Winter 2-1912

Volume 21 - Issue 5 - February, 1912

Rose Technic Staff
Rose-Hulman Institute of Technology

Vol. XXI FEBRUARY :: 1912 No. 5

THE ROSE TECHNIC

VOL. XXI TERRE HAUTE, IND., FEBRUARY, 1912 NO. 5

THE TECHNIC

TERMS

One Year, $1.00 Single Copy, 15 cents

Issued Monthly at the Rose Polytechnic Institute.

Entered at the Post-Office, Terre Haute, Indiana, as second class mail matter.

IN this issue we wish to call attention to some of the activities of the Camera Club, which, if generally known throughout the school, would no doubt do much toward increasing the interest of the student body in that organization.

At a recent meeting of the club, Prof. J. B. Peddle gave a lecture on "Lantern Slides" which greatly interested some thirty odd members who were present. As a result, the club is at present engaged in a lantern slide contest, which will close about the 30th of March. On March 23rd, Prof. Peddle will give a talk on "Color Photography", and upon this occasion the lantern slides from the contest will be shown.

The club will have a meeting on March 2nd, at which time President Harry C. Uhl will give a talk on "The Toning of Bromides."

Right at present, the Camera Club is "booming," and we advise every Tech student who is interested in the subject of photography to join now, and help push the good work along.

———ooo———

WITH the school year more than half gone, it seems evident that the new system of handling the Students' Fund has already shown its efficiency, and has filled a long-felt want. There is no longer room for doubt that the system is a complete success. While in the future improvements may naturally be made from time to time, thus far the system as it stands has fulfilled every requirement, and each student organization and branch of athletics has been greatly benefitted by it. The presiding officers of each organization, and the managers of the various athletic teams, have had a great burden of red tape ilfted from their shoulders; and the deplorable complications in the keeping of the different financial records is a thing of the past.

The system is successful and will continue to be so; it has supplied a systematic financial management that has been needed here for some time.

———ooo———

THE Alumni article in this issue was given in the form of an address to a general assembly of the students by Mr. Edgar G. Jones, '09. Owing to the considerable length of the article, is was found necessary to allow it to

take the place of both leading article and Alumni article for this number of the *Technic;* consequently this issue will present but one article instead of the customary two.

———ooo———

MEETING of the Student Council, held Saturday, February 10, 1912.

Roll Call—Denny, Price and Uhl absent.

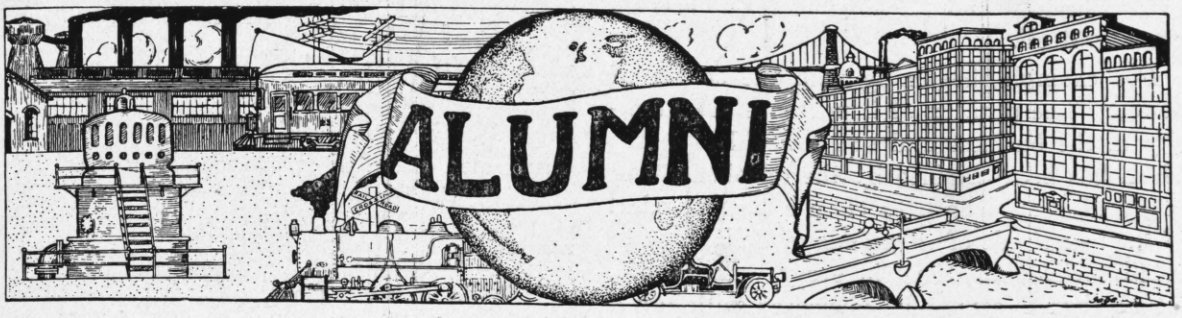
Minutes of previous meeting read and accepted.

Financial Secretary reported $159.12 in bank. Moved by Krieger and seconded by Spindle that report be accepted as read. Carried.

Moved by Beauchamp, seconded by Hepp, that $100.00 out of the General Fund be appropriated to the Athletic Association. Carried.

Moved by Krieger, seconded by Nehf, that the President of the Council interview Dr. Mees in reference to some action to be taken to stop the use of vulgar language and improper remarks at the basketball and baseball games. Carried.

Adjournment.



THE TELEPHONE SWITCHBOARD AND CENTRAL OFFICE PRACTICE

By Edgar G. Jones, '09.

THE subject which I have selected and to which I shall endeavor to confine my remarks on the whole, is "The Telephone Switchboard and Central Office Practice." Had I chosen either one of them, the time allotted me would hardly be sufficient to cover the subject thoroughly, so I shall try to touch upon a few of the principal points of both. However, beferoe setting forth on my subject, I should like to begin with a few preliminary remarks in an endeavor to focus your thoughts and attention on the scope and magnitude of the Telephone from an engineering standpoint, and to bring to you the realization of the fact that it is not merely the work of and for an electrician and mechanician, but that it contains problems and questions requiring a knowledge of every branch of engineering taught in this Institute. Then, I should like to make a hasty summary of the history, or marvelous growth of the telephone from its first stages—two wires joining together two receivers—to the modern telephone exchange of the present day.

The general idea of the graduate and student in Electrical Engineering is, that the telephone since it has to do with only a very weak and insignificant current and voltage, as compared with that used in electric power work, rightfully belongs to the minor grades of electrical engineering. A more mistaken idea could not prevail, and one has only to step into the operating room, or terminal room, of a telephone exchange and look about him, not with the casual observing eye and mind of an ordinary person, but with that of an electrical engineering student and graduate—and attempt to analyze the cause and effect of the different operations, both manual and automatic, falling beneath his attention. It is then that the mysteries of the science of Telephony begin to develop, and the necessity of an education comprising the elements of Electrical, Mechanical,

Civil, Chemical and Architectural Engineering presents itself.

For example, beginning with the source of power: The position of importance and necessity in the business and social world of today which has been attained by the telephone, ever ready at arms length to close a business deal of the magnitude of thousands of dollars, or to fulfill social obligations in every walk of life, means that it cannot be dispensed with for a single moment when once it has ornamented the wall of a home, or desk of an office, and its conveniences have been enjoyed; hence, it is to the interest of the telephone company to guard against an interruption of service due to a failure in power. Ordinarily a motor of from five to fifty horsepower (the size of the motor depending upon the size of the exchange) is connected to the mains of the city electric power station where such is availble, and in reserve, a similar motor is held for emergency. These are direct connected to generators for use in charging storage batteries. In addition to this, there is available either as a constant source of power and energy, or for use in case of emergency, a gas eingine or other prime mover, used in driving a generator to charge the storage batteries. When a direct current source of power cannot be had, a two or three phase alternating current motor is connected directly to a direct current generator. Thus you can see that the various kinds of electrical machinery supposed to belong to other classes of business, play quite an important role in the operation of the telephone.

The storage battery used in the telephone exchange, while it does not compare in size with that used in electric power work requires a knowledge and understanding of its theory in order to maintain it for constant use and enable it to meet all demands of service.

In the telephone exchange of the present, the switchboard used for the completion of subscribers calls is not the only one necessary, but in addition there is required, almost a duplication of the power board found in the central stations of most of the power and light companies. Of course, the size will not compare, but the switches, meters, circuit breakers, busbars, starting and regulating boxes, are all there, and operated in a similar manner. In addition will be found the same safety devices, such as fuses and cutouts. Here it is that the telephone engineer must use his knowledge and skill in designing a means of protection to the delicate and expensive equipment, so sensitive to an excessive flow of current. In comparison with the requirements of central station practice, where a fuse carrying a stipulated amount of current plus an unknown quantity is used the telephone engineer designs a one and one-third ampere fuse which means that the fuse will blow when a current in excess of that amount flows in the circuit.

In connection with the switchboard itself, there are found hundreds of miles of wires, cables, switches, hundreds of incandescent lamps, transformers, retardation and induction coils. Each of these various pieces of apparatus must be designed with the utmost care and accuracy, with no working margin as is usually found in electric power work. For instance, the repeating coil, used in the talking circuit, is of the highest type of transformer, and its function is of the greatest importance to the proper operation of the circuit.

The problem of terminating at one place, and enclosing such a large number of wires as are required in a modern telephone exchange, is a question involving a knowledge of not only Electrical Engineering, but also that of Civil and Mechanical.

The underground system of cabling brings the telephone engineer face to face with problblems in electrical engineering found concentrated in no other branch, such as the dealing with the conductor resistence, dielectric capacity, size of conductors to be used, etc. The latter, of course, must be dependent upon the territory to be served. The size and design of the ex-

change building will depend upon the same factors. It is very seldom that a building already constructed can be converted into a telephone exchange, owing to the peculiar requirements of the latter, and here again the telephone engineer must bend his skill and knowledge to meet the flexible requirements of his profession.

Hence, you can see what a vast field of engineering is covered, and what a broad and versatile experience is required in the science of Telephony.

Relative to the history of the Telephone—I presume all or most of you are familiar with the name of its inventor—Alexander Graham Bell—who is today able to enjoy the distinction of having given birth to the most wonderful instrument ever invented by man—who has done more probably toward opening up the possibility for a closer relationship of man through his patent, than any other single person.

Professor Bell at the time of his discovery of the possibility of a telephone, was at work upon a harmonic telegraph in an endeavor to transmit musical sounds over telegraph wires. His early training and teaching had been along the line of acoustics, his father having invented what is known as visible speech, or a method of facilitating deaf persons in understanding what was being said to them by watching the lips in the formation of different words and sounds.

There were several men at work upon the invention of the harmonic telegraph at the same time, but Professor Bell was probably the only one who was versed in the principles of sound and who had a clear insight as to what was necessary to produce the transmission of sound by wires, through the aid of a magnet. While at work upon this idea one day with his assistant, Thomas Watson, there was emitted from one end of the line to which he had his experimental apparatus connected, a strange, yet familiar sound, which he immediately recognized as coming from the adjoining room. Upon going into the other room and questioning Watson, found that he had snapped a spring in front of the magnet connected to the line. This was the first sound ever transmitted and received over a wire.

The experiments were continued and Prof. Bell found that with the use of a magnetic transmitter, he could reproduce vocal sounds. The first diaphragm of the receiver was made of gold-beaters skin, with a patch of sheet-iron glued to the center. Finally this was discarded and a solid metallic diaphragm was used. Considerable experimenting was necessary, however, before a satisfactory disc or diaphragm was found: if it were too thick, the voice was transformed into a squeal; if too thin, the voice became a hollow groan, similar to that heard in speaking while the head is in a rain barrel.

The telephone was first patented in 1876, or at the time the Centennial Exposition was being held at Philadelphia. Professor Bell was too poor to make an elaborate display of his discovery, and was largely dependent upon his father-in-law, Gardiner G. Hubbard, for financial aid in carrying on his experiments, the latter being Chairman of the Massachusetts Commission to the Centennial, and who had it placed in the Massachusetts exhibits of various kinds, it being labelled, "Transmitting Telegraph."

The Commission appointed to examine the exhibits did not get around to the telephone until very late in the evening, and were going to give it very little consideration, but the Emperor of Brazil, who was in the Commission, and whose acquaintance Professor Bell had made several years before while teaching visible speech in the Boston University where the Emperor had visited, rushed up to him, saying, "How do you do, Professor Bell." This naturally drew the attention of the Committee to Professor Bell and his patent, and they were then a little more willing to give it consideration. The Emperor and his wife, one at each end of the line which Professor Bell had strung up, tried the invention, and were astounded to hear their voices actually transmitted in full

volume of tone and quality, and became as two children, running back and forth from one end of the wire to the other, to hear each talk. Lord Kelvin was also among the audience and pronounced the tlephone one of the greatest inventions of the age. On the day following, the telephone was given the most prominent place in the Exposition, and became the center of attraction and wonder to all visitors.

The legal history of the telephone is in itself a complete story of the trials and troubles which beset this most wonderful of inventions. The litigation over the rights to the patent extended over a period from 1878 to 1906. In all there were thirteen lawsuits of national interest, five that were carried to the U. S. Supreme Court, and five hundred and eighty-seven other lawsuits of various natures, all having been decided in favor of the Bell Telephone Company, with the exception of two, which were of minor importance.

After the public was stripped of its pessimistic and doubtful attitude toward the new invention, and the tlephone had been palced upon a commercial basis by its marvelous and wonderful performances, still more was demanded of it; subscribers were not content with communication with simply one or two other subscribers, but were desirous of being in touch with each and every one of the other parties. Intercommunication was first made through switchboards patterned after those used in tlegraph offices for switching different instruments together, or from one circuit to another, and were known as "peg switchboards."

As a means of receiving calls, some of the first switchboards had a row of electric bells mounted along the top of the board, one for each line, and in such cases, there was normally connected battery supplying current to a group of lines, the bells being operated by break keys at the substation. Others had closed circuit annunciators, (relay drops) one for each line, these being operated by breaking the circit. However, the battery was soon discarded, being superseded by magnto generators at the substations, and then, of course, the open circuit announciators were substituted at the central stations. It is a curious fact, although unquestionably the same is true in other branches of engineering, that methods and apparatus which were used in the early stages of the telephone business have been revised and remodelled and are at present among the most useful and important details. Such is the case of the common battery, discarded at the beginning, only to be brought back twenty years later to revolutionize the whole industry of telephony, and place it on a commercial basis, such as was undreamed of ten years ago.

Between the years 1880 and 1885, switchboards of various descriptions were placed in operation, there being no standard to work to. The old adage of necessity being the mother of invention becames very much in evidence, and the individual managers of exchanges resorted to their own ingenuity to devise ways, means and apparatus to meet the demands. In 1885, the different types of switchboards which had been placed upon the market became inadequate for the needs. They did very well for the smaller communities requiring not more than five hundred phones, but in the larger cities exceeding many times that number, as many as half a dozen operators were necessary to handle a single call. The method of handling a call The method of handling a call through one of the representative boards at that time would be as follows:

The call would come into the exchange through an annuciator; one of a number of switchmen provided with a magneto telephone connected with a loop-plug adapted to fit the spring jack of the calling line. would plug in and receive the order. The same switchman then united the calling line and the line wanted. to a common bar of some particular pair of lines; in this operation he connected them not only with one another, but also to the table of some particular operator. The operator noti-

fied of the connection thus made would first send a calling current from a generator to the subscriber wanted, and receive his answer orally; he would then unite the two lines through a disconnecting drop. It was usually a matter of difficulty to get the two subscribers to talk with one another, and the operator had, as it were, to coax them along.

In 1885, what is known as the multiple switchboard was placed in service. This consisted of a series of similar sections of the switchboard, wherein each line with its accessible terminals, known as jacks, was placed within convenient reach of each of the many operators sitting side by side. It meant a duplication of the equipment of a single section, in each of the succeeding sections, so that the entire force of operators may work as a single unit and perform the work as systematically as in a small exchange of only one operator, and with as much celerity and rapidity.

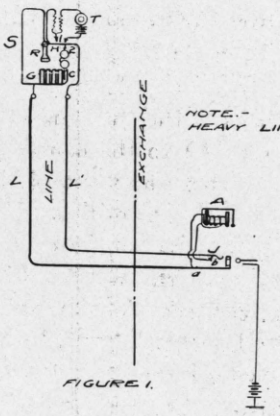


FIGURE 1.

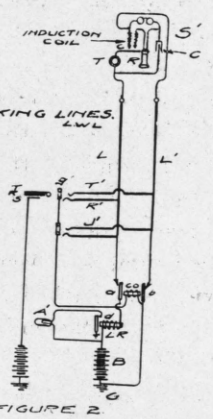


FIGURE 2.

In the first of the multiple switchboards, the jacks were grouped in numerical order in panels, below which appeared the annunciators or drops. Overhead, hanging suspended from a shelf with the tips pointing downward, were the plugs. On the key-board in front of the operator were the switching and ringing keys. It, however, soon became apparent that much time was lost and inconvenience encountered by the operator having to reach overhead for the plugs; also, from the fact that when an annunciator was operated or dropped, it was necessary for her to first look down to ascertain the number which was painted on the face of same, and then search for the panel or group in which such number was located, before she could answer a call. All of this meant time—one of the factors which was the endeavor of each improvement to reduce to a minimum. Finally it occurred to those interested in this problem of saving time that it would help considerably to have the jack of the calling line located near the annunciator. Then came into use what is known as the answering jack, or a jack used solely for the purpose of answering subscribers who have signalled central. With the advent of the multiple board necessarily came what is known as the "busy test," or a means for one operator to ascertain whether or not a line which is multipled through the entire board—a remote section often being out of view of the operators—is busy, or is being used for a connection at some other part of the board. This is done by the operator touching the tip of one of the connecting plugs to what is known as the sleeve (called a test-ring in earlier days) of the jack, which is a metallic ring appearing in the face of the switchboard, and which is connected to ground. Each of these rings, of jacks bearing the same number in different sections, are connected to one another

by looping wires. If the line is in use at some other part of the board, the plug which has been inserted in same will bring the potential of this test-ring circuit up to that of the storage battery so that upon touching the tip of a plug to the test-ring at another position in the switchboard, a distinct click will be heard in the operator's telephone set, caused by the flow of current to ground; should the line not be busy, no click will be heard.

This system of annunciators and substation battery and magneto generators prevailed for a number of years, and in quite a number of rural districts are still to be found doing service, However, in 1896, there was introduced a system which was to revolutionize the telephone switchboard industry; was to reduce the expense of maintenance, and give better service; and more than all of that, was to save four seconds on each and every call. This was the introduction of the Common Battery Exchange, or a transfer of the source of current supply and energy from each substation to the central office, where it could be under the constant watch of competent and experienced men, and maintained to its highest degree of efficiency, thus eliminating a constantly recurring annoyance of having service interrupted by a failure of the local battery at substations, which was in the form of dry cells.

By a comparisn of Figure 1, which represents a magneto substation (S) with its associated annunciator (A), and answering jack (J), at the central office, with that of Figure 2, which is a diagram of a common battery substation (C') with its associated exchange equipment—answering jack lamp (A'), answering jack (J'), some idea may be obtained of the radical changes of equipment involved in the introduction of the common battery system to replace that of the magneto.

The operation of the magneto circuit, shown in Figure 1, is as follows:

The hook lever, represented by (H) is so arranged as to make contact at (1) or when the receiver (R) is liftd from same, and to rest normally on contact (2) when in place on the hook. When the receiver is in the latter position, it will be noted that the circuit through the transmitter (T) and receiver is open, and that a ringing current may be sent from the central office, out over line (L), through shunt around the generator (G), through the windings of the bell magneto, through contact (2), to line (L'), and back to the central office to ground, thus ringing the subscriber's bell. When the call is answered, the receiver is removed from the hook, allowing same to be forced upwards against contact (1), closing the circuit through the subscriber's transmitter and receiver. The bells are now removed from the circuit, and the path for voice currents closed.

Should the subscriber wish to call central, he turns the crank (C) of the magneto generator, thus sending an alternating current out over the line (L), to the point (a) within the exchange, then through the winding of annunciator (A) to the contact (2) of the answering jack spring and out over the other side of the line to the opposite side of the generator, thus energizing the relay or annunicator (A), which draws up the armature at the rear and permits the drop, or armature of the annunciator, to fall, displaying the number of the line in full view of the operator.

Upon referring to Figure 2, it will be noted that the battery has been removed from the subscribers set and placed in the line at the central office. When this was done it was found that there was considerable leakage of current through the windings of the bells, which meant considerable unnecessary waste. The condenser, which is an open circuit to direct currents, and a free path or closed circuit to alternating currents, was then placed in the circuit.

In singalling or ringing the subscriber, central inserts the plug in the jack and rings on the line, sending ringing current out over the line (L), through the windings of the ringer,

through the condenser (C), and back over line (L'), to ground. The removal of the receiver from the hook places a low resistance shunt around the ringer through the receiver and transmitter.

In order to call central, the only operation necessary is to remove the receiver from the hook. This will allow the hook to close the contact at the point (c), permitting a flow of current from the exchange battery (B) through the winding of the line Relay (LR), through the contact (a) of the Cut-off Relay (CO), out on the line (L), through the subscribers set, and back to the exchange on line (L'), through contact (b) of the Cut-off Relay and to ground (G). The flow of current in this circuit will energize the Line Relay and close the contact (d) of the local circuit through the glow lamp which appears immediately beneath the answering jack with which it is associated. The operator upon seeing this lamp light, immediately inserts one of the plugs located on the keyboard in front of her. From the figure it will be noted that the plug of an operator's cord is divided into three distinct and insulated parts known as the tip (T), ring (R) and sleeve (S), which make the contact when inserted in a jack, with three corresponding distinct and insulated parts—tip ring (T'), ring spring (R'), and jack sleeve (S'). It will also be noted that the sleeve of the plug is connected to battery and ground, and that when it is inserted in the jack, a circuit is closed through the windings of the Cut-off Relay to ground, thus energizing this relay, which upon drawing up its armature, opens contact (a) and (b), and also the circuit through the Line Relay, permitting its armature to fall back and open the local circuit through the lamp, thus extinguishing it. The line is then opened for conversation between the calling subscriber and central.

On the keyboard in front of the operator are arranged, one in front of the other, seventeen pairs of cords; the cord nearest the operator is known as the Calling Cord (CC), Figure 3, and the one nearest the switchboard is known as the answering cord (AC). Immediately in front of each pair of cords are two small incandescent lamps known as Supervisory Lamps, one for each cord; these also are arranged one in front of the other so as to distinguish easily to which cord each belongs. Next in order toward the front of the keyboard is found the Listening Key (LK), after which comes the Ringing Keys (RK), usually four in number.

When a call appears in the answering jack lamp, as explained previously, the operator takes up the rear plug, or the answering plug, and inserts same in jack, which extinguishes the lamp; at the same instant she will throw the Listening Key, which is in the form of a lever working on a cam, which forces downward through a small sylindrical barrel, a piston on the end of which is a conical shaped wedge engaging and spreading apart two springs, the latter being shown in Figure 3 at (LK). This operation, as will be noticed, places the operator's talking set in connection with the subscriber's line through the cord and plug. The wanted number is then obtained, after which she will take the plug immediately in front of the answering plug which has been used, known as the calling plug, and place the tip of same in contact with the sleeve of the jack of the number called, as shown on drawing. As explained before, this is what is known as the "Busy Test" and enables her to ascertain whether the line called for is busy. If the operator receives a sharp click in the ear, she does not complete the connection, but reports to the calling party that the line is busy. If there is no click received, she inserts the calling plug into the jack and then depresses a ringing key. Should the desired number be located on a party line, the ringing key of the party asked for is depressed. Various companies have their party lines designated in a different manner; for instance, some use the letters of the alphabet after the number, as J. L. R. and W. The greatest of care and effort has been used in the selection

of the letters which are the most euphonius and less likely to be misunderstood in transmission over the telephone.

When the calling cord is inserted in the jack, the Supervisory Lamp associated with same, lights. By referring to the figure, you will note that current will flow from the common battery, through the resistance (R), through the lamp (CL), through the sleeve of the plug and jack, to ground through the winding of the Cut-off Relay, causing the lamp to burn. However, as soon as the called subscriber removes the receiver from the hook of his instrument to answer the call, thus placing a low resistance shunt around the condenser and ringer, current will flow from the common battery, through one winding of the Repeating Coal (R'), through the winding of the Calling Relay (CR), out through the ring of the plug and jack, through

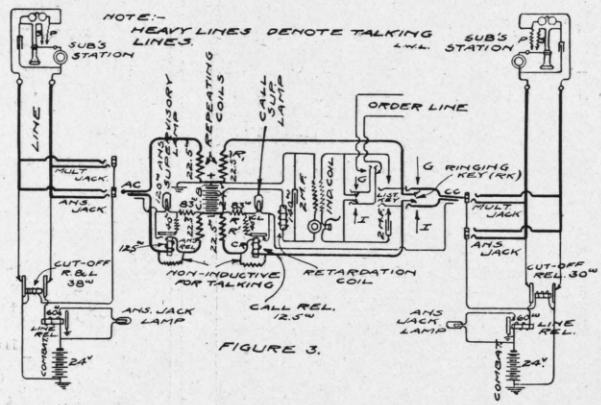


FIGURE 3.

the ring side of the line and subscribers instrument, and back on the tip side of the line, jack, and plug; through the other side of the Repeating Coil (R,), and to ground. This flow of current will energize the Calling Relay and cause its armature to operate, thus placing in parallel with the Supervisory Lamp a much lower resistance and shunting same until the filament is heated to much a dull glow as to not be discernible through the thick lamp camp covering it, and giving it the appearance of having been entirely extinguished. This enables the operator to know whether the call has been answered.

As soon as conversation is completed, and the receiver has been replaced upon the hook, the circuit will again be opened, and the armature of the Calling Relay will be permitted to fall back, compelling all of the current to pass through the lamp, lighting same and indicating to the operator that the lines may be disconnected. The same condition prevails on the answering cord, except that the answering lamp will always be extinguished when a call is answered, since the receiver has been previously removed in order to signal the central office.

Now let us examine the Operator's Telephone Set, and ascertain the various uses and necessity for the different pieces of apparatus found in same.

In the original telephone of two receivers, a very weak current was used, depending upon the strength of the magnets. Since the transmitter has been introduced, a greater pressure is obtained by using the battery. Naturally on first thought it would seem possible to transmit voice currents an indefinite distance, could sufficient battery be furnished. However, the result would be that the granular carbons in the transmitter would be consumed from the heat generated by the passage of electricity at too high a voltage. This trouble was obviated by the introduction of the induction coil into the circuit, which is a core of soft iron wound with two different sizes of wire in such proportion that the flow of current in one winding, known as the Primary, will induce in the second winding, or Secondary, a current which will be weaker or stronger as the number of turns in the second winding are less or greater. In the primary circuit was placed the transmitter and battery; in the secondary, the receiver. With this equipment it was found that when the Listening Key was thrown, the secondary circuit formed a path for the flow of current from the common battery through the Calling Relay, Listening Key, Induction Coil and Receiver,

thus operating the Calling Relay and causing the light to be shunted, or performing the same function on the calling cord as does the subscriber's instrument, and confusing the signals. To avoid this, a condenser was placed in the ring side of the secondary circuit, thus opening the line to direct currents, and also acting as a cushion in the circuit to reduce the sharp click received in the operator's ear when she threw the Listening Key, caused by the sudden pull of a twenty-four volt battery on the diaphragm of the receiver; also, the condenser permitted voice currents to pass freely.

Thus far we have a telephone set composed of a Transmitter, Battery, Induction Coil, Receiver and Condenser. With this equipment arranged as shown on the drawing, Figure 3, should one attempt to listen with it, there would be found considerable noise of the nature of burning grease, and the transmitter would become very hot. This is caused by the excessive current being forced through the transmitter by the exceedingly high voltage of the storage battery, hence additional resistence must be introduced. If a common busbar be used to connect several talking circuits, cross-talk (faint voice currents induced from other lines) will very likely result. If a direct connection of every talking circuit were made to the large storage battery, this cross-talk could probably be avoided. However, it is not practical to connect directly to the battery; therefore, to prevent this troublesome cross-talk in the primary circuit, the resistance must be inductive, and is called retardation. This retardation guards against the entrance of stray electrical impulses, because all such have a reluctancy to passing through coils with iron cores. But at the same time, the introduction of a winding on an iron core in the talking circuit will form an almost insurmountable barrer to voice currents; therefore, a free path for voice currents must be found. Again reversion is made to the condenser, which is connected in the primary circuit so as to divide it equally—the transmitter and primary in one-half and the retardation and battery in the other half, as shown on the drawing.

Most of the modern switchboards in the larger exchanges of the present day are designed to accommodate ten thousand lines. To exceed this number means to enlarge the switchboard to such size that it would be inconvenient, as well as impractical. To place ten thousand jacks within convenient reach of each operator so that there will be no unnecessary loss of time in completing all connections called for, has compelled the telephone engineers to reduce the size of the jack and plug to such an extent that a further reduction would increase the expense of maintenance, owing to the breakage of same, and in that case, the increased revenue derived from the additional lines accommodated would be offset by the loss sustained in the initial cost of changing the standard size to one smaller, and the future maintenance of same. The method adopted to take care of the rapidly increasing business is to construct and equip other exchanges in the centers of what are known as Telephone Districts, care being exercised to so locate the exchange that the smallest amount of copper will be required to reach every section of the District. Naturally then it must follow that intercommunication between the various exchanges must be furnished in order that subscribers located in one District may be connected with those located in the other Districts. This is done by lines known as Trunking Lines, as distinguished from Subscribers Lines—the former being used to connect one exchange with another; the latter to connect a subscriber to an exchange.

It would require only a few minutes observation in an exchange at its busy hour of the day to convince one of the fact that it would be highly impossible to add more work to the operators engaged in answering subscribers' calls. Furthermore, it would necessitate the addition of more equipment to the already overcrowded switchboard, taxing the operators to their utmost to

handle the calls with the greatest possible speed and accuracy. The solution to the problem was obtained in the construction of a separate and distinct switchboard known as the Trunk Board, or "B" Board, as distinguished from the Subscriber's Board, or "A" Board. The "B" Board is attended by operators whose duties are very different from those at the "A" Board, from the fact that the "B" operator has no means of connection with the subscribers whatever; e. g., the "A" operator receives a call from a subscriber for connection with a subscriber located in another District. The multiple jacks before her are confined to subscribers located in the District common to her exchange; hence, she must reach the operator in the district where the called subscriber is located in some way and inform her of the number wanted. This is done by means of a circuit known as an Order Wire, which is connected at one end directly to the telephone set of the "B" operator at one exchange, and at the other to a key located in the key-board before the "A" operator of another exchange, the pressing of which places the latter in direct talking connection with the former.

In the switchboard in front of the "B" operator is located subscribers' multiple jacks similar to those in front of the "A" operator of the same exchange. On the keyboard before her are located a row of cords terminating in plugs known as incoming Trunks, each of which are designed by the name of an exchange and a number; also, on the same keyboard, associated with each cord, is a Supervisory Lamp, and Ringing Keys, similar to those found on the "A" board. These brunks, after passing through various relays, terminate in the exchange to which they are assigned, in jacks located in the face of the "A" board and are known as Outgoing Trunks, being designated by the same numbers as are given to the incoming Trunks located in the "B" board of the distant exchange.

The "A" operator, after pressing the key of the Order Wire circuit, gives the name of the exchange in which she is located and the number of the subscriber's line wanted, which is located in the exchange of the "B" operator. The latter then assigns a trunk by calling back the number of same, picks up the trunk assigned and inserts it in the multiple jack (after making Busy Test) of the line of the called subscriber. Immediately the "A" operator receives the number of the trunk assigned, she inserts the calling cord of the pair being used for the connection into the Outgoing Trunk jack bearing the same number as the trunk assigned. This operation completes her responsibility with the connection. If the number desired is located on a party line, the "B" operator simultaneously with the action of picking up the cord with one hand depresses the proper ringing key with the other.

Upon making the Busy Test, should the "B" operator find that the desired line is busy so that she is prevented from completing the connection, a means must be provided whereby she can notify the "A" operator of the fact. Since the "B" operator has no talking connection with the "A" operator except when the latter presses the Order Wire key, a signal has been arranged, known as the "Busy Back Signal," which is a method of flashing the Supervisory Lamp before the "A" operator. There are special jacks, known as "Busy Back Jacks" located in the switchboard before the "B" operator for use in this connection. The "A" operator upon receipt of this signal notifies the calling party that the line is busy, and disconnects.

The "B" operator is provided with a supervision over her connections in a manner similar to the "A" operator, in that when the connection is completed from the "A" board, the Supervisory Lamp is shunted out. However, the Supervisory Lamp before the "A" operator is not shunted out until the called party removes the receiver from the hook. Likewise when the conversation is completed and both

receivers are restored to their hooks, the Supervisory Lamps before the "A" operator burn brightly and upon the observance of same, she removes the connection from the jacks, which operation causes the Supervisory Lamp before the "B" operator to illumine and indicates to her that the conversation is completed and ids-connection can be made.

A comparison of the conduct of the operators in the exchange of the earlier days with that of the present is quite a contrast, considerably more favorable to the latter, and is well stated by quite a prominent writer on the subject of Telephony as follows:

"To describe one of those early telephone exchanges in the silence of a printed page, is a wholly impossible thing. Nothing but a language of the noise could convey the proper impression. An editor who visited the Chicago exchange in 1879 said of it, 'The racket is almost deafening. Boys are rushing madly hither and thither, while others are putting in or taking out pegs from a central framework as if they were lunatics engaged in a game of fox and geese.' By the clumsy methods of those days, from two to six boys were needed to handle each call. And as there was usually a squabble between the boys and public, with every one yelling at the top of his voice, it may be imagined that a telephone exchange was a loud and frantic place.

"Boys as operators proved to be most complete and consistent failures. Their sins of omission and commission would fill a book. What with whittling the switchboards, swearing at subscribers, playing tricks with the wires, and roaring on all occasions like young bulls of Bashan, the boys in the first exchange did their full share in adding to the troubles of the business. Nothing could be done with them. They were immune to all schemes of discipline. Like the Mysterious Noises, they could not be controlled and by general consent they were abolished. In place of the noisy and obstreperous boy came the docile and soft voiced girl.

"A telephone call under the boy regime meant Bedlam and five minutes; afterwards, under the girl regime, it meant silence and twenty seconds. Instead of the incessant tangle and tumult, there came a new species of exchange—a quiet, tense place in which several score of young ladies sit and answer the language of the switchboard lights."

Such is the telephone exchange of the present day. Upon entering same there is heard only the mixed tones of low and well modulated voices.

There is in most all of the larger cities, quite a great demand for operators, due to resignations, increase of business and to the supply of operators for subscribers who install private branch exchange switchboards, so that in order to safeguard itself and maintain an efficient force, the telephone companies have opened schools for student operators, where they are thoroughly instructed in the theory and practice of telephone operating. The school is equipped with a switchboard which is as complete on a small scale as any of the switchboards in service, and is also designed that all types of calls are handled by the student operators in practice, in exactly the same way that they are handled at the regular central offices.

In order to minimize the delays in responding to calls for information of various kinds, the telephone companies after devoting considerable time and study to the situation, have drawn up a code of phrases in the form of answers to questions which are perhaps asked the operators scores of times during each day, and in which are eliminated all unnecessary words with the view of giving the desired information in as short a time as possible, and with the least effort to the operator, upon whom every unnecessary word, when summed up at the end of a day, means a considerable loss of energy and hence an inferior class of service. This, then, is also one of the aims of the school, to introduce a uniformity of practice among all operators. Upon passing along in back of the

chairs, one will notice very readily the repitition of the same phrases spoken by the operators in answer to questions and requests of the subscribers.

As a further assurance of the highest and most conscientious service on the part of the operators toward the public, there are employed by the telephone companies, Supervising Operators, stationed directly in the rear of the operators at the switchboard, whose duties are to remain constantly in touch with the many details of the switchboard operations, to immediately relieve the operator of all complaints of and irregularities in service, in order that the latter may not be compelled to devote too much time to one subscriber, causing a consequent neglect to others; to see that all calls are answered promptly and that courteous and polite replies are given to subscribers under all conditions. In addition to these Supervising Operators, there is in charge over all, a Chief Operator, who is provided with an especially equipped desk, and connected in such a way that direct connection by means of a cord and plug, and a set of jacks, may be had with each and every operator and Supervising Operator in the exchange; also, connection may be made through the deck and switchboard with subscribers.

On the occasion of a visit to an exchange, one cannot help but notice the clocklike and methodic manner in which such an unusualy large number of details of a varied and mixed business are carried on without the slightest evidence of confusion.

There is also provided for the benefit of the public alone, a desk known as an Information Desk, for the purpose of giving to the public and patrons, a source of general information upon subjects pertaining to the city at large, and the telephone business of same. For instance, many times during the day a request is made as to whether a party named John Smith has a telephone; whether a party living at such and such a location has a telephone; or what is the name of the party whose telephone is numbered so and so; is there a telephone near such and such an address; what street car will I take to reach this or that street, and so on, until it is necessary to place at the fingers' ends of these Information operators, a source of reference which will enable them to compare favorably with a revised and latest edition of an encyclopedia and city directory.

An interesting feature of a telephone exchange is the constant daily and yearly variation of the traffic load, or number of calls handled. The load curve in the average exchange in the larger cities will show during the midnight hours a value of from one-tenth of one percent, to perhaps five percent of the maximum hourly load. In the exchange located in the business districts of the lager cities, very few calls are received between 7:00 p. m. and 7:00 a. m. Between the hours of 7:00 a. m. and 8:00 a. m., there will be a decided rise from about one percent to approximately five percent of the maximum. The rise from this hour on will be extremely rapid until between 10:00 a. m. and 11:00 a. m., when the maximum is reached. About noon, or during lunch hour, when business has been partially suspended, there will be a drop in the load curve of about forty percent below the maximum. After lunch hour, when business has been resumed, the traffic curve will rise to an afternoon maximum, which is reached between 2:00 and 3:00 o'clock. This afternoon maximum will be less than that of the morning, and will approximate about eighty percent of the maximum traffic of the day. From 3:00 p. m. until 5:00 or 5:30 p. m. there will be a rapid decrease in the traffic load, with an almost complete cessation of business at 6:00 p. m.

In a residence district the slump of traffic at noontime is not very well marked. There is, however, a decrease in the number of calls made late in the afternoon, and a corresponding increase in the number of calls for the telephones of a residence district. The evening traffic is also a feature of the residence district, originating from the social calls made when

people are usually expected to be found at home. The evening traffic of a residence district often continues heavy until 9:00 and 10:00 o'clock.

Telephone traffic varies with seasons as well as with the time of day, the maximum being reached during September and October with the minimum coming in July and August. Of course, this will vary considerably in different districts, depending on the habits of the people and business located therein.

A necessary adjunct to the Operating Room, and considered one of the main features of a telephone exchange, is what is known as the Terminal Room, or as the name signifies, a place where the lines from the switchboard and from the outside plant meet or terminate. Ir this room are located the Main Distributing Frame, Intermediate Distributing Frame, Relay Rack, Fuse Panels, Wire Chief's testing equipment, and sometimes the Power equipment.

The systematic and easily accessible arrangement of all wires and terminals is one of the most noticeable features of a telephone exchange. This is very necessary on account of the fact that if a line is found to be in trouble, owing to the exceedingly large number of pieces of apparatus and the great amount of wire involved in same, various intermediate points of access between the ends of the line must be provided in order to definitely locate the trouble in the shortest time possible.

The Main Distributing Frame stands as a connecting link between the outside lines and the lines from the switchboard. Its purpose is to provide a means of connecting the outside lines with any multiple jack in the switchboard, to agree with the number of the telephone; e. g., should a subscriber wish to change his place of residence, and still retain his original telephone number, it would only be necessary to change the connection at the Main Distributing Frame. The outside lines enter the exchange through ducts in the form of cables, and are brought up to what is known as the vertical side of the Main Distributing Frame, which consists of terminals arranged in vertical rows. These terminals are in the shape of springs, between the ends of which are placed a form of fuse or cut-out, known as a "heat coil."

The pairs of wires contained in the cables are fanned out into what are known as "forms," and the individual wires are fastened to one side of the pairs of springs or protectors. To the other side of the springs are fastened short lengths of twisted pairs of wires known as "jumper wires" and which terminate at the opposite side of the Main Distributing Frame, known as the Horizontal Main Distributing Frame. On this side of the Frame, are located rectangular blocks of wood, to which are fastened lugs or terminals, usually forty in number, or twenty pairs, and known as "terminal blocks" arranged in horizontal rows. The jumper wires are fastened to one end of each pair of these lugs. On the other end of these lugs are connected the pairs contained in the cables which terminate at the springs of the multiple jacks in the switchboard. The lugs on the Horizontal Main Distributing Frame are numbered to correspond with the number of the multiple jack or to the number of the subscriber's telephone, while the protector springs are numbered to agree with a code number used to identify each pair of wires in the cables.

There is also provided, for the purpose of distribution of lines to the switchboard, a frame known as the intermediate Distributing Frame. This, however, has an entirely different object from that of the Main Distributing Frame, and is for the purpose of distributing uniformly among the different operators, the load of traffic, or giving to each the same number of answering jacks to take care of, as far as possible.

The opposite sides of the Intermediate Distributing Frame are distinguished in exactly the same way as the sides of the Main Distributing Frame; viz. Horizontal Intermediate Distributing Frame, and Vertical Intermediate Distributing Frame. On the Horizontal Intermediate Distributing Frame, the terminal

blocks are arranged in horizontal rows, and to one end of the terminals are connected the pairs contained in the same cables which appear on the Horizontal Main Distributing Frame, the Intermediate Distributing Frame usually being so located that the cables originate on the Horizontal Main Distributing Frame and pass along the Horizontal Intermediate Distributing Frame on their way to the switchboard, or to state it more briefly, the cables are tapped as they pass the Horizontal Intermediate Distributing Frame. To the other end are connected jumper wires running to the Vertical Intermediate Distributing Frame.

On the Vertical Intermediate Distributing Frame the terminal blocks are arranged in vertical rows. To one end of the terminals are connected pairs contained in cables which terminate at the springs of the answering jacks in the switchboard. To the other end are connected the jumper wires coming from the Horizontal Intermediate Distributing Frame. The lines terminating at the Vertical Intermediate Distributing Frame are numbered according to the panel and jack number where the answring pack may be located in the switchboard.

Now it may be asked—what relation exists between the answering jacks, the multiple, the operator and the distribution of load. Simply this—in the first place, the answering jacks are designated by small rectangular number plates, which are fastened immediately alongside of the answering jack lamp. The number on this plate is the number of the multiple line to which it is connected, and also the number of the subscriber's instrument to which the line is connected. The number on this plate, however, is of no interest to the operator, for the only time she is concerned with the answring jack is when the lamp is lighted, when she immediately plugs it out, and asks what number is wanted.

This number, though, is of interest to the Traffic Department, or the department whose purpose it is to see that the service is maintained at its highest efficiency, both toward the telephone company, and the public. The records of this department will show the number of the line, the name of the subscriber, the class of service (whether the telephone is used in a residence, business house, and is paid for by the month or message, etc.), the location of the answering jack in the switchboard (number of panel and number of answering jack in panel; the latter are numbered consecutively in the panels, there being ten jacks in a horizontal row, and the first jack in the lower left-hand corner is numbered "0," the second one to the right, "1" etc.) It can thus be plainly seen that there would be no object in arranging the answering jack so that the number plates were in consecutive order. In fact it would serve as a detriment, for it is quite often that a subscriber wishes to discontinue the use of his telephone, and it may so happen that others whose telephone numbers follow very closely in the same numerical order as the first may likewise discontinue the use of their instruments. Hence, the result would be that possibly certain operators would perhaps have one or two subscribers to look after, while those sitting immediately on either side would be taking care of perhaps that many hundred; consequently, the means of distribution afforded by the Intermediate Distributing Frame.

Practically all of the relays are located in the Terminal Room on what is known as a Relay Rock, there being a certain few found in the rear of the switchboard. All relays are grouped systmatically according to the circuits in which they are used, and are so designed on the cape and covers used to protect them from dampness and dust, that one can tell at a glance to which individual circuit each belongs.

The fuses are located on Fuse Panels, which are made of marble slabs similar in appearance to those ordinarly used for power boards. The fuses, like the relays, are grouped and designated so that there is no difficulty in locating any particular fuse for the purpose of renewing

same. In this connection I might state that as an aid in determining with the least possible delay, the fact that a circuit is disabled or opened by the blowing of a fuse, so that the service may not be interrupted for an unnecessary length of time, what is known as a "fuse alarm signal" is installed. This consists of a bell or ringer, similar to that of a subscriber's instrument, which is connected to busbars on the fuse panels, and so arranged that at the instant the fuse is blown, a small tongue on the special type of fuse used is released and strikes against a busbar located under the center of the fuse, and closes the circuit through the ringer, causing it to vibrate. An attendant, one of whose duties it is to replace fuses, is thus automatically notified, and loses no time in doing so. Should the circuit be in trouble so that a fuse of the specified capacity will not hold, the attendant known as the "Troubleman" is notified, and he immediately ascertains the cause and rectifies same. There is also associated with each row of fuses, a small incandescent lamp of the nature of a pilot lamp, which is located at the top of the row, and which illumined at the instant the circuit is closed through the ringer.

The Wire Chief, by means of desk equipment afforded for his use, occupies one of the most important positions in the exchange. In the equipment located on his desk are meters and connections for the purpose of making a complete test of lines both inside and outside of the exchange. By the aid of his voltmeter and ammeter, or Wheatstone Bridge, he can locate within a few feet, a break, ground, or cross in a line on the outside.

In one of the positions at the switchboard, usually the last, there are located, cords connected directly to his desk, known as plugging up lines, provided for the purpose of making an electrical test on any subscriber's line in the switchboard from his desk in the Terminal Room. There is also provided a means of testing subscribers' lines from the Main Distributing Frame, either from the Main Frame to the subscribers' instrument, or from the Main Frame to the switchboard.

The source of current supply is obtained from storage batteries, the size of which will depend mainly upon the size of the exchange and the extent of the locality served. The telephone power plants generally comprise at least two direct current machines of suitable voltage and capacity for properly charging the storage batteries, and two alternating or pulsating current ringing machines for operating the subscribers' bells, and in the case of the ringing machines, one of them is driven from the same source or sources of power which drives the charging machines, while the other should be driven by a motor taking current from the discharge leads of the storage battery.

It has become the general practice to use a gas engine, belted to a direct current generator for charging purposes whenever possible.

The construction of power machinery for use in telephonic work is one that requires the closes attention of the engineer to minor details, which for the same machinery in other branches of electrical work, could be disregarded. The current delivered by the charging generators or consumed by any motor deriving its current from the central battery, must be, as nearly as possible, absolutely "smooth." The fluctuations of electromotive force and current, due to commutation at the brushes, should be eliminated to such an extent that no noise will be heard in the talking circuits deriving currents from the terminals of the battery during the use of the machines. Hence, it is apparent that if the voltage across the terminals of the storage battery were subject to rapid periodical fluctuations, due to the action of the charging machines, or motors driven from the battery, a noise would be heard in all receivers connected across the lines fed by the battery.

In conclusion it would seem most befitting to all that has been said, and possibly interest a great many of you as engineering students, to give a brief summary of the history, and a

few details of a business and company that has progressed hand in hand with the rapid development of the telephone business.—*The Western Electric Company.*

The Western Electric Company is the oldest and largest manufacturer of telephones, telephone exchange equipments, cables and associated appartus and supplies in the world. The company is doing an annual business of approximately $70,000,000. It produces in half a day, telephonic goods to the value of $100,000, as much as the Western Union refused to pay for the Bell patents in 1877. In its plants and offices, located in all parts of the world, about 25,000 people are employed. Approximately 75 per cent. of these are productive day workers in the Company's plants; among the remaining 25 per cent. are some 600 college men in all phases of the Company's activities.

As one writer has chosen to put it:

"The Western Electric Company was born in the ashes of the big fire of 1871, and it has grown up to its present greatness, quietly, without celebrating its birthdays. At first it had no telephones to make; none had been invented, so it made telegraphic apparatus, burglar alarms, electric pens, and other such things, but in 1878, when the Western Union made its short lived attempt to compete with the Bell Company, the Western Electric agreed to make its telephones. Three years later, when the brief spasm of competition was ended, the Western Electric Company was taken in hand by the Bell people, and has since then remained the great workshop of the telephone.

The main plant in Chicago is not especially remarkable from a manufacturing point of view. Here are the inevitable lumber yards, and foundries, and machine shops; here is the mad waltz of the spindles that whirl silk and cotton threads around the copper wires very similar to what may be seen in any braid factory. Here electric lamps are made, five thousand of them in a day, and in the same manner as elsewhere, except that here they are so small and dainty, as to seem designed for fairy palaces.

The things that are done with wire in the Western Electric factories are too many for any mere outsider to remember. Some wire is wrapped with paper tape at a speed of 9,000 miles a day; some is fashioned into fantastic shapes that look like absurd sea monsters, and in reality are only the nerve systems of the switchboards. And some is twisted into cables by means of a dozen whirling drums—a dizzy sight as each pair of drums revolve in opposite directions. Because of the fact that a cable's inevitable enemy is moisture, each cable is wound on an immense spool and rolled into an oven until it is as dry as a cinder. Then it is put into a straight packet of lead pipe, sealed at both ends, and trundled into a waiting freight car.

No other company uses so much wire and hard rubber, or so many tons of brass rods as the Western Electric. Of plantinum, too, which is more expensive than gold, it uses one thousand pounds a year in the making of telephone transmitters. This is imported from the Ural mountains; the silk thread comes from Italy and Japan; the iron for magnets from Norway, the paper tape from Manila, the mahogany from South America, and the rubber from Brazil and the valley of the Congo. At least seven countries must co-operate to make the telephone message possible.

Perhaps the most extraordinary feature of the Western Electric Company's factories is the multitude of its inspectors. No other sort of manufacturing company, not even the Government navy yard, has so many sleuths of inspection. They test every tiny disc of mica and throw away nine out of every ten. They test out every telephone by actual talk, set up every switchboard, and try every cable. A single transmitter by the time it is complete has had to pass three hundred examinations; and a single coin box is obliged to count ten thousand nickels before it graduates into the outer

world. Seven hundred inspectors are on guard in the two main plants at Chicago, and New York. This is ruinously large number from a profit making point of view, but the fact is, that in a telephone system, nothing is insignificant."

In a growing business of such wide extent and interests, there is constant need for well trained men. It is the policy of the Company to offer these opportunities to properly aquipped men familiar with the Company's products and methods.

Training courses are carried on for college men planning to take up work in the commercial, manufacturing or engineering departments. These courses give the college man a comprehensive view of the Company's work as a whole, how and why responsibility is divided and how his special work will bear on that of other departments and the entire work.

The Commercial Course gives men, planning to take up the commercial side of the business, an understanding of the quality of the product and a knowledge of the facilities for manufacturing, business getting, carrying and distributing the produtcs and billing and collecting for those sold.

Actual experience in various departments of the Shops familiarize the men with the raw material, manufacturing, assembly, testing and inspection of the apparatus; also, with shop practices, tool design, machine location, scheduling, routing and tracing of parts in process and after assembly.

Similarly, the Engineering Course familiarizes the men with the Company's principal products. Work is assigned in the branches and laboratories of the Telephone Engineering Department where the service requirements, apparatus and circuit design, theoretical, research and development studies are carried on; in the Equipment Branch where the specifications and plans for complete telephone exchange equipments are prepared for the Manufacturing and installation departments. Work is done too in the field, installing the complete telephone switchboard and power equipments and preparing them for operation by the customer.

This training in the various departments is supplemented by lectures and class-room work, and is under the direction of the Educational Manager, who keeps in close touch with the men to aid them in intelligently and efficiently taking up each part of their new work. The Educational Department's supervision continues throughout a regular course, extending over a period of from six months to a year, and until the student has been assigned to regular work in a department for which his qualifications and training best fit him. For the first six months, $10.00 a week is paid, $15.00 a week for the second six, and $18.00 at the beginning of the second year, at the time when the man ceases to be a student and becomes a producer.

Further detailed information regarding the Western Electric Company, opportunities in Commercial Telephone Engineering and Manufacturing work, or the training courses, may be had from Mr. J. W. Dietz, manager of the Educational Department, Western Electric Company, Hawthorne Station, Chicago, Ill.

IMPROVEMENTS IN WATCH ESCAPEMENTS

By Arthur W. Nehf, '14.

WATCHES, or portable clocks as they are called, were first made by one Peter Hale, a clockmaker in Nuremburg, Germany, in or soon after the year 1500. This honor has sometimes been erroneously ascribed to Isaac Hebrecht, which said Isaac lived in Strasburg a century after Hele.

In the Hele watch it seems that the mainspring was not enclosed in a metal case or barrel, as it is called, but was unenclosed as in a clock; however, by an ingenious contrivance the pressure of the mainspring on the train or system of wheels was kept constant, that is, it exerted as much force when nearly unwound as when wound up to its fullest extent. This form of watch with unenclosed spring was known as a stackfreed. A more developed stackfeed was shortly afterward invented and was in fact a forerunner of the famous fusee type of watches invented by Jacob Zech, of Prague, about 1525 and which will be fully explained later.

The circular balance wheel must have been introduced no later than 1530 at the latest, as any other type was not adoptable for a pocket watch.

All early movements were made entirely out of iron or steel, which fact gives sufficient reason to think that the first horologists were in reality locksmiths who must have been very skilful artists, machinists and mathematicians.

Watches were not carried in the pocket for a century after they were introduced. The larger ones were kept on a table or cabinet and the smaller ones when attached to the person or rather when the person was attached to it, were originally worn around the neck. The fob from the German "Fugger" meaning a small pocket seems to have been introduced by the Puritans who, because of their dislike of display, concealed their watches from public gaze. This conjecture as to the origin of the fob is borne out by the fact that a short chain belonging to the watch of Oliver Cromwell, in the British Museum, is in point of date the first appurten-

ance of the kind to be found.

The leading escapements used in watches are five in number, named in the order of their introduction or invention: The French Verge, the Cylinder or Horizontal, the Duplex, the Lever and the Detached or Chronometer.

The Verge may be considered obsolete, although it has been used in excellent timekeepers at certain times. For pocket watches the Lever has come into general use with the exception of the detached or chronometer escapement, which is used exclusively for marine chronometers.

Earlier in this paper the fusee was mentioned and as most of the early watches received power from this peculiar arrangement it will now be explained before entering into the intricacies of the escapements.

The fusee consists of a spirally grooved pulley which is placed between the barrel and the great or driving wheel of a clock or watch, the connection between the barrel and the fusee being made by a cord or chain one end of which is attached to the barrel and the other to the fusee. The power is equalized in the fusee by having the spring when wound up pull the chain off the smallest part of the fusee wheel. Advantage of a larger radius is gained as the spring unwinds and by proportioning the diameter of the fusee to the varying pull of each successive turn of the main spring, an excellent adjustment is obtained so that the pressure exerted by the great wheel on its axle or center pinion is constant. (This is the same principle upon which low gear and high gear bicycles are made.)

The connection between the barrel and fussee was generally of catgut until a Swiss named Gruett in 1664 introduced chains in place of the gut.

French Verge Escapement.

This type received power from the fussee. The oddly shaped fourth wheel works in to the pinions on the escape wheel which in turn works into the lugs on the balance staff which are set at an angle of 90 degrees to each other. When the teeth strike the top lug it swings the wheel in the direction of its motion and the botton lug is struck by the teeth going up, the wheel is thus revolved or oscillated back and forth. Watches of this type were very thick and heavy.

Cylinder or Horizontal Escapement.

This type is a slight improvement over the French Verge. The escape wheel works into the balance staff much the same as the French Verge but instead of being placed in the upper plate it is placed in the lower plate or base. On account of the placing of the escape wheel on the base the watches could be made much thinner and the balance wheel put between the plates.

The nimble witted Yankee made the next important changes in watches. They did away with the fussee wheel and its troublesome connections, putting the mainspring in a barrel and making it so the power was transferred directly to the center wheel. The watches after this improvement wound away from the winder while the formerly the opposite was true. At that time the stem set and stem wind watches were being introduced as a great improvement over the lever set and key wind kind.

Duplex Escapement.

This movement because of its outlandish shaped wheel, has caused more gray hairs to spring upon a watchmaker's head than all other types. The principle is the same as that of the French Verge or Cylinder except that instead of the lug or roller jewel in the balance staff striking a tooth in the escape wheel at every beat the balance oscillates as high as four (4) times a second.

The Lever Escapement.

This style of movement is in most common use, in fact it is used in even the cheapest kind of watches, dollar watches. The lever works into the teeth of the escape wheel and the roller jewel into the forks of the lever. In this movement the balance wheel oscillates 18,000 times an hour.

The chronometer Escapement is in fact a combination of the lever and duplex styles, but is is so rarely used except in marine timepieces that it is best to pass over it, merely remembering it makes one complete oscilation to one tick which is unlike the other types which tick twice to one oscillation.

The height of perfection of today in horology is the modern full jewel railroad watch, adjusted to heat and cold, isochronism and fine positions.

The watch is adjusted to heat and cold by having the balance wheel made of two pieces of metal, steel on the inside and brass the outer rim, and by having he wheel cut instead of the old style solid rim of one metal.

Isochronism is a subject understood fully by few watchmakers but it merely means that property of the hair-spring which causes the vibrations of the balance to be performed in the same time if they be either long or short.

Five positions means practically all positions into which it is possible to place a watch.

By these rapid steps watchmaking has been developed until the old heavy bundlesome stockfreeds and French Verge watches have been as rare as electric light at the north pole. Watch making has been advanced from the crude efforts of clumsy locksmiths to the most painstaking care of the highest skilled mechanics in the world. The last word of watchmaking was very nearly spoken when a Swiss "Uhrmacher" after working for three years, produced and exhibited to an astonished world the smallest watch ever made, one-fifth of an inch in diameter. This wonderful work of art keeps perfect time and sold for $25,000, a poor recompense indeed for the maker who ruined his eyes constructing it.

THERE has been a great deal of comment lately on the attitude of Rose students at the basket ball games. It has not been confined to the students and faculty alone, but to the people of the city as well. Anyone will have to admit that the yelling and hooting at an opposing player when he attempts at a foul goal and strenuous efforts on the part of the students to make quiet when a Rose man attempts at a foul goal is a very unsportsmanlike attitude. We all have done it and this is not an attempt to place the blame on any few. But if the practice is to be stopped the students themselves are the only ones that can do it. I am afraid that faculty action would have but little effect in this case and it remains to the student body to stop it. There are some that never have liked the idea, others who do it just because someone else starts it and to be plain there are those who —well they can not help it. If some of the students would make it plain at the games that this spirit was not popular there is no question but that it would soon disappear. Everyone likes to see Rose win and there is no getting around the fact that in a close game it is hard to control oneself, but there are many other ways of letting the excitement loose.

A few years ago Rose Tech-men had the reputation of being true sportsmen and of knowing how to lose, while now, some of our neighbors are pleased to call us "roughnecks." Surely there must be some reason back of it. We all laugh at the name but there is not one that feels any better for being designated that way. Rose Tech stands first class in the ranking of state college athletics and for a school of its comparative size this is quite a record—now, if we could only add to that the reputation of being true sports! Everycne will realize that it is to the school's and his benefit to consider this matter and that a correction will soon be noticed by others and in time we will not have to be known as "roughnecks."

BASE BALL time will soon be here and the team is going to need the support of the student body badly. With only a few of last year's men to start with, Capt. Lawler will have to have a large squad of new men to turn out any kind of a team. We lost six men by graduation, two more by ineligibility and another prospective by the same route. There are only five "R" men in school who are eligible and there will be plenty of room for new men. A strong battery is practically all there is as a starter, and although that goes a long ways it will be far from making a winning team. Besides one pitcher can not do all of the pitching, especially when the team plays two or more straight games. The Freshmen have done pretty well so far in furnishing material and we hope they will do as well for baseball. According to the present state of finances we will have to do without a coach but past teams have done without and it should not be a drawback.

Indoor practice will start soon but a real line on the ability of the candidates cannot be had until the outside work starts. This will be the first time in four years that the men will get to work on the regular diamond when they start outside work. For the last three years there has been repairs to be made on the diamond and the men have had to start their work on an improvised diamond on the south end of the campus.

———ooo———

THE Basketball has been up against some genuine hard luck so far. There have been six games with two victories and the four defeats would have been victories with an even break in luck. The games with Wabash and the Michigan Aggies were both close ones and it was only a question in both of them as to which team would get the last goal before the final whistle. The first game of the season with Wabash was close and two field goals by Lambert in the last minute of play decided the contest. Rose put up a good game considering it was the first of the season while Wabash had played several games. The men lacked a little in team work but more than made up for that by their fighting spirit. Then the game with the Michigan Aggies was a heart-breaker. It was one of the fastest ever seen on a Rose floor and the score was tied most of the time. With about twenty seconds to play, Spencer, one of the "Aggie" guards, got a shot at the goal that he couldn't miss and made the score 33 to 31. Then the whistle blew just as the ball was thrown up in center. Indiana came next and the rooters could well be satisfied with the result. Rose was the whole show especially in the second half. The first half ended 24 to 19 in Rose's favor but in the second half Indiana only managed to score 5 points while the Tech men counted 21. The score, 45 to 24, really tells the relative strength of the two teams. Everyone would like to forget the first trip away from home. Hanover and Franklin were the opponents and both came out victors. It was a hard trip for the men and it told on their playing. The team was away below its standard and when these two teams come to Terre Haute to play there will be a far different story. Earlham then came to Terre Haute with a string of seven victories and one defeat and that by Wabash, but they went back to Richmond with two defeats to their credit or discredit. It was not a game to brag about as neither team put up a first class exhibition of basket ball. It was a rough and tumble affair and Rose seemed to be a little better at that art, merely because they were bigger and not because they wanted to any more than Earlham. It was the first time in three years that Rose had defeated Earlham.

The team then went to Notre Dame and received the short end of a 31 to 34 score. Rose played hard in the first half but the pace was too fast, especially as the men were not used to a dirt floor. The game was played in the afternoon and after a long morning's ride on the train and the players were not able to stand the pace set by the Catholics.

MANY important changes have been made by the foot ball rules committee this year and the following is a brief summary of the new rules. The idea of the committee was to eliminate the kicking to a great extent and allow more scoring by touchdowns. There have been many articles written by well known sporting authorities since the rules have been made public as to their benefit. There is a great diversity of opinion and it remains only a question as to how they show in actual play next fall.

One down has been added to the three, in which the ball must be advanced ten yards.

A forward pass if legally captured ten yards back of the goal line is allowed under the new rules. To make such a play possible on fields that do not have ten yards clear behind the goal line, the length of the field will be 100 yards instead of 110.

The kick-off will be made from the forty yard line instead of from the center of the field.

The on-side kick is eliminated as being unnecessary.

The forward pass, which under the old rules is allowed 20 yards, may go as far as possible this year.

Following a touch-back the ball must be kicked from the 20 yard line instead of from the 25 yard line.

The intermisison between the first and second and the third and fourth periods is changed from two minutes to one.

A touchdown will score six points instead of five with an additional point added for a successful kicked goal.

A goal from the field must clear the bar "on the fly."

———ooo———

BASKET BALL.

The following are the records of the points scored by the members of the basket ball team, including the Notre Dame game:

Player	Field Goals.	Foul Goals.	Tl. Pts.
Hegarty	23	34	80
Wente	19	3	41
Gray	17	....	34
Deming	6	....	12
Poggensee	3	....	6
Black	1	....	2
Crowe	....	....	....
Sheldon	....	....	....
Totals	69	37	175

Rose 175; Opponents 182.

———ooo———

WABASH 25—ROSE 22.

A good crowd turned out for the first game of the season and it was shown some first class basket ball. Both teams were evenly matched and it took until the last few minutes of play to decide the contest. Considering the fact that Wabash had played several games while Rose was in its first contest the result was far from discouraging. The score was tied 21 to 21 until the last minute of play when Lambert scored two field goals and Hegarty got one foul goal. The first half ended 12 to 10 in favor of Wabash. The line-up:

Wabash 25	Position	Rose 22
Lambert (capt.)	F	Hegarty
Eglin	F	Deming
Ellis	C	Gray
Hill	G	Crowe (capt.)
Burrows	G	Wente

Field Gols—Lambert 5, Eglin, Ellis 4, Burrows, Hegarty 5, Gray 2, Wente, Deming. Foul Goals—Hegarty 4, Lambert 3. Referee—Reimann, of Purdue. Time of halves—20 minutes.

———ooo———

MICHIGAN "AGGIES" 33—ROSE 31.

This game was a good example of Rose's come-back spirit. With the score 21 to 12 against them to start the second half the fellows

put up a great game and during the greater part of this half the score remained tied, a series of goals at the start having evened matters. The Aggies put up a far better game than did Wabash and the fact that Rose held them close showed the improvement in the rose and white team. The visitors rushed matters in the first half and Tech was played off its feet, in fact, it seemed as if there were only Aggie men on the floor. But the second half told a different story and only those that were there can appreciate the spurt made in that period. Vatz, Chambrlaine and Spenser were the stars for the Aggies while Gray and Hegarty did the best work for Rose. The line-up:

"Aggies" 33	Position	Rose 31
Gauthier	F	Hegarty
Vatz	F	Deming
Chamberlaine, Nies	C	Gray
Spencer	G	Poggensee, Crowe
Goss	G	Wente, Black

Field Goals—Spencer 4, Vatz 4, Gauthier 3, Chamberline, Nies, Goss, Hegarty 5, Gray 2, Deming, Wente, Poggensee, Black. Foul Goals—Hegarty 9, Vatz 5. Referee—Wischmeyer, Rose Tech. Time of Halves—20 minutes.

———ooo———

ROSE 45—INDIANA U. 24.

This one-sided victory was nearly enough to make up for all the defeats that Indiana has given us. The fact is that it was Rose's game from start to finish and in the second half Indiana only managed to get five points while Rose was getting twenty-one. Coach McKinney used a new style of play by letting Gray and Hegarty alternate at center and the trick seemed to baffle the Indiana guards who didn't know which man to stay with. Gray was the largest point maker getting eight field goals but Hegarty was a close second with four field and seven foul goals. Wente's eye was especially good and his playing reminded one of some of the games in 1910. Crowe and Poggensee put up especially strong games at guard. The line-up:

Rose 45	Position	Indiana 24
Hegarty	F	Freeland
Wente	F	Munkelt, Chattin
Gray	C	Graves
Crowe, Deming	G	Davis
Poggensee, Black	G	Stayton, Edwards

Field Goals—Gray 8, Wente 6, Hegarty 4, Poggensee, Freeland 5, Munkelt 3, Graves 2. Foul Goals—Hegarty 7, Graves 4. Referee—Westover, of Purdue.

———ooo———

HANOVER 27—ROSE 22.

It would be better if little was said about this game. It is surely not true that Hanover has a better team but something just—slipped. The players had made a hard trip and did not show their usual speed and being possessed of a little self-confidence when they started were beaten before they realized what had happened. Wente and Crowe were best in this game, the former making a couple of sensational shots. The line-up:

Hanover 27	Position	Rose 22
Kehoe	F	Hegarty
Trotter	F	Wente
Voris	C	Gray
Mann	G	Crowe, Deming
Ramsey, Iddings	G	Poggensee

Field Goals—Kehoe 5, Trotter 3, Voris 2, Mann, Wente 3, Hegarty 3, Gray 2. Foul Goals—Hegarty 6, Kehoe 2, Trotter 3. Referee—Simpson. Time of halves—20 minutes.

———ooo———

FRANKLIN 19—ROSE 17.

Rose started out all right, and the first half ended 13 to 10, but the Franklin guards played close to their men in the second half and Hegarty and Wente were unable to get many baskets. Sheek's three field goals near the end of the game gave Franklin the lead. Wente was again the shining star in this game, scoring

five goals from the field all of which came in the first half.

The line-up:

Franklin 19	Position	Rose 17
Hill	F	Hegarty
McQuinn	F	Wente
Sheek	C	Gray
Wagner	G	Crowe, Black
Burton	G	Poggensee, Deming

Field Goals—Wente 5, Hegarty, Gray 2, McQuinn 3, Sheek 3, Wagner 2, Hill. Foul Goals—Hegarty, McQuinn. Referee—Westover of Purdue. Time of halves—20 minutes.

———ooo———

ROSE 24—EARLHAM 23.

The above score gives an idea of how close this game was and it was the same all the way through the game, the first half ending 11 to 10 in favor of Rose. It was not an especially fast game but was more inclined to be rough. Sheldom, a freshman, was given a chance in the last half and put up a good game. Wente played a good game at forward and Crowe and Deming did especially good work at guard. The line-up:

Rose 24	Position	Earlham 23
Wente	F	Gilbert, Trueblood
Hegarty, Deming	F	Beery, McMann
Gray, Hegarty	C	Brownell, Gilbert
Crowe	G	Furnas
Poggensee, Deming		
Sheldon	G	Wolfe

Field Goals—Wente 2, Deming 2, Hegarty 2, Poggensee, Gray, Gilbert 3, Beery 2, Furnas, McMann. Foul Goals—Gilbert 9, Hegarty 5, Wente 3. Referee—Wischmeyer. Time of halves—20 minutes.

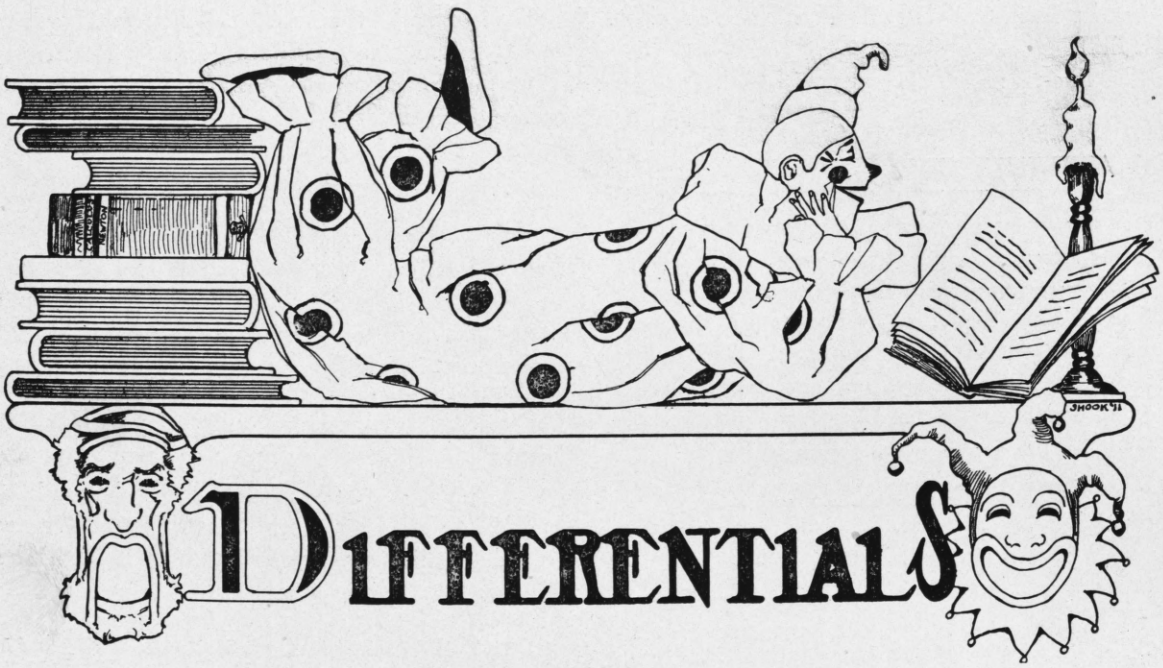
———ooo———

NOTRE DAME 31—ROSE 14.

The fact that the men hadn't had any dinner, were playing on a dirt floor and had ridden on the train all morning told in this game and in the second half it was easy for Notre Dame to pile up the score. Both teams roughed it and the referee let many fouls go. The team work of Granfield, Cahill and McNichol was too much for the fellows and in the second half the Catholics scored nineteen points. Wente, Crowe and Gray were the best for Rose. The line-up:

Notre Dame 31	Position	Rose 14
Cahill	F	Wente
McNichol	F	Deming
Granfield	C	Hegarty
Nowers	G	Gray
Feeney	G	Crowe, Poggensee

Field Goals—Granfield 5, Cahill 4, McNichol 3, Nowers, Feeney, Hegarty 3, Deming 2, Wente. Foul Goals—Hegarty 2, McNichol 3. Referee—Barnhart of Indiana. Time of Halves—20 minutes.



First Freshman (in blacksmith shop)—Ever played golf?

Second Freshman—Yes.

First Freshman—Well, come here, we're going to make some links.

* * * *

Senior—Hey, somebody get me a comb and brush; I want to fix the hair-spring in my watch.

* * * *

Holloway (coming in late at the blacksmith shop, and finding the best forge occupied)—Hey, Newhart, get out of there; that's my stove.

* * * *

It is said that the Juniors in Applied Mechanics are taking a parallel course in Zoology. We are informed that the subject of the first lecture in this course was a very entertaining discourse on "Cats."

Prof.—Mr. O'Laughlin, what does K stand for in this formula?

Slim—Why, K stands for key.

* * * *

"Stevie"—Find the atomic weight of zinc.

Freshman—I didn't know it was lost.

* * * *

First Soph (as Hath demonstrates a problem on the board)—Say, Professor, is that rotation?

Sesond Soph—No, that's 15 ball.

* * * *

LOST—By Slim O'Laughlin, in Electrical Lab., three perfectly good hours, while waiting for the mercury to rise in the hydrometer.

* * * *

To the students who made contribution to the Technic box during the last month—Many thanks, do it some more, and see if you can encourage any more to do the same.

WASH DAY.

When Eve held forth in Paradise,
She found much pleasure in it.
For when she did her Monday wash,
It only took a minute.
—*Milwaukee Sentinel.*

And when the washing blew away,
Eve didn't fret or whine;
She merely sauntered forth and picked
New garments from the vine.
—*Springfield Union.*

Ever never sassed the laundryman
Who brought her washing back;
And didn't growl because no starch
Was in her dressing sack.
—*Scranton Tribune-Republican.*

And Adam never had a grouch
When washing day was due;
No washer did he have to run,
And turn the wringer, too.
—*Allentown Democrat.*

And after washing day was o'er,
Adam felt glad and free—
He never found Eve's stockings
Where his neckties ought to be.
—*Houston Post.*

When Eve held forth in Paradise,
Some things Ad's frau might lack;
But when the wash was sorted he
Didn't pin her up the back.
—*St. Louis Times.*

* * * *

If, in the vegetable race, the cabbage was ahead, would the Tomato Ketchup?

Aw, Lettuce give up, for I don't Carrot all who Beets.

* * * *

Rose Senior—Can you keep a secret?

Normal Co-ed—Yes, but unfortunately I always tell it to someone who can't.

Grocer—Did the watermelon I sold you do for the whole family?

Customer—Very nearly. The doctor is calling yet.

* * * *

From the Vincennes "Morning's Milk."

"Mrs. Jones, of Lost Creek, let a can-opener slip last week, and cut herself in the pantry."

"John Doe climbed on the roof of his home last week looking for a leak, and fell, striking himself on the back porch."

"While Harold Green was escorting Miss Violet Wise home from a church social last Saturday night, a savage dog attacked them, and bit Mr. Green on the public square."

"Mr. White, while harnessing a broncho last Saturday, was kicked just south of the corn crib."

* * * *

Of all the fishes in the sea, the bullfrog is the fish for me.

* * * *

If William J. B. would steer the Presidential craft, we wonder who Woodrow? (The first man that sprung that is now out on parole.)

———ooo———

NEWS OF OTHER COLLEGES.

At a Union dance given at Wisconsin University, the co-eds were graded on the program according to the pleasure the man derived from each dance.

"Cully" Thomas will be chief coach in all branches of athletics at Butler College in 1912-13.

Every Chicago University student taking swimming for gymnasium credit will be compelled to spend at least twenty minutes a day in the pool.

The DePauw student council has submitted a resolution to the student body, characterizing the use of tobacco on the campus as a breach

of the DePauw spirit, and recommending that it be treated as such.

Freshmen at Franklin have adopted a class shirt.

A Freshman at DePauw figured that ten popular co-eds ate 210 tons of ice cream during their four years at school.

The first call for crew candidates at Princeton was answered by 52 men.

Twenty thousand dollars has been raised for a new baseball cage at Yale.

The Wisconsin Athletic Council has decided to be more liberal with the awarding of the "W." Hereafter the player who gets into the Chicago and Minnesota games will be granted the varsity letter.

Illinois Freshmen inaugurated a new precedent by giving a smoker. About 500 attended, and the crowd was entertained by vaudeville acts and witty speeches.

A movement is on foot at Pennsylvania to prohibit the wearing of all jewelry symbolic of the University, such as pins and buttonhole seals or watch fobs.

The late Joseph Pulitzer left $2,000,000 to Columbia for the purpose of establishing a school of journalism there.

Dennison University has a Booster's Club, which does active work during the summer. An increased attendance of 65 is attributed to its efforts.

Out of 328 games Yale has played since 1884, the Blue has returned victorious in all but sixteen.

The architects of Washington University honored their patron saint (Saint Fatima) by having an amateur show on February 7th.

Kentucky State University has adopted the honor system in examinations.

———ooo———

LOCALS.

Mr. Alexander Jonhson gave a short but very interesting talk on "Problems of Everyday Life" before the student body.

An elective course in Machine Design is now offered to Junior Chemists.

Mr. Stephenson read a paper on "History and Manufacture of Matches" at the meeting of the Indiana Section of the American Chemical Society, held at Indianapolis, February 9th.

Prof. Thomas lectured on "Slide Rules and their Accuracy" before the Scientific Society, on February 17th.

STREET MECHANICAL STOKER.

A description of the Street mechnical stoker was published in the *Railway Age Gazette* of May 26, 1911, page 1197. Since that time an improvement has been effected in the design and construction of the conveyor used for moving the coal from the tender to the elevator hopper beneath the frame of the locomotive. The natural construction of such a conveyor is to use the screw type, but so long as the stoker was expected to feed everything from run-of-mine to slack, such a machine was inapplicable to the work. Something not apt to jam was needed. But if prepared—that is, crushed —coal is used, then the screw conveyor can be employed.

Mr. Street has always insisted that the coal used in his stoker be crushed before delivery to the distributing nozzles, and, to that end, put a crusher on the tender, not that he approved of it, but because railway officials were not educated to the point of preparing coal for stoker use. With the crusher, the fireman has to rake down the coal to the stoker jaws, from which it drops into a chute delivery into the deep hopper below the conveyor. This crusher is driven by an engine of its own located on the tender and taking steam from the locomotive. This arrangement was made to meet requirements and will be abandoned as soon as officials are educated to the point of recognizing the advantages of using one crusher at the coaling station instead of one on each of the locomotives.

With crushed coal furnished to the tender, a screw conveyor is used to carry it to the elevato hopper. The second engine, that was located on the tender, has been dispensed with, and the screw conveyor is driven by a sprocket wheel mounted in the lower hopper, and in turn driven by the elevator chain.

The screw runs back from the hopper beneath the floor of the tender. It lies in a heavy sheet iron trough, which is pivoted on a strong pin to the hopper. The back end of the trough rests on a wrought iron support bolted to the floor of the tank. A double toggle joint is provided for driving the screw, and this, together with the pivot connection for the trough makes ample provision for passing around curves and over uneven track.

A screen having 2-in. square meshes and made of 1-4-in. wire is placed directly above the screw conveyor and in the floor of the tank. This screen is covered with sliding plates, which plates are arranged so an opening 10-in by 12 in. is the maximum which can be obtained, and this opening is always in front of the coal, and therefore at a point where it can be seen by the fireman. The screen has a sliding support in the tank and is provided with an agitator which keeps it in constant motion while the locomotive

is running, and prevents the coal from briding and clogging over it. When taking coal these plates are placed in a position which covers the entire screw, and prevents any coal from being fed to it until such time as the fireman is ready for this to be done. He then moves the front plate ahead, uncovering the opening beneath it, and allowing the coal to flow down upon and through the screen until the slope will deliver no more. The second plate is then drawn out against the first, thus moving the opening to the rear. The other plates are afterwards moved in succession to meet the demands of the fire until the last plate has been drawn out and the tender has been emptied.

With the stoker and crusher combination as described in the former article, the lower hopper was very deep so as to obtain a sufficient steepness of slope for the chute to cause the coal to flow under all circumstances. With the screw conveyor the lower hopper is located between the floor of the cab and the deck casting. A section of the cab floor is made removable, and by lifting it access is obtained to all parts of the lower hopper. This hopper is provided with movable slides to facilitate cleaning it out, and is also fitted with a steam jet for blowing in steam to thaw it out in case of freezing. When the screw conveyor is used it is possible to construct the tank of such a form that all of the coal can be taken from the tank and fed into the firebox without being handled by the fireman. Under the most unfavorable construction of the tank the only handling of the coal required on the part of the fireman is that of scraping it out of the sides of the tank on top of the screen when the coal supply is low or nearly exhausted. The agitator prevents bridging, and the only attention the screw must receive from the fireman is that of occasionally drawing out one of the plates which cover the screen, bringing the opening further back. With this type of stoker the amount of coal fed to the firebox is governed by the speed of the screw conveyor, which is regulated from the fireman's seat.

The elevator engine and elevator run at a constant speed, and a gear changing box is provided, by means of which three different speeds can be given to the screw conveyor. The operating handle for this gear changing box is located at one side of the fireman's seat, to enable him to change the speed of the screw, and therefore the amount of coal fed to the firebox without leaving his seat. The gear changing box is mounted directly on the shaft of the driving sprocket, and motion is transmitted from the box to the screw through the medium of a link chain and a pair of sprocket wheels. —*Railway Age Gazette*, Jan. 5, 1912.

———ooo———

A NEW TYPE OF FLUID MOTOR.

IF a pair of spiral or herringbone gears are held together, there will be found to be a lozenge-shaped pocket in the center. If the gear is revolved, this space is extended, and as the teeth inclosing it advance to the respective positions, the volume will be increased.

A fluid under pressure admitted to this space and acting upon the receding surfaces would drive the gears, the energy produced being equal to the product of the pressure and the volume generated. If the driving fluid were expansible and were cut off at any point, it would expand into the increasing volume, and the advantages and economies of expansion be realized just as in a cut-off engine working with a regular piston. When the ends of the grooves in which the action occurs pass the line of contact so that they are no longer closed by the teeth of the opposite gear, the fluid would be exhausted.

It is upon this principle that the "Spiro," a new type of motor invented by John H. Van Deventer, superintendent of the Buffalo Forge Co., acts. The operating fluid is admitted through ports, and one of the claims to turbine classification, for the inventor inisists that it is a turbine, is that the gears are driven as well by the impact as by the pressure of the entering

air or steam. There is no intention, however, to produce a considerable drop between the steam chest and the admission pressure, and no nozzle or other means is used for inducing velocity. The width of the entrance port in the axial direction determines the point of cutoff. The regulation may be effected by varying the cutoff by an adjustable port, or by throttling; inclosed forms of both types of governors being furnished.

With a given mean effective pressure the capacity of an engine is proportional to the volume which it generates; that is, to its piston displacement. As this displacement is the product of the piston area and speed, or of the factors *LAN* in the common formula,

$$HP=\frac{PLAN}{33000}$$

we may write

$$D=LAN$$

and

$$HP=\frac{P}{33000}XD$$

The secret of the large capacity of this little motor lies in the large displacement afforded by its numerous chambers and the high velocity at which their volume is increased.

Assume a gear 8 in. in diameter with teeth 1 in. in depth. The annular space between the roots of the teeth and the casing would have a cross-section of about 22 sq.in. As one-half of this space is occupied by teeth and one-half available for displacement on *each* gear, the available volume would be that of the whole space considered with reference to one gear.

Assume the length to be 24 in. and the speed 2000 r.p.m.; then the displacement will be

$$22\times24\times2000=105600 \text{ cu. in.}$$

or 611 cu.ft. per min., which is about that which would be generated by a piston 13 3-4 in. in diameter running at 600 ft. per minute.

It is possible, therefore, to get a large amount of power into a small weight and space with pure rotary motion, no pistons nor abutments, and with no necessity for packing. The surfaces of the teeth, as the gears drive each other, run in sufficiently close contact to preclude serious leakage; leakage between the tops of the teeth and the casing is minimized by the small pressure difference between continuous grooves, and what stem is present between the teeth forms an elastic cushion reducing tendency to wear. The contact pressure imposed upon the teeth does not exceed 5 lb. per sq. in., which is very small compared with that used with gears designed for power transmission. The ends being in the exhaust chambers do not require to be packed. The reaction of the steam as it escapes after its release at these points is another claim which is urged for classification as a turbine.

A little study will show that the steam is exhausted while the chamber in which it has been working is still above the center. There is, therefore, a greater pressure upon this upper surface than upon the under one. This unbalanced pressure is carried directly upon the bearings, which are made ample to withstand it, and are so constructed that each acts as its own oil pump, circulating oil between the shaft and bushing under a constant pressure. In the actual engine the under surface of the gears is the active one, the exhaust being on top. The weight of the gears is thus opposed to the unbalanced pressure. Or the gears may be set one above the other.

The "Spiro" is to be built in sizes all the way from small units, which may be held in the hand and used to operate drills and other air-driven tools, up to those of several hundred horsepower.—*Power*, Feb. 6, 1912.

———ooo———

THE EFFECT OF SALT IMPREGNATION ON TIMBER.

SOME observations as to the effect of salt impregnation on the life and strength of timber have been made on the Oregon Short Line Railroad over a period of years in connection with structures exposed to the water of the Great Salt Lake, and with ties immersed in its

waters for experimenting on the preservative virtue of such treatment. According to Mr. A. M. Nelson, assistant engineer of the Oregon Short Line, at Salt Lake City, it is the general impression of those having experience with the timber constantly in contact with this heavily-charged salt water that the life is extended to an indefinite period without rotting where this timber is in a position such as that in the railroad trestle over the lake. It is believed, however, that when wood so exposed or immersed is removed to other points and subjected to the action of rain and snow the preservative materials are leached out.

Experiments have been made at several times during the past twenty years to study the value of immersing ties in the lake as a means of preserving them. In one of these experiments 15,000 first-class Douglas fir standard crossties were placed in the lake and allowed to remain five or six months. They were then distributed in small lots over the system for trial in various kinds of ballast and soil. At the end of five years some of them were removed from the tracks and tested chemically and in such other ways as to determine whether there had been an increase in the longevity and general usefulness as crossties. The report of this test did not show that any special benefit had been obtained in the ties when laid upon ordinary soil. A small quantity of chlorides remained in the ties after five years in the track, one sample showing 1 1-4 oz. per cubic foot of timber. This was equivalent to about one-fifth of the weight of zinc chloride usually injected in chemical treatment on that system.

Another test of timber exposed to the water of the Salt Lake was made in the case of two stringers removed from the trestle on the Lucin cut-off after a service of six years. They were taken to the testing laboratory of the University of Utah, at Salt Lake City, and tested to destruction to ascertain whether or not they had been affected by the alternate wetting and drying with salt water during successive periods of storm and calm weather. These tests made by Prof. R. B. Ketchum, professor of engineering at that university, showed an ultimate strength as high as might be expected from timber of the age and general condition of the stringers. The report stated that there was no indication of abnormal weakness from the effects of the salt.

Further observations were made on piles during the construction of the second track on the west arm of the lake in 1909. A number of piles were removed which had been driven in the lake since the first construction of th trestle, or a period of eight years. Examination showed the growth cells of the timber to be completely filled with crystallized salt from the water surface to the top of the piles. The timber appeared perfectly solid, but was somewhat brittle.—*Engineering Record.*

———ooo———

SINGLE PHASE RAILWAYS BREAK SNOW BLOCKADES.

THAT the single-phase system is inherently fitted for electric railways is well illustrated by some experiences that the Spokane and Inland Empire R. R., which operates a 11,000-volt, single-phase line in the state of Washington, has had during the last two years.

It has been found that during the winter when the steam trains operating on routes paralleling that of the single-phase, are unable to get through without considerable delay, single-phase trains hold very closely to their schedules. The principal reason for this is that on a single-phase road the voltage is so high that it holds up to almost normal even when the motors on the locomotives or cars are drawing very heavy currents. Upon an ordinary 600 volt road when the car must "buck" snow, the current consumption is so great that the line voltages usually drop to a value too low for effective operation. On a steam road the ability of a steam locomotive to haul loads is actually reduced in cold weather because of the greater

losses of heat from the locomotive. The reverse is true with an electric locomotive because in cold weather the motors are maintained at a much lower temperature than in warm weather, hence their ratings are increased.

As indicated in the illustration the only plough used on the Spokane and Inland trains was one of the usual shield type mounted on the pilot. This has proven to be entirely effectual in keeping the line clear enough of snow for satisfactory single-phase operation.

The winter of 1909 and 1910 was one of the most severe ever experienced in that vicinity. The Spokane and Inland was said to be the only local road that maintained its regular scheduled service through this trying winter. At no time during the worst storms were its trains more than 20 minutes behind its schedule. This excellent showing was maintained even when there was a foot or more of snow on the ground and six to ten feet of it in cuts.—*Railway Master Mechanic*, Jan. 1912.

———ooo———

WHEELER BAROMETRIC EJECTOR CONDENSER.

THIS condenser has been designed to operate in connection with reciprocating engines where a high vacuum is not demanded for economical steam consumption and where a short exhaust-pipe connection is not essential.

The condenser consists of a pear-shaped body, with a large exhaust-inlet opening at the top and an opening at the side for cooling the water. At the bottom, connection is made to the barometric column which discharges the water to the atmosphere without the air of a tail pump.

The condensing water is distributed in an annular reservoir which has vertical slots in its inner walls through which the water falls in numerous small streams in the direct path of the exhaust steam.

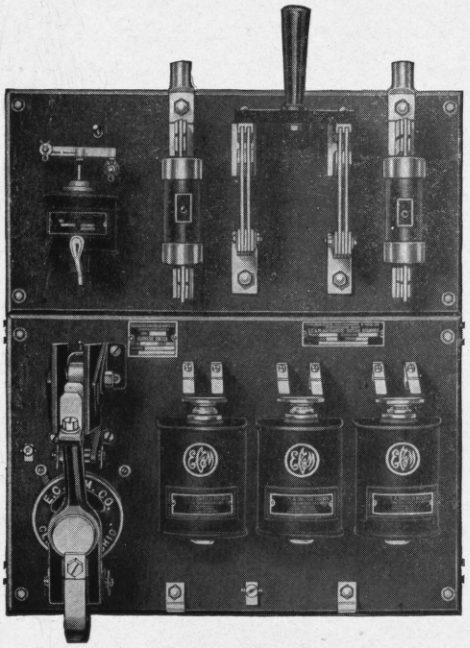
The falling water from this annular distributer is collected upon the tray placed immediately beneath and is distributed so as to fall through the small openings in this tray in a fine rain to the bottom of the condenser, where it again comes in contact with the exhaust steam.

Air may be drawn from the condenser either by the water ejector or by both the ejector and a dry-air pump. As the water falls down through the condenser shell, air is entrapped and is carried out through the converging nozzles of the shell, and at the same time the water acquires a higher velocity so that at the neck of the condenser an ejector action is set up. The air supplied through the lower pipe, is thus carried out through the ejector to the atmosphere. The barometric column attached to the bottom of the condenser is approximately 34 feet in height, which insures that the water and air will be delivered to the sump at the foot of the column against the pressure of the atmosphere.

For intermittent service this condenser will maintain a good working vacuum without the use of an air pump. Where the conditions are such that a better vacuum is desired, a dry-air pump used in connection with the condenser will maintain a vacuum up to 29 inches of mercury.

This condenser is manufactured by the Wheeler Condenser and Engineering Company, Carteret, N. J.—*Power*, Jan. 2, 1912.

Throwing One Switch Starts or Stops the Motor



NO CONTACT BUTTONS OR SEGMENTS TO BURN OUT OR ROUGHEN UP.

NO MATTER HOW CRUDE OR IGNORANT THE OPERATOR MAY BE HE CANNOT BURN OUT THE MOTOR

If You Use The E. C. & M. Automatic Motor Starter

It is absolutely simple in construction. It embodies one or more magnetic switches connected in series with the motor, which automatically close their contacts **only** when the motor current is below a predetermined value.

These switches will "lock out" and will not close until the current has been reduced by the speeding up of the motor. More. By means of push button, float or pressure operated switch, automatic starting of motor may be simply obtained from any convenient point, no matter what the relative position of motors and driven apparatus may be.

The E. C. & M. Automatic Motor Starter will positively protect the motor and driven machinery against too quick acceleration. It requires no special skill to install or maintain.

There are no contact faces or buttons which burn, pit and roughen. No spring return arm to stick or hang. No relays. No small control contacts.

Ask us for further details. Details that will put Central Stations in excellent position to eliminate one of the principal objections to more general use of electrical power in shops. Write

THE ELECTRIC CONTROLLER & MFG. CO.

NEW YORK
50 CHURCH ST.

PITTSBURG
515 FRICK BLDG.

CLEVELAND, OHIO, U. S. A.

CHICAGO
1417 MONADNOCK BLK

BIRMINGHAM
827 BROWN-MARX BLDG