thing in its path. At temperatures to be found in places where carbide is stored during a fire it is not very probable that carbide would burn; at any rate, firemen should remember to keep water off it.

Carbide Works.—Although there are carbide plants at Lockport, N. Y., and Holcombs Rock, Va., they are not operating, the supply for the United States coming from Niagara Falls and Sault Ste. Marie, Mich. These works have shown remarkable development, both in quantity and quality of output. No one can realize the difficulties there were to contend with in bringing this simple process up to its present perfection. Outside of manufacture were such questions as irregular demand and consequent storage, of being managed by an office untrained in the business and who did not realize the needs of the works, of the general spirit of "booming" acetylene, regardless of fact and the mischief done by unscrupulous promoters in securing investments upon misrepresentations, the result being an unsatisfactory business and the dissolution of the operating company. While these unsatisfactory business methods were being practiced, the works under able chemists and electricians were gaining experience which finds its consequence in the improvements now going on and those just completed, and which have so increased the uniformity and quality of the carbide that 3 foot carbide is no longer to be had. The present situation, which will be of interest to all users or contemplating users of carbide, is as follows:

The Electro Gas Company own all the fundamental patents relating to electrical furnaces for reduction purposes, all carbide process patents and the principal patents relating to the use of acetylene, among which is one broad claim upon the use of acetylene for lighting. The Union Carbide Company has purchased the rights from the preceding to make calcium carbide and to sell it. They own the works at Niagara Falls and the "Soo," and operate them on their own account. Their purpose is to sell to generator users and large consumers principally, for which purpose they have divided the field into two districts, the Eastern and Western. The former has offices at 45 Broadway, New York City, and takes care of both the domestic and export trade, while the latter is in charge of W. P. Martin, 6 East Madison Street, Chicago. Carbide can be ordered from either of these places or contracts made, with the full assurance of a constant and uniform supply, as the works are now equal to the demand.

For use in portable lamps, such as bicycle or table lamps, the Electro Lamp Company has purchased the exclusive rights for the sale of carbide, but although they are makers of these lamps themselves, they will sell carbide to the users of lamps of any other make—a policy which is both generous and wise, and which will give a new stimulus to the industry. This carbide is selected stock, is dark in color, can be ordered in several sizes ranging from ¼ inch to dust, is packed in tin cases holding 2 and 5 pounds, the former retailing at about 25 cents, or in 100 pound cases at a lower price. This latter company, offices 45 Broadway, New York City, have a contract with the Union Carbide Company, at Niagara Falls, whose works are adjacent to theirs, for a continuous supply of carbide, so that orders can be promptly filled at all times. These carbide works have been so frequently described in electrical papers and proceedings that we will not touch upon it here. The Michigan works are especially active and have in operation a furnace which is of considerable interest. They are contemplating extensive additions to their works, have just given an order for twenty 500 horse power Walker generators to supply the carbide works on the American side of the "Soo," and made a contract with the water power company, who own a canal having a fall of 20 feet, for a period of 25 years, for the supply of 20,000 horse power and additional. The Union Carbide Company have a capital of $4,000,000, and are going into the business with an earnestness and method which is as refreshing as it is surprising in the carbide industry, and will no doubt bring their immense capital to bear with such telling effect that the rumors of orders for exporting carbide will be turned into fact, although there will be probably a dozen new carbide works put in operation in Europe during the next year. The product of the works in the United States during 1897 was 3,850,000 pounds, or 1,975 short tons.

In Canada the product of the Willson Carbide Works Company, at St. Catherines, Ontario, the only one in Canada, was, according to the official report of Bureau of Mines, 574 short tons during the 13 months ending December, 1897. From this and other official sources we find that during the 12 months of 1897, 80 tons of this was exported to the United States, 284 tons were exported elsewhere, and 196 tons were sold for consumption in Canada, making a total for the year of 560 tons. This carbide sells for $60 per ton. The sales are constantly increasing, being for Canada 9,361 pounds in January and 118,125 pounds in December. The exports to this country were none the first quarter and $2,120 the last quarter. This year's figures are not yet published, but no doubt we will import less since the new management has taken hold of our works. "To produce the 574 tons of calcium carbide, 768 tons of coke and 903 tons of lime were used, the value of the former being $2,646.37 and of the latter $2,707.39. The average number of workmen employed at the works was 30 and the amount of money paid out for wages during the year was $12,544.63." So says Director Archibald Blue. By this time the third lock on the Welland Canal, at Merritton, will be put in operation, placing 1,200 horse power at the disposal of the works, instead of the 800 horse power furnished by two locks during 1897. Willson has four furnaces in operation, 24 hours per day and every day (notwithstanding the scandal created by Sunday working), producing 3 tons of carbide daily. In 1896 the price was $80 per ton of 2,000 pounds, having dropped $20 up to the present time.

If the United States produced 3,850,000 pounds of carbide during 1897 and there was imported from Canada 160,000 pounds, there was a total of 4,010,000 pounds of carbide used. If we take the average yield of this carbide to be 4·8 cubic feet per pound, the acetylene gas used during that year aggregated 19,248,000 cubic feet. As 1 cubic foot of acetylene is equal in light-giving power to 10 cubic feet of city gas, the total would be equal to 192,480,000 cubic feet of illuminating gas. This would supply a town having a population of about 80,000 people with 25 candle flames. The prospects for 1898 are even brighter, so that acetylene for isolated lighting may now be looked upon as a commercial possibility.

ANALYSIS OF THE HORSE'S MOTIONS THROUGH CHRONOPHOTOGRAPHY.

The method that I have styled chronophotography, and which consists in taking upon a film that unrolls in the focus of an objective a series of instantaneous photographs of an animal in motion, is well known to the public in the form of animate projections. The photographic images that are projected successively at very short intervals become blended upon our retina into a continuous sensation which strikingly reproduces the appearance of the motion itself. But such images scarcely answer for the physiologist, who perceives therein nothing more than what an observation of nature would show him, that is to say, actions so rapid and complex that he is unable to seize the phases thereof. And yet the series of images contains all the elements necessary for obtaining a perfect knowledge of the motion of animals; but, to this effect, it is necessary to unite the images in a general figure with their relative positions in space, since a comparison between separate images is too difficult. Our mind does not preserve a remembrance of the first impressions faithfully enough when a series of others reaches us.

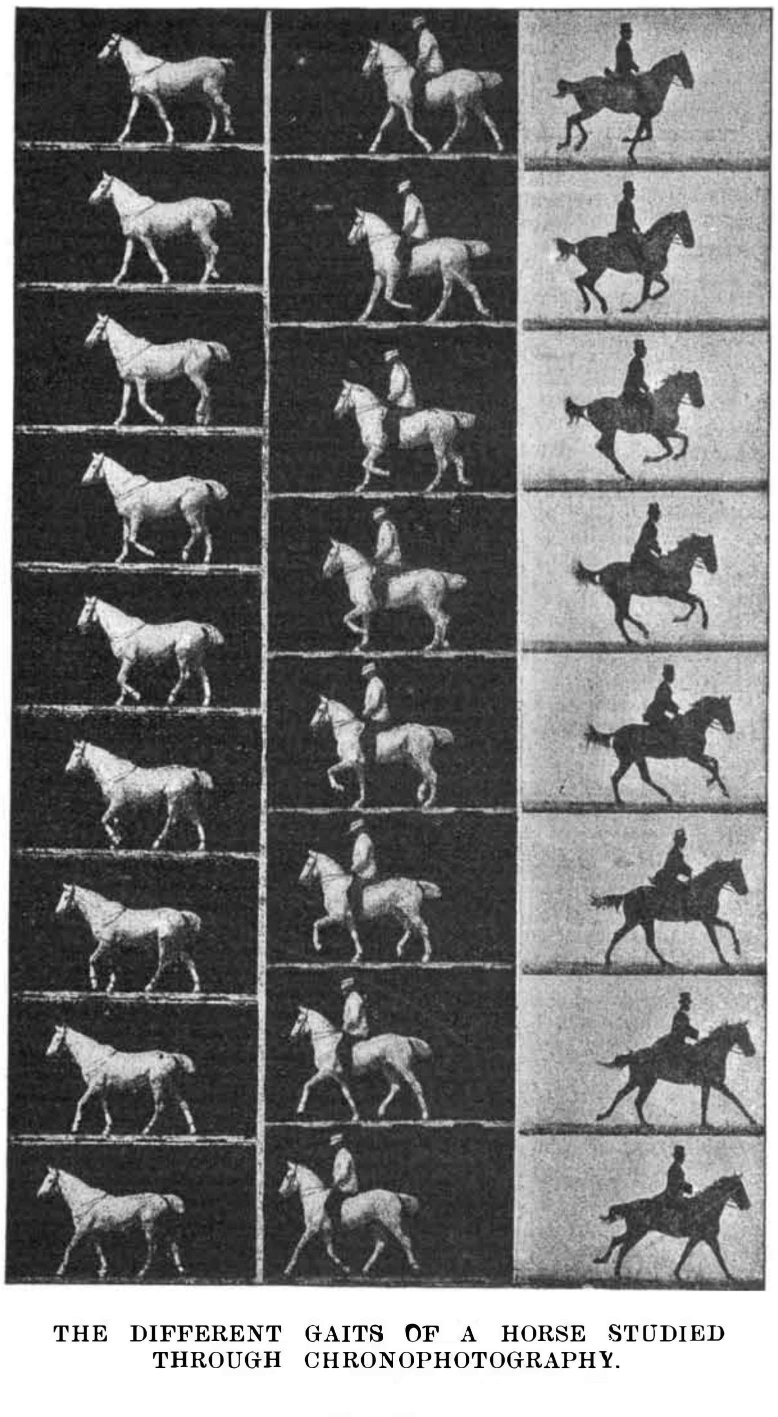
I once had recourse to a special method of chronophotography for the analysis of motions, and brought together upon the same plate a series of well-lighted images of an animal passing in front of a dark ground. This method was perfect in certain cases, such as when one operated upon an object or an animal of small dimensions moving with speed. The successive images then arranged themselves in their respective places without becoming confused with each other, and it was possible to obtain a true geometrical diagram of the motion under study. But animals of large size, especially in their slow gait, gave images that lapped over one another, those of their hind limbs becoming confounded in an intricacy impossible to decipher. Fortunately, by means of certain artifices, it is possible to assemble the separate images of the chronophotograph upon a movable film, and from this to draw a diagram of the motion. It is possible, even, to combine the form of the bones and muscles with the diagram of the external forms, and thus obtain a knowledge of the hidden mechanisms of which the motions of the animal are merely an external manifestation.

It is this method that I am going briefly to describe. For a starting point of the operations, we take a series of chronophotographic images of a horse such as are shown in the last of the accompanying engravings. The dimensions of the page have permitted of representing only half of a step, save with the gallop, in which the succession of the motions is more rapid.

The film that carries the images of a horse on a trot is introduced into a projection lantern. The luminous pencil, reflected upon a mirror inclined at an angle of 45 degrees, forms a large-sized image of the horse upon a horizontal sheet of drawing paper. The contours of the image are followed with a pen in limiting it at the head and right foreleg in order to avoid any confusion (Table I., Fig. 1). We likewise draw the line of the ground, the extremities of which will serve as datum points for subsequent projections. The image that we transfer in the first place is the last of those that correspond to the series of a step. We then project the second image and arrange the drawing board in such a way that this image shall be well in its place. This may be judged of by the perfect concordance of the ground line and its two extremities with the same points of the preceding transfer. In making this second transfer, we dot the contours that are regarded as covered by the image already drawn. The third image is drawn in the same way, and then the series of other images, until we have figured a number of attitudes equal at least to that which corresponds to the duration of one step of a trot.

These images thus assembled (Fig. 1) recall the results that chronophotography gave upon a fixed plate; but they present no confusion.

Table II., obtained in the same manner, represents the successive attitudes of the right hind leg. In these simple outlines, we already find numerous data as to the manner in which the fore and hind legs act, and as to the very similar trajectory of the two feet during their ascent, and as to the direction of the legs at



THE DIFFERENT GAITS OF A HORSE STUDIED THROUGH CHRONOPHOTOGRAPHY.

the moment at which they strike the ground and rise from it. It will be seen that, at the moment of the lifting, the animal lowers the neck and shoulders. This is the effect of the action of the levator scapulæ, the upper insertion of which is found at the vertebræ of the neck.

I shall not dwell upon these details, which have already been made known in a study upon the exterior of the horse by means of chronophotography.

It is a question now of determining in these images of the legs the position assumed at every instant by the various parts of the skeleton, and the state of contraction or elongation of the different muscular groups at the successive instants of the step. In the first place, as regards the skeleton, it is necessary to slaughter the animal, prepare the bones of its legs and photograph them on the same scale as the living animal. This constitutes the great difficulty of an experiment of this nature, if we operate upon a costly animal.

A favorable circumstance has supervened to overcome this difficulty. The state stallions, after they have been retired from service, have to be slaughtered. Prof. Le Hello, of Haras-du-Pin, has thus been able to have the trotter Tigris sent to the physiological station in order to be slaughtered there after being submitted to chronophotography.

Immediately after being killed, Tigris was dissected and his muscles weighed for future study. A skeleton of his legs was then prepared along with the articulations, in order that a photograph of them might be taken. These images of the skeleton, projected upon the same scale as the outlines of the animal, were cut out in such a manner as to give the various profiles of the bones under the form of small patterns that were fitted into the profile of the legs, and the contours of which were drawn as seen in Figs. 2 in the two tables.

It would have been impossible, and experiment has demonstrated it to me, to place in the profiles of Tigris the skeleton of any other horse whatever. Between one animal and another, there are differences of proportions too great between the osseous radii. In the present case, the two transfers fit of themselves with accuracy. It may be seen, in fact, that the osseous projections of which the relief is outlined under the skin fall well into their places. Here, then, we have the successive attitudes of the skeleton determined for the successive instants of the trot. This double figure, necessary for the construction of the diagram, may seem to be somewhat complicated if we wish to analyze the motions of the skeleton. This latter is isolated muscle at the moment considered. As the muscles are not contractile in their entire extent, but only through their red fibers, there has been taken from the straight line that represents each muscle a constant length at each of its extremities. This part corresponds to the tendons, while the middle part, marked with a darker line, corresponds to the contractile fiber. This diagrammatic representation has the advantage of rendering the elongations and contractions more sensible by placing such variations on a shorter line.

However, although the original figure was of somewhat large dimensions, it was difficult to grasp therein the phases of elongation or contraction of the various muscular groups. These phases have been rendered more sensible by means of curves which, in our two tables, surmount Fig. 4. They were obtained by placing as negative ordinates, under each image of the horse, a length corresponding to that of the muscle considered. In Fig. 4, the same letter designates the muscle and the curve of its changes in length. Thus, in Table I., which corresponds to the foreleg, the letter the hind leg, the antagonists, running from the pelvis to the leg, control the motions both of the haunch and the knee.

Despite such difference, we are struck by the analogy of the motions of the cubitus with those of the calcaneum. This shows, as has been observed by M. Baron, that functional adaptation has caused bones which are not anatomically homologous to acquire a similar action.

The curve, *C*, of Table II. represents the action of the gastrocnemii. It offers a singular peculiarity, for we here see small undulations in the direction of the contraction, although the extension of the muscle is limited, the curve of the maximum lengths being reduced to a straight line. Now anatomy gives an account of this exceptional phenomenon. The gastrocnemii contain in the interior of their contractile fasciculi a sort of inextensible tendinous cord. This latter does not prevent the muscles from shortening during their contraction, while in the phase of relaxing it opposes an insurmountable obstacle to their elongation. This arrange-

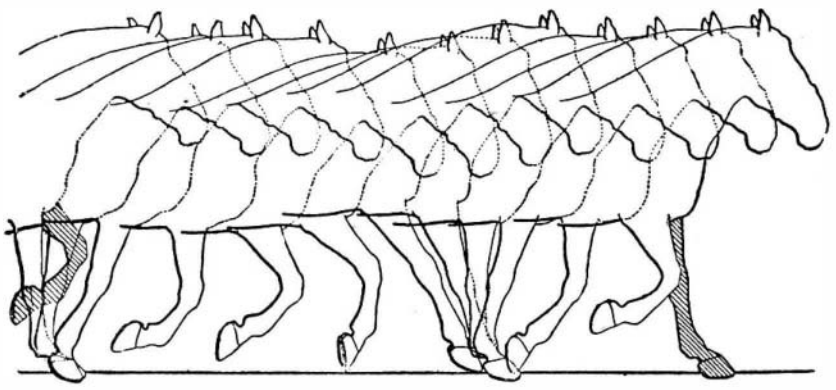


Fig. 1.—Successive Attitudes of the Right Fore Leg on a Trot.

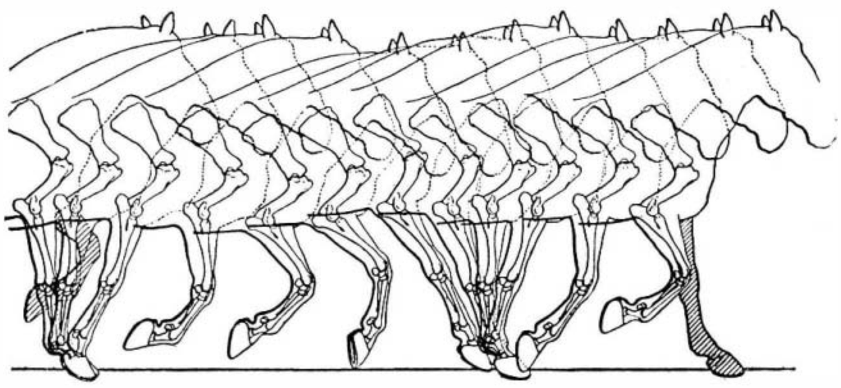


Fig. 2.—Positions of the Skeleton in the Interior of the Leg in each of its Attitudes.

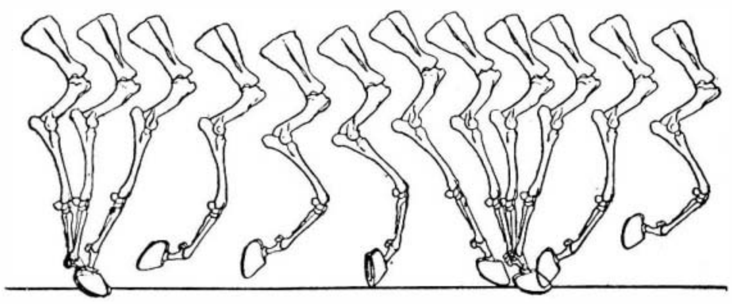


Fig. 3.—Attitudes of the Skeleton Alone.

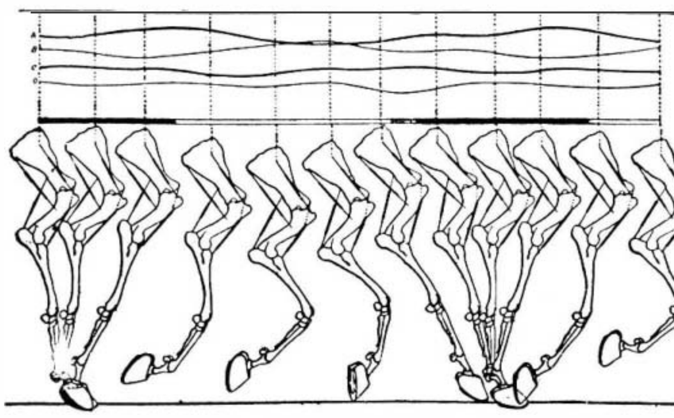


Fig. 4.—Skeleton—The Lifting and Planting of the Foot.

Curve of the various muscles: A, the teres major; B, the supraspinatus; C, the triceps; D, the biceps.

Table I.—TIGRIS ON A TROT (RIGHT FORE LEG).

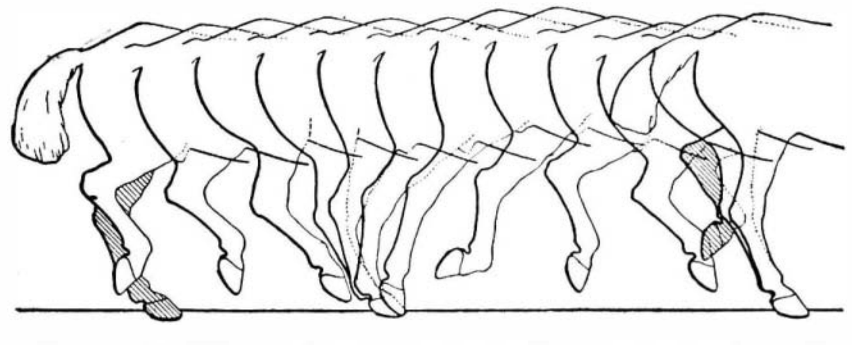


Fig. 1.—Successive Attitudes of the Right Hind Leg on a Trot.

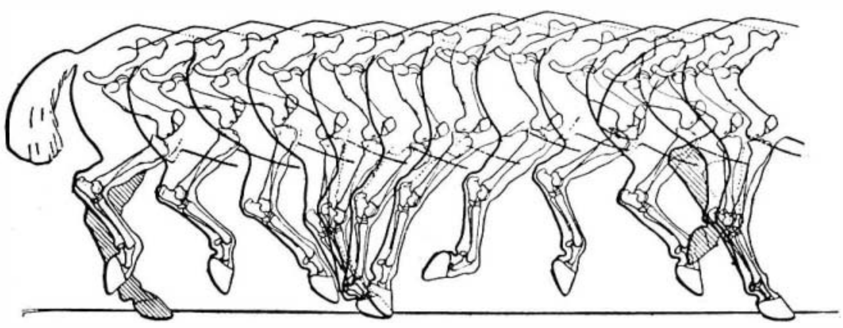


Fig. 2.—Positions of the Skeleton in the Interior of the Leg in each of its Attitudes.

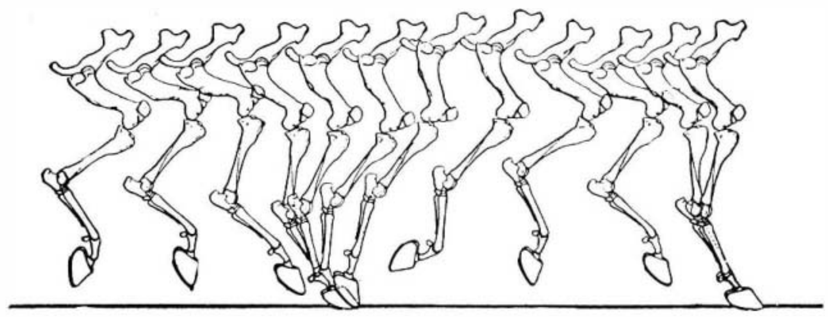


Fig. 3.—Attitudes of the Skeleton Alone.

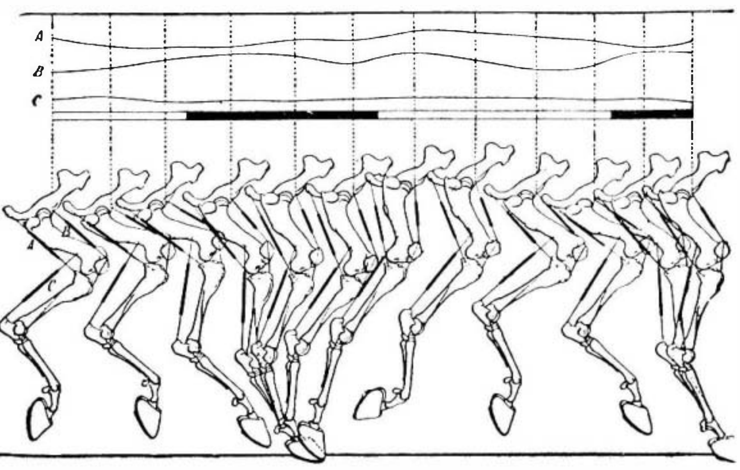


Fig. 4.—Skeleton—Lifting and Planting of the Foot.

Curves of the different muscles: A, the ischio-tibials; B, the rotulians; C, the gastrocnemii.

Table II.—TIGRIS ON A TROT (RIGHT HIND LEG).

in Figs. 3, which better translate the play of the articulations as well as the displacements of the shoulder and pelvis. It will be clearly seen, for example, that the shoulder descends under the weight of the body at the beginning of the lifting of the foot. At the end of the lifting, on the contrary, the shoulder is raised, as above stated, by the muscles which, on another hand, lower the neck and shoulders. But, aside from the various data given by a study of the skeleton, the latter permits also of knowing, at every instant, the state of contraction or elongation of the different groups of muscles.

Anatomists have determined the place of insertion of each muscle of the horse upon the bones. If, then, according to M. Barrier's tables, we mark in Figs. 3 the mean position of the attachments of a muscle, and if we join these two extreme insertions by a straight line, the length of the latter will represent that of the *A* designates the teres major with its scapulo-humeral insertions. This same letter is found again opposite the curve of variations in the length of the teres major. The same is the case with the supraspinatus, triceps, and biceps. Finally, in Table II., the muscles of the hind leg and their curves are likewise designated by the same letters in common.

An inspection of these curves shows that for each leg there exist muscles having alternating actions and one of which contracts while the other is relaxing. This is due to the alternate convergences and divergences of the curves, *A* and *B*, in the two tables. These antagonistic muscles are, in the fore leg, the teres major and supraspinatus and, in the hind leg, the ischio-tibials and rotulians.

However, the muscular actions are not homologous in the two legs, as the scapulo-humeral muscles act only upon the articulation of the shoulder, while in ment assures the interdependence of the articulations of the knee and foot, the extension of the first necessarily involving that of the second.

In order to show better to what moment of the action of the legs correspond the contractions of the different muscles, a notation of the planting and lifting of the foot has been drawn beneath the curves. A very heavy black horizontal line marks the duration of the bearing of the foot and a double white line the lifting of the same.

It is unnecessary to point out the many data that may be obtained from an inspection of these figures. One may pass from one to the other according to the details that he may desire to obtain therefrom. What has just been read suffices to show that from chronophotography may be naturally derived, through operations that are quite simple, a host of data upon the complicated mechanism of the gaits of the horse. It is from figures of this kind that Prof. Le Hello has established his new theory of the mechanism of progression.*

I have applied the same method to the study of the mechanism of locomotion in a large number of animal species and at different gaits. My object has been to study the anatomy and physiology of the locomotive apparatus comparatively.—E. J. Marey, in La Nature.

* Comptes Rendus de l'Academie des Sciences, June 8, 1896.

HOW TO SELECT A TELEPHONE.

By H. P. Clausen.

For the inexperienced telephone exchange manager it is a very difficult problem to select a telephone instrument best suited for his requirements. From the very beginning he has absolutely no confidence in the often conflicting statements made by rival manufacturers of telephone apparatus; therefore, he relies much more on an opinion given by the user of a certain type than he does on the claims of the maker of that particular instrument. On first thought it may appear to be the best plan to first consult the user of an instrument under consideration and then consult the manufacturer; however, this is not always true, unless, perchance, the instrument required shall meet the same conditions exactly as those that are met by the instrument of which a practical trial has been made. Therefore, if it become necessary tomeet conditions not found in the system tested, an instrument constructed on a radically different plan may be required; in fact, the instrument required for one class of service might be almost useless if employed in connection with an instrument built to meet other conditions, though both may have been constructed by the same maker, and in outward appearance differ in no respect whatever.

Suppose, however, that you have confidence in what a certain manufacturer might suggest, and that you ask him to quote a price on the telephone instrument it would be best to employ in connection with your system. The chances are that he will send you, with the price list, a few simple questions, which you are supposed to answer. If you neglect to furnish the desired information, but send an order, you may be sure that the order will be entered for instruments such as are employed for ordinary service, and perhaps not at all suitable for your requirements. Therefore, make it a rule to give the maker of an instrument all the information he wants relating to the manner and conditions under which you are going to operate the telephone. There is no better plan for getting just what you need, assuming, of course, that it is a responsible concern with which you are dealing.

Another suggestion for the "green" telephone manager is that it is far better when buying a telephone, the ins and outs of which he does not fully understand, to admit a little ignorance and let the salesman answer for possible mistakes, than to take the entire blame by exhibiting a superior knowledge of the apparatus under consideration.

When the necessity arises of purchasing a large number of telephones for exchange service the first cost generally receives the most consideration, whereas the maintenance expenditures that must develop sooner or later in a cheap grade of instruments seldom receive any attention at all. For use on the metallic circuit system the telephone employed need not be quite as expensively constructed as the instrument that is required to give an equally efficient service on a ground-return or common wire return (McCluer) system, for in the metallic circuit system the telephone is not liable to many serious interferences that are met with in the common return system. In contracting for a large number of telephones many points should be considered that may be relatively unimportant of themselves, but of considerable value in their relation to the conditions of operation and as bearing directly upon the question of first cost and operating expenses. The character and quality of the apparatus makes this unavoidable. Attention is therefore demanded for the essential features of construction. Let us examine the apparatus and consider the work it is intended to do.

The signaling apparatus of a telephone consists of the magneto-electric generator and a polarized magneto bell. The generator is employed at the telephone instrument for the purpose of enabling the user to conveniently generate an electric current sufficiently strong for the energizing of an electro magnet placed on the switchboard at the central office. The electro magnet is arranged with an armature and the call recording shutter, and when properly adjusted requires only a very small amount of current, that is, about 0·01 of an ampere, or, more clearly, the current that passes through an ordinary telephone receiver connected in series with one cell of battery should throw the annunciator drop. The average line resistance of a metallic circuit system usually is less than 300 ohms, and a magneto generator that will cause a call to be recorded over 10 times 300 ohms, that is, 3,000 ohms, would give an entirely satisfactory service. The generator, however, employed in connection with a ground return system should be capable of sending a signaling current through a line resistance of at least 6,000 or 7,000 ohms, for the liability of poor ground connections, partial grounds on the line wires, and other outside interference is great. Moreover, some manufacturers prefer to install a less sensitive annunciator drop at the central office, for the obvious purpose of preventing the recording of a call signal by every stray current that might pass over the line. The same rule, though somewhat modified, applies to the common wire system.

The signal receiving apparatus of a telephone consists of two polarized electro magnets, so set in relation to a movable armature that an attraction or repulsion of either pole will cause the armature to be moved to and fro. An extension of the armature is arranged for alternately striking one or the other of a pair of gongs, thus producing at the telephone the usual audible signal.

As a general rule, the first care of the wary purchaser of a telephone is to receive an assurance that the instrument he desires to purchase will ring through a certain resistance, usually 10,000 ohms, but sometimes this requirement is raised to 30,000 and even 50,000 ohms resistance. To meet such extreme and only too often useless requirements, the manufacturer is compelled to make a more sensitive magneto ringer than is actually necessary for giving an efficient service. Though it may be true that it is some satisfaction to be able to ring a bell through a very large resistance, it is equally true that a talking service is far from satisfactory, if obtained at all, between the extremities of telephone circuits over 7,000 or 8,000 ohms in resistance. Normally, the magneto ringer coils must be left in circuit with the line wires, and they are therefore always exposed to the damage that an accidental cross with highly charged wires might produce. For that reason the manager in selecting an instrument should make it a point to ascertain how much current the ringer coils will carry with safety, and not how small a fuse wire will protect the coils against burning out. The former, when known, will quickly help determine whether the fuse wire you must employ is of a sufficiently large size to warrant any certainty of action when the occasion arises.

The question has been asked by many: "What receiver is it best to employ, the single pole or the double pole?" Considering the first cost and the probable maintenance expense, there is little choice. The single pole receiver costs less in the first place, but calls for more attention, whereas the double pole receiver costs more but demands less attention when giving an everyday service.

There has been some discussion regarding the advisability of winding the receiver coils for a lower resistance for the purpose of eliminating somewhat the effects of extraneous disturbances, such as the inductive noises usually caused by high tension currents on wires running parallel or passing over the telephone wires of a common return exchange system. It may be said that there are in daily service double pole receivers wound for 6 ohms resistance, which give very satisfactory results, where the regular 75 or 100 ohm receiver was not at all satisfactory. The telephone receiver is a very delicate instrument and requires to be well made, but it should not be made more sensitive than is really necessary for the proper reproduction of speech, for it is the voice current that is to be conveyed to the listener's ear, and not the pernicious wail of every wayward line of force.

The telephone transmitter is a very important part of the telephone, and good judgment should prevail in its selection. Outside appearances go for naught. The fact that an instrument talks well on making a general test does not indicate that it will continue to talk well. The American Bell Telephone Company, with its numerous able engineers and immense corps of assistants, required over ten years of experimenting before the present standard, "the solid back," was developed and adopted, together with its inherent faults.

Most transmitters may talk well for quite a long while, but, after some time, there is a gradual falling off in the general efficiency—the batteries require recharging more often than seems necessary, the receivers, the line wires, the switching appliances, and the trouble men, are all called on to take a share of the difficulties an ailing transmitter may produce. The best plan to follow in the selection of a transmitter is to see that the containing case proper is made of solid metal. The diaphragm, if made of a metal, should be at least three inches in diameter, and if composed of a pressed carbon disk, it should not be less than two inches in diameter and well protected against accidental mechanical damage from the outside.

The office of an induction coil is to transform the variations of an electric current produced by a microphone, connected in series with the battery and the primary winding of the induction coil, into currents that have greater ability than the mere battery current would have of forcing their way through large resistances. The primary winding of an induction coil should consist of as few turns of wire as may be consistent with the transmitter and battery employed. The secondary winding, it must be remembered, is a part of the receiving circuit, and as it offers a certain amount of resistance to the so-called voice currents, its resistance, or more properly its apparent resistance, to the voice current should be comparatively low. Practically in a telephone circuit the best results are obtained when the apparent resistance of the telephone receiver and the secondary winding of the induction coil employed are equal. However, it may be safely assumed that the induction coil, when employed as a part of the telephone, will cause less trouble and require less attention than any other part of the instrument.

The telephone employing a local battery should be equipped with an automatically operated switch that either connects or disconnects the battery as needed. The switch must also produce at the proper time either of two conditions in the telephone circuit, that is, normally a signaling or call receiving circuit, and a talking circuit when the instrument is required for a conversational purpose. For practical reasons a switch that is operated by removing the telephone receiver from its support is the best for an ordinary service. The purchaser that has some knowledge of mechanics will have no difficulty in selecting a good switch out of a lot of fairly good switches; however, the primary requirements may be mentioned. The telephone switch must perform exactly the same functions as any other kind of electrical switch by connecting the battery to the transmitter circuit and the secondary circuit to the line wires. The mechanical construction of a telephone switch should be such that the friction of all movable parts is reduced to a minimum. The body of the switch should be constructed so as to allow rigid fastening to the containing case, and the lever or receiver supporting prong must be sufficiently strong for preventing any serious damage done by every careless operator. The electrical requirements are that the contacts must always be made firm. Perhaps the least possible sliding motion is an advantage when the contacts are at all exposed to the collection of dust particles, but as the sliding motion creates a wear at the point of contact, it is doubtless better to select a hook wherein the contacts are made direct and properly protected against the accumulation of dust. It is needless to say that all contact points should consist of platinum and be fastened to the springs proper either by clamps, wedges, or, what is the best plan, riveted fast directly to the springs.

Different people entertain widely differing opinions relating to the kind of wood that should be employed in building a telephone instrument. The old telephone manager, however, will not for a moment hesitate in recommending as the best a solid walnut cabinet, and with good reason, for the walnut woodwork will retain its true color always, whereas the originally bright color of the oak telephone is soon replaced by a fly specked and a generally unclean appearance.

The writer's lack of faith in the serviceability of the lightning arresters such as are usually placed directly on the telephone will not permit him to make any special recommendations. However, the presence of a grounded plate near the line binding posts, if mounted on a wood base, is a fire trap of the worst kind. Moreover, it does not offer the protection desired, for the lightning arresters should be mounted separately and on a non-combustible base in combination with a fuse wire of the proper size for protecting the telephone. Im many cases it is preferable to employ a fuse wire only, which, if properly constructed, offers ample protection against atmospheric discharges.—Western Electrician.

FOLK-MEDICINE IN ANCIENT INDIA.

"The most primitive witchcraft," says Sir Alfred Lyall, "looks very like medicine in the embryonic state." This is pre-eminently the case in ancient India, where it is not difficult to trace the history of medical science—such as we find it in scientific works on medicine, like the Charaka or Susruta—back to its early beginnings in the charms and witchcraft practices of the Atharva-veda, the most ancient compendium of sorcery.

In India, as elsewhere, the general doctrine of disease prevails that all abnormal and morbid states of body and mind are caused by demons, who are conceived either as attacking the body from without or as temporarily entering the body of man. The consequence is that primitive medicine consists chiefly in chasing away or exorcising these hostile spirits. This is done, in the first instance, by charms. The spirit of disease is addressed with coaxing words and implored to leave the body of the patient, or fierce imprecations are pronounced against him to frighten him away. But these charms, powerful as they are (in fact, there is nothing more powerful to the primitive mind than the human word, the solemn blessing or curse), are yet not the only resource of the ancient physicians or magicians.

From the earliest times people had become aware of the curative power of certain substances in nature, especially of herbs. This knowledge was first gained by experience, and, after it had once been obtained, people began to ascribe similar curative power to plants, as well as to animal and mineral substances for various other reasons. Analogy or association of ideas serves to explain not only many of the practices of primitive medicine, but also accounts in many cases for the belief in the curative power of certain substances. The principle that similia similibus curantur prevails throughout the whole range of folk-medicine. Thus dropsy is cured by water. A spear amulet is used to cure colic, which is supposed to be caused by the spear of the god Rudra. The color of a substance is of no small importance in determining its use as a medicine. Thus turmeric is used to cure jaundice. Red, the color of life-blood and health, is the natural color of many amulets used to secure long life and health. A black plant is recommended for the cure of white leprosy. But even the name of a substance was frequently a reason for ascribing to it healing power. One of the most powerful medicinal or magical plants is called in Sanskrit apamarga (Achyronthes aspera), and it owes its supposed power essentially to its etymological connection with the verb "apamarj," meaning "to wipe away," and in Hindu charms the plant is constantly implored to wipe away disease, to wipe out demons and wizards, to wipe off sins and evils of all kinds.

To wipe a disease away is a very common and a very natural means of getting rid of it. This seems to be the meaning also of that ancient method of curing disease by the laying on of hands, which is already mentioned in the Rig-veda, though it is also possible that it was intended to press the disease down by means of the hands in order to make it go out of the body. Some of the charms used with the laying on of hands point to still another explanation. As the priest had to touch the person for whom he was offering prayers and sacrifices, so it was thought that the imprecations could only have effect on a person if there was an actual connection between the medicine man and the patient. There is a striking similarity between this ancient Hindu custom and the modern practices of faith healing, in which, after all, prayer has merely been substituted for the ancient charms.

The two chief resources of folk-medicine, then, are charms and magic rites, the principal object of the latter being to bring the body into contact with some supposed curative substance. These substances are frequently applied in the shape of amulets or talismans.

The most ancient collection of charms is that found in the Atharva-veda, an excellent translation of which, with extracts from the ritual books, has just been published by Prof. Bloomfield in the "Sacred Books of the East" (vol. xlii., 1897). In the medical charms of the Atharva-veda the diseases are always personified. It is only our way of speaking when we say that diseases are supposed to be caused by demons. As a matter of fact the diseases themselves are addressed as personal and demoniacal beings. Thus Fever—"the king of diseases," as it is called in the "Susruta," the great work on Hindu medicine—is addressed as a demon who makes men sallow and inflames them like a searing fire. He is implored to leave the body, threatened with destruction if he does not leave it, and yet at the same time worshiped as a superhuman being. "Having made obeisance to the Fever, I cast him down below." This is a very characteristic way of dealing with evil spirits, which we find among all primitive people. The healing power, too, is addressed as a supernatural being and invoked to destroy the demon of disease. Thus the plant Kushtha (Costus speciosus), which was always considered by the Hindus as one of the most potent remedies against fever, leprosy, and other diseases, is addressed with such words as: "O plant of unremitting potency, drive thou away the fever that is spotted, covered with spots, like reddish sediment." In some of the charms against fever we meet with vivid descriptions of all the symptoms of malarial fever. We read in one charm: "When thou, being cold, and then again deliriously hot, accompanied by cough, didst cause the sufferer to