TELEGRAPH INSULATION.

CHAPTER XXXIX.

English Telegraph Insulators—The American, the French, the Sardinian, the Bavarian, the Holland, the Baden, the Austrian, the Seimens and Halskie's, and the Hindostan Insulators—Tightening the wires in Asia, England, and on the Continent.

ENGLISH TELEGRAPH INSULATORS.

In Great Britain the telegraph enterprise has been under the administration of gentlemen skilled in the science and the art. Every arrangement employed on the lines in that country contemplates permanency and perfection of operation. The system of telegraphing adopted in Great Britain does not require the same organization, in every particular, as necessary for the American lines. This remark may be applied to the insulation at the posts. On the American lines stronger voltaic currents are employed in the working of the telegraphs, and these currents are continuous. On the English lines the electric force is weaker and non-continuous. Besides these facts, there are other reasons which might be mentioned, if necessary, explaining the fact that the telegraphs of the two countries are different, one from the other, and that the requirements of the one are not the same as those of the other.

The invention of an insulation received from the telegraph veteran, Cooke, at an early day, a proper appreciation. On the 8th of September, 1842, he obtained a patent for his particular modes of suspending wire in the air, &c.

The modes described are various, but the principal features were the causing of *zones* of dry wood to exist between wire and wire by the means of artificial boxes or circular sheds like umbrellas, the tightening of wires by certain well-known mechanical means, the use of compound twisted wire, a kind of portable telegraph instrument to be attached to the wires, as also the use of wires suspended under the particular modes as described and patented, if used for the purposes of sending currents of electricity to work electric clocks, or particular kinds of apparatus connected with certain descriptions of electric telegraphs.

The plan of causing zones of dry wood to intervene between wire and wire was tried and abandoned. It was succeeded by the following method, which was very extensively employed in England.

The following figures will explain this plan: *a a* are arms of wood attached to a post or standard by means of a bolt passing through the porcelain tubes *y y*. *e e* are tubular insulators of porcelain, affixed to the arms by clips of iron. The wires pass through the tubes *e e*, and are thereby insulated. About every tenth post is made stronger than the intermediate

Fig. 1.

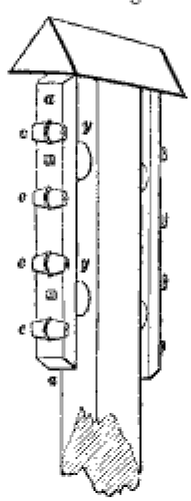


Fig. 2.

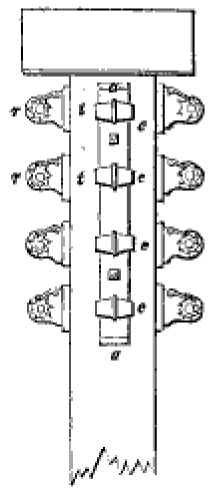
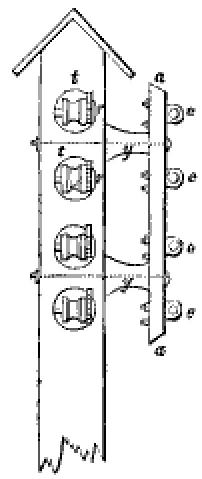


Fig. 3.

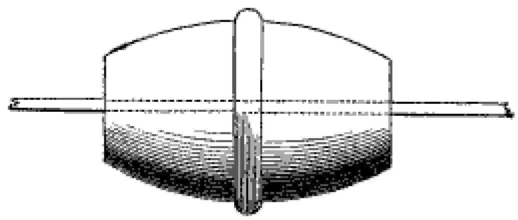


ones, and strong cast-iron ratchet-wheels, with barrels, *r r*, are affixed to it for drawing up the wires. When the wire has been threaded through the insulators *e e* on the intervening poles, its end is attached to these winders, and on turning the ratchet wheels round by means of a strong handle, the wire may be wound round these barrels and thus drawn up to any degree of tension desired. The ratchet-wheels and barrels on each side of the posts are connected to each other by bolt *b*, and insulated from the post by means of the porcelain tubes *t t*.

The first plan of insulation adopted by Mr. Cooke was to cover each wire with cotton or silk, and then with pitch, caoutchouc, resin, or other non-conducting materials, and to enclose them, when thus insulated, in tubes or pipes of wood, iron or earthenware. The telegraph on the Great Western Railway line was originally laid down on this method. This mode of insulation was, however, abandoned on the introduction of the baked wood zones.

The insulator described in figs. 1, 2 and 3, has been known in England as the Cooke Pole system, and fig. 4 represents the insulator as fastened to the pole and the wire run through it.

Fig. 4.



It is formed like an egg, slightly flattened at each end, and about three inches long. The wire had to be run through the holes, and when once on they could not be separated from the wire, except by cutting it or breaking the insulator. This mode of insulation was extensively employed until about 1848. when others were introduced and found to be more practicable.

Fig. 5.

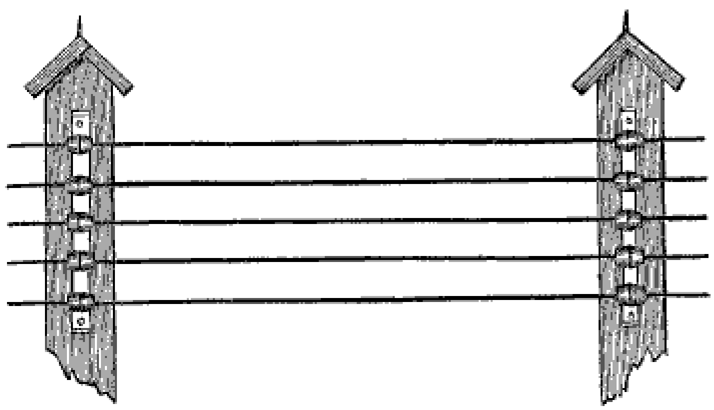
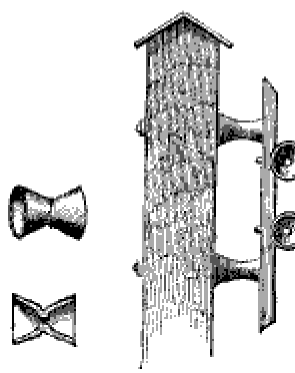


Fig. 5 represents the wire suspended upon the poles through the above described insulator. The wire was fastened at proper distances, the description of which will be hereinafter given.

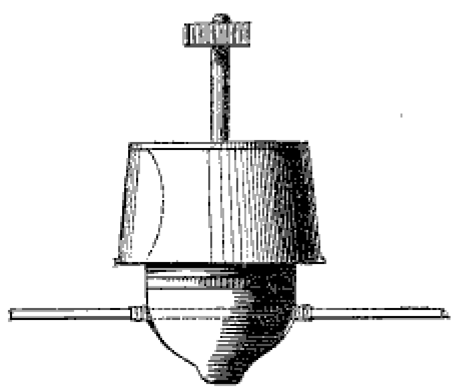
About 1849, Mr. Physick devised an insulator by which the wire was supported by a hook, the upper part of which passed through a shed of earthenware, and fastened by a nut at the top; above this mastic was laid to insulate the hook from the post. This was found to be a faulty insulator. The vibration of the wires and other causes broke off the mastic.

Fig. 6.



Mr. Charles V. Walker adopted an insulator shaped like an hour-glass, as represented by fig. 6. They were made of brown salt-glazed stoneware, and were fastened to a bracket, as seen by the figure, by several turns of wire passed outside the narrow part of the insulator, and entirely unconnected with the telegraph wire within. The wire threaded the insulator. The bracket is partially insulated from the post. This mode of insulation was a success, so far as pertained to the working of the line, but the hour-glass shaped cones were liable to break, and when they were thus displaced, the wire had to be cut to thread on new cones. This was objectionable.

Fig. 7.



The next insulator adopted was that known as Clarke's, having been patented by Mr. Edwin Clarke, the engineer of the Electric Telegraph Company, in 1850.

Fig. 7 represents the insulator with the wire attached to it. Figs. 8 and 9 are sectional views of it, which I will now explain. Letter A is the arm to which the insulator is bolted by

Fig 8.

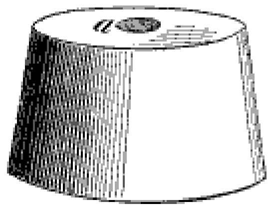
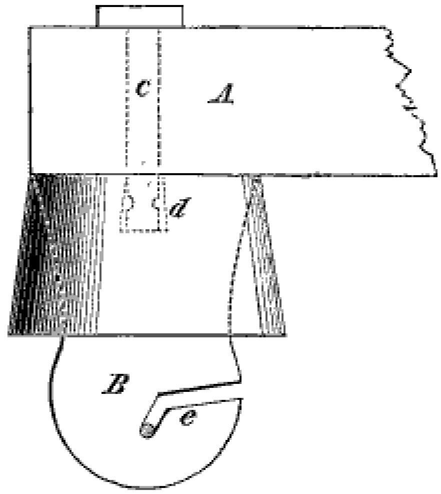


Fig. 9.



means of the bolt *c*, let into the earthenware B at *d*. The part B supports the wire by the slot *e*. Between the arm and the earthenware is fixed, by passing over the bolt at the hole *a*, a zinc cap of the shape represented by figure 8. The insulator is about four inches long.

Fig. 10.

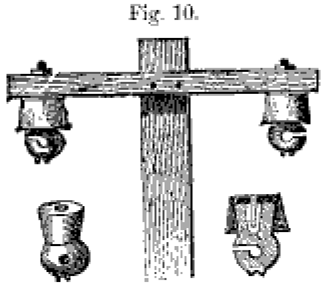


Fig. 10 represents the insulator as fastened to the cross beam and sectionalized.

This form and combination was then followed by another made of glass and suspended from an arm fastened to the post. The object of the application of the zinc or metal cap was that the moisture might condense on it rather than on the earthenware.

Fig. 11.

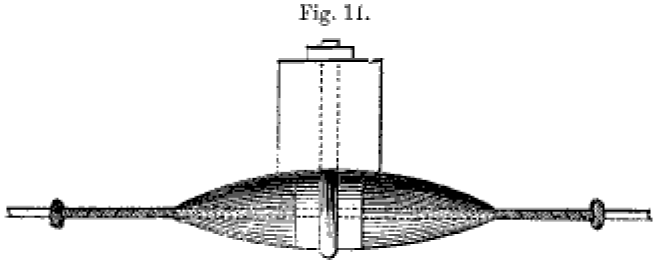


Fig. 12.

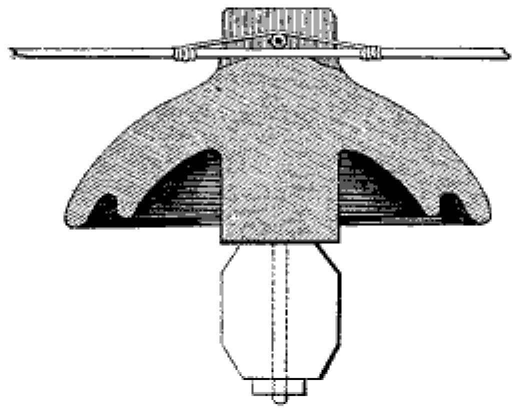
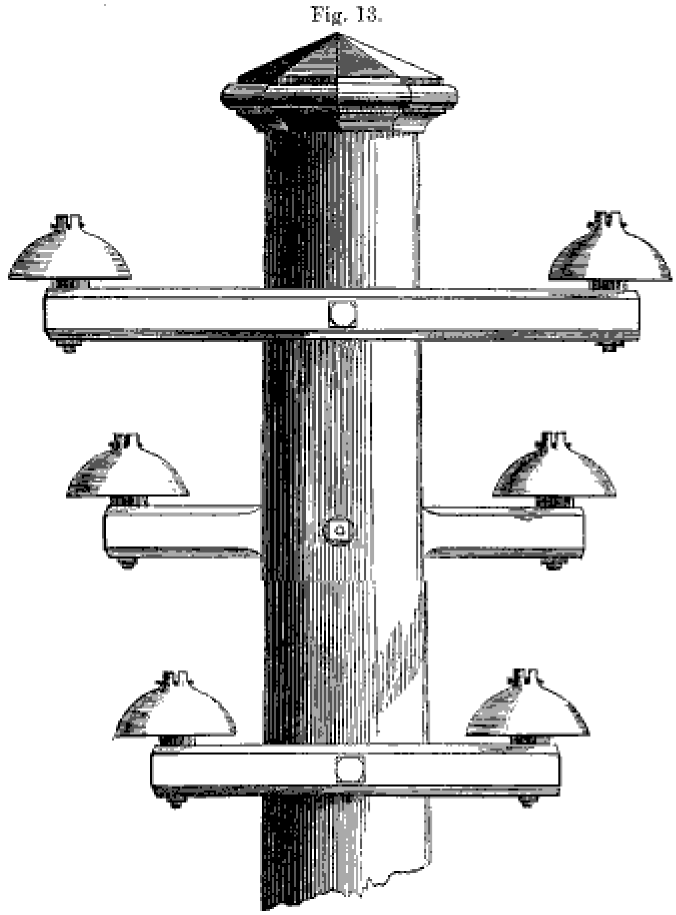


Fig. 13.



Mr. Hightons adopted the plan represented by fig. 11. The wire was capped with silk ribbon for about six inches on both sides of the point of support, and covering about five inches in the centre of the foot of ribbon with a piece of gutta-percha, shaped like an elongated sphere; the whole was then varnished with brown hard varnish.

Fig. 12 represents an insulator invented by the Brothers Bright, of the Magnetic Telegraph Company. It is mounted upon the pole or a cross-beam as seen in fig. 13. The inverted bowl is fastened to the beam by a bolt and nut, as seen in fig. 12. The wire is attached to the top. Neither rain nor fog form a connection between the wire and the pole. It is made of earthenware or glass, very heavy, and about five inches diameter. Fig. 13 represents an arrangement for six wires. In connection with this mode of insulation, the brothers Bright devised the arrangement of the cross beams as represented by fig. 13, and also by figs. 14 and 15.

Fig. 14.

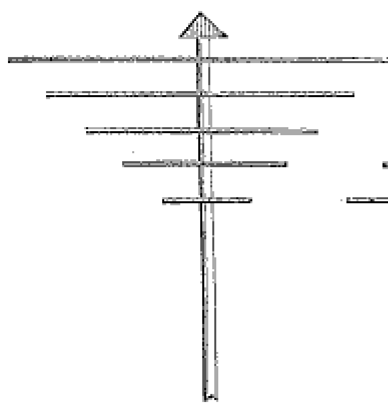


Fig. 15.

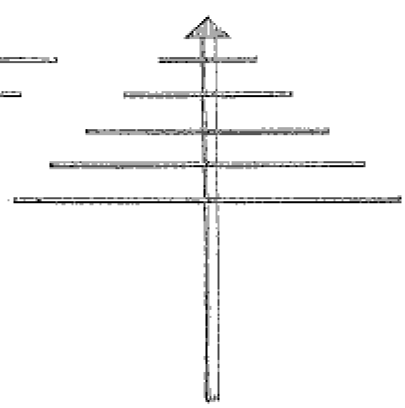


Fig. 14 represents the cross beams or arms reduced in length from the top. Fig. 15 represents the cone above. In either case when the wire breaks it falls clear, and does not get entangled with the other wires, as is often the case when they are on the same perpendicular line. Fig. 14 is a form more convenient for the erection or replacement of the wires. Fig. 15 is a stronger combination than fig. 14, the greater leverage arms being nearer the centre of the pole.

There have been various other insulators invented, and employed to a limited extent on the English lines, but those in general use are described in the foregoing. Gutta-percha insulators were tried, but were not successful, and other forms had to be substituted in their place. The earthenware insulator has proved to be the most substantial and best in every respect for the purposes of insulation.

AMERICAN INSULATORS.

There is a greater variety of insulators upon the American telegraphs than is to be found on the lines elsewhere in the world. The enterprise, from its commencement on the Western continent in 1844, has been in the charge of "many men of many minds," and each has been ambitious to excel the others. This commendable spirit has been productive of much good. Besides this circumstance attending the erection of the lines, different sections of America have required an insulator peculiarly adapted to their special wants. On the other hand, however, there have been devised many kinds of insulators for special sections of the service which have proved destructive to practical telegraphing.

The first insulator used in America was the cloth, saturated with gum-lac, wound around the wire at the post contact. This was on the experimental line, constructed in 1843–'44, between Washington and Baltimore, under the direction of Professor Morse. Copper wires were used, and a cross board was fastened at the top of the pole. A small notch was cut in the top edge of the board, and the wire, covered with the saturated gum-lac cloth, was laid in the notch. Over this was nailed a board, serving as a roof, so that the rain could not have access to the wire contact on the perpendicular edge of the cross-board.

Various plans were suggested for the proper and better insulation of the wires. The horn used for lightning rods was tried and abandoned. Finally the glass was determined upon as the only reliable means of effecting the great desideratum. The question was then as to the form of the glass. On this the opinion of telegraphers are still at variance. Every new man that comes into power seems to aim for a novel form of insulation. This singular infatuation among telegraphers I

Fig. 16.

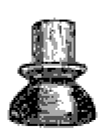
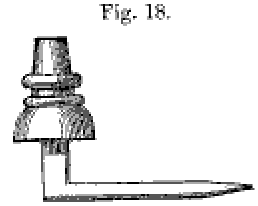


Fig. 17.

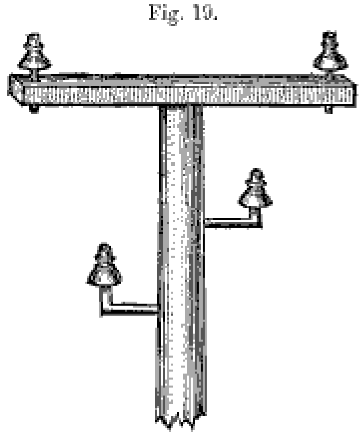
Fig. 18.



have noticed for many years past, and even at this day I find a great diversity of opinion as to the most acceptable insulation.

In the adoption of the glass insulator the form first employed was the ordinary door-knob. It was found to be a partial success, but the large projection at the top of the knob was considered useless, and then the shape represented by fig. 16 was employed. The glass was set on a wooden pin fixed in a cross beam at the top of the pole. This form was then improved as shown by figs. 17 and 18. The wire was laid in the grooves of figs. 17 and 18, and on the projection in figure 16. The line wire was then tied to the glass with a small wire, either No. 16, 14, or 12, according to circumstances and the opinion of the constructor.

Fig. 19.



This insulator was again improved by Mr. William M. Swain, president of the Magnetic Telegraph Company. He abolished the flange and constructed the glass in the shape of an egg, as represented by the following figures.

Fig. 20 represents the form of the glass with line wire groove at its centre. The lower end is concave and the upper slightly convex. The flange insulator was easily broken, but the egg form cannot be broken by the ordinary service of the telegraph. I have seen this insulator thrown as much as a hundred yards, and against brick houses, and not break. This rotund-shaped glass insures long service, as has been demonstrated by its use on a long range of lines for many years.

In the arrangement of this insulator Mr. Swain did not only have in view substantiality, but also the perfection of the insulation of the line wire from earth currents. At numeral 1, fig. 21, the cone is concave. When the water collects upon

Fig. 20.

Fig. 21.

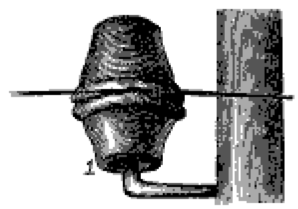
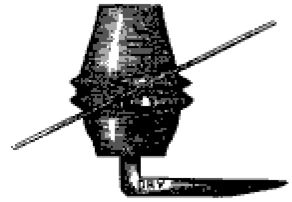


Fig. 22.



the upper part of the insulator it does not follow the glass to the numeral 1, but falls from the centre projection. The moisture under the drip forms globules, and breaks from the cone at or above 1, as seen falling from the flange of the cone, fig. 25. The point of drip, therefore, is not at the lower end,

Fig. 23.

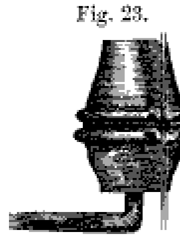
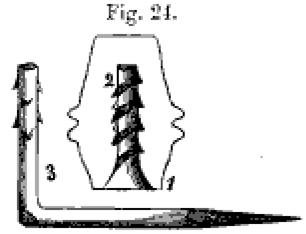


Fig. 24.



but above at the centre projection as just described. Fig. 26 represents the drip of a house. The falling drop breaks the rain and keeps dry the projection seen under the eave of the house. In the same manner the dripping from the above described glass insulates the lower cone from the rain. Of

Fig. 25.

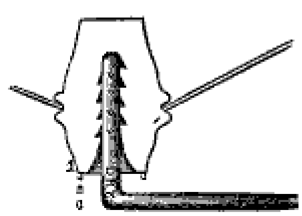
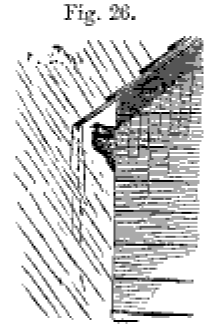


Fig. 26.



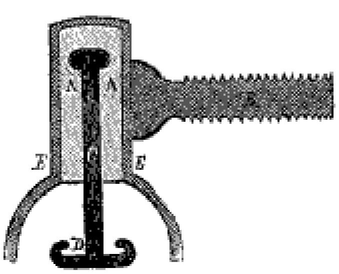
course the lower end of the glass will not be dry, but there will be less liability for a watery connection with the earth from the wire than when the drip is at the lower end of the glass. I have seen this philosophy illustrated at the Niagara Falls. The immense volume of water passes over the shelf or point of drip, and beneath the mass of water is a passage-way for travellers, precisely as represented by fig. 26. If the reader desires to see this idea illustrated, he can do so by setting a teacup upon an upright pin, then fill the cup with water until it overflows. The water will fall over the rim, and the smaller end of the cup will be dry.

Fig 21 represents the glass adjusted to the wire when on a right line; fig. 22 when the wire is oblique, as upon the side of a hill, and fig. 23 when the wire is perpendicular with the post. In order to prevent the glass from pulling off from the iron arm, the screw combination represented by fig. 24 was adopted. The iron arm 3, is cut so that the teeth will serve as a male screw. The glass is made with a female screw as seen by numeral 2. Fig. 25 represents the glass on the arm, with the line wire fastened to it at an angle pulling the glass upward, the teeth of the iron arm fitted into the grooves of the screw prevents the glass from being separated from the iron arm.

The above figures are engraved with so much variety that further explanation is unnecessary. They have been gotten up with care, and they are replete with demonstrative philosophy.

Fig. 19 represents the application of these insulators to the poles. The cross beam at the top of the pole has upon it two insulators, set upon iron pins. Some lines have several of these cross beams on the poles for the use of other wires; others have the insulators fastened to iron arms driven into the sides of the poles, as seen below the beam in fig. 19. This iron arm is shaped as seen in fig. 18. An auger hole is bored into the post, and into it is driven the iron arm as seen by the figure. An advantage is realized in the use of this class of insulaters, in the fact that there is not much surface for the wind to act upon. Many lines are leveled to the earth by the heavy storms.

Fig. 27.



Among the improvements historic in telegraphing is the one called the brimstone insulator, represented by fig. 27. Letters A A are sulphur; B an iron arm to screw into the auger hole in the pole or tree. C is an iron pendant to support the wire in the eccentric hook D. E E is an iron casing, and is a part of B. The flange below E E was to prevent a watery connection in times of rain, dew, or fog. These insulators were extensively used on the early lines constructed by Messrs. Ezra Cornell, John J. Speed, jr., and J. H. Wade of the north-east and northwest. This combination of materials proved to be very defective; and at an enormous expense they had to be removed from the lines and others substituted. The losses sustained by their use were very great, almost producing the ruin of some of the companies. The reader may be surprised to learn that it proved so seriously fatal, and he may be unable to comprehend why it was not found to be defective for telegraphic service before it had been so generally applied. The explanation will be readily understood when it is remembered that these various lines were all being built at the same time, in different directions, by different gentlemen, contending against rivals on the same routes. In the course of a few weeks several hundreds of miles were constructed. It was but a short time before the fault of the non-working of the lines was found to be in the application of the sulphur. The complete failure of these insulators has prevented others from attempting to use sulphur in connection with the insulation of telegraph lines in America.

Fig. 28.

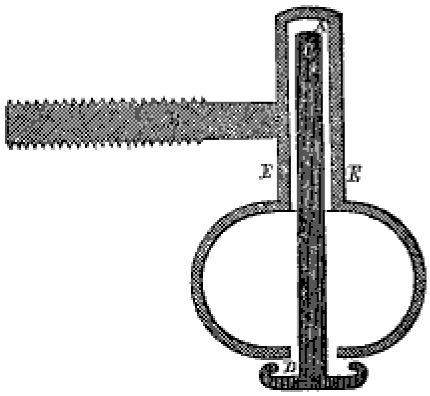
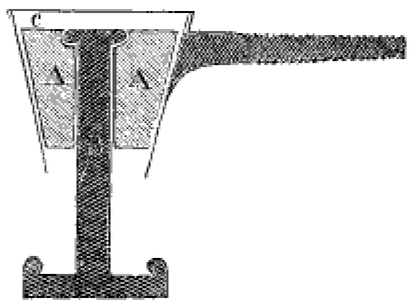


Fig. 28 is an iron insulator, adopted by Mr F. N. Gisborne for the Newfoundland telegraph lines. Its construction is similar to that of fig. 27, except the flanges E E are made spherical so as to better protect the pendant from watery connections in wet weather. The inside of the bell E E was at first enamelled with a thick coat of glass. The white space seen in the figure was then filled with lead to hold the pendant C. The insulator thus arranged proved to be defective. The enamel soon wore off by the vibrating of the wire in the wind, and the lead coming in contact with the iron, a metallic connection was formed with the earth whenever the pole was wet, or through the sap when the insulator was fixed into a tree. To remedy this fault Mr. Gisborne applied vulcanized rubber in the place of the lead. In this latter form the insulator has proved to be a success.

Fig. 29.



The first insulator constructed so as to hold the wire by suspension, on the American lines, was devised by Col. John J. Speed, jr., and used on the line from Detroit to Dearborn, Michigan, in 1849. Fig. 29 represents the form adopted. It was made of a cast iron casing, with a cap *c* to serve as a roof. The glass was in two pieces, indicated by A A. The pendant B supported the wire. The insulator was considered very good, but expensive. This insulator was subsequently improved by moulding the glass in a cylindrical form, and fastening the pendant through the glass with a nut at the top. The glass thus arranged was fitted into a cast iron cylinder, with a moveable iron cap. There were objections to the use of the iron. The next insulator was a cylindrical glass fitted in an auger hole bored into the cross beam. The glass, when fitted into it, was held in its place by a wooden pin, driven through the cross arm, fitting also in a notch made on the side of the glass. This form of insulation has been extensively used on the central range of lines, running from New-York to the West, and has answered as a good insulation.

Fig. 30.

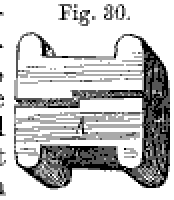
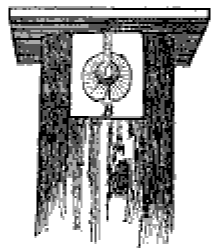


Fig. 30 represents an insulator very extensively used on the lines constructed by Mr. Henry O'Rielly. It is made of glass, porcelain, or earthenware; the former was found to be preferable. It was about five inches long and two inches across, the groove being made so that the wire could not get out of the glass when subjected to an upward strain, which is often occasioned by the location of one pole lower than the o... 's. The hole through the glass is round and at each end enlarged, forming a funnel or flange. The wire lays upon the centre of the glass, touching not more than an eighth of an inch. The projections seen on the sides at each end are also on the under side. The top is flat. The pole is cut so that the insulator will lay in it, as

Fig: 31.



seen in fig. 31. An auger-hole the size of the glass is bored through the pole about two inches from the end. With a chisel the wood about the auger hole is cut out, which leaves a mortised opening for the insulator, as seen in fig. 31. Letter A is the insulator, with the flange opening; B is the projecting head; C the groove or hole for the wire, D one of two small boards nailed on the top of the pole to form a roof. When trees were used on the route of the line, a bracket was attached to the tree, as represented in fig. 32, excepting that the board roof is not shown in the figure. This insulator allowed the wire to rend through, so that whenever a tree fell upon the line, communication was not interrupted. When the

Fig. 32.

wire is first stretched it is taut, but in a short time it becomes slack by expansion, and whenever a tree falls upon the line the wire is not broken but carried to the earth with the tree. If the wire does not [illegible] n the moist ea[illegible] the telegraph continues to work without interruption. If, however, the wire is imbedded in the earth, communication will be stopped until the wire is elevated. In forest provinces the open insulator has been found indispensable. In open countries it has not been considered of any advantage.

Fig. 33.

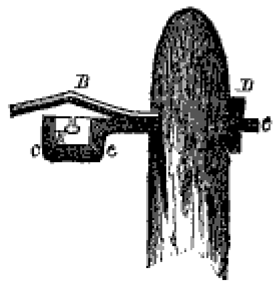


Fig. 33 represents another combination for insulation. It was adopted by Messrs. O'Rielly, Kendall, Tanner, Shaffner, and others, and was considered on its introduction as the most perfect for the purposes in view. A is the telegraph pole. B an iron roof about four inches wide and six inches long from point of connection with C C, from which point it is reduced to an arm the same in size as *c c c*. The part through the pole is round and about one and a half inches in diameter. D is a wedge or key to hold *c c c* in the pole. E is the insulator made in the form of fig. 30, but only two and one half inches long. The glass insulator E is set in the arm *c c*. The projections at the ends and the weight of the wire hold it in the arm. B, the iron roof, mentioned above, covers the glass, so that the rain cannot make a connection with the earth. These insulators were well approved and extensively employed, but in a few months they had to be taken off and others substituted for them. They proved to be more disastrous than the brimstone insulators. They brought ruin on every line that used them. The glass E would easily break, and then the wire resting on the iron arm *c c c* gave the current an earth circuit whenever the poles were damp; and if trees were used the sap carried off the voltaic current. It was found impracticable to work successfully a line one hundred miles with them.

It is impossible for the reader to comprehend the sad results that fell upon the lines that used this insulator. Many thousands of dollars were lost in the constant repair and loss of business. They had to be removed from every line that used them. The telegraphers of the Northwest ever keep in sad remembrance the brimstone insulator, and the telegraphers of the Southwest will never forget the painful history of the iron insulator.

Fig. 34.

Fig 35.

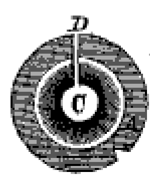
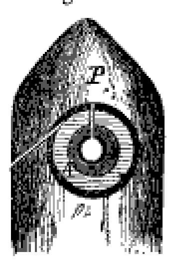
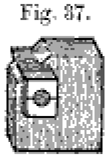


Fig. 36.



Among the open insulators successfully employed on the Southwestern lines was the cylinder form, invented by Mr. John Yandell, and first adopted by Messrs. Shaffner and McAfees on their Southern line, and by Messrs. Shaffner and Veitch on their Western line. Fig. 34 represents the side view of the glass cylinder. A the flange projecting one quarter of an inch. B is the body of the insulator, made conical, or one quarter of an inch larger at the flange end than at the other. Fig. 35 represents an end view. A, the flange, is eccentric to the body B. Letter D is the groove for the wire to be placed through. C is the hole or bed for the wire. The opening at each end is enlarged and funnel-shaped. The notch below A is for the nail. To apply this insulator it is necessary to employ two different-sized augers. The first must be the size of the flange, which bores a hole not more than half an inch deep. The other auger, the size of B, fig. 34, is then employed, commencing with a centre eccentric to the flange. When the hole is thus bored, with a saw a groove is cut from the side of the pole, as seen at letter D, fig. 36. P is the pole, cut tapering or in the shape of a roof. A is the insulator. D is the opening through which the wire is carried to the groove of the insulator. When the wire is in its place, the glass is turned as seen in fig. 36. A nail is then driven into the pole at the notch. The object of the nail and the eccentric flange is to prevent the glass from falling out of the pole and to keep the groove upward as seen in the figure. In order to employ trees on the route of the line, a bracket is made in which is fitted the glass as above described. This insulator has been modified by Mr. J. D. Caton and used on his extensive range of lines in the West. He abandoned the flange and adopted the plain cylinder, and with the nail only the glass is held in the pole.

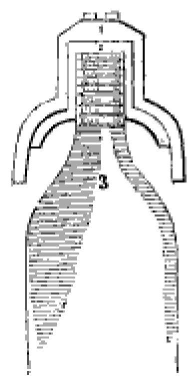
Fig. 37.



To a limited extent the insulator represented by fig. 37 has been employed. It consists of two rectangular pieces of glass; in each is a semi-cylindrical groove, in which is laid the wire. In the figure the white part represents the two pieces of glass, one laid above the other. They are fitted into a bracket and a small board is nailed to the bracket to serve as a roof. The whole is attached to the post or to a tree.

The House lines have had in successful use the insulator represented by fig. 38. It consists of a glass cap about six inches in length and four inches in diameter, having a coarse screw-like surface cut inside and out. This glass cap, indicated by the numeral 2, is screwed and cemented into a bell-

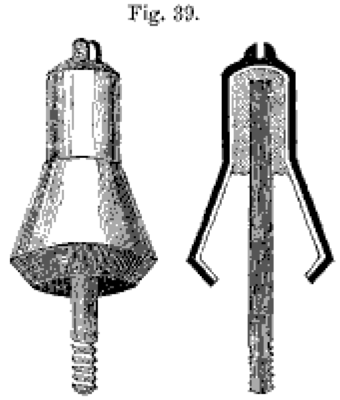
Fig. 38.



shaped iron cap marked 1, from three to four pounds in weight, projecting an inch below the lower edge of the glass, protecting it from being broken; this is then fitted with much care to the top of the pole, marked 3, and is covered with paint or varnish. The line wire is fastened to the top of the cap by the projecting iron points, and the whole of the iron cap is thus in the circuit, as the iron wire is not insulated. To prevent the deposit of moisture, the glass is covered by a varnish of gum-lac dissolved in alcohol, and the rim-like form of the glass is to cause any moisture to be carried to the edge and there drop off.

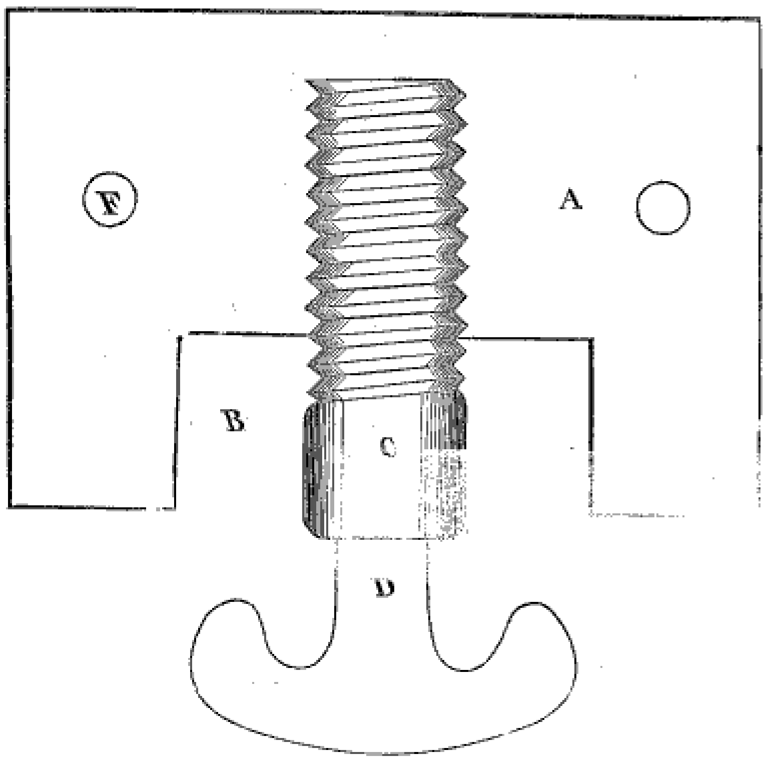
The insulator represented by fig. 39 has been in use for some years on the Boston Fire Alarm telegraph, and has proved to be a success. The cast iron cap is represented by the black line in the section. This is lined throughout with glass, by the operation of blowing, or with porcelain. The shank is then introduced with a hot mass of glass or any fused or semi-fused material, by which it is firmly fixed in its place. This is represented by the shaded portion. Between the lower edge of the cap and shank, in the section, there are four inches of glass surface. The re-entering angle of the lower part of the cap protects the glass within from missiles, and is calculated, in a storm of wind and rain, to drive the latter downward and thus preserve the insulation. The wires pass over the top of the insulator. The shank, which should be longer than is represented, screws into a bracket or the ridge-pole of a house.

Fig. 39.



The insulator represented by fig. 40 is called Batchelder's hard rubber insulator. Hard india-rubber has been used for the insulation of telegraph wires for several years past, and has served successfully during the heat of summer and the extreme cold of winter. The seasons have not affected it. This substance does not soften at a lower temperature than 300° F.; it is much stronger than glass, it does not absorb moisture, nor does the dew collect upon its surface as readily as upon glass or porcelain. The figure represents the insulator in its full size. A is a wooden block, in which are the holes F F, converging together toward the back, so that the spikes which pass through them are dovetailed to the post. The circular cavity B is about two inches in diameter and two inches in depth, within which the lower part of D C is protected from rain and moisture. A hole is bored in the block the proper size for the reception of D C. The hard rubber C covers the iron rod or pendant D, so that there can be no metallic or other conducting connection with the earth. The hard rubber cannot

Fig. 40.



be broken from the iron other than by a hammer or some great force, greater than befalls a telegraph insulator. The line wire is laid in the hook D, which has its flanges at angles to hold the wire taut. This insulator has been very extensively used, and particularly in the Northern States.

Fig. 41 represents an insulator used on several lines with satisfactory results. It is made of white flint. The material is anti-porous, is vitrified throughout, and is considered as perfect for insulating purposes as glass. It is very hard and difficult to be broken, and it has resisted bullets and other missles thrown at it by mischievous persons. The form adopted has been regarded as advantageous in preventing the gathering of lines of water. The corrugations separate the watery accumulations.

Fig. 41.

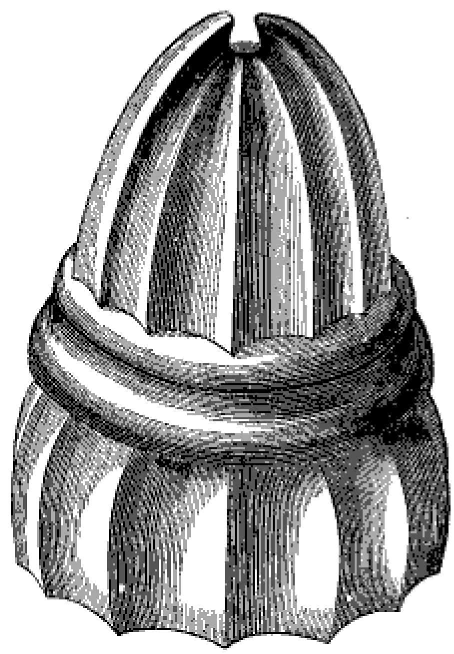


Fig. 42.

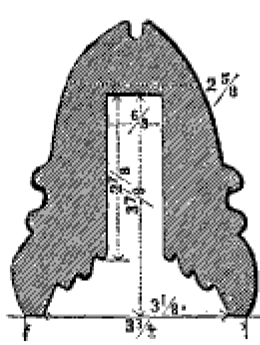


Fig. 43.

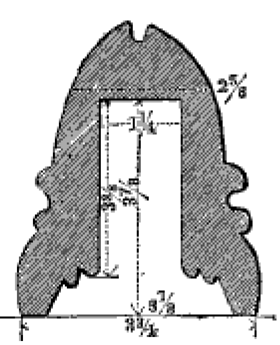


Fig. 44.

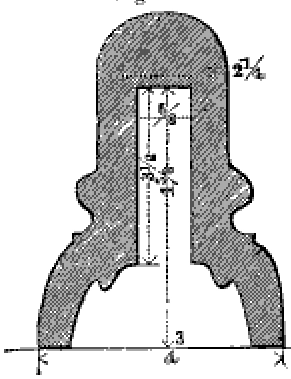
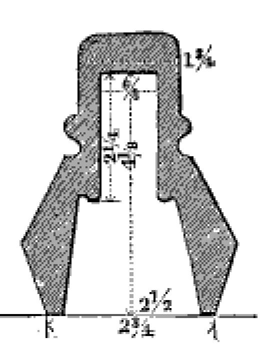


Fig. 45.



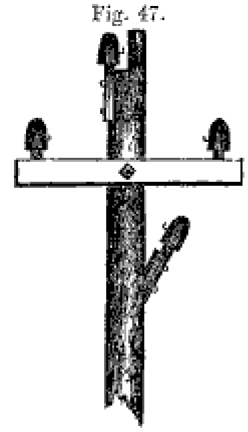
The insulator is either fitted to an iron or to a wooden pin, driven into the poles or to the cross-beams.

The four sectional drawings represent different forms adopted. The first two are arranged for the line wire to be fastened to the top of the insulator with wire ties or small wedges. The latter two are shaped so that the line wire can be fastened to the side by tie wires.

In 1849, at Erie, Pennsylvania, Col. Speed, of the Northwest, devised an insulator with a wooden shield covering the glass, having in view its protection. At that time it was but little used. A few years afterward the wooden shield insulator was again introduced with improvements of different kinds. Fig. 46 represents the most improved form, which is known as the Wade insulator, having been gotten up and extensively used on the lines in the Northwest under the direction of Mr. J. H.

Fig. 46.

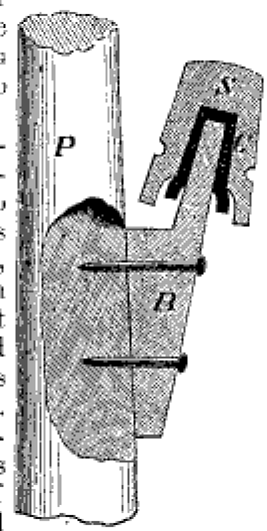
Fig. 47.



Wade. It is considered the best insulator used on the American lines. It is cheap and very durable. Fig. 46 is a sectional view of the different parts. A is a wooden pin one and a quarter inches in diameter, saturated with coal tar and pitch; B is the glass, four and one half inches long and two and one quarter inches in diameter outside; C is a wooden shield four and one half inches in diameter outside, and six and one half inches long, saturated with coal tar and pitch. D is a groove turned around the shield for a tie wire, with which the line wire is fastened. Fig. 47 represents the arrangement of this insulator on the pole by a wooden pin, on cross beams or by a bracket.

Fig. 48 represents a similar insulator, manufactured by Messrs. Chester, of New-York city. P is the post; B the bracket; S the wooden shield, and G the glass. The manner of fastening to the post is shown by the figure.

Fig. 48.



The Wade insulator is used extensively on the telegraph lines in the North-west, and it is believed by those who have tried it, to have many advantages over all others. The wooden shield, when dry, is a non-conductor, and when painted or saturated with coal tar it remains dry. The glass is protected and seldom breaks. It is strong, and is calculated to give long service. Mr. Wade has had great experience in telegraphing, and he has tried many kinds of insulators on his lines, and he is of opinion that this insulator has proved to be more perfect than any other heretofore employed on the American telegraphs. Expert telegraphers concur in the above opinion.

Porcelain and earthenware insulators have not been used on the American lines. Baked clay, enamelled, was tried, but the vibrations of the wire soon wore through the enamel and the porous clay absorbed water, and they then served as conductors. Nothing but the materials herein stated have been found to answer the purposes of insulation.

FRENCH TELEGRAPH INSULATORS.

On the French telegraph lines the bell-shaped insulator has been in general use. Figs. 49 and 50 represent this insulator. In fig. 49 a side and front view is given as it is fastened to the pole. Fig. 50 are sectional views of the same. It is made of

Fig. 49.

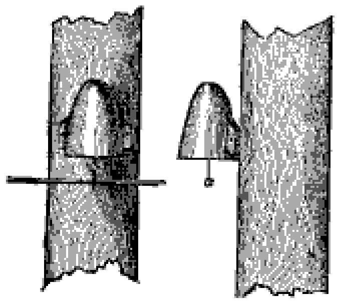
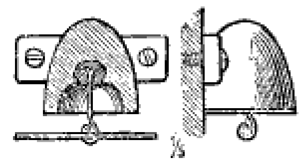


Fig. 50.



porcelain or glass, and it is moulded with two side pieces or ears, through each of which is a hole traversed by a screw about three inches long, which fastens the insulator to the post. The line wire is held by the hook suspended from the interior of the bell. The iron hook is fastened by sulphur into the highest part of the cavity, as seen in fig. 50.

Fig. 51 represents an insulator used on the early lines in France. A slot was made in the insulator, in which was placed the line wire, and then the insulator was fastened to the post. Fig. 52 represents another form, through which there was a hole for the line wire. It had to be threaded on the wire and then fastened to the post as seen in the figure. This was

Fig. 51.

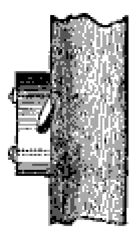


Fig. 52.

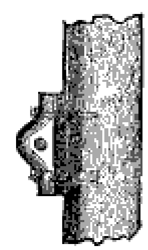


Fig. 53.

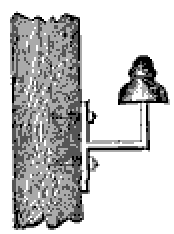
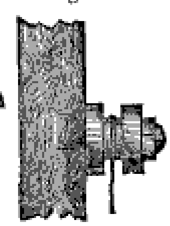


Fig. 54.



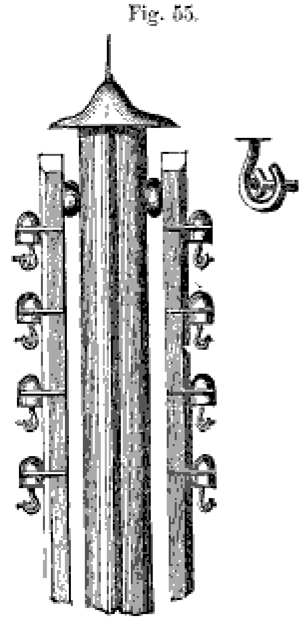
called the ring or eye insulator. They have been considered as inferior to the bell form, and are only used at obtuse angles on the line. On the lines examined by me in France, I saw but few of these insulators in use. Fig. 53 is another form of insulation. The line wire is fastened to the bell-formed porcelain by being wound around it and tied by another wire. Each bell or porcelain insulator is fastened to an iron arm with cement. Fig. 54 represents another form. The line wire is wound around the grooved drum or cylinder.

The insulator most common in France is that represented by fig. 49. They are fastened on each side of the pole. I have seen as many as twelve wires on the same line of poles. They were but a few inches apart. In the working of these wires no difficulties were experienced. It must be borne in mind that in France the battery current is not constantly on the line. If the wires were continually charged, as they are in America, it is possible, and very probable that the wires arranged as above described, would be more or less subjected to cross or induced currents as experienced on many of the duplicate wire lines of America.

THE SARDINIAN INSULATOR.

Fig. 55 represents the insulation now used on the Sardinian telegraph lines. It is made of glass, earthenware, or porcelain, generally, however, of the latter. It is made with a circular groove around its middle, in which is placed an iron clamp, and the clamp or staple is fastened to a perpendicular wooden beam. An iron hook, in which is fastened the line wire, is cemented to the interior of the porcelain. This hook, enlarged, is represented by the letter A to the right and at the top of the figure. To this hook is attached a binding screw, which holds the line wire. The perpendicular beams are fastened to the posts above and below with iron bolts, fastening between the beam and the post large porcelain cylinders, as seen in the figure. By this arrangement it is intended to have a double insulation, and I have been informed that it fully accomplishes the end contemplated. In order to further perfect this insulation, it is proposed to place over the porcelain a cap to serve as a roof. Each pole has its top covered with a wooden or zinc cap, and to each too is attached a lightning rod as seen in the figure. It consists of a large iron wire, made sharp at top and extending above the post about six inches. It is conducted down the post into the earth. Lightning rods similar to the above are also used upon some of the lines in Holland. The extent of their usefulness has not yet been determined. The earth connections have been frequently found to be imperfect. If the rods be connected with

Fig. 55.



moist earth, commensurate with their conductibility, there can be no doubt as to their efficiency in preserving the line from much, if not all of the annoyance resulting from atmospheric electricity.

THE BAVARIAN INSULATOR.

Fig. 56.

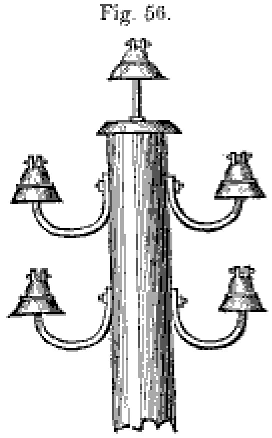
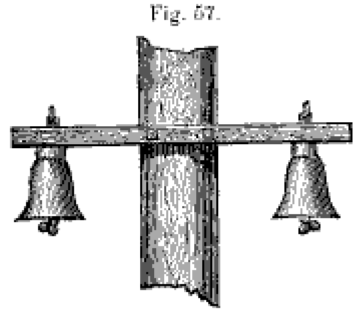


Fig. 56 represents the insulator used on the Bavarian lines. It is a glass bell, fitted and cemented to an iron arm, which is screwed to the post as seen in the figure. To the top of the glass is cemented, in small openings, two cast-iron projections, through which are two holes. The line wire is laid on the top of the glass between the iron projections, and then two wedges are driven through the holes in opposite directions, which securely binds the wire and prevents it from moving upon the insulator. The iron arms are fastened on the sides of the post. Sometimes one bolt, with nuts at each end, fasten an arm on each side, but the metallic connection between the two arms might prove to be disadvantageous to the working of the line. In damp weather cross currents will pass from one wire to the other.

THE HOLLAND INSULATOR.

Fig. 57.

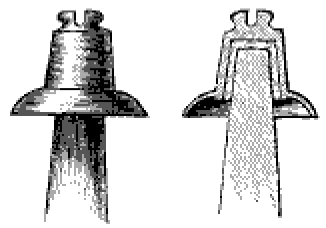


On the line from Amsterdam to the Hague, in Holland, is used the insulator represented by fig. 57. It is made of glass, with an iron bolt cemented at the top and fastened to a cross-beam by a nut screwed to the upper end of the bolt. To the interior is cemented an iron pendant for supporting the wire. This insulator has proved its usefulness.

THE BADEN INSULATOR.

The insulator represented by fig. 58 is used on the Baden lines, extending from Manheim on the Rhine, *via* Carlsruhe to Kehl and Strasbourg. The insulator is composed of earthenware, cemented on the top of the pole by plaster-of-paris, as seen by the sectional fig. 58. The wire is twisted around the neck of the cap. When more than one wire is used on the route, the insulators are fixed to brackets or iron arms.

Fig. 58.



On the line from Frankfort to Castel, opposite Mayence, I noticed, in 1854, the wire was insulated with a covering of india-rubber, fixed in a notch at each pole. Over the notch was fastened a piece of tin to serve as a roof.

THE AUSTRIAN AND PRUSSIAN INSULATORS.

Fig. 59 represents an insulator used on some of the Austrian lines. The post T is tapered to a point *c*, about two inches in diameter at top, and the tapered part above *c* is about six inches long. A porcelain cap or inverted cup is fitted to the tapered end. On the top of the cap at *e* there is a small groove or hole *a*, in which the conducting wire *b b* is fastened.

Fig. 59.

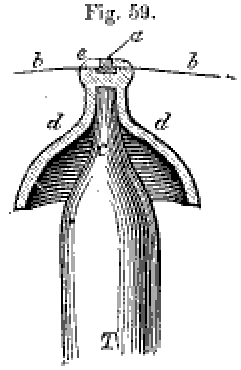
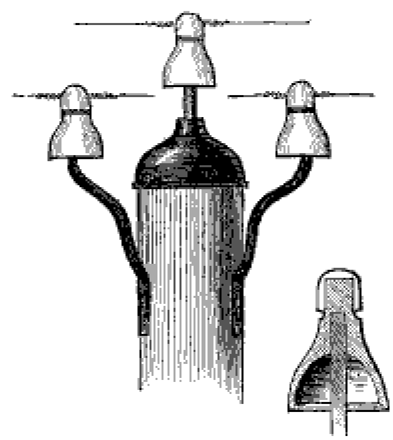


Fig. 60.

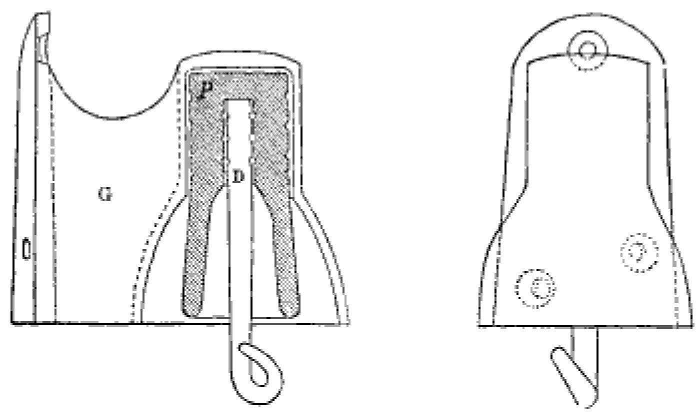


The Prussian telegraph lines are remarkable for their perfection as to construction, and particularly in regard to the efficiency of their insulation. Fig. 60 represents the mode of insulating heretofore employed on many of the lines in Prussia and Hanover. The cap is made of porcelain, four and one half inches high, three and one half inches wide below, and one half an inch thick. These caps are fitted to iron arms as seen in the figure, and the line wire is fastened to the cone with tie wires. On the top of the pole is fitted an iron or earthen covering, through which projects the iron pin for the upper insulator. In its use it has proved to be a good insulator, though the porcelain is very liable to be broken. When the insulating cap breaks, the wire remains suspended to the iron arm, and during wet weather the line is interrupted in its working. These annoyances have been frequent, and to remedy them other contrivances have been invented.

SEIMENS AND HALSKIE'S RUSSIAN INSULATOR.

Until the year 1852, the insulators used on the continent were made of glass, porcelain, or burnt clay. At that time Messrs. Seimens & Halskie proposed the bell-shaped insulator, protected by an iron shield. Those then in use were fragile and easily broken, even after they had been placed upon the poles. Many of them would crack and absorb water, which gave a conductor for the electric current, the means of passing from the wire to the earth, or to the next wire on the same line of poles. These cross currents were very great hinderances to the successful working of the lines, and it naturally became

Fig. 61.



a matter of very great importance to remedy the evil with all the speed possible. To this end Messrs. Seimens & Halskie, gentlemen distinguished for their great telegraphic skill, applied their ingenious minds to the perfection of an insulator that would more substantially subserve the purposes of the telegraphic service. After various improvements in the form and insulating properties of materials, and their combinations, those hereinafter mentioned were tried and proved eminently successful. It has been estimated that at least twenty-five per cent. of the former insulators had to be annually renewed. This breakage occasioned not only a great expense for their replacement with new insulators, but heavy losses were sustained by the lines not being able to transmit the necessary business of the government, nor that which was offered on commercial affairs.

Fig. 62.

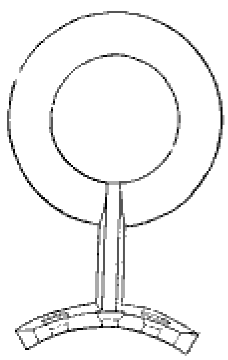
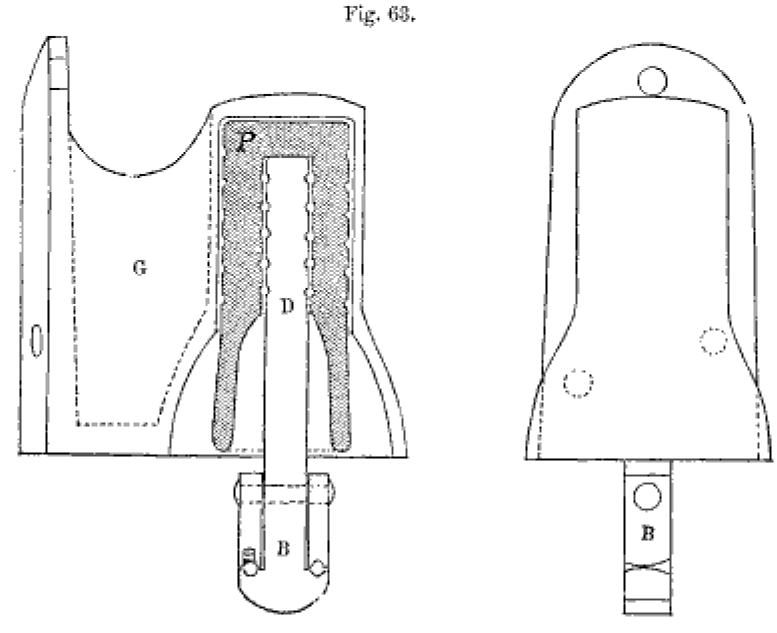


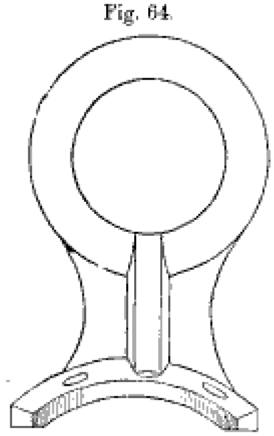
Fig. 61 represents the common insulator now used on the Prussian and Russian telegraph lines. Letter G is a cast iron body. P is the china, glass or porcelain insulator fitted into the iron bell. D is the wire supporter fastened into the insulating material. The insulator P, and the iron supporter

Fig. 63.



D, are fastened in their respective places by a mixture of sulphur and colcathar, which makes a good cement, and firmly binds the respective parts to each other. The three views, figs. 61 and 62, are sufficient to represent its construction without further explanation. Fig. 62 represents the top view and the curvature that fits to the post. The nail or screw holes are marked by the dotted lines. Besides this form of insulator, another is employed for holding the wire taut upon the poles. Fig. 63 represents the contrivance, commonly known as a Spankoff, or tightening apparatus. The figs. 61 and 62 are the same in form and make, excepting the wire support D of fig. 63 has the klemmbacken, B B. The wire is drawn taut, and then B B holds it tight and does not permit it to slip through or become loose or sagging. If the wire is cut between two of these insulators, it can only be slack for that particular section, and it does not extend to the sections beyond the spankoffs. They are usually placed on the line, one for each half mile, and sometimes at a less distance.

Fig. 64.



I have seen these insulators on the German and Russian lines, and wherever they have been employed the telegraph worked with the most complete success so far as pertained to the insulation. The glass P, securely insulates the iron supporter D, from the cast-iron bell G, and the flange mouths of G and P prevent the collection of water whether in times of rain or of fog.

Fig. 64 represents the top view and the curvature that fits to the post. The nail or screw holes are also shown.

This insulator has proved to be the most perfect as to insulation and permanency used on the continental telegraph lines.

It cannot be broken from the post, and it is capable of sustaining a far greater weight than the wire which it suspends. It is used on the Russian lines, and comports fully with the otherwise substantial structure of those northern telegraphs.

THE HINDOSTAN INSULATOR.

On the Hindostan lines, Dr. O'Shaughnessy, Surgeon of the Royal Bengal army, adopted a novel process of insulation, peculiarly applicable to the lines of that country.

The post is tapered so as to be two and a half inches in diameter at the small end, and three inches in diameter at seven inches from the top. The wood is to be roughened with a chisel so as to hold the cement by which the cap is to be attached.

The cap is of wrought iron, galvanized, eight and a half inches high, ten and a half inches in circumference above, twelve and a half inches in circumference below, its lower edge or rim everted to thirteen and a half inches, closed above, and perforated to permit the passage of a screw bolt four inches long and one half inch in diameter. Two strong metal studs, three fourths of an inch in diameter, and one inch long are riveted on the cap, one at each side of the screw, for the purpose of preventing lateral motion of the bracket to be afterward applied.

The cap being inverted, the cement is thus applied. Three parts, by weight of fine, clean and perfectly dry sand, with one part by weight of the best pine rosin, are melted in an iron pot and well incorporated by stirring. The consistence should be that of thick mud. Enough of this cement to occupy half an inch of the cap should be poured in and allowed to cool, which takes about five minutes.

The post is now inverted, and its small end placed on the hardened cement, so that a clear space of half an inch remains between the wood and the cap all round. Melted cement is now poured in so as to fill this space up to the brim. As the cement cools, it contracts slightly, so as to become concave. The post must be kept perfectly steady while the cement is cooling and setting, which occupies about five minutes. It is now ready to receive the bracket.

The quantity of cement used for each cap is one pound fourteen ounces.

Fig. 65.

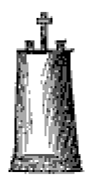
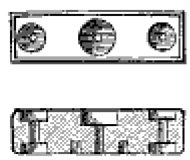


Fig. 66.



The bracket (fig. 66) is of oak, eleven inches long, four broad and three deep, perforated in the centre for the passage of the cap screw, also perforated at one and a half inches from the end for the passage of the binding screws for the attachment of the iron rods, and having on its lower surface two cavities, one inch deep, three fourths inch wide, to r ceive the studs of the cap. On the upper surface a circular hollow is sunk at each end, one half inch deep and one and one half inch in diameter, to receive the necks of the porcelain insulators, subsequently described.

The bracket is now placed on the cap so that the studs sink into the holes to receive them, and the nut is firmly screwed down so as to countersink in the substance of the bracket.

The post is now ready to be mounted in the screw pile; but it is more convenient to describe in this place the application of the insulators to be used on the final completion of the double line.

Fig. 67

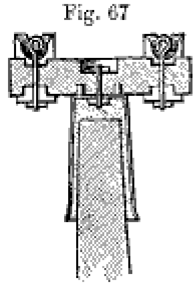
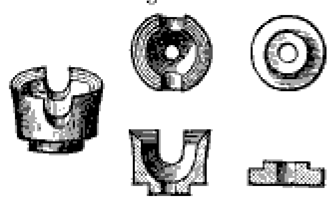


Fig. 68.



The insulators, (fig. 68) are of brown stoneware, glazed, and consist of two pieces. The larger, of the form shown in section in the cut, is three inches high, including the neck; two and one half inches in diameter above; the neck one and one half inches diameter, perforated vertically to allow the passage of a half-inch screw, traversed by a groove three fourths of an inch wide and one inch deep, to receive the telegraph rod, and hollowed out internally, so that after it is in its place, and its binding screw secured, the cavity may be filled with the melted cement previously described.

The insulators are placed in the brackets as shown, and their binding screws put in loose, ready to be used when the line rods are set in their position.

The line binding screws are five inches long, of one half inch iron, galvanized. They clasp the lines securely in their place.

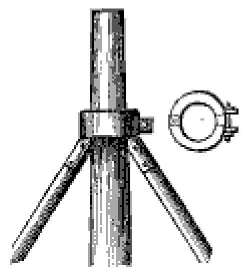
These insulators are not, however, to be used on the line in the second stage. This, it is to be remembered, affects only the erection of a single line, for which the metal cap insulator is sufficient; but in this case the bracket requires to be surmounted by a piece of wood two inches thick, fastened by screws, and grooved on its surface. Into this groove, precisely over the centre of the post, the line rod is placed. It requires no binding screw in this stage of the operations, but a second piece of wood should be cleated down on the first after the rod has been placed.

TIGHTENING THE WIRES IN ASIA.

As a part of the insulating appliance, I will here explain the manner of tightening wires on the Asiatic, European, and African telegraphs. That of the latter, however, is the same as adopted in France.

On the Hindostan lines the following is the process adopted for tightening the wires:

Fig. 69.



Whenever a strong tree is available, it can be made use of in the straining operation. if it be necessary to strain on one of the line-posts, four strong props should previously be applied, to prevent its being drawn out of the ground. The post is on no account to be notched for the props, but a cast-iron clamp is to be screwed round the post, against which the props may lean. A post, the collar, and two of the props, are shown in the accompanying cut, fig. 69.

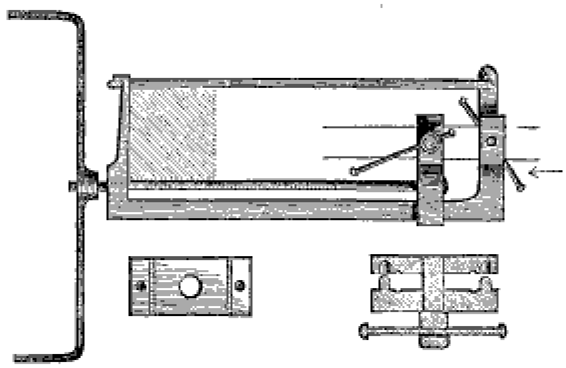
The operation of straining is very greatly facilitated by the use of temporary intermediate props. As the flying line will afford a large supply of bamboos or other light timber, these may be used crossed, like "shears," or the supports of lines for drying linen. The greater the number of these employed, the easier is the straining, and the less is this liable to injure or dislocate the permanent posts.

When required, it is best performed by the erection of a temporary but very substantial straining post of saul or teak timber, seven or eight inches square. One of these, placed on a truck with four wheels, should accompany each party. The beam is twenty-two to twenty-four feet high, shod by a screw pile six feet long, and has two grooves at top four inches deep, to receive loosely two double-eye bolts, each twelve inches long, of half-inch galvanized iron. The post is erected under the lines at a place convenient for the erection of the scaffolding, and at the lowest part of the line to be braced up. The post is screwed six feet in the ground, and its top rises *between* the two line rods, which are then firmly clamped to the post by two powerful screws, which pass through it from side to side. The screw clamps are four inches apart, and a wedge of iron is driven in between to aid in preventing the slipping of the rod.

A platform or scaffold of loose poles and boards is now erected about the post to support the workmen and the straining apparatus. The post rises *above* and *between* the rods *to the height which the line is to be when braced tight up.*

A straining screw and vice, shown in detail in the cut, fig. 70, are now secured on the post below the eye-bolts by the iron arm, and both line rods are seized in the jaws of the double vice, which is then screwed up by the winch, thus bracing the wires two feet. The jaws of the stationary vice, through which, previously loosened, the rods have moved freely, are now tightly screwed together, so as to retain the rods while the main screw and moveable vice are loosened and returned for another journey.

Fig. 70.



The portions of the rods between the moveable arm and the post are now in loose loops between the post clamps and the stationary vice. By relaxing one of the post side-screws, the loop may be brought up so that it can be cut in the centre between the side-screws, and each end be passed through the eye-bolt resting on the groove at the top of the post.

A second journey of the bracing screw should now be made, the portion of the rod gained secured, and the apparatus turned in the opposite direction to strain on the other side. This alternate straining should be carried on till the line is braced, so that the lowest part subject to the strain shall be sixteen feet clear above the ground.

Temporary props being now placed under the lines near the straining post, *this is removed*. The ends of the rods are turned into hooks on the eye-bolts, and an ingot of zinc is carefully cast over each hook, in the manner already pointed out.

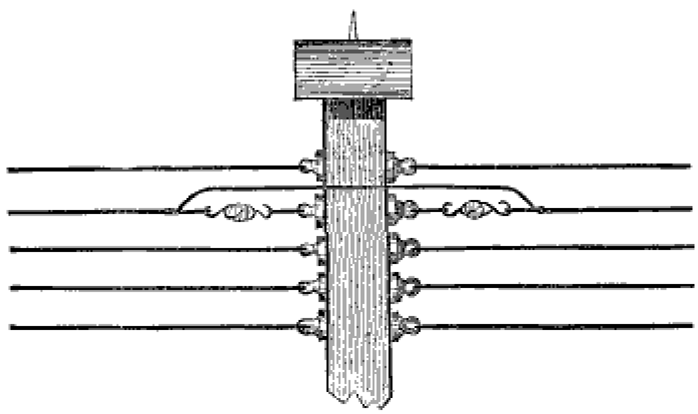
The temporary props and scaffolding are now to be taken away. This straining operation is to be performed as sparingly as possible. Moderate curves on the line are not objectionable. All that straining is required for is to elevate the lowest part above sixteen feet from the ground. The application of the straining apparatus once in a mile will be amply sufficient.

During the straining, men should look carefully along the posts, half a mile at least at each side, to prevent any locking of the rods on the insulators, or distortion of the brackets and caps. When the bracing is complete, the screw bolts on the insulating caps should be screwed tightly up, and melted cement poured into the cavity; finally, a layer of cement one inch thick should be poured all over the top of the bracket.

TIGHTENING WIRES IN ENGLAND.

On the English telegraph lines the wires are tightened at winding posts placed at convenient distances, usually about a half mile apart. An iron bolt passes through the post, but clear of the wood, having at each end a winder, as shown in the figure, consisting of a grooved drum with a wheel and ratchet attached. The winder heads are kept away from the posts by earthen collars, through which the bolt passes. The winder and bolt being of galvanized iron, constitute a continuation of the metal circuit, and the current passes on through them, as shown in the upper wire. But as the joints of the winder may corrode or form *bad contacts*, and as dust may

Fig. 71.



accumulate round the collars and form a receptacle for water, it has been found better to use the winder merely *as* a winder; to insulate it altogether from the wire; and to provide a side path to take the current onward from one side of the post to the other. This plan is shown in the second wire. The pulley-like appendage, or, as it is called, the *shackle*, consists of an earthen ring furnished with two hooks; the connections of one of which pass *round* the ring, and those of the otner *through* its centre, so that the hooks are effectually insulated from each other, and no current can pass from one to the other. The wire is cut, and the shackles are inserted one on each side of the post, so that the post is now doubly cut out of the circuit. A thin wire is then soldered over from the outside of each shackle, and along this wire the current can pass. The posts are placed at every quarter of a mile. Half the number of wires are wound at each post, and the other half pass on to the next, being sustained on this post as they pass by an arm at the back. Each wire, therefore, is wound in half mile lengths. The lengths are made up of pieces of wire looped and bolted together, with a short wire soldered over the joint. Similar apparatus is used at bridges and tunnels; but is supported by the masonry instead of by standard poles. The points, visible above, are connected with the earth by a wire to protect the poles from lightning.

TIGHTENING THE WIRES IN FRANCE.

The winding apparatus used on the French lines is represented by figs. 72 and 73. The latter is a porcelain or earthenware support fastened to the post. The section to the left is a front view showing the screw heads and the cross-bar run

Fig. 72.

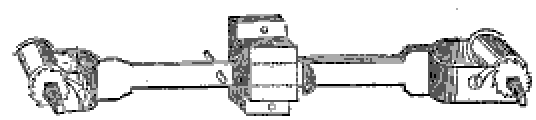
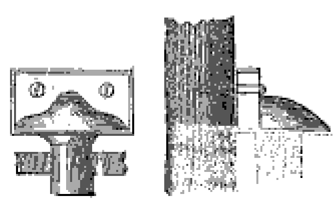


Fig. 73.



through it. The section to the right is a side view and, the lower part shows the oblong opening for the cross-bar seen extending through the section on the left. The lower part of the section to the right is imperfect. Fig. 72 represents the metallic binding apparatus. At each end is a revolving drum, with a ratchet attachment. The section to the right has two iron arms or bars; the one to the left has but one. The two sections are made in separate pieces, and are united by fitting the arm of the section to the left between the two arms of the section to the right. They are held fast by cross-pins, keys, or screw-bolts. These arms are fitted through the oblong hole seen in the sections of fig. 73. The line wire is attached to the respective drums at the ends of fig. 72. A crank is applied to the projecting heads of the drums, and the wire is then wound around them, and the ratchet catch holds the drum, preventing it from turning back. The voltaic current is conducted from wire to wire through the iron work of the figure.

In order, however, to make the circuit more reliable, sometimes a wire is run from one side to the other, as seen in fig. 71. There are other contrivances used in Europe for the tightening of wires, but sufficient has already been given to explain the mode, the objects and purposes of this process in telegraphing.

On the German lines, a similar contrivance has been used for the tightening of the wires. The mechanisms for tightening the wires have generally been disconnected from the line, only applied for the special purpose at the special time.