficing to set into action an indefinitely large quantity of the acid.—Chambers's Journal.

HOW DYNAMOS ARE SOLD.

THERE is, perhaps, no commercial business so susceptible to ingenious twisting of facts as that which has for its object the sale of electrical apparatus, and this may be well illustrated by the common practice of a good dynamo salesman. Let us suppose, for instance, that we have a capitalist who wishes to install in his office building a 500-light dynamo. Relying on his own business shrewdness, which has stood him in stead for many years, he writes to a number of dynamo builders, and is soon surrounded by their agents, who are anxiously bidding to secure the contract. The various prices are submitted, each agent bidding on the nearest size which he manufactures. If the quality of the machines are equal in every case, the bids will be very close indeed, and in a measure proportional to the size of the machines. The capitalist will review the bids carefully and then talk with each of the representatives upon the merits of the machines in order to make a decision.

The lowest bidder does not need to argue very eloquently. He has the initial advantage, but it is not an infrequent occurrence that the highest bidder can readily carry off the palm. The shrewd agent will soon see that his price is high, and will admit as much to his prospective purchaser, but will say: "These other gentlemen are bidding on machines which will carry 500 lights and no more. The machine that I propose to supply you is specially designed to carry an overload of some 50 per cent. for four or five hours. The conditions of your load might be such that you will find this an extremely valuable feature. We rate our machines very liberally and allow ample margin for contingencies; for this reason we think we justly ask better prices." The prospective purchaser will take this matter very much to heart, and the chances are strongly in favor of his buying a 600-light machine disguised under the name of a 500-light machine able to carry overloads. If the agent had said that his machine would carry 600 lights, the buyer would have said, "I do not want 600 lights, 500 lights is ample;" but the idea of getting added capacity for practically the same money is most attractive.

Again, we have the case of the purchaser who has pretensions to electrical knowledge. In no case is the old proverb, "A little learning is a dangerous thing," more forcibly illustrated. The chances are ten to one the agent knows about as much of electricity as the purchaser, and the way they exchange high-flown technical terms to their mutual mystification is amusing in the extreme. To illustrate, an actual case in point may be mentioned—an instance where a certain man had been considering the relative merits of several bids for a dynamo machine for his factory. Some of the agents had been talking knowingly of losses, efficiency, rise of temperature, hysteresis, and other matters relative to the performance of a dynamo. The purchaser gathered that these various qualities were desirable qualities, arguing to himself if they were not, the agents would not have mentioned them; or more probably obtaining his idea from inference rather than argument. When the next bidder appeared and asked for an audience, he proceeded to talk of temperature rise, hysteresis, and like matters. The agent, likewise, at once inferred that these things were much to be desired in a dynamo. He was of German extraction, and he commended within himself, "If Thomas Huston and Edison had hysteresis in their dynamos, we must have some too." He succeeded, however, in arguing so well that he closed the contract, one of the inducements being that he should write to his firm and stipulate particularly that in the dynamo to fill this order there should be an exceptional amount of hysteresis.

Again, we are told of a case which seems hardly worthy of credence, but is said to be an actual fact—that of two bidders, one making a proposition on an

DR. CORNING'S METHOD OF TREATMENT WITH MUSICAL VIBRATIONS AND MOVING SLIDES.

or soft leather, which enveloped the whole head, extending forward over the ears, so that the face alone remained uncovered. Just at the point where the cap rests upon the ears, he caused the material to be cut, and a kind of metallic saucer was then placed over each ear and its margin, broadly flanged and perforated for the needle, was sewed to the edges of the opening. Each saucer was provided with a hollow metallic nipple, situated just above the ear and communicating with the inclosed ear space. A piece of small rubber tubing twenty five feet long was attached to these two nipples by a short bifurcation. The other end of the tube was connected with the reproducing mechanism of an Edison phonograph.

In spite of obvious imperfections, the phonograph presents incontestable advantages as a producer of powerful musical vibrations. Persons who suffer habitually from mental and physical atony in the morning, who are capable of little or no exertion before midday, and whose constant complaint is that they derive little or no good from sleep, no matter how long prolonged, often experience a decided revival of vigor if subjected to the vibrations of the phonograph during sleep. Dr. Corning's experience is that harmony is more effective than melody in his vibratory plan of treatment, and for this reason selections from Wagner's compositions render excellent service. Arpeggios and minor chords are likewise exceedingly effective. The simple appliance just described possesses many advantages; the least of these is its ability largely to exclude disagreeable or disjunctive noises. This is rendered possible by the careful padding of the edges of the metallic saucers where they press upon the cranial bones. The subject, as a result of this arrangement, is effectively screened from intrusive elements of environment whose presence could not but materially diminish if not wholly inhibit the benefits otherwise to be derived from the treatment. While soft, musical vibrations, far from interfering with sleep, tend rather to induce it, there is no denying that the

through the cut hole. By using two phonographs it is possible to avoid any break in the continuity of the harmonic vibrations. With the use of the apparatus which we have described, depressive ideas lose their ability to a certain extent to engender moods of corresponding somberness. In order to speak to the subject without removing the acoustic hood, a small speaking tube is connected with the phonograph tube, as is shown by the illustration. Suggestions made by way of this tube while the mind is engrossed by the sounds and colors have a semi-hypnotic effectiveness. Dr. Corning has submitted a number of his patients to the effects of musical vibrations for many hours during many consecutive nights at the time when he had every reason to believe that unconsciousness was most complete, and after prolonged and numerous trials he had become convinced that here, in this untrodden field, we have spread before us a host of new opportunities, not of theoretical acquisition merely, but of substantial achievement in the realm of the tangible and useful.

LYDDITE—THE NEW EXPLOSIVE.

PROBABLY one of the most interesting features of the Omdurman campaign, from a military standpoint, was the great success achieved by the lyddite shells, which, used for the first time in actual warfare by the British army, proved that lyddite is the best explosive as yet discovered for use in shells. It is the object of the present article to give a short description of this substance, which is destined to play an important part in the wars of the future. Lyddite is only a variety of picric acid, which has been melted and allowed to solidify, thereby becoming denser. Melinite, recently introduced into the French army, is also another form of picric acid; indeed, most of the so-called "new" explosives consist of this substance in one or other of its forms, disguised by different names. The history of picric acid as an explosive is remarkable, and furnishes