sneezing. Shivering is a less effective convulsion to restore the paralyzed nervous energy, but in a lower degree it may answer the same purpose. The shivering that results from the effect of a poison on the nervous centers is a totally different matter. We speak only of the quick muscular agitation and teeth chattering which occur whenever the body is exposed to cold and evil results do not ensue. It follows from what we have said that the natural indication to ward off the effects of a chill is to restore the vital energy of the nerve centers, and there is no more potent influence by which to attain this object than a strong and sustained effort of the will. The man who resolves not to take cold seldom does."

THE TELEPHONE CENTRAL OFFICE SYSTEM.

[*Continued from first page.*]

is represented in the larger view in the engraving. Each person having the use of a telephone connected with the central office is called a subscriber, and his wire entering the office is connected with a small switch—a jack-knife switch; just below his name, and by this switch an electrical communication between the line and one of the annunciators above the switch is established or broken.

The arrangement of a telephone line in its normal condition is as follows: One wire from the subscriber's local battery is grounded; the other connects with the push button seen at the side of the desk. When this button is pressed the current from the local battery passes through the line wire, through the switch at the central office, through the magnet of the annunciator to the ground. The effect of the passage of the current through the annunciator is to release the little cover concealing the number of the subscriber's wire, permitting it to drop and expose the number. On seeing the number, the switchman connects his portable telephone with the subscriber's line, by inserting the plug at the end of the flexible telephone cord in the jack-knife switch. This operation not only connects the switchman with the line, but it also breaks the connection between the subscriber's line and the annunciator. The switchman's telephone being already connected with a battery and induction coil, and in condition to talk over the subscriber's line, he says to the subscriber, whom we will call A: "Well, A; what will you have?" A then says: "Connect me with B (say) at 25 Wall street."

The switchman then connects A's jack-knife switch with one of the long horizontal bars seen below; switches and turns the bar slightly, to indicate that it is occupied. He then goes to B's jack-knife switch; inserts one end of a flexible cord in the switch, and taps on a long brass strip connected with the central office battery, thus sending electrical impulses through B's line wire, ringing B's bell, when B removes his receiving telephone from its switch, and listens while the switchman connects B's jack-knife switch with the same horizontal rod that is connected with A. He then removes A's connection from the rod, and tells A "All right; go ahead," when the conversation between A and B proceeds. It takes only seconds to do what has required minutes to describe.

The boys attending the switches become expert and rarely make mistakes, although it is difficult to see how anything could be done correctly amid the din and clamor of twenty or thirty strong voices crying, "Hello! hel-l-o, A!" "Hello, B!" "What will you have?" "Who?" "Which?" "What?" "A-l-l right," and so on. It seems anything but orderly and systematic; but, nevertheless, it is the very embodiment of order and system. There are no less than six thousand calls per day; yet there is no delay, no mistakes, no trouble, save from the occasional breaking of a wire or the crossing and interference of one wire with another.

An idea of the activity of a telephone central office may be obtained from the larger view. The actual condition of things is far from being exaggerated.

It doubtless will be asked, How is it known at the central office when A and B have finished talking? The clearing out relays shown in one of the lower views, and at the farther end of the office in the upper view, indicate this. These relays, which are of comparatively high resistance, are each arranged to work a local circuit in which there is an annunciator representing one of the switch rods.

Each horizontal switch rod is connected with one of the relays, and all of the relays are grounded. Now A, having begun the conversation through the telephone, must indicate when it is ended; therefore, upon hanging up his receiving telephone, he pushes the button four or five times, working the relay, and consequently the annunciator connected with it, indicating that whatever is connected with the horizontal switch rod whose number corresponds with that of the annunciator, may be removed, and the switch rod may be used for C and D, or any one else.

One desk, seen at the right of the larger engraving, is the chief operator's desk, and the line-men, whose business it is to rectify troubles, get their orders at this desk.

There are upwards of 600 wires entering this office alone, and it requires over a thousand cells of battery to work this maze of wires.

Persons desiring to avail themselves of this means of communication subscribe to certain conditions, which require, among other things, the payment of a monthly rental, and the observance of the rules of the company. Men are then sent from the central office to place the telephone and battery, and to run from the subscriber's telephone to the central office a wire, supporting it at intervals by poles and fixtures as in the case of telegraph lines. The line and the instrument are kept in order by the company. Any imperfection in the action of either reported to the chief operator's desk at the central office receives immediate attention, men being sent out at once to find and remedy the trouble.

An alphabetically arranged list of subscribers is furnished with each telephone, and as new subscriptions are made, supplementary lists are furnished to all subscribers.

Among the recent improvements in telephone exchanges is the portable switchman's telephone, which is clearly shown in the lower left-hand view in the engraving, and the switch rods, shown in the same view, and also in the larger one. The latter are the invention of Mr. T. G. Ellsworth, the manager of the central office. They certainly save a great amount of labor, and prevent confusion and trouble.

The telephone, like many other modern inventions, needs to be used to be appreciated. It is wonderful enough that we are enabled to talk to persons in all parts of this great city, but when we can talk without difficulty with persons in neighboring cities, it becomes even more wonderful and interesting. The lines which connect New York with Newark run under the North River. Those that connect New York and Brooklyn are suspended from the East River bridge towers. The wires may run underground, under water, or high in air.

The large and rapidly-increasing number of telephone lines indicate the growing popularity of this means of communication, and we confidently expect at no distant day to see it almost universally adopted for business and even domestic purposes. Already the wires extend in every possible direction from the central office, and fairly darken the sky in some localities. The Gold and Stock Telegraph Company have in this city three exchanges similar to the one we have described, connected with each other, and, with the central office systems, several of the adjoining cities. Jersey City, Newark, and Orange, N. J., and Brooklyn, N. Y., are so connected. Yonkers, and, in fact, all of the other important cities surrounding New York, will undoubtedly be telephonically connected with the metropolis before the beginning of another year. We understand New York and Philadelphia are soon to be connected in this way. The convenience of such means of communication is thoroughly appreciated by business men, whose operations are confined to a few hours, and whose time is valuable. The SCIENTIFIC AMERICAN has constant proof of the utility of this invention, as there is scarcely an hour in the day that the telephone in the office is not used in communicating with some one, either in this or one of the adjacent cities.

ON THE DEPHOSPHORIZATION OF IRON.

BY PROF. MAURICE KEIL.

Science has of late years made fast strides, and one scientific fact after the other has been forced to yield the point which it is the business of our utilitarian age to force from facts. In the chemical metallurgy lately the perfection of the process for the dephosphorization of iron has caused quite a sensation, and has set scientists to work for further investigation. Not long ago the convenient and economical use of our most reliable metal—iron—was hampered by the facility with which it rusted and decayed. Once attacked by rust, the rust point was a center from which proceeded further corrosion with fatal rapidity; but also in this instance, true to the exacting spirit of the age, nature has been made to yield up her secret, and iron is to wear in future a protecting coat of oxide of iron, to the perfection of which centuries testify.

In the new dephosphorization processes of Krupp and Bell, and of Thomas and Gilchrist, a problem has been solved which has baffled the scientific world for years. And it must be admitted as a great invention, the importance of which it is scarcely possible to exaggerate. In the light of the past history of inventions, it is not surprising to find that the development of this important process is not the work and thought of one man. The same end certainly has been accomplished, independently, but by different means. The importance of the invention lies in the fact that, while up to the present districts which had only at their disposal iron ore of a phosphoric nature exclusively, were not able to produce any forged iron or steel, will now be able by means of this process to work iron up to any imaginable form or shape or manufacture steel. This process will certainly also revolutionize a complete alteration in the relative iron production for the future.

As remarked above, both processes are alike in principle but different in execution. The process of Krupp and Bell is divided into two stages. First, elimination of the phosphor (100 parts of iron melted in a cupola oven to 15 of oxide of iron, or 25 per cent consumption of ore if worked in a Siemens-Martin furnace) in a rotating oven attained a reduction of the phosphor from 0·6 to 1·2 up to 0·13 to 0·3, therefore a refining, and afterward conversion of the refined iron in the converter. Silicium iron must be added to the product, as this is taken away in the first stage.

In the Thomas and Gilchrist process both stages are united in the converter, as by means of a basic lining and basic flux the elimination of the phosphor is produced, as shown further on.

Taking particularly this process the last experiments that have lately taken place in an eight ton converter fully demonstrate the complete success of the invention, which is as follows:

The converter used for the experiment was lined with basic bricks, of the following chemical composition: SiO_3 = 9·50, CaO = 50·21, MgO = 21·50, Al_2O_3 = 10·00, Fe_2O_3 = 4·46 NaO = 4·00, and it had a perforated bottom of dolomite, for want of the exchangeable pipes, which could not be obtained, as they had not been manufactured.

The gray Cleveland pig iron, which had been remelted in a cupola oven, contained: Si = 3·030, C = 3·200, P = 1·800, S = 0·030, Mn = 0·450, of which 5 tons 18 cwt. were poured into the converter.

Directly afterward there were poured in (about 20 per cent against the above in-put) 21 to 24 cwt. of flux of a mixture of limestone and oxide of iron (20 to 27 per cent of blue billy), which before had been melted together into firm pieces of the following chemical composition: SiO_3 = 1·000, CaO = 60·000, Fe_2O_3 = 31·890, CO_2 = 6·400. After which the converter was raised upright and blown with 120 cm. column of quicksilver.

By the first charge, after four minutes the line of natron appeared in the spectrum, while during the period of boiling a large quantity of iron was thrown out; after 17 minutes the green lines had disappeared, and by usual hematite melting the process would have been finished with this charge. But the blowing was continued for another 1½ minutes, the converter tilted, and a proof taken in the usual manner, which still showed a luminous grain proceeding from considerable alloy of phosphor. The process was therefore continued for another minute and 22 seconds, after which no trace of phosphor was perceptible. Now followed the addition of spiegel iron in a liquid state, containing 22 per cent of manganese, in proportion of 9½ per cent to the pig iron put in, which created a violent reaction, and the slag was thrown out in powerful columns of flame. On the pouring out in the casting pans the steel appeared agitated and of soft quality, but rose in the pans and was uncovered in the usual manner. The converter, after running quite empty, did not show the least trace of injury, the borders of the bottom perforators were strongly marked, the joints of the bricks were regular, somewhat darker as the glowing brick matured, but perfectly uninjured. The finished steel showed the following composition: C = 0·171, Mn = 0·160, P = 0·223, S = 0·037, Si = traces.

The blocks were afterward transferred to the gas furnace and rolled in quadruple lengths for rails. The experiments were highly satisfactory, and a special advance to the Bessemer process.

MECHANICAL INVENTION.

An improvement in windmills, patented by Mr. Thomas Dewees, of San Antonio, Texas, consists in arranging three stationary sails between arms on central shaft, so as to obtain double or increased power from the air passing through the wheel.

MIASM AND FEVERS.

Abundant experience has already established the following facts regarding the appearance of intermittent fevers and the causes which are designated as *malaria:* First, that the real cause is to be sought for in the soil, where it is developed in greater intensity under favorable conditions of heat and warmth; second, that this poisonous substance, when the surface is dry, is lifted up a little above the surface by ascending currents, and can then be carried further or raised to a greater height by stronger draughts of air; third, that this substance, the cause of the malaria, is not developed in every soil of the same composition and the same degree of moisture, a circumstance which has repeatedly led to the assumption that it possesses the nature of a specific organism, which requires for its development not only the most favorable conditions, but first of all a *germ* from which it is developed.

From time immemorial the Roman campagna has been known as one of the poisoned plague spots of the earth, hence the interest that naturally attaches to the investigations made there last spring by Klebs and Tommasi-Crudeli.

The malarial powers of different kinds of soil, of water, and of air, were tested. The solid and liquid portions of the former were tested separately. Under the supposition that the germs of the disease were organism, substances rich in infective matter were exposed to those conditions which have been found by experience most favorable to the development of the disease (30° to 40° C., or 86° to 104° F.; plenty of moisture deeper in the soil and rapid evaporation on the surface). Small particles of substances thus prepared were transferred to different liquids for cultivation, and then experiments were made to determine whether, after frequent successive fractional cultivation, the same activity was present as in the substance first employed. Finally, the liquid was mechanically separated from the solid microscopic particles in the cultivated liquids, as in the original, by filtration through gypsum and other filters, and the relative activity of filtrate and residue separately examined. To test the activity of these different substances they were injected hypodermically into rabbits; the temperature was measured every two hours, and the dead body examined. The regular intermission of the fever and the swelling of the spleen and want of other changes were employed as guides and measurements.

The results may be briefly summarized as follows.

1. The malarial poison is found in large quantities and largely disseminated through the soil of malarial districts at a season when people are not yet attacked by disease.

2. At these times it may also be obtained, in especially