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THE

PHILOSOPHY AND PRACTICE

— OF —

Morse Telegraphy

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OF

MORSE TELEGRAPHY

A PRIMARY RATIONALE AND PRACTICAL GUIDE

FOR

THE YOUNG TELEGRAPHER

By T. JARRARD SMITH

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MECHANICAL FUNCTIONS OF THE INSTRUMENTS.

To obtain prominence in the practice of any art it is quite necessary to acquire a knowledge of the tools, through the use of which such art is prosecuted. The farmer, his plough; the carpenter or engraver his edged tools, and the telegrapher his instruments and battery. True, one may plod through life with an indifferent knowledge of trade implements but he can never obtain the success that is possible where thorough practical knowledge goes hand in hand with theory.

THE TELEGRAPH LINE.

A Telegraph line is a roadway for an electric current. Its construction is governed by Electrical, Mechanical, and Financial or expedient considerations. Electrically the object is to so build that the current will escape therefrom as little as possible. The mechanical result sought is a line that will remain intact, while the financial side of the problem is to do as much as possible of these two things as cheaply as possible, without trespassing upon the prerogatives of other institutions. The way to accomplish the first object is to make the roadway as easy to travel upon as possible to prevent any effort being made on the part of the current to leave it. To wed the current to the line, so to speak. This is done by rendering the line itself as attractive to the current as possible by building it of material of the highest CONDUCTIVITY consistent with reasonable cost, and to select material of the character most obnoxious to the current to come into contact with the line along its entire length.

The antipodean quality of conductivity is obstructiveness or RESISTANCE, and, therefore, while the line itself should possess the highest conductivity, the material surrounding the line is chosen as far as reasonable expense will permit, with regard to its resistance.

Let it be borne in mind that there is no known material or composition that does not possess some conductivity, and none that is without resistance. There is, however, a medium line or neutral ground between the two which some substances approach so closely that it is hard to decide which quality in them preponderates, conductivity or resistance.

Those substances in which it is finally decided that conductivity predominates are termed "Conductors," and those in which resistance obtains are termed "Insulators." We append a list showing, by the order in which they are set down, the gradation in which the quality of conductivity and resistance is possessed by the respective substances named, the best conductors and best insulators heading their individual lists.

Conductors.—Silver, Copper, Gold, Zinc, Platinum, Iron, Tin, Lead, Mercury, Carbon, Graphite, Acids, Saline Solutions, Water.

Insulators.—Dry Air, Paraffine, Hard Rubber, Shellac, Gutta Percha, Glass, Silk, Dry Paper, Porcelain, Dry Wood, Cotton, Dry Ice, Dry Oxides.

The character of both the conductor and the insulators employed along the line is certain to vary according to the exigencies of the case. Air being one of the cheapest as well as one of the most plentiful and best insulators known, is most used.

In buildings where the Telegraph Station is established, the conductor is generally a copper wire of suitable size covered with an insulator or insulation of cotton or some rubber compound, as the requirements demand. In perfectly dry places cotton suffices. Where dampness exists rubber must be used.

Out upon the line, the conductor is generally an iron wire insulated by the atmosphere, into which element the line is raised by means of poles located at convenient distances. These poles in wet weather would be very poor insulators, and for that reason the line is not attached directly to the pole itself, but is fastened to knobs of thick glass, hard rubber or porcelain, the knobs being secured to the poles in a variety of manners. The glass knobs are mounted on little wooden arms called "brackets," which brackets are spiked to the poles.

All this description of knobs bear the common name of insulator, and are distinguished from one another by being designated by the material of which they are composed, as, "glass insulator," "rubber insulator," "porcelain insulator," and so forth.

In crossing rivers where it is practicable to use it without infringing upon marine rights, the air is still preferred as an insulator, but sometimes to avoid interfering with navigation, and sometimes for lack of means to effect the suspension of wires in the air, they are put beneath the water. As by reference to the table it will be seen that water is a tolerably good conductor of electricity, it becomes necessary to envelop the submarine wire in a layer of high resisting material. Notwithstanding its great cost, as few other substances are impervious to water to the same extent, and as durable when immersed, gutta percha is preferred for this service. To increase the tensile strength and to protect the gutta percha against injury from abrasion, the **Cable,** as conductors prepared for submarine or subterranean use are styled, is covered with an armor of iron or steel wires, or of lead, according to the demands made upon it. As the heart or conductor of the cable is perfectly insulated from the metalic armor by the gutta percha, what substances the armor may come into contact with is no longer electrically, a source of anxiety to the line builder.

Notwithstanding the great economy of the air as an insulator, and the great expense of gutta percha and rubber compounds for a similar purpose, in large cities the wires are sometimes put under ground for a variety of reasons.

In the first place, owing to the number of them, the poles and wires are a nuisance, and the public will not permit telegraph companies to make unrestricted use of the streets, to the prejudice of other interests. Again as great destruction is wrought by storms in overhead lines, rendering expensive repairs necessary every season, the telegraph companies themselves are inclined to believe that in the end it is cheapest to put the wires below the surface.

The kind of a line that is run in ordinary use throughout a house, consisting of a few yards or a few hundred feet of wire with one or more instruments on it for practising purposes, is not dignified by the name of telegraph line. It is usually called **"a Local Circuit."**

No. 16 or No. 18 office wire, which is a copper conductor with a double covering of cotton braided over it, is all that is required for such a circuit, and no lightning arresters are needed as a protection to the instruments on it. The wire is either suspended through the air, guyed by cleats, or tacked against the plaster or woodwork with steel office wire staples, as may be most convenient and neat.

In running these wires through damp spots and in proximity to metal pipes, precaution should be taken to prevent "crosses." Sufficient dampness will destroy the insulating properties of the cotton covering, and for that reason rubber covered wire is to be preferred for such spots. If the insulation of a wire resting against a metallic substance becomes abraded or water soaked, a "contact" that is apt to prove troublesome is effected at once. Two wires should never be fastened together beneath one staple for the same reason. The staple may cut or rust through the insulation in the course of time if not at once, and establish a cross between the wires. Such crosses are often difficult for the amateur to locate.

Telegraph lines extending a distance from station to station in the open air may be classed under two heads: "Metallic Circuits" and "Grounded Circuits."

A Metallic Circuit consists of two wires, the MAIN and the RETURN wire. Instruments will work equally well upon either wire of a metallic circuit when there is only one main wire. This exception is made for the reason that as a matter of convenience and economy, whenever the opportunity offers, the same RETURN wire is utilized for several distinct MAIN wires. This is done by splicing the termini of the respective MAIN wires to the common RETURN wire wherever most convenient. In such case it is essential that all instruments that it is intended shall work together, should be connected in on the same MAIN wire. Each such MAIN wire will work independently of all the others.

As metallic circuits are not intentionally connected with the earth, but both wires carefully insulated therefrom, and as such circuits are comparatively short, the instruments employed on them are in but little danger from lightning; still it is wisest to use lightning arresters as a precaution against possible accident.

A Grounded Circuit is a single "main" wire in which the earth is used as a "return" wire, by attaching the ends of the line thereto at the most convenient point. It is immaterial whether the line is one mile or a thousand miles in length, if both the ends are "GROUNDED" (attached to the earth), the current will readily flow through it.

To the reflective beginner it will thus be seen that the earth as a factor in telegraph lines is nothing more than one vast "return" wire, faithfully performing its work for a million telegraph lines, short and long, scattered over the earth's surface and under its seas, without any virtual interference on its part between the respective "main" lines.

Now comes the explanation why the earth sometimes is and sometimes is not used as a "return."

It is apparent on the face of the proposition that the use of the earth saves an extra length of wire and the expense of erecting it, and that in long lines the economy therefrom must be considerable. It is also seen that on a very short line, the trouble and expense of burying ground plates may often be greater than that of furnishing a second wire. But these ars not the only reasons why the earth is usually incorporated into long telegraph lines and shut out of short ones. To appreciate the second reason, which is sometimes the main reason for so doing, it is necessary to understand something about the nature of electrical resistance.

Resistance in its electrical sense is that inherent quality in an entity which obstructs the passage of the electric current. That quality might just as well and just as understandingly have been christened "obstruction." The import of the two terms are the same. In order to fix in the mind and convey the idea of the quantity of resistance existing in a given substance, a unit of resistance has been adopted, just as a unit has been adopted in avoirdupois for a similar purpose. In avoirdupois the unit is a pound, and at a very early age children, through familiarity of handling the factors without any special study on their part, learn that many bulky articles, like cork, weigh considerably less than small portions of other material such as lead, without knowing anything about the law of gravity as an explanation therefor. The unit of resistance is an OHM, and the quantity of resistance in any substance is expressed as, so many ohms, just as to express a given weight we would say, so many pounds.

In order to get the student to grasp more completely the idea of electrical resistance it is convenient to establish an analogy or rather to elaborate an analogy already established.

Water flowing through a pipe having so often been used as an illustration of the locomotion of an electric current we will continue the figure to illustrate resistance.

The seeker after knowledge having understood that just as water is conveyed from place to place by being confined in a tube or pipe and pushed forward by a pressure to its destination, so is a current of electricity compelled to flow from one point to another through a wire under the pressure of the battery power behind it, pertinently remarks, "well if the size of the pipe is increased in the one case there will be greater freedom in the water flow," and adds: "but if an iron wire, twice the size of the copper one is substituted in the other, he gets even poorer electrical results."

Here is where resistance comes in, and it does not satisfy the student to explain that the resistance of iron metal is so many times as great as that of copper and that the increase in mass does not fully compensate for the increased ratio of resistance in the metal substituted. He does not seize the sense of the problem. He is stunned, not enlightened.

To explain the function of resistance in a wire by the analogy of the water pipe, we would point out that the student must introduce the quality of resistance or obstruction into the pipe also.

This he can do by supposing that the interior of the pipe instead of being a clear and open tube, consists of a meshy or porous structure like net work or an elongated sponge varying in density according to the amount of obstruction or resistance it is desired to represent. The denser the fibre of course the more resistance and the more contracted is the water flow. The idea being now put into tangible shape the student at once sees that the copper wire is analogous to a pipe comparatively open while an iron wire is one that is comparatively clogged.

As it needs no argument to make him understand that more water will flow through a small pipe free from obstruction than a large one densely packed, he appreciates the analogy and comprehends something of the nature of resistance.

If the student is now told that in a telegraph line the composition and size of the wire and the length of the line, and that whether it is a grounded circuit or a metallic circuit, are factors second in importance to the whole resistance of the line, he is apt to give an intelligent assent. Just as it is easier to force a greater volume of water through a clear pipe of small diameter than can be done through a clogged pipe of larger diameter, he also sees that a long clear pipe will yield more prolifically than a short clogged one, even though the longer pipe be of smaller diameter than the short one.

Let us see how this rule works in practice. By consulting the table of resistance attached hereto for the express purpose of making just such calculations as this, we find that No. 10 iron wire has a resistance of twenty ohms to the mile. We select this size simply because the figure 20 admits of easy calculation.

Now, say we have a line ten miles in length to be built of No. 10 iron wire worth ten dollars per mile. The question arises, shall we "ground" it or make it a metallic circuit?

Grounding it would give an expense of $100 for wire alone; insulators, brackets, spikes and labor will cost say an additional $125, exclusive of cost of poles, which we will not consider, as that item of expense would be the same in any event. Ground plates and labor will cost say five dollars at each end, making a total expense of $235.

If, on the contrary, it were to be made a metallic circuit, theoretically ten dollars would be saved on ground plates, but an additional expense of $225 would be incurred for the "return" wire, making a net financial difference of $215 between the two systems, a sufficient reason in itself, other things being equal, to decide the method of construction.

Now, what is the electrical calculation?

Ten miles of wire, at twenty ohms per mile, give 200 ohms resistance. If the line is made a metallic circuit, there will be of course 400 ohms of resistance in it. Now, the calculation is not exactly 200 ohms against 400 ohms, as something must be allowed for the resistance of **the Ground.** Not of the earth itself, as that virtually has no resistance whatever, but the resistance of THE CONNECTION BETWEEN THE GROUND PLATES AND THE EARTH. This resistance varies very much. Its amount depends upon the superficial measurement of the ground plate itself, and the character of the earth in the spot where the connection is estsblished. As the surface measurement of the ground plate is increased, so the resistance of the CONNECTION decreases. So much is this the case, that a ground plate less than fifteen inches square, which gives a surface measurement of a little over three square feet, should never be used for a telegraph line. A ground plate 30 x 30, which contains just four times as much surface as the 15 x 15, is much to be preferred.

As a perhaps timely warning, we would point out that in these days of liberal telephony the reader should guard against being misled by basing his calculations for a telegraph line upon the requirements of a telephone line. The line material that will serve for a telegraph line will undoubtedly make a most excellent telephone line, but what might answer admirably for a telephone line may, for sufficiently good electrical reasons, prove entirely inadequate for the telegraph. This is ecpecially true in "ground plates". Telephone requirements are much less exacting.

A continually moist clayey soil is the best for a "ground," and it is often better to extend the line a short distance in order to secure such a bed than to bury the plate in a dry, sandy or rocky spot, especially if the spot is an elevation. Where the choice is open without inconvenience, a hollow is to be preferred, as constant moisture is more apt to be present in such a spot. The conductivity of poor "grounds" may be enriched by mixing a bushel or so of broken charcoal with the earth immediately surrounding the plate. The position of the plate in the earth should be edgewise, not flat.

Instead of burying ground plates, "grounds" are sometimes established by connecting the terminal wire to either gas or water pipes at the most convenient point in the house, and trust to the pipes to make the necessary contact with the earth. This is done by removing the insulation from the wire for a distance of two or three feet, and scraping the conductor clean. The pipe is also scraped or filed clean and bright, and the wire wrapped tightly about it, and bound down in place by another piece of wire so that it cannot work loose. If the pipe is lead, special care should be taken to bind the wire tightly to the pipe, as by action of the air, oxide soon forms over the brightest lead, and in the course of a few months or sooner, the oxide practically insulates the pipe from the wire and impairs the efficiency of the ground.

Soldering the wire firmly to the pipe is the best plan, but no unskilled hand should attempt such a process with a lead pipe. The supply pipe is always to be preferred to the waste pipe, the latter being less certain in its metallic continuity. Gas pipes are to be preferred to water pipes as the process of soldering can be resorted to by any one, and where binding proves to be the most convenient, the connection is more apt to remain electrically perfect. Whenever there is a possibility of the gas meter being removed without due notice to those interested in the line, the terminal wire should be attached to the pipe at some point between the street and the meter, as a removed meter would of course make a break in the circuit.

As it avoids the expense of plates and the labor of burying them, gas or water pipes are recommended for "grounds" where they connect with the street, as in municipal gas and water supply systems.

It will occasionally puzzle a novice to find that on some short lines he can get along with less battery power with grounds made on gas and water pipes, than if a metallic circuit is put up. This happens when the stations are CONNECTED UNDERGROUND BY A METALLIC PIPE, possessing very much less resistance than the main line wire.

Pipes leading into cisterns, tanks and wells are usually, but not always, useless as "grounds," owing to their imperfect connection with the earth.

The importance of the ground connection must be the excuse for this digression, and we will conclude it by adding that, all things taken into consideration, if conscientiously made, each "ground" is apt to have on an average a resistance of ten ohms. This, then, would make the electrical calculation, we have been considering, stand 220 ohms against 400 ohms resistance in favor of the "grounded" line; argument enough independent of the financial plea to decide against the metallic circuit.

To cite another case: Suppose the line is only one-quarter of a mile long. The cost of construction would be about the same with No. 10 wire whether the circuit is metallic or grounded. But the former gives a total resistance of only ten ohms, five each way, while the latter would make it twenty-five ohms, counting the "grounds." The verdict on this evidence would be at once given in favor of the metallic circuit, but sometimes mechanical reasons prevail against financial, and even electrical dictation.

One wire is less unsightly than two. Two wires are apt to swing or twist together in high winds, and so disable the efficiency of the line by what is technically known as a "cross." One wire is easier to maintain, as two wires multiply the opportunities for a "break" to occur, and so upon the whole, purely as a measure of expediency, the "grounded" circuit may be adopted not unwisely in this instance.

The student should now be able to decide what method to adopt under varying circumstances much better than some one not acquainted with ALL the attendant conditions that might modify the whole problem.

The object of these citations will have been accomplished if they have succeeded in making the novice realize why resistance should hold an important place in considering the selection of a line wire and the method of stringing it.

When the question arises as to whether iron or copper should be adopted, the resulting aggregate resistance of the entire line under a given proposition should be consulted first, then such mechanical features as tensile strength or capacity to resist rupture, avoirdupois, ease of handling, etc., then considerations of expediency, expence, importance of the service for which the line is designed, its length, the period of time it is calculated to remain in use, etc., etc.

The student who closely figures up the cost of his line may naturally be led to inquire why should he not use copper instead of iron wire since he can obtain about as many lineal feet and as much conductivity in copper for a dollar as he can in iron? The answer is that copper wire of the proper conductivity has not the necessary tensile strength for a stable line, and when he gets a size in copper that is strong enough, he has more conductivity than the requirements of a short line call for, and consequently an unnecessarily expensive line. This is realized when copper wire of No. 20 B & S gauge, weighing about sixteen pounds to the mile, is compared in strength with No. 14 galvanized iron wire weighing ninety-seven pounds to the mile. They both measure about fifty-three ohms resistance to the mile, and for that reason, are electrically equal, but as the iron wire is mechanically very much superior, it is deservedly the favorite for short lines.

Holding all these considerations in view, a mistake in selecting line wire is hardly probable.

Copper wire, as regularly made, is unfit for any serious out of door telegraph line, as it is so soft it elongates from its own weight, and sags until it finally pulls apart. For this reason, only Hard Drawn Copper Wire is used for this purpose. Hard Drawn Copper Wire requires a great deal more care in handling than Galvanized Iron. Short bends, kinks and abrasions are more injurious to it than at first sight would seem to be possible. In soldering joints excessive heat should also be avoided, as it softens the wire and consequently weakens it.

It is the ordinary practice to use No. 14 or No. 12 Galvanized Iron Wire in building short private lines.

No. 14 wire being light and easily handled is, for these reasons, a favorite size for lines not exceeding a mile or so in length, while No. 12 is preferred for longer lines on account of its greater strength and higher electrical conductivity.

For hints on insulators see page 15.

APPROXIMATE RESISTANCE AND WEIGHT PER MILE
OF
GALVANIZED IRON LINE WIRE AND HARD DRAWN COPPER LINE WIRE.

Galvanized Iron Birmingham Gauge.	Ohms Resistance Per Mile.	Pounds Per Mile.	Hard Drawn Copper B. & S. Gauge.	Ohms Resistance Per Mile.	Pounds Per Mile.
No. 14	52.8	97	No. 20	53.	16
" 12	32.7	163	" 16	22.10	41
" 10	20.	264	" 14	13.7	
" 9	16.4	323	" 12	8.7	104

THE SELECTION OF INSTRUMENTS.

What has preceded and especially what follows will tend to put the reader in a position to select intelligently the kind of instrument electrically fit for his use. Here we will simply mention the rule governing the electrical requirements; the mechanical adaptability of instruments being treated apart.

The rule is to sum up the internal resistance of the battery and add it to the resistance of the line (including that of the "grounds" of course) and choose instruments equal in resistance to the total of the two.

This rule is not rigidly adhered to, we confess, still it is the proper basis for calculations, even though it is only approximately consulted. It is entirely unsafe to say choose the instruments according to the length of the line.

A very short line of a few hundred feet, if it is a grounded circuit will require a twenty ohm instrument at least, on account of the resistance of the "grounds," irrespective of the size of line wire, whereas a line built of heavy copper wire, such as is used in electric light service, if in a metallic circuit, might be a couple of miles in length and still require only an instrument designed for local use.

Instruments for local use are usually wound to five ohms resistance and it will be safe and economical to use them when the line does not exceed, say, ten ohms resistance.

When the resistance of the line reaches twenty ohms, but does not exceed fifty, a twenty ohm (main line) sounder will answer very well.

When the resistance increases beyond seventy-five ohms it will in all kinds of weather, give the best results if Relays are used.

The weakness of main line sounders on long lines is felt most in wet weather when the current escapes badly, as sounders are not adapted for fine adjustments and relays are. It might occur to the student that the defect from leaks might be compensated for by using additional battery, but the higher electro motive force resulting from the additional battery, would very likely aggravate the trouble instead of curing it.

A twenty ohm relay, for this reason, can be worked on a bad line successfully where a twenty ohm main line sounder would absolutely fail.

On a line of 100 ohms resistance, a 50 ohm relay will be sufficiently economical.

Where the line measures 200 ohms and over it is customary to adopt the standard relay, which contains 150 ohms.

In practice it is found that a 150 ohm relay will give all desired results on any line of from 200 to 2,000 ohms or more resistance, by increasing the number of cells of battery to overcome the additional resistance.

Whatever may be the mechanical character of the instruments on any line whether some of them are Main Line Sounders, some Regular Relays and others Box Relays or Pony Relays, THEY SHOULD ALL BE OF THE SAME RESISTANCE. If any disparity, the higher resistance instruments will work best, but to the certain disadvantage of the others in proportion to the disparity, those of the least resistance suffering most.

In Proportioning Battery it is customary on very long lines employing 150 ohm relays, to add up the entire resistance of the line and relays and then allow one cell of battery to each forty ohms.

For short lines, where 20 ohm instruments are in use, the following crude rule will be found to work well in practice:

Allow one cell of battery for the first mile, or fraction thereof, of line wires.

One cell of battery for the two "grounds."

One cell of battery for each twenty ohm instrument in use on the line.

One cell of battery for each additional mile, or fraction thereof, of line wire.

This calculation is based on wire not smaller in size than No. 12 Galvanized Iron.

No. 14 Galvanized Iron wire will require two cells of battery for the first mile and two cells for each subsequent mile, the calculation for "grounds" and for instruments being the same in either case.

If the "grounds" are defective, still another cell or two of battery may be required on that account.

If it is a "metallic circuit," the battery allowance made for the "grounds" will compensate for the first mile of return wire. For subsequent miles of "return" wire the same allowance will have to be made as for the "main" wire.

In calculating battery required for lines employing instruments WOUND FOR LOCAL USE, it is assumed that the line is necessarily a metallic circuit, as local instruments are unfit for use on a "grounded" circuit without using excessive battery.

On short metallic circuits allow one cell of battery for each local instrument in use. If the line comprises more than one to two hundred feet of copper office wire, it may be necessary to add an additional cell on that account. If the line extends beyond the house and employs an iron outside wire, an extra cell of battery for every 1,000 feet, or fraction thereof, of iron wire in use, will not be too much.

Insulators. When the line wire is not heavier than No. 12 Galvanized Iron, the Pony Screw Glass Insulator is in general the most satisfactory.

When wire as heavy as No. 9 Galvanized Iron is used, the Regular Screw Glass Insulator is preferable on account of its larger size and increased weight.

The same size and style of "bracket" is used for both the Pony and the Regular Insulators.

Porcelain Insulators are occasionally adopted for outside wire, but their use is not to be recommended for telegraph lines, as in wet weather, unless they are located under the eaves of houses or similarly favorable locations, they allow heavy escapes. There is a temptation to use them on account of their small size, neat appearance and ease of application. Where they can be put under cover there is no objection to their use. There is less objection to their employment on short metallic circuits than on grounded circuits, as good insulation on the latter is most imperative.

One of the neatest and most effective insulators for use about a residence where there is wood-work in which to mount it, is the Rubber Hook Insulator. A hole about seven-eighths of an inch in diameter and two and one-half inches deep in the wood-work, is all the fastening it requires. It is provided with a threaded shank that will screw into the hole and hold it firmly in place.

THE BATTERY.

One complete set of the constituent parts of a galvanic battery is termed a "cell." All the various parts of a cell are denoted by special names, according to its make up. Although one of the two so-called "elements" entering into the composition of a cell of battery forms, the Positive Element and the other the Negative Element of said "cell," it does not follow that the material composing such element is invariably positive or negative, as the case may be, in any pattern of battery in which it may be found. An element consisting of either Lead, Iron or Copper may be the negative element in a battery of a given construction, and in some other form of battery be the positive element. Its determination depends upon the character of the other element with which its is associated. If the other element consisted of zinc in the above reference, the former would be the case. If of platinum, the latter would be true. The comparative, negative and positive electric qualities of metals have been arranged in the following electro motive rotation:

All metals in this table being, in a single solution, positive toward those that follow, and consequently negative towards those that precede them in the order of mention.

Zinc, Cadmium, Tin, Lead, Iron, Nickel, Bismuth, Antimony, Copper, Silver, Gold, Platinum, Graphite.

It should be borne in mind also that the terms "element" and "pole" are not synonymous. On the contrary, the negative element is invariably the positive pole and VICE VERSA. Therefore, to prevent being misunderstood, it is always safest in speaking of any battery element to mention the metal of which it is composed.

Although batteries most frequently contain not only two characters of metal but two mechanically separated solutions, those in general use to-day in the telegraph service have been reduced to a very simple form called the Gravity Battery.

The positive element of the gravity battery consists of a mass of zinc, variously shaped according to the whim of the manufacturer, with either thin strip copper or lead as the negative element. The solution in which they are commonly immersed, is water in which both sulphate of copper and sulphate of zinc have been dissolved. (The method of setting it up is described elsewhere.) Under the action of the current, these two solutions are separated and kept apart by the force of gravity. Hence the name of the battery. The copper solution being heavier falls to the bottom, its limit being defined by its blue color, while the zinc solution is colorless and remains on top. The dividing line between the two is a jagged margin of weak blue. This dividing line should occur about half way between the two metals. The blue should never touch the zinc. When it does happen, it indicates that the battery is not doing enough work, which can be remedied by "short circuiting" it for a few hours, or else that too much sulphate of copper is being put into the jar, the remedy for which is to refrain from putting any more in until the blue color has subsided to the required point. Any excessive fall of the blue color from the half way line indicates that there is not enough sulphate of copper in the cell, in which event add more, or else that the battery is doing too much work and generating an unwonted surplus of zinc solution

Whether the latter is the case or not can best be ascertained by the use of a hydrometer.

The Hydrometer is a small glass tube with a graduated scale on its face and a bulb filled with shot at one end. It determines the density or gravity of fluids. When floating in the gravity battery solution, it should register at some point between the limits of 15 and 35 degrees. Less than 15 indicates the presence of too little zinc, more than 35 indicates too much. The former will be remedied by "short circuiting." The latter by drawing off a portion of the colorless fluid from the top and replacing it with pure water. Care should be taken at all times to not shake the battery jar or agitate the contents, as that would serve to mix the solutions and prejudice the action of the battery. Large hard rubber battery syringes are made expressly for handling all kinds of battery fluids with safety and convenience.

The process of "short circuiting," as the expression implies, is to shorten the circuit, and in this case means to make it as short as practicable. This is done by connecting the two elements together outside of the jar by means of a very short piece (a foot or two) of wire.

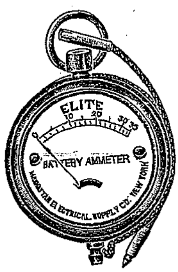
According to the severity of the work the Gravity Battery is called upon to perform, a cell will need no further attention than that mentioned above for a period of from one to six months. It then requires to be thoroughly cleaned and set up new again as at first.

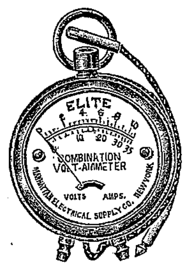
In subsequently setting up the battery, it is usual to preserve a part of the clear, colorless liquid (sulphate of zinc solution) from the top of the jar for use in the renewed cell, as it expedites the cell reaching its full power.

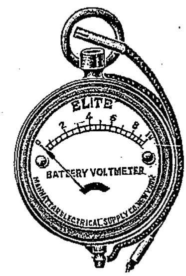
No trouble will be experienced in managing the gravity battery if the fact is kept in view that the natural tendency of the battery while at work is to CONSUME sulphate of copper, and CREATE excessive quantities of sulphate of zinc. This explains why sulphate of copper is constantly added, and sulphate of zinc drawn off from time to time.

All batteries, notwithstanding they are the promoting agents of electrical power, still possess within themselves the quality of resistance. The resistance varies according to the mechanical construction of the cell and the condition of the battery. This is more than ordinarily true of the gravity battery. In its best condition it has an internal resistance (so called to prevent possibility of confounding it with external resistance, which may exist in the line, instruments, "ground," defects, etc.) of about three ohms. In its average condition in general service, this resistance will more frequently register twice that amount. A knowledge of the normal internal resistance of the battery is essential in calculating the aggregate resistance of a telegraph line.

In putting more than one cell of battery in circuit, unlike poles must be toward one another, no matter what kind of a circuit they may be on, the number of cells there are, or the distance that separates them. It will therefore be found that in all "grounded" circuits the Negative Pole will be connected to the ground at one end, and the Positive Pole to the ground at the other. This rule applies to all kinds of batteries, and let it be added here that connecting different kinds of batteries in on one circuit is not approved of. It should not be done.







A Pocket Battery Ammeter is a very convenient instrument for measuring the amperage of either a dry or wet cell. So is the Pocket Voltmeter for the voltage; while a combination instrument will give both the amperage and voltage. A "Red Seal" Dry Cell will test 1½ Volts and more than 20 Amperes. An open circuit wet battery like the Carbon Cylinder or Leclanche type will test 1½ Volts and 7 Amperes, while an ordinary Crowfoot Gravity Battery will test about $\frac{7}{10}$ Volts and about ¾ Ampere.

The use of these pocket battery gauges often locates trouble in a single cell of battery contained in a group, where otherwise the entire lot would be condemned and discarded. The cost is nominal as compared with its usefulness and should be in the hands (pockets) of every person who has the care of, or is using batteries of any description.

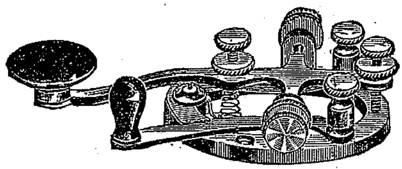
To become practically acquainted with rudimentary electrical apparatus, such as the Key, Sounder, Relay and Battery, analyze the functions of the respective parts aside from their electrical operation.

Do not be over-awed by any thought of the really wonderful results obtained through their use, or the mysterious character of the agent employed in them as a motor. Study them first sectionally in their mechanical capacity and the simplicity of the apparatus becomes apparent as soon as this primary object is fully understood.

THE KEY.—The Telegraph Key is simply a device for the purpose of breaking the wire and restoring it again in a rapid and reliable manner.

The same result precisely can be obtained by holding the two ends of the wire in either hand and tapping them together. Indeed, this very primitive method is sometimes employed by line repairers who, in arriving at the "break" they are looking for, report telegraphically in this way, the attending circumstances to headquarters.

Telegraph keys as first made were as crude with respect to the present form of keys, as the tapping of the ends of the wires together was as compared with the early key form.



The key consists of a lever hung or suspended to admit of its being vibrated perpendicularly in a free and easy manner, with a key knob as a handle to grasp hold of to create the vibrations. The lever is in metallic (consequently electric) connection with the base on which it is hung and to this base, sometimes by means of a binding post on top, sometimes by means of a metallic leg extending from below, one of the wires of the circuit is attached. The lever in being pressed downward is arranged to strike upon a point projecting upward from the base; the whole arrangement is in the nature of a hammer (the lever) striking upon an anvil (the projecting point).

At the point of junction where they come into contact, both the hammer and the anvil are fitted with a small platinum wire not far in diameter from that of the lead in an ordinary lead pencil, These platinum wires (less than one-eighth of an inch in length) are termed the "contact points," which name holds good throughout the variety of electrical apparatus in which they are similarly employed.

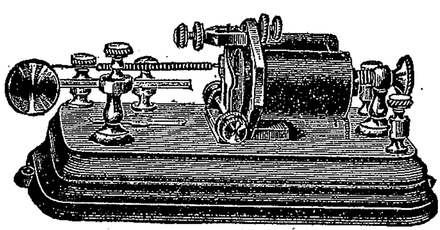
Platinum, as a material for contact points, has so far been preferred on account of the freedom of that metal from oxidation, its resistance to wear and its slowness to fuse. The anvil of the key while mounted upon the same metallic base with the lever, is electrically insulated therefrom by the interposition of hard rubber, bone, ivory or other suitable non-conductor. To this anvil is attached in some suitable manner the other wire of the circuit. Thus it will be seen that as the lever is only a convenient extension of the first wire held in suspension over the anvil, the circuit may be made and broken with exactness and rapidity according to the skill of the manipulator. All the other appurtenances of the key are merely devices serving to secure the integrity of the above primary object. The fewer of such appurtenances there are, the better. The spring is a valuable one as it raises the lever automatically between the depressions, which among skilled operators are very rapid, and so saves the hand some labor.

As in the normal condition of a key with the hand off, the lever would be "up" and so leave the circuit "open," it is neccessary to provide a wedge of some shape to fit into and close the electrical gap occasioned by the hard rubber, bone or ivory insulator when the key is not in actual use. This is done generally by means of an arm of sheet brass, pivoted at one end to the key base and provided with a handle (circuit breaker knob) at the other and so arranged that it can be swung into the gap and removed at pleasure.

THE RELAY.—This instrument we mention before the Sounder because its history is oldest, and moreover, like the key, is a main-line instrument.

In principle it is simply a small plate of iron, commonly called the armature, suspended or hung in such a manner in front of the poles of an electro-magnet as to be susceptible of rapid vibration. Unlike the vibrations of a telegraph key, which are made by hand assisted in some measure by a spring, as already described, the vibration of the relay armature is automatic, occasioned by the application of two forces. In one direction by the constant application of a mechanical force in the shape of a rectractile spring. In the other, by the intermittent application of a magnetic force generated in an electro-magnet. But just as in a telegraph key, the immediate object of this vibration is to open and close an electrical circuit, called the LOCAL CIRCUIT, as will be hereinafter shown.

The remaining parts of the relay are all subsidiary to the above. There are four binding posts on the base. Two of which form the terminals of the wires of the electro-magnet and answer for the attachment of wires leading to the main line, and the other two which are connected with the local contact points serve to accommodate the wires leading to the sounder and local battery.



The two forces are so proportioned towards one another and the armature, that, when no magnetism is present, the spring is strong enough to haul the armature away from the electro-magnet, making what may be called the "back-stroke," but still so weak that when magnetism is present the magnetism has no difficulty in overcoming both the inertia of the armature and the antagonizing power of the spring, and so haul the armature sharply forward toward the magnet, executing what may be termed the "front stroke."

Magnetism is generated in the electro-magnet, and discharged therefrom intermittently, by simply opening and closing a telegraph key inserted in the same circuit with itself, and which key may be situated in close proximity to the relay or miles distant, according to the length of the line.

From this description it might be imagined that the armature in its forward and backward movement, was carried through a considerable space. As a matter of fact, the limit of its motion is usually about .003 of an inch. This distance varies. Sometimes greater, sometimes less, but .003 is ample for the purpose. The movement of the armature, however, is amplified at the point of registration of these vibrations, which vibrations form "dots" and "dashes," constituting, together with the spaces between them, the Morse Telegraph Code.

The points of registration are the platium "contact points." One is mounted on the extreme of a lever extension attached to the armature, by which means the amplification of movement is obtained. The other is a platinum pointed stop screw in front of it, capable of being regulated, and which holds the same position to the armature lever that the anvil point does towards the key lever in a telegraph key. If, in the nature of things, the armature lever came into contact with its front stop with sufficient force to produce a sound that could be readily heard and analyzed under all ordinary circumstances, it is probable that the sounder would be a comparatively unknown instrument.

In order to get an armature to vibrate rapidly, and register in full its signals in front of an electro-magnet being operated by a key at a great distance, it is necessary to construct it very light, and suspend it delicately, so that it will respond quickly to whichever force, magnetic or mechanical, is dominant at the instant. As in rapid work these responses amount to about twenty-four a second, half in each direction, and as the forces themselves on long lines are necessarily very weak, frequently exerting a pulling power of less than a quarter of an ounce weight, it is apparent that no great volume of sound can be evolved from the blow struck by the armature lever on either the front or the back stroke, yet both must be distinctly heard in order to read the signals. Much ingenuity has been expended in the effort to produce a relay that would overcome the difficulty. One of the results of such efforts is the "Box Relay," which is substantially similar to the others in all respects, except that the front contact or anvil screw is mounted upon a structure of light wood in the form of a box, which incidentally covers the electro magnets. It is designed that the acoustic properties of this box shall dilate to the desired extent, the sound derived from the blow. The result, however, only straddles the issue. It is neither a complete success nor an entire failure.

As will be seen by reference to the catalogue, the Box Relay is now made to a considerable extent, but its use is far from universal. It renders it possible to do away with the use of sounders in ordinarily quiet places. Wherever it can be used successfully it is a great boon, as it saves desk room, reduces the number of instruments required, and does away with the LOCAL battery, which is indispensable with a sounder, and is generally looked upon as an unavoidable nuisance.

Except in Pony Relays the electro-magnet is usually provided with adjustment screws at the yoke, to further assist in approaching the magnet poles toward or retiring them from the armature to meet the varying electrical conditions of very long and poorly insulated circuits in bad weather. The theory being that in wet weather the escape of the current along the line is very great, and occasions the presence of CONSTANT magnetism in the magnet as long as such leaks exist, even when a distant key is actually open. It is therefore necessary to increase the tension of the spring until such illegitimate magnetism loses its ascendancy over the armature. Upon the key being closed at the distant end, however, the current that flows through it, added to the escape, readily overcomes the strength of the spring. It often happens, on very bad lines, that the leaks are so very great that there is not power enough in the spring to permit of its compensating for the escape. In such cases it is customary to weaken the influence of the magnet by retiring it the necessary distance from the armature, by means of the screws located at its yoke to meet that emergency.

The position of the front contact screw seldom requires altering. It should be so adjusted that it will stop the forward movement of the armature in time to prevent the armature touching the cores of the electro-magnet. It should approach as closely as possible, but to actually touch would produce a defect technically known as "sticking," rendering the signals unreadable. For this reason as much care should be exercised to avoid advancing the electro-magnet too far, through adjusting the screws at the yoke, as to prevent the front contact screw receding too far. The effect would be the same in either case. When not actually being handled, the yoke adjustment screws should be kept firmly chocked, as the current has a tendency to work the electro-magnet forward.

The "take up" screw of the adjustment spring in a relay is an important detail. While being readily movable, it should have friction enough to prevent slipping. This screw has a great inclination to slip, and no operator can work in comfort unless he can depend upon his adjustment remaining as it is put.

One word more about relay armatures. As the most essential element in their character is that they should magnetize and demagnetize quickly, every measure should be taken to add any feature that will enhance that effect and reject anything inimical thereto. Hence it follows that armatures should present surface enough to cover the face of the poles of the electro-magnet, but, after that, no more surface than is absolutely essential to consistent construction, should be tolerated.

Whatever may be the bulk or weight of metal that, in consulting magnetic saturation, it is decided is best adapted for a relay armature, that weight or bulk should be condensed and located as far as possible immediately in front of the cores of the electro-magnet. To expand that bulk and increase its surface has the effect of DIFFUSING the magnetism induced in the armature, whereas the point aimed at is to CONCENTRATE it.

The larger the mass of metal, the longer it takes to magnetize and demagnetize, and the more permanent magnetism it will retain. It is unfortunately true of iron that a quality that will remain entirely free from residual magnetism is practically unobtainable. This accounts for all relay magnet cores and armatures, while being made of selected iron, still having more or less permanent magnetism. It then follows that any increase of the volume of metal above what is essential for the best magnetic effect, will retard the charging and discharging of the armature, injuring its electrical functions. It will also enlarge a seat for permanent magnetism, thus aggravating an already serious evil.

As a relay is first an essentially electrical instrument, that fact should never be forgotten in looking for mechanical novelties and economical construction.

THE SOUNDER.—The sounder is an instrument which in its operation is of the same general character as the relay, viz., an armature suspended in front of the poles of an electro-magnet, and arranged to vibrate in precisely the same manner as in a relay, but with a special view to the sound resulting from the blow delivered by such vibration being made clear and loud.

As the Sounder is only intended for local use, that is to say, for use on very short circuits, and its object being simply to render easily audible the signals received on the relay, its construction is much coarser. The electro-magnets are regularly wound to about five ohms resistance and the coils are mounted upright instead of horizontally as in the relay. The position of the armature lever as compared with that in most relays, is reversed, it being horizontal instead of perpendicular, While adjustable in the main, the provisions for adjustability are by no means complete. Ordinarily it has only one set of binding posts which serve as terminals for the wires of the electro-magnet. Sometimes, however, local contact points are attached to the sounder for the purpose of repeating the signals into STILL ANOTHER CIRCUIT. The instrument then has two sets (four) binding posts the same as a relay and is called a "Repeating Sounder" to distinguish it from the regular sounder.

Right here we have a parallel that illustrates more forcibly than any other argument the similarity in the two instruments. Just as a relay is sometimes constructed with a "box" (box relay) to render the signals audible and dispense with the use of a sounder, so sounders are sometimes wound to a resistance of twenty and even more ohms, so as to work on main lines and dispense with the use of the relay! Such sounders are called "Main Line Sounders."

Very good results are obtained on lines up to 50 miles in length by using a main line sounder, having the lever made from the lightest known metal—aluminum. Sounder levers made from this metal are supplied at the same price as the regular composition metal.

Unless the exact resistance is mentioned, it is generally understood in speaking of a main line sounder, that such an instrument wound to twenty ohms resistance, is referred to.

THE REGISTER is fast growing obsolete as a "Morse" telegraph instrument. In the early days of telegraphy, before the now universal Sounder was known, the Register was an indispensable bit of machinery, as telegraphic communications were then first recorded on a paper ribbon and afterwards read by eye

The Register embraces all the mechanical and electrical features found in the Sounder, and in addition thereto, has an adjustable needle or stylus affixed to the armature lever that, in its descent, falls upon the paper ribbon and indents it with the dots and dashes of the Morse code. The Register is also provided with a clock-work movement, the only office of which is to carry the ribbon along so as to keep a fresh surface of paper continually presented to the stylus, and so enable the operator to distinguish between dots and dashes, and measure spaces with the eye. As time went on, however, the operator discovered that he could do the work more readily with the ear by listening to the sound of the vibrating lever. It was only another step to abandon the paper ribbon, and build an instrument with a special view to eliciting sound. The clock-work and stylus was discarded, and the Sounder of to-day is the result.

Registers, however, are creeping into a variety of other uses where it is essential or desirable that a permanent ocular record of communications or signals should be preserved, as in the Fire Alarm and District Telegraph Service.

Vast improvements have been made in the instrument to meet these modern requirements, and to-day the best registers not only have the clock-work improved and encased in glass, but have the stylus replaced with an ink wheel that prints the dots and dashes in a bold clear manner on the surface of the paper ribbon, instead of indenting or embossing it.

The Ink Writing Register is superior in very many ways to the best Embossing Register that can be produced

TO LEARN TO TELEGRAPH.

To learn the art of telegraphy is simply a question of application and persistency.

Just as large edifices grow up, brick by brick, so will practice, hour by hour, day by day, surely make a first-class operator in the course of time of any one possessed of the average human faculties.

Skill as a penman in the first instance will be a great aid to the learner, but it is a matter of record that some of the finest telegraphers in this country were miserable penman at the outset and that they acquired facility of chirography simultaneously with skill as a telegrapher.

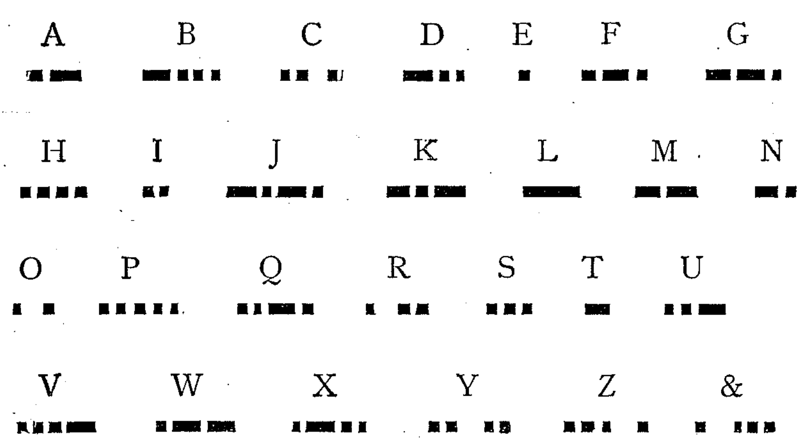
A quick ear and a knowledge of "time" is another advantage; not necessarily an ear with a cultured or naturally musical sense. A musical ear is evidence, but by no means proof, that the owner may readily learn telegraphy. In the telegraphic world there are some surpassingly good musicians who are indifferent operators and still some exceedingly good operators who could not distinguish the difference in pitch between the sound of a falling log and the hum of a telegraph wire. It would be quite as reasonable to expect an artist to develop into a good marksman simply because possessed of a trained eye with reference to form and color, as to guarantee that a musician would make a good operator.

Flexibility of wrist and nimbleness of finger, trained or natural, is a good augury and will aid in mastering the manipulation of the key.

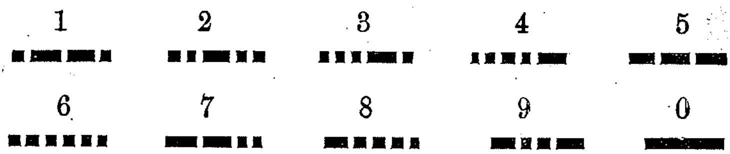
Youth also has its advantages, but age is not debarred. Readily impressible memory is an excellent quality; not a retentive memory that is capable of recalling ancient incidents and dates, but one having that quality which enables the possessor to charge the mind with a lengthy speech at a single hearing and reproduce it faithfully a few minutes afterwards.

The main thing, however, is to have application. The long pull and the steady pull and the pull right along. Practice, practice, practice! There is no magic that can give you the art without practice. There is no power that can prevent you learning if you practice and have the mental and physical equipment of the average individual.

First learn the alphabet mentally. Here it is,



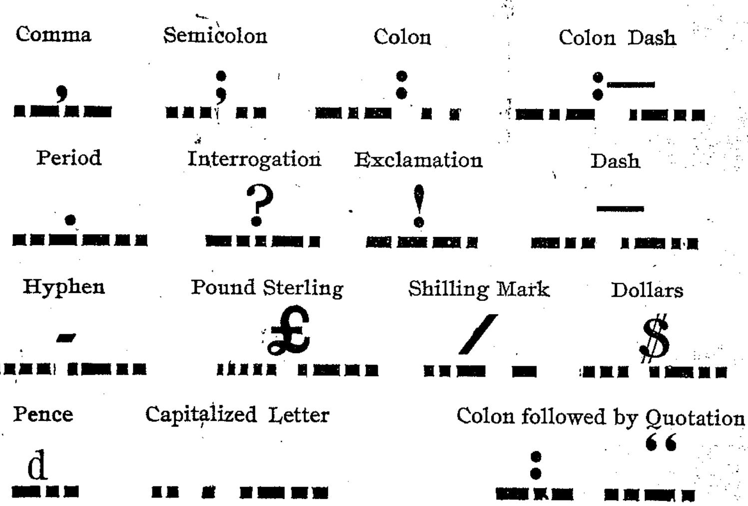
You can practice at all times, and in all places. Think of a letter, then call up in your mind the image of the character representing it; take a business card or any piece of print and put down underneath each letter with lead pencil the characters as fast as you can think of them. Continue this at odd intervals when not practicing on the instrument. When thoroughly familiar with them attack the numerals. Here they are:

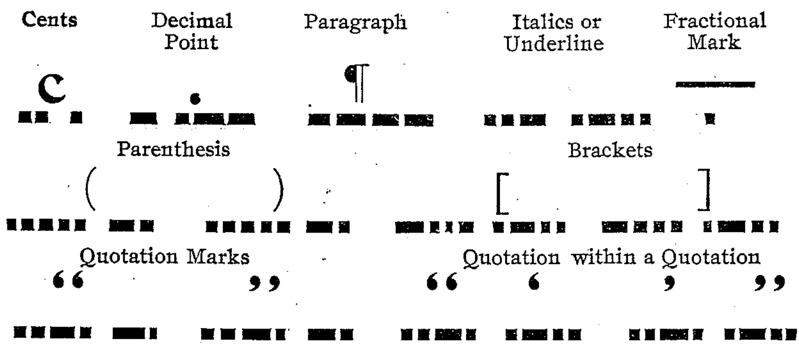


master them in the same way.

At your leisure learn such of the punctuation marks and other signs as the requirments of your practice demand.

At first it will be quite sufficient to learn the PERIOD, COMMA and INTERROGATION POINT, as these are the only punctuations in frequent use in transmitting regular messages. Many operators have seen service for years without becoming acquainted with any others until they began to handle "Newspaper Specials," "Market Reports" and general press matter. In handling such business a fuller knowledge of the various signs is necessary. Those that follow are now the recognized standard for punctuations, etc.





These can be more easily learned by resolving them into the letter elements of which they are composed. For instance the period is "ud," comma "aa," and so on. The danger from this course is that the learner may unconsciously introduce a space that does not exist. The interrogation point for instance embodies the letter "tq" or "tue," but WITHOUT any space between the letters composing it, while the dollar sign ($) "SX," colon "KO," and many other signs are made WITH a space as will be seen by consulting the code. It would be fatal to the legibility of the learner's manipulation to fall into the habit of so forming his characters by introducing unwarranted spaces that their intended grouping could not be determined.

Even among the letters, it sometimes requires the utmost vigilance to prevent this serious defect creeping in. We will mention some of the pitfalls so that the learner may keep on his guard.

J —— – —— – is apt to be rendered NN —— – —— – or TF —— – —— –
O – – " " " I – –
A – —— " " " I – –
H – – – – " " " Q – – —— –
B —— – – – " " " TS —— – – –
K —— – —— " " " NT —— – ——
P – – – – – " " " 6 – – – – – –
Y – – – – " " " AA – —— – ——
V – – – —— " " " ST – – – ——

The letters in the alphabet most difficult to form are usually found to be J, K, B and V.

Familiarize the mind with these points. Physical perfection in the formation of the characters is acquired most easily when the mental dissection of the figure is complete.

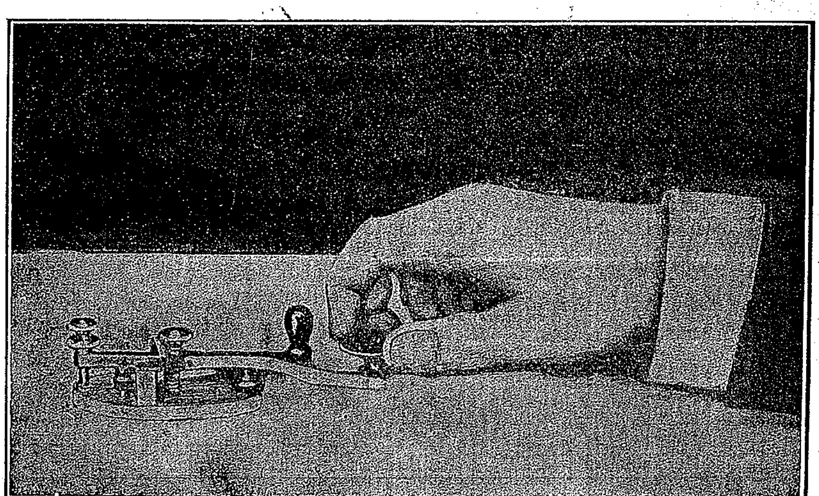
THE "GRIP."

THE "CATLIN GRIP."

Because it is interesting to the telegraphic fraternity at large, and of consuming importance to the learner, to set at rest as far as possible the question of the form of grip that is best calculated to conduce to ease, speed and endurance in the art of **key** manipulation, we have determined to devote a space to that subject.

It is a calamity for an operator to be visited early in his career with the affliction known as "telegraphic paralysis" or "loss of grip." To be reduced in a single night, as it were, from a point where his Morse is the pride of the wire to a position in which his manipulation is as detestable and labored as that of the contemned plug, is mortification enough, but the evil does not end there. The market value of his services decreases and his labor is rendered more irksome and monotonous by the tendency of the complaint to confine his work to "receiving." The paralysis is also apt to develop into "writers cramp," damaging the victim's control over the pen with all its attendant consequences.

There can be but little doubt that telegraphers paralysis and writers cramp have a common origin, although not necessarily common to the same individual, and that much of the contributing cause lies in the nature of the grasp of the key or pen, as the case may be. The acquirement then of a correct style in the beginning is a subject worthy of study.



Take hold of a key just as you would of a pen. The index finger forming a convex figure, or arc, resting on the top of the key knob, and the thumb pressing slightly upward on the lower side of the knob. A straight, stiff forefinger should be avoided. A concave forefinger is worse.

The second finger often rests upon the top of the key knob also, together with the index, but if found more comfortable, let it drop down alongside of the knob, there being no objection to that position, as will be seen by reference to the "Catlin Grip" illustration.

Work is the most easily done when the key sets so far back on the table that the elbow has a rest on the same bed. When sufficient depth of desk cannot be secured, the forearm should rest on the edge of the desk, but under no circumstances should the wrist be allowed to lie or rest upon the table; on the contrary, it should be raised therefrom a couple of inches, and move up and down in harmony with the hand, allowing the elbow or forearm, as the case may be, to act as the axis or hinge of the movement, assisted by flexibility at the wrist.

The nature of the "grip" upon the key should be similar to that in seizing a pen. It should be light, gentle, but even and sure. It must be firm enough to secure unquestioning obedience of the lever, but must not be rigid. Indeed, when we say handle a telegraph key as you would a pen, we have said everything. There must be no skipping, hopping or timidity; neither is any especial vigor required. In the downward pressure do not continue the downward motion of the hand after the lever comes to rest, in order to secure what is called firmness of contact. Such a habit, when it is attempted in rapid work, will handicap the writer. There is no time for any surplus movement. It will be found that the upholstery of flesh at the finger point is a cushion sufficiently elastic to secure this result without any laborious effort on the writer's part, if he is cool, concise and even in his pressure, avoiding convulsive impulses.

In the upward movement, the tension spring will and should assist in raising, but should not control the lever,

As a matter of fact, the student who has an opportunity for observation will see that these rules are outraged in every direction by many expert operators, some being about as eccentric in their method as Doré is reported to have been when he, as said, used to lie upon the floor on his stomach in making sketches. If the learner desires to acquire a reputation for eccentricity, he may insist upon writing with his thumb nail, or in some other equally absurd style, but we would recommend him to stick to rule and learn the art first, and indulge his freaks afterwards.

PRACTICE.

The Morse alphabet, as seen, consists of dots, dashes and spaces. It is the last element, the spaces, that give to the Morse alphabet its difficulty and at the same time its beauty. As spaces assisted by judgment are the only means the telegrapher has of determining the end of letters and of words, it is obvious that their unwarranted introduction into the middle of a letter is very confusing. To bring this feature prominently into view let the student try to render in a readable manner the following:

"Ziekiel recently received three tierces zoological specimens." Even when the characters representing such a sentence are put down in type before the eye, the novice will find it difficult enough to decipher the spaces.

Almost the entire Morse code, with the exception of L and the cipher 0, is composed of combination of Es and Ts, the "space" being used to increase the combinations up to the required number.

The space is nothing more than a hesitation WHILE THE LEVER IS UP and the contact points apart. To illustrate:

Four dots without hesitation or space - - - - constitute the letter H. Introduce a space after the first dot - - - - and the letter rendered is &.

Put the space in the middle - - - - and Y is the result.

Put it in front of the last dot - - - - and it is Z, and so on throughout the entire alphabet.

It will be noted that a space never occurs in a letter in which a dash forms a part of the combination.

Thus it will be seen that too much importance cannot be given to "time" in forming letters. An unintended hesitation and the characters denote an altogether different letter and error is the result.

The letter L is composed of a dash about twice as long as that used to denote a T.

The cipher 0 in the code is still longer than an L, but in practice, when figures are being made in groups without the intermixing of letters, the cipher 0 is made as short as the T, but the space is increased, as in 15,000 - —— —— - —— —— —— —— —— ——

The only case of actual duplication of symbols in the whole code is the fractional mark —— which is denoted by one dot, the same as the letter E. The sense of the message and the judgment of the operator will prevent any confusion arising therefrom; ½ being written - —— —— - - - - —— - -, and 4 1-16 - - - —— - —— —— - - - —— —— - - - - - - -

On railroad and express telegraph lines where freight is largely handled, and the shipping marks are reported and traced up, it is customary to express the marks in this way:

P in a diamond.

K in a triangle. G below, etc., etc.

On press wires still further signs are used, but the beginner need not encumber his early studies with any more symbols than his daily practice from print calls for. When the ear is trained, new symbols are learned without any effort whatever.

The student with these hints can conduct his exercises to suit his pleasure and convenience. Either systematically practicing the dot letters, the space letters or the combination dot and dash letters, or practicing at random from a book, scraps of writing, etc.

Practice from promiscuous manuscript is valuable, as it teaches the student to read various styles of handwriting readily, quite an art in itself.

The main thing, however, is to practice long and often. Devote a given space of time to practice every day, and do not permit other considerations to break up or encroach upon the study hour.

Practice in couples when it is convenient to find a companion. Even if not so far advanced, a companion's practice will aid wonderfully. If further advanced, so much the better. After a week or two of practice, the students should occupy separate rooms and only communicate telegraphic ally. When practicing alone, one is inclined to doubt the value of his own labor, but it should be remembered that the sound of even one's own writing will discipline the ear. The great danger in such case is that the student will fall into bad style and faulty Morse, with no one near to criticise his work.

The most valuable help to a learner is the coaching of an expert after the learner is able to form the characters, as he believes, correctly.

Where two or more learners are connected in upon a single line, the writing of one will answer for all.

Each station, whether a town or an individual, is designated by a "call" consisting of one or two letters. The initials of the name of the town or of the individual are usually selected, as "NY" for New York, "B" for Brown, "J" for Johnson, and McCauley, "MC."

In calling up a station, it is customary to repeat the call of the office wanted several times, the caller signing his own signature at intervals.

If Johnson wants McCauley, he will call "Mc Mc Mc Mc J"; "Mc Mc J"; and so on until Mc responds by saying "aye aye Mc"; instead of spelling aye, aye, in full, however, he simply says "I I Mc."

In telegraphing, when the receiver fails to get a word, he "breaks" and repeats the last word received. If there are several receivers on the line, and it is desired to keep a record of the number of "breaks" and who makes them, so as to gauge the capacity of the respective receivers, the station that "breaks" not only repeats the last word, but signs his office signal as well, which serves to prevent confusion along the line. Until students have acquired some little skill, it is not advisable to "break" whenever a word is missed, as this would occur so frequently that the sender would make but little progress, to the annoyance of the more advanced students at the other stations.

Confusion will result sometimes in spite of all precautions, and the sender, losing the thread of his work, not know at what point in his message to proceed. He will then say "4" which means "where shall I go ahead?" or "start me!" Some one on the line shall then say "G A" which means "go ahead," followed by the cue, and sign his station signal. If the sender wants some particular station to start him, he, for instance, will say "B 4," and Brown will accordingly give him the desired cue. It is not necessary for the sender to sign in such cases, as there is only one sending office at a time, unless he wishes to emphasize his request, in which event if "Mc" is the sender, he will say "B 4 Mc" or "B pls 4 Mc" introducing the abbreviation for "please," which is a courtesy that in serious telegraphing serves to mollify when there is irritation among the workers.

Students should grow up in the art of preserving a tranquil and courteous demeanor in their work on the line. They must be careful to not burden their speeches with ceremony but treat their VIS À VIS with respect. There are circumstances in the peculiarity of telegraphers' work on a wire, dealing with men they have never seen, that seems sometimes to breed irritation at every dot. The bickering of lawyers at the bar is not a parallel to it, and strange to say in an exceedingly large number of instances in which the operator on the line is pronounced "crank" or "mule" he in personal, individual intercourse is an affable, courteous gentleman, elevated above petty spite and unwilling to wound the sensibilities of even a tramp.

The only good rules to follow in working with nervous, ill-tempered or brutal Morsemen, are, keep your temper, stick to the text, ignore innuendoes and try calmly to progress your business without attempting to either propitiate or further antagonize your partner on the line, and he will soon become ashamed of himself and special ill treatment on his part toward you at least will cease. These are rules more easily laid down than followed but their practice yields a big return upon the investment.

The following are some of the abbreviations and codes in common use in telegraphy:

1 Wait a minute.
2 What's the time?
4 Start me. Where shall I begin?
5 Close your key.
7 Have a communication for you.
8 Am busy elsewhere.
9 "Wire testing" (this signal calls for imperative right of way on the line, any one using it wrongfully being subject to disciplining).
13 I understand, or do you understand.
18 What is the matter?
27 Adjust your instrument.
30 Good night. (No more biz.)
73 My compliments.
134 Who is at the key?
O. K. All right.
Ahr. or Hr Another (usually refers to a message).
Fr. or Fm. From.
Sig. or Sg. Signature.
Pd. Paid.
Col. Collect.
D. H. Deadhead (free).
N. M. No more.
Ck. Check.
Sine. Sign. (Give private or office signal as case may be.)
G. A. Go ahead.
Hm. Him or Home.
G. B. A. Give better address.
Ans. Answer.
RR. Repeat.
Msk. Mistake.
Immy. Immediately.
Impt. Important.
Ofs. Office.
Ct. Cannot.
Ads. Address.
Min. Minute.
Qk. Quick.
Bn. Been.
Pls. Please.
Opr. Operator.
Wt. What.
Ntg. Nothing.
G. M. Good morning.
G. P. M. Good afternoon.
G. N. Good night.
Btn. Between.
Bk. Back, Break or Book.
Bf. Before.
Btr. Better.
Ckt. Circuit.
Tt. That.
Ha. Signifies a laugh.
Um. " " grunt.
Gd. Ground or Good.
Gg. Going.
Dt. Don't.
Kw. Know.

All abbreviations in common commercial use are also adopted on the telegraph line and understood. Such as S. S. for steamship, Frt. for freight, P. O. for post office, Hhd. for hogshead, Cwt. for hundred weight, A. M. for morning, etc., etc.

These are reinforced by innumerable others according to the ingenuity and knowledge of phonetics on the part of the individual operators convers- ing over a wire. The following is a fair sample:

"Bn ot a nite Smtg mst b dn wi th biz rt awa bt dt sa aytg abt it pls. U kw hw tis urslf. Ha Ha."

"Been out all night Something must be done with this business right away but don't say anything about it please. You know how it is yourself (laughter)."

In transmitting commercial business the messages are numbered from No. 1 up in regular order to keep track of and to refer to them. In large offices there are often many men, each being identified over the line by a private signal, which no one else would think of using, any more than they would commit a forgery by signing another's name to a document. The sending operator signs his private signal immediately after the office signal. The name of the month and the date of the year is omitted in sending messages. The number of COUNTABLE words are named in the "check" which is sent ahead of the address so that the receiver can gauge his "copy" according to the length of the message and by writing a given number of words to each line, keep tally as he goes along. At the end of the message, if his tally fails to correspond with the check, he challenges the count by quoting the number of words as per his version. To determine the correctness of the count the sender starts at period and gives the initial of every word in the body of the message in rotation as they occur, until the discrepancy is found, or the check declared false. Messages with false checks usually continue en route and are delivered "Subject to correction," while the error meantime is being traced to its origin and formally corrected.

The body of a message is that part lying BETWEEN the Address and the Signature. It is separated from the former by a PERIOD and from the latter by "SIG."

The following is a model of the telegraph message as it is usually transmitted over the wires of the large telegraph corporations in the United States, the matter appearing in small capitals being foreign to the message itself, but introduced for craft reasons:

AHR No 36 PK X ** 7 PAID

FM Pulaski N Y 15

To JOHN SEARLES

No 14 Carondelet St

New Orleans La

Please hurry forward my last order. Urgent

SIG GEORGE HEMPSTEAD

At the point where the asterisks are introduced the receiver signs his own private signal, so as to put on record not only the personality of the sender, but also that of the receiver. The sending operator in the above instance signs X; "pk." being the official office call, and 36 the number of the message; 7 paid is the check, and indicates that there are seven words in the body of the message and that the message is paid for in advance. If the charges were to be collected at New Orleans then the check would read 8 COLLECT, instead of 7 paid, the telegraph companies making it a rule to count the word "collect" and record it in the check, as an additional safeguard against error, although the word is not charged for. This precaution is an excellent one.

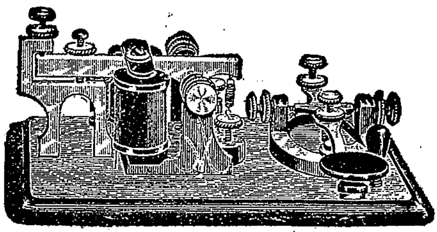
Upon the receipt of a communication the receiver replies "O. K.," adding his private signal which is endorsed on the original message, together with the hour at which the "O. K." is given.

Skilful operators accomplish the feat of "endorsing" sent business with a lead pencil in the left hand while they continue the transmission of new business with the right. It is quite necessary for the finished operator to be able to do this, but such exhibition of skill is not expected from the raw recruit.

TO SET UP THE EUREKA OUTFIT.

Screw the instrument down firmly upon the table, shelf or board, wherever it is intended to locate it permanently for practicing.

The effect of this is to increase the sonorousness of the instrument. A round-head screw accompanies the outfit for this purpose. The instrument is adjusted about as it should be, before leaving the factory. It is just possible that some of the screws may be shaken loose in transportation. Do not assume that to be the case, however, until a thorough trial by battery, and examination of the various parts prove it, as otherwise you may disturb an accurate adjustment of the parts, that you would not be able to restore with an equal nicety until you become better acquainted with the machine. When properly adjusted, the axis of the lever should admit of a very slight lateral movement in its trunnion screws, when taken hold of between finger and thumb and shaken. If no movement at all is perceptible, it is possible that the trunnion screws on the side are too tight, and consequently stiffen annaturally the up and down movement of the lever, which should be perfectly free. If there is considerable lateral movement, it leads to wabbling and one of the trunnion screws should therefore be turned up until this lateral movement is reduced to a minimum. The screw should then be fastened securely in place by means of its lock nut, or as the washers on telegraph instruments are termed, the "check" nut. These instructions apply equally to the lever on both the key and the sounder.



When the knob of a key or the armature of the sounder is pressed upon with the finger, if it is properly adjusted the lever will descend freely, and without stiffness, the only resistance to the descent being the strength of the tension spring. In adjusting, the best plan is to have only strength enough in the spring to just raise the lever when the finger has been removed. When it is concluded that the trunnion screws have been adjusted so that they impart no undue stiffness to the lever, they should be secured in place by check nuts, and the tension spring turned up as high as the strength of the battery will permit in the sounder, and as strong as the taste of the operator dictates in the key. The screw in the rear end of the key lever is to regulate the "play," and its management will be seen at a glance.

The screw in the free end of the sounder lever is termed the anvil screw. It should be adjusted so as to permit the armature to approach within a hair's breadth of the magnet cores; as close as possible without actually touching. A good test of this is to introduce, while the lever is up, a thin piece of paper between the armature and the cores, on both sides. If, upon pressing down upon the armature with the finger, the paper cannot be withdrawn freely, the armature is too close.

The adjustment should be close enough to rub the paper both top and bottom, but not close enough to squeeze or clamp it. Once adjusted in this way, secure the anvil screw by means of its check nut, with especial firmness, taking care that you do not alter the actual adjustment in so doing. This screw should not be altered afterwards no matter how strong or weak the battery may be.

The remaining screw upon the Sounder is similar in purpose to the one last described on the Key. It is to govern the play of the lever and control the volume of sound. It may be altered at pleasure within the limit of the power of the battery, to suit the fancy of the operator.

To Prepare the Eureka Outfit Battery. See that the glass jar is clean. Spread out the copper, noting that it rests on the bottom, as shown in the illustration of Crowfoot Batteries. Put in sulphate of copper (the blue crystals) enough to cover the copper. Pour on pure water until the jar is half full. Then, in a separate vessel, dissolve the sulphate of zinc (the white crystals) in a little less water (warm water is best) than it is thought will be necessary to fill the jar. Now hang the zinc on the rim of the jar, as shown, and connect to it the other wire. THE ZINC MUST NOT TOUCH THE COPPER at any time. The wire from the zinc should run to one of the binding posts on the instrument. It is immaterial which. The wire from the copper should connect with the remaining binding post.

When this has been done, pour the water containing the sulphate of zinc into the jar, filling it up to within an inch of the top. If the quantity of water to do this has been misjudged, and there is too much, throw the balance away. If not enough, add sufficient pure water to effect it. The wires may now be connected to the instrument.

If the student is not too impatient, however, it would be better to fasten the ends of the two wires together for several hours before attaching them to the instrument. This is called "short circuiting," and its object is to more quickly separate the copper solution (blue water) from the zinc solution (colorless water) in the jar, and so get the greatest strength from the battery. Should the sounder work weakly or not at all at first, do not be discouraged as the battery does not acquire its full strength for three or four days. The ends of the wire wherever connected to battery, instrument or another wire, should have the covering (insulation) removed and the metal scraped clean and bright.

In electrical work never make a splice by turning the wire back and twisting it around itself in the form of a loop or an eye, but twist it firmly around the opposite wire as shown in diagram No. 15. Wherever the two wires come into contact in the splice, they should be bare and clean.

To keep the battery in a healthy condition the circuit should be kept closed a large part of the time. The longer the circuit, the longer the time. On very short circuits such as a single instrument for practicing purposes, five or six hours a day will be sufficient.

The management of gravity batteries is more extensively treated of under the proper head in this book, which should be read throughout for general information on this subject and also with respect to lines and instruments.

Dry Battery can be used for operating the Eureka Telegraph Outfit where only one instrument is in the circuit. When a Dry Battery is used the circuit breaker (little lever with small knob) should be removed from the key base, otherwise the circuit may be carelessly closed and the battery run down. If this lever is taken off, this trouble is not likely to occur, and the dry cell will last a long time for ordinary practicing.

THE NEW MORSE CODE OF PUNCTUATION MARKS.

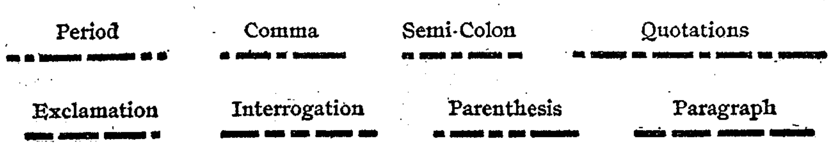
The new code of punctuation marks set forth on pages 26 and 27 were originated by the general manager of the United Press, Mr. Walter P. Phillips.

The extensive press experience of this gentleman as an old-time telegrapher and news expert suggested years ago the necessity of a revision and an extension of the old code of punctuations, in order to facilitate elaborate press work.

While the use of the new code was in the beginning confined to the wires over which Mr. Phillips had personal control, their superiority over the old code and the demand for a complete system of punctuations have not only succeeded in firmly establishing them on the press circuits of the entire country, but are making them heard generally on the first-class commercial circuits of all American telegraph companies.

Every telegraph operator in the land should be familiar with them.

Nevertheless, as the old code is still in use to some extent on the wires of sundry railroad companies, we append below a list of the old characters for reference and comparison:



DIAGRAMS.

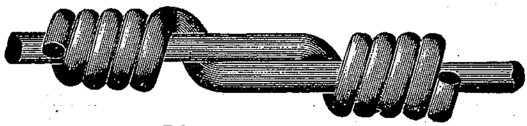


Diagram No. 15.

This cut illustrates the correct method of splicing electric wires, whether iron or copper, large or small. If the wire is insulated, the insulation must be removed and the metal scraped clean and bright at the point where the wires come in contact. Soldering improves the splice.

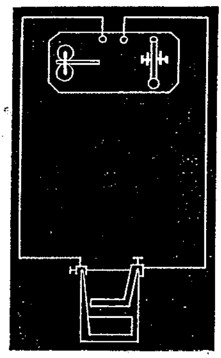


Diagram No. 16.

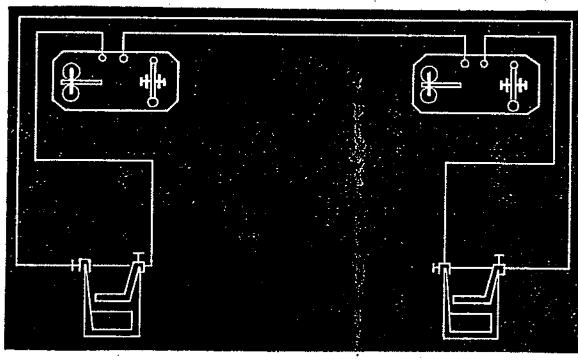


Diagram No. 17.

Diagram No. 16 outlines the method of connecting up a Learner's Outfit or any short line combination set of instruments with a single cell of battery for practising purposes.

Diagram No. 17 shows how to connect up two Learner's Outfits or other short line combination sets of instruments upon what is termed a **"metallic circuit,"** when the instruments are located in different rooms or different buildings. In general, while it is considered best to keep half the battery at each station, equally good results can be obtained on such a circuit as this if all the battery is located at one station, but it will not be so convenient for "testing" should any trouble occur on the line.

When it is desired to put a Lightning Arrester on a **metallic circuit,** it should be connected to the line in the same way as shown for the **middle station** in Diagram No. 19, and the instruments must be attached to the Lightning Arrester also as shown therein, keeping the switch pin in the "dead hole." A ground wire will then be required also, even though it is not connected direct to the line.

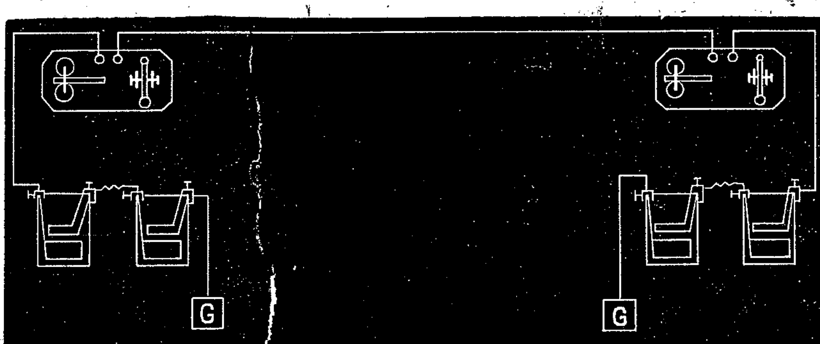


Diagram No. 18.

Diagram No. 18 illustrates precisely the same thing as Diagram No. 17 with the exception that the line in this case is a **"grounded circuit"** instead of a **"metallic circuit"** and that there are two cells of battery at each station instead of one.

More battery may be added at pleasure at either one or both the stations, according to convenience and the requirements of the line.

For method of connecting in a Lightning Arrester, see Diagram No. 19.

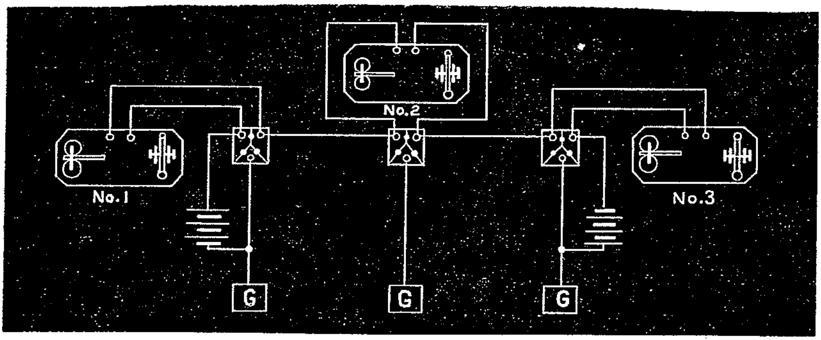


Diagram No. 19.

Diagram No. 19, showing three Instruments or other short line combination sets, connected up on a **grounded circuit** with Lightning Arresters. The Switch Pin in this case, while instruments are in use, must be kept in the "dead hole," which is the hole in the centre of the middle plate.

When there are only two stations on the line, the method of "connecting in" Lightning Arresters shown in Diagram No. 20 is best. The objection to adopting that method at **terminal** stations when there are three or more stations on the line, is that in "cutting out" the instruments the main battery would also be cut out at that end, and the other stations deprived of its use, which should not be the case.

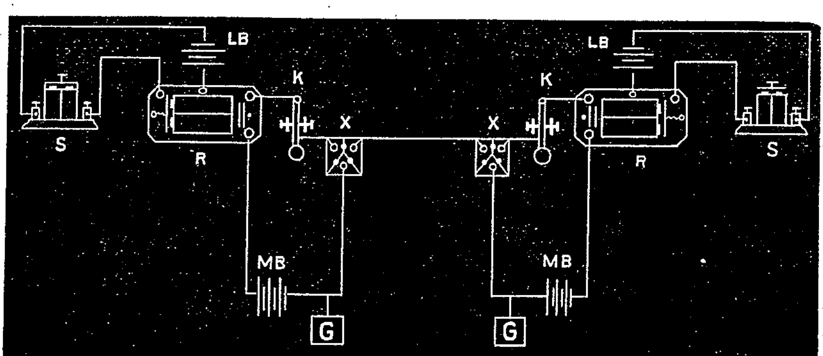


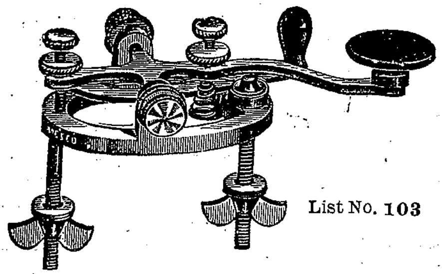
Diagram No. 20.

Diagram No. 20 shows the best method of setting up a full set of instruments and Lightning Arresters on a **"grounded circuit"** consisting of only **two** stations.

K represents the Key at each station, R the Relay, S the Sounder, X the Combined Switch Cut-out and Lightning Arrester, M B the Main Battery to operate the main line, and L B the Local Battery to work on the Sounder, which is on a local circuit. G represents the "Ground" or earth connection, from which run two wires, one to one end of the battery as shown, and the other to the binding post on the middle plate of the Lightning Arrester. During working hours the pin should be kept in the top hole of the Lightning Arrester, but at nights, when out of use and when lightning prevails severely enough to make it advisable to "cut out" the instruments, the pin should be inserted in the hole between the Line plate and the Ground plate. The remaining hole may be used when for individual practice or other purpose it is desirable to "short circuit" the instruments at either station.

When more than two stations are on the line, it is preferable to connect the line to the Lightning Arrester, in the manner shown in Diagram No. 19, which also explains the reason therefor.

STEEL LEVER KEYS



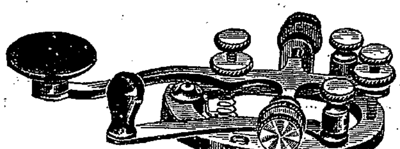
List No. 103

The lever and trunnion is made of one piece of fine wrought steel polished and nickel-plated, giving a perfect bearing and avoiding the loose trunnion trouble so common in other types. All other metal parts finely finished and lacquered.

Each key is fitted with our improved adjustment spring holder.

Both knobs are of hard composition rubber.

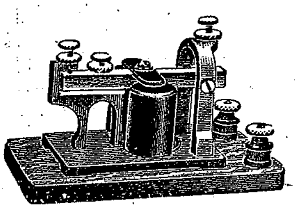
The durability, lightness and quick action of the steel lever pattern is recognized by experts and operators and is preferred to any other type. The Postal and Western Union Telegraph Companies have adopted this type as their standard.



List No. 108

List No.		Price
103	Key, with nickel-plated Lever, brass frame, with legs	$3.00
108	Key, with nickel-plated Lever, brass frame, legless	3.25

IMPROVED GIANT SOUNDER

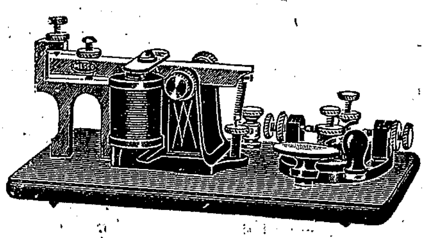


It is unequalled for quick action, loudness and clear tone. Its proportions are scientifically correct. This is the type of Sounder adopted by the Western Union and Postal Telegraph Companies and nearly all railroads.

The clear and distinct sound makes it very popular with expert telegraphers.

List No.		Price
111	Improved Giant Sounder, 4 Ohms, Aluminum Lever	$4.30
113	Improved Giant Sounder, 20 Ohms, Aluminum Lever	4.55

LEARNERS' EUREKA SET



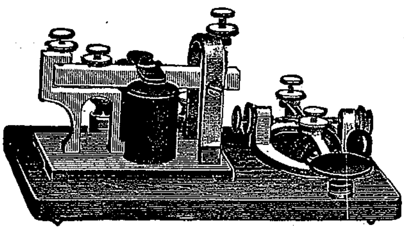
The Eureka Telegraph Instrument is a first-class, standard size telegraph set. All of the working parts—which includes key lever, sounder lever, sounder yoke or anvil, adjusting screws, etc.—are finely finished composition metal, such as is used in all high-grade instruments. Sounder base is Japanned, striped with gilt. The base is mahogany nad highly polished. The key is our well-known steel lever pattern, and sounder gives a loud, clear distinct sound.

Our Red Seal Dry Battery will operate this instrument nicely, but we recommend it only for use on a single instrument, and the key must be left open when not being used.

A copy of "Philosophy and Practice of Morse Telegraphy" is furnished gratis with each instrument.

List No.		Price
178	Eureka Telegraph Instrument, 4 Ohms	$4.30
179	Eureka Telegraph Instrument, 20 Ohms	4.55

GIANT COMBINATION SOUNDER AND KEY



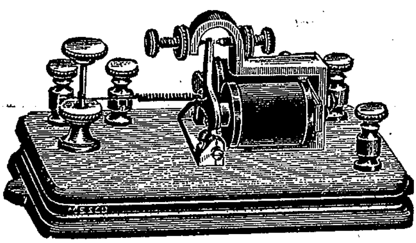
The set comprises our standard Improved Giant Sounder, finely finished, with rubber-covered coils, mounted on polished mahogany base, with our regular Steel Lever Solid Trunnion Key; all highly polished and lacquered.

The practical telegrapher appreciates the advantage of operating the best instruments made. It gives him a lead over the user of a cheaply constructed affair and the student will be better equipped for practical service after learning on this instrument as the sounders and keys are the standard types adopted by the Postal and Western Union Telegraph Companies and leading Railroads.

A copy of "Philosophy and Practice of Morse Telegraphy" (42 pages), furnished gratis with each instrument.

List No.		Price
182	Giant Combination Set, 5 Ohms, Aluminum Lever	$8.75
183	Giant Combination Set, 20 Ohms, Aluminum Lever	9.00

STANDARD PONY RELAY

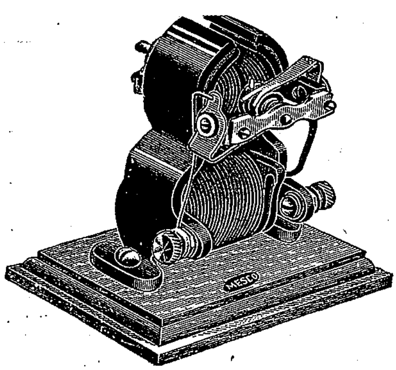


A relay will improve the efficiency of a telegraph system on lines of three miles or more in length when several instruments are connected on the same line.

The working parts are much lighter than a sounder and more susceptible to electric pulsations. It requires much less battery to operate it than does any main line sounder of a like resistance.

List No.		Price
114	Standard Pony Relay, 4 Ohms, for Burglar Alarm Work	$6.00
115	" " " 20 " " Lines up to 10 Miles	6.00
116	" " " 50 " " Lines 10 to 30 Miles	6.25
118	" " " 75 " " Lines 30 to 50 Miles	6.50

THE NEW GEM BATTERY MOTOR

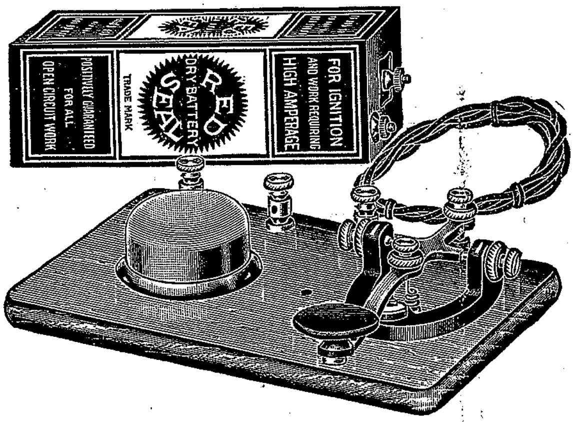


The improvements on the New Gem are Brush Adjusters, permitting a deli cate adjustment and independent con nections. Finished in black enamel and mounted on polished wood stand Used for operating small mechanical toys and advertising devices; runs on a single cell dry battery and is a very powerful motor.

List No.		Price
3580	Gem Battery Motor, with pulley	$2.25

MESCO WIRELESS PRACTICE SET

For Learning the Morse and Continental Codes



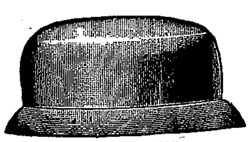
The main object of the Mesco Practice Set is to enable the beginner to learn the Morse and Continental Codes, which are easily mastered as the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

The key and buzzer are mounted on a highly finished wood base; three nickel plated binding posts are also mounted on the base and so connected that the set may be used for individual code practice or for operation of a two-party line, an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil. Full directions with each set.

Only one Red Seal Dry Cell with necessary cord for attaching required to operate the set satisfactorily.

List No.		Price
344	Wireless Practice Set only, no battery or Cord..................	**$4.35**

WIRELESS BUZZER



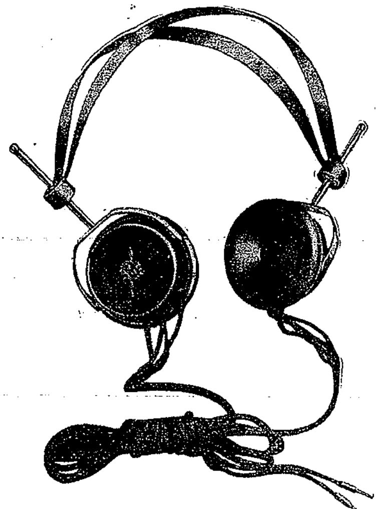
List No. 251.

The base and cover are made from sheet brass polished and nickel plated. The operating parts are adjusted to emit a clear high pitched sound similar to a modern wireless transmitting station. The frequency of the note approximates 500 cycles. Size 2⅛ in. diameter, 1 in. high.

List No.		Price
251	Wireless Buzzer only	**$0.95**

Manhattan Radio Headset

This headset is an attractive instrument. It compares in sensitivity with any instrument on the market. Particular attention has been given to all small details. The material entering into the construction of this headset is of the highest grade; the magnets are of tungsten steel; the pole pieces of silicon steel; and the diaphragm of the best type available. Polarity indicating cords are used and the cord tips are entirely concealed within the receiver case. The headband is designed to be absolutely sanitary. It is made of flat spring steel—rubber japanned. It is extremely comfortable and easy to adjust.



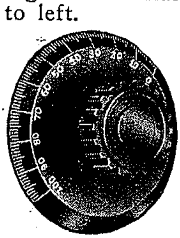
The Manhattan headset recommends itself to those who are interested in securing an instrument with fine operating characteristics and attractive in appearance, at a medium price.

Manhattan Radio Headsets are made in two styles:

List No.		Price
2500	Manhattan Radio Headset 2000 Ohms	$6.50
2501	Manhattan Radio Headset 3000 Ohms	7.00

Manhattan Genuine Bakelite Knob and Dial

The Manhattan line of genuine non-warping bakelite dials will appeal to those who desire precision and quality. The brass bushings for the shaft are accurately centered and insure perfect alignment. The engraving on the dials is extremely fine and clear. Numerals read from right to left.

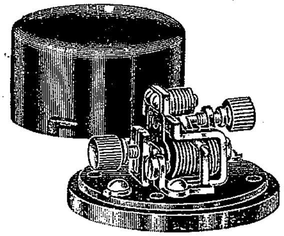


Manhattan Knobs and Dials are made in the following sizes:

List No.		Price
2530	2 in. Bakelite Knob and Dial for 3/16 in. shaft	$0.60
2531	2 in. Bakelite Knob and Dial for 1/4 in. shaft	.60
2532	3 in. Bakelite Knob and Dial for 3/16 in. shaft	.75
2533	3 in. Bakelite Knob and Dial for 1/4 in. shaft	.75
2534	4 in. Bakelite Knob and Dial for 3/16 in. shaft	1.25
2535	4 in. Bakelite Knob and Dial for 1/4 in. shaft	1.25

Manhattan Radio Buzzer

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.



It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 4 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensite base to insure constancy in operation.

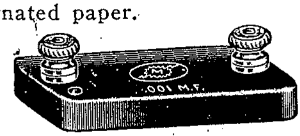
Diameter 2 in., height 1¼ in. The cap is attached to the base by a bayonet joint.

List No.		Price
55	Manhattan Radio Buzzer	$3.35

Fixed Receiving Condenser

The Telephone Shunt Condenser is used in every radio telephone receiving set, whether of the crystal or vacuum tube type.

Manhattan Telephone Shunt Condenser is constructed of copper foil and high grade impregnated paper.



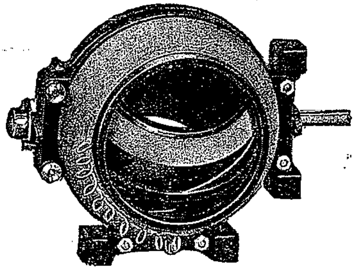
The small condenser unit is completely molded in an outside container case of hard shellac compound. This construction insures the condenser against outside mechanical injury.

Insulation used in constructing the condenser is sufficient to withstand a voltage of about 250, which is considerably above any voltage in the average radio receiving set.

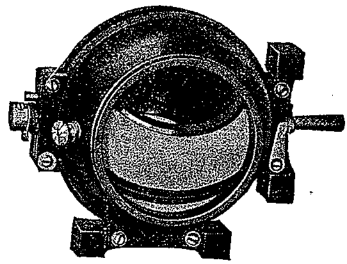
The condenser has a capacity of .001 M. F.—sufficient to fulfill all requirements.

List No.		Price
266	Fixed Receiving Condenser	$0.93

Manhattan Variocoupler and Variometer



No. 2525



No. 2520

Manhattan Variocouplers and Variometers are made of Genuine Bakelite of reddish brown color. Genuine Bakelite is the material best adapted for the manufacture of variocouplers and variometers. It has a permanent luster which will not wear off or become dulled with use. Bakelite will not yield under strain or change its shape.

The electrical losses have been reduced to a very low point—first, by the use of Bakelite, with its high insulating qualities; and, second, by reducing to a minimum the amount of metal used.

Variocouplers and Variometers are frequently mounted on "shielded" panels. To eliminate all insulation difficulties a Bakelite mounting block is provided, thus permitting the use of both devices on a metal panel if desired.

Both instruments are provided with substantial "pigtails" making connection with the rotating member. This insures positive contact and quiet operation. Sufficient friction is provided to permit easy turning of the rotor, with just sufficient binding to have it stay put in the position desired. A strong stop limits its movement to 180 degrees.

The Stator of both variocoupler and variometer is provided with a one-quarter inch collar permitting the attachment of a standard 3-inch Bakelite tube for constructing the familiar "long-wave" coupler.

Manhattan Bakelite Knobs and Dials are designed to be used with the Variocoupler and Variometer.

Variocoupler

The primary winding of the Manhattan Variocoupler is provided with 12 taps, giving complete control up to a wave length of 700 meters.

Variometer

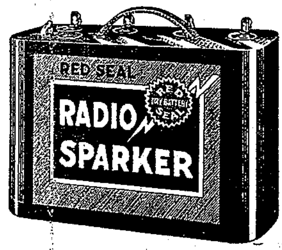
The Manhattan Variometer as commonly connected in a receiving set has a wave length of 170 to 490 meters. This insures efficient reception of amateur and broadcasting stations. The wave length range may be increased to approximately 1000 meters by the use of a fixed or variable condenser of .00025 M.F. across the variometer, or the familiar "long wave" coupler may be readily constructed to give a range up to 3000 meters.

List No.		Price
2520	Manhattan Variometer	**6.50**
2525	Manhattan Variocoupler	**$6.50**

Red Seal Radio Sparkers

No. 221

No. 282



2 cell. Designed for operating a single WD-11, or similar dry battery vacuum tube.

8 cell. Designed for operating from one to four dry battery vacuum tubes.

Radio Sparkers operating radio receiving sets equipped with the new small dry battery vacuum tubes (WD-11) are a great advancement in convenience and saving over the earlier type of sets having tubes operated by a storage battery.

Heretofore it has been customary to operate each tube on a single Red Seal Cell. The new Radio Sparker has been designed to operate each on a pair of special cells, thereby giving nearly three times the service of a single cell. Simple wiring diagrams and instructions for connecting are provided on the back of each Radio Sparker. Spring clip connectors make "hooking up" quick and positive.

Radio Sparkers are low in cost. They are dry and clean. They contain no injurious acid to spill. They require no attention or recharging. In operating sets equipped with WD-11 tubes as compared with sets using storage battery tubes, it is acutally much cheaper to throw away Radio Sparkers when their life is exhausted and buy new, than to buy a storage battery and keep it recharged.

Radio Sparkers are designed for radio work. The cells are connected in parallel so that Radio Sparkers cannot be used for operating ignition systems, for blasting, or for other uses requiring a greater voltage than 1.5. For such purposes use regular Red Seal Sparkers.

Red Seal Radio Sparkers are made in three sizes as follows:

List No.	Description	Arranged in	Voltage	SIZE IN INCHES			Standard Case		Price
				L.	W.	H.	Quantity	Weight Lbs.	
221	2 Cells, in Parallel..	1 row	1½	5⅛	2⅝	7½	24	136	**$2.00**
262	6 Cells, in Parallel..	2 rows	1½	7⅝	5⅜	7½	12	207	**6.20**
282	8 Cells, in Parallel..	2 rows	1½	10⅜	5⅜	7½	6	153	**8.00**

Red Seal Dry Battery

No. 2445
Round Case

No. 2448
Square Case

The Red Seal Dry Battery is the "all-purpose" battery. This means that it is designed to produce sufficiently high amperage to satisfactorily meet the needs of all ignition, while giving long life for open circuit work and other uses requiring less amperage.

It has rapid recuperation after continuous service, and does not easily or quickly deteriorate if kept on dealers' shelves.

Red Seal Dry Cells are furnished in either round or square cartons, and with screw binding posts or spring-clip connectors.

Red Seal Dry Batteries are used for operating bells, buzzers, annunciators, fire alarms, telephone and telegraph systems, electric horns, electric clocks, burglar alarms, time stamps, counting devices, medical apparatus, sprinkler circuits, cigar lighters, testing apparatus, blasting devices; for lighting electric lanterns, Christmas tree lighting outfits, auto parking lights, auto stop signals; for ignition on automobiles, farm engines, tractors, stationary engines, motor boats, farm and house lighting outfits, air compressors, concrete mixers, etc., etc.

List No.	Size	Carton	Terminal	Price
2445	2½x6½ in.,	Round	Screw Binding Post	**$0.80**
2448	2½x6½ in.,	Square	Screw Binding Post	.80
2434	2½x6½ in.,	Round	Spring Clip Connector	**.80**

Red Seal Sparker

No. 151 fibre case

No. 141 steel clad

The Sparker is several Red Seal Cells assembled in a handy durable container.

Red Seal Sparkers are provided with two terminal binding posts. The terminal nuts on these are large and are formed of insulating material. Their size and shape permit of exerting sufficient pressure on them to insure perfect permanent contact without using pliers.

The carrying handle is a particular feature of Red Seal Sparker Batteries, being constructed of wide strong webbing, which will not cut the hand when it is required to carry the battery any distance.

The method of construction necessarily eliminates all trouble from moisture, loose terminals, broken or improper connections.

The new steel clad Red Seal Sparker has been developed for use where batteries are to be given extra rough service or used in damp places. We believe that this is the most perfect container ever produced for an assembly of dry cells.

There are three points of superiority in the Red Seal Sparker steel clad:

1. A thoroughly waterproof container of heavy steel.
2. The fastening points of the handle are raised, so that any water which might settle on top of the can will not seep through the rivet holes.
3. This battery is distinguished by a new label of brilliant color and distinctive design.

Red Seal Sparkers are designed for ignition work on gas engines, tractors, automobiles, motorboats, or for blasting.

Red Seal Sparkers are now made in two styles—

1. Steel Clad—single row and two rows.
2. Fibre Case—single row and two rows.

Red Seal Sparkers—steel clad

List No.	Description	Arranged in	Voltage	SIZE IN INCHES L.	W.	H.	Price
141	4 Cells, in Series..	1 row	6	10⅝	2¾	7½	**$4.40**
152	5 Cells, in Series..	2 rows	7½	8⅛	5¼	7½	**5.20**
162	6 Cells, in Series..	2 rows	9	8⅛	5¼	7½	**6.20**

Red Seal Sparkers—fibre case

List No.	Description	Arranged in	Voltage	L.	W.	H.	Price
142	4 Cells, in Series..	2 rows	6	10⅜	5⅜	7½	**$4.40**
151	5 Cells, in Series..	1 row	7½	13¼	2¾	7½	**5.20**
161	6 Cells, in Series..	1 row	9	15½	2¾	7½	**6.20**