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.

## 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 every-day 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. In many cases it is preferable to employ a fuse wire only, which, if properly constructed, offers ample protection against atmospheric discharges.—Western Electrician.

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

## 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