BRANCH DISCUSSIONS.

DISCUSSION AT UNIVERSITY OF ILLINOIS, FEB. 7, 1903.

In regard to Mr. Hammer's paper, Prof. Williams said that intricate automatic machinery required expert attention, instancing the necessity for adjustment and repairs upon linotype machines, and suggesting that the saving in operators' salaries might be required for the pay of expert mechanics. Prof. Brooks thought that the 10 per cent. depreciation claimed by Mr. Hammer as ample for the automatic switchboard would prove inadequate, especially in view of the probable changes in details of construction to be expected. The bookkeeper's 10 per cent. depreciation becomes but 9 per cent. the second year, and about 8 per cent. the third year, hence at the end of ten years the entire first cost has by no means been charged off. He asked if any switchboard built in 1893 would now be worth 35 per cent. of its original cost, as it would have to be on the basis of a 10 per cent. yearly depreciation deduction.

DISCUSSION AT PITTSBURG, FEB. 5, 1903.

TELEPHONY.

Programme:

President's remarks at the New York Meeting read by Secretary, J. S. Peck.

"An Automatic Telephone Operator," by Mr. W. J. Hammer, abstracted by Prof. S. M. Kintner.

"Evolution of the Telephone Switchboard," by Mr. Thos. D. Lockwood, abstracted by Mr. S. P. Grace.

Exhibition and Description of Arcophone, or Talking Arc Lamp, by Mr. R. A. L. Snyder.

GENERAL DISCUSSION.

The discussion was participated in by Mr. S. P. Grace, Mr. Charles Bradley, Mr. P. M. Lincoln, Mr. Gallegher and Mr. L. Hommel.

MR. GRACE.—Mr. Lockwood in his paper on the Evolution of the Telephone Switchboard has admirably described the manner in which the present perfected arrangement of switchboards developed from the crude switching devices of the early days of the telephone.

Mr. Lockwood has also given a very complete description of a modern common-battery telephone switchboard, and has also shown and described the line of investigation which was pursued to attain this development. It is not necessary for me to add anything more on the evolution of the telephone switchboard, since Mr. Lockwood has covered this matter in such an admirable manner; I shall simply call attention to a few of the great advantages that the common-battery system possesses. We may sub-divide the advantages accruing from the common-battery system into three general heads:

1. Improvements in operating.

2. Economy of maintenance.

3. Quality of service.

In discussing the question of operating, it is, perhaps, instructive to look back and see the difficulties under which the operator worked under the old arrangement of magneto switchboards. The switchboard was arranged with a large number of annunciators or drops mounted on the face of the switchboard near the top. When a subscriber turned the crank at his telephone, his annunciator was displayed in front of the operator, who had to look up at the annunciator, ascertain its number, and then hunt out the corresponding answering jack in which to plug. This kept the telephone operator's head tilted upward at an awkward and disagreeable angle.

In the common-battery system the subscriber merely removes the receiver from the hook, which act lights a small incandescent lamp immediately adjacent to the answering jack belonging to the calling subscriber. The operator in answering does not have to ascertain the particular number calling, but merely "plugs out" the light. This act alone increases the speed of operating from three to four seconds.

Another great disadvantage of the magneto system was the entire absence of supervisory signals, *i.e.*, the operator had no means of knowing when the calling or called subscriber was at the telephone. The only arrangement for disconnection was a clearing-out drop bridged across the cord circuit. It was necessary for the subscriber to ring off when through using the line.

Undoubtedly, many of you have run across the sign painted in large letters on the telephone, "Ring off." But it is human nature to do as little as possible when once you receive the benefit asked for; so, while all the subscribers would ring in to get central, but a very small percentage of them would remember the injunction to "ring off."

In the common-battery system there is placed a supervisory-lamp signal on each side of the cord circuit, which is used to connect together two subscribers' lines. When a subscriber is rung by the operator, one of these lamps remains lighted until he answers. When both subscribers are finished with the conversation the simple act of hanging the receiver upon the hook lights both of these supervisory-lamps, which is a signal to the operator that that pair or cords, and consequently the connected lines, are no longer in use. She will, therefore, immediately remove the connection. If either one of the subscribers wishes to call in the operator during the course of a connection, it can be done by simply working the hook up and down, which flashes the supervisory signal. It is thus seen that for all local connections the operator has complete supervision over the calls.

It is, however, in a multiple office district, such as Pittsburgh, where the advantages of the common-battery system are particularly in evidence. In such a district it is necessary to operate

a number of offices and arrange for trunking connections between them.

In the magneto system there were provided no supervisory or disconnect signals on these trunk lines. This made the operation of them extremely difficult and also impaired the quality of the service rendered, since the operators would frequently make mistakes and take down the connection before the conversation was finished.

In the modern common-battery system, when a call is received for a line in a distant office, the operator who receives the call cuts in directly on what is known as a calling-circuit wire, to an operator who is located at the exchange which contains the line asked for. This operator assigns a trunk to be used and at the same time plugs the trunk which ends in a plug and cord into the line asked for. The originating operator, of course, plugs into the other end of the trunk line. When both subscribers are through talking, the disconnect signals are received by the originating operator in the usual manner, who will take down the connection. The taking of the plug out of the trunk line automatically gives the trunk operator at the distant exchange a disconnect signal to show her that the trunk line is no longer in use. She will then remove the trunk line from the local subscribers' line. Similar automatic trunks are provided for use between the local boards and the long distance boards. It will thus be seen that from an operating standpoint the common-battery system removes the necessity of the personal supervision of calls by the operator, automatic signals being the means of warning her of all stages of the connection.

The common-battery system also enables us to increase the operator's load, which means that an operator can answer more telephones than in the old style systems. Our payrolls show that with a first-class common-battery system we can handle the same business with about 20 per cent. less number of operators. The common-battery system is therefore easier and cheaper to operate than the old style system.

Economy of Maintenance.—In the magneto systems each individual telephone was a small edition of a central office power plant. We provided batteries for furnishing the direct transmitter current and a complicated magneto generator for furnishing alternating current for signalling the central office.

Anyone who has had experience in the maintenance of even a small central office power plant will recognize the difficulty and the expense of maintaining these thousands of isolated power plants which were located in each telephone. The maintenance of this generating outfit was from \$2.00 to \$3.00 per year per telephone. But in the common-battery system all these isolated power plants are done away with, and a single central office power plant suffices for the entire exchange. One large storage battery, consisting of eleven (11) cells, is installed. This main battery is charged from motor-generators from off the lighting

mains and supplies all the current used in the telephone exchange. The cost of all current supply per telephone, including the fixed charges, probably does not exceed \$1.00 per telephone per year in a modern common-battery system. The removal of the generators and batteries from the instrument has also cheapened its first cost and maintenance, and the instrument as it exists to-day contains the fewest possible number of parts.

It might be well to remark at this juncture that the successful operation of the common-battery system depended upon the evolution of the storage-battery. We had to have at the central office a source of current of constant e.m.f. and which possessed practically no internal resistance. If the source of power were not constant or contained any internal resistance, all the lines connected with the exchange would be noisy or would have cross-talk on them. As is well known, the modern storage-battery produces a current of constant e.m.f., and it besides possesses a very low internal resistance, these two features making possible the common-battery system of to-day.

In the common-battery system there is a pressure of 24 volts on every line all the time, and any poor or defective insulation will cause a leak of current and consequently the display of the signalling apparatus at the central office.

One of the great objections to the use of common-battery by telephone engineers was the fact that it required superior outside line construction, but this in reality has been a benefit, for with the common-battery system we must put our wires and cables underground and use as little open wire as possible, in order to obtain a good quality of service. Also the current being upon the lines at all times, it acts as a sort of watch-dog to the entire system, and makes those in charge of the plant keep it in good repair.

From the above statements the economy of maintenance of the common-battery system is plainly apparent.

Service.—From the subscribers' standpoint the common-battery system is eminently satisfactory. He is not required to grind a crank in order to signal central. All he has to do is to remove the telephone from the hook which immediately displays the signal in front of the operator. This gives the subscriber practically nothing to do and transfers all work to the central office, where it can be taken care of by skilled operators. It is always possible for the subscriber to call in the operator by moving the hook, and the possibility of his being hung up and unable to get the central office is very remote.

That the subscriber is satisfied with the common-battery system is evidenced from the fact that in ordering a telephone or a private branch exchange he will always tell you "that he wants that system where you take the receiver off the hook and it lights one of those little lamps."

I have stated above that in the old systems batteries were provided for each telephone for supplying the transmitter with

current. When these batteries were new and in good condition, the service from the telephone was good, but after they had been used for a short time, or if the subscriber accidentally left the receiver off the hook and thus allowed the batteries to run down, the transmission from the telephone would be very poor. Therefore, from the magneto system, with local batteries, we never could hope to obtain a uniform grade of service.

It is highly necessary that all of the instruments talk well over both local and long-distance lines, for it is our aim and ambition to produce a satisfactory volume of transmission between all telephones in the entire country. In the local-battery system, if we spent a large amount of money in battery maintenance and kept the batteries in first-class order, the transmission for all local connections would be entirely too strong, although it must be admitted that it would be excellent for the long-distance connections. In the common-battery system the source of current supply is from the central office battery and we can, therefore, regulate the amount of current for each connection; *i.e.*, for all local service we will have our apparatus so wired that the instrument receives sufficient current for local transmission, but when a long-distance connection is put up we will triple or quadruple the amount of current given to the transmitter. Thus, with the common-battery system we are enabled to give an absolutely uniform grade of transmission for all local connections, and for long-distance connections we can give the transmitter the ultimate amount of battery power that it will stand. This, in my opinion, is one of the most important advantages of the common-battery system.

So successful has the common-battery system proved in large exchanges that it is now the intention to carry the work still further and make even the smallest exchanges in country towns work on the common-battery basis. Plans have been prepared for a number of these small exchanges, which will work on the common-battery basis, but which will be provided with no power plant. The necessary current for operating the transmitters and signals will be supplied from the nearest large common-battery plant.

In conclusion, at the risk of being considered too optimistic in my views, I will say that within the next ten years the local battery magneto telephone instrument, with its associated magneto switchboard, will be considered as a rarity in the United States.

MR. CHARLES BRADLEY:—As has been explained here this evening, great improvements have been made in the design and operation of the telephone switchboard since 1880, and also in central office apparatus. It is however, only, in the past ten or twelve years that the planning of installation work has been given much attention, especially from an engineering standpoint. Previous to the advent of

the branch terminal switchboard nearly all work outside of the building of the switchboard proper and the distributing frames was done by the foreman at the time of installation. In fact, the same man wrote the specifications, went into the shop and superintended the forming of cable, such as they were, and then started on the road to look after the erection of the switchboard. Up to this time switchboard cable was made on the unicolor insulation principle; *i.e.*, in a twenty pair switchboard cable, all the twenty pairs had one red and one white wire. As you can readily understand, this necessitated the testing of one of every pair of wires before soldering them to the multiple jacks or to any other terminal. This, of course, entailed a great loss of time in the erection of the switchboard. The multi-colored insulation scheme was then devised. This consisted of having the insulation of one of each pair of wires of a color different from all the rest; for example, one of a pair blue, of another pair orange, of another pair blue-orange, etc., until the whole combination was effected. Also a regular form was made so that the same colored wire would take the same jack throughout the multiple. Also it was found, since the framework of the sections was made of iron and more uniform than those of wood, that by careful measurement the cables could be cut and soldered to the multiple jacks in the factory. This plan was tried with great success in one or two installations and thereafter used universally as it meant more accurate work and a great saving of labor on the road.

With the advent of the branch terminal board came the power plant. Instead of the gravity batteries a storage battery was used, necessitating charging machines, a power board and conduit work. This storage battery was used to restore the drops electrically as well as for the transmitters.

As improvements were being made from time to time by different installation men, though each had his own ideas regarding the work and no two installations were made in the same manner, certain of these men were retained in the shop as consultation men and an attempt was made to classify the work and have it done in a uniform manner. More elaborate specifications were prepared, and plans furnished showing the location of the switchboard, power plant, conduit, etc.

When the common-battery board was planned this work increased greatly, owing to the number of cable runs, more apparatus and power plants of larger capacity. It was found that by locating exactly each piece of apparatus that the racks for carrying the cables could be designed accurately and built in the shop, conduit plans be prepared and in fact innumerable details that were formerly left to the installer were now figured out by the engineer before the installation actually started. Particular attention was paid to the arrangement and location of apparatus on the switchboard proper, so that the cable work could be done in such a way that all apparatus would be accessi-

ble and easy to maintain. To-day practically all cables are cut and formed from plans made by the engineer, and are soldered to their respective terminals or jacks before they leave the factory.

Of course, I have taken but a few examples to illustrate the progress of installation work, but I think it sufficient to show the great improvement made in this class of work in recent years.

(COMMUNICATION AFTER ADJOURNMENT BY SIDNEY HAND BROWNE.)

In his closing remarks, Mr. Lockwood, in his article entitled, "The Evolution of the Telephone Switchboard," refers to the complex organization of the modern relay switchboard and intimates that the next step in its evolution may be along lines which will simplify it rather than in a direction involving a radical departure from its present organization.

A partial simplification has been obtained, resulting in a better "talking circuit" and reduction in first cost and in maintenance. Such simplification consisting of a reduction in the amount of switchboard cable required in wiring the multiple jacks to two-thirds of what is required under the system described; avoiding the use of a shunt to put out the supervisory-lamp; dispensing with the use of the repeating-coil in the cord-circuit as shown, and with the third contact in the multiple-jacks.

In the diagram, Fig. 9 (Lockwood's article), it will be seen that the relay which controls the operation of the supervisory-lamp is placed in series on one side of the talking-circuit, although there is no corresponding impedance in the opposite side of this circuit. And although this relay is of low resistance, it will slightly unbalance the line; its insertion in this manner should be avoided if possible.

It is also seen that the test-rings of the multiple-jacks are connected by a third wire running the entire length of the switchboard. If this third connection could be avoided, it would simplify matters and be a desirable improvement. By reference to the diagram attached hereto, it will be seen that this has been accomplished, with a consequent saving in switchboard cable, first cost of construction, and reduction in cost of maintenance. By dispensing with this third wire in the multiple-jacks, we have also been able to use a two-conductor cord instead of a cord with three conductors, as shown in Mr. Lockwood's diagram. This reduces the first cost of cords and their maintenance.

It is desirable, if possible, to avoid the use of the repeating-coil in the circuit shown in Mr. Lockwood's diagram, as it is frequently the case that these coils are not properly balanced; and a very slight variation in the size of the core, or inaccurate winding by the manufacture will cause enough unbalancing to interfere with the proper working of the circuit. The use of this repeating-coil has also been avoided in the system described in the drawing attached.