CHAPTER III.

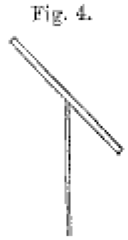
Description of the Chappé Telegraph—Organization of the Signal Alphabet—Process of Manipulation—Its Celerity in Sending Dispatches.

DESCRIPTION OF THE CHAPPE SEMAPHORE TELEGRAPH.

I WILL now proceed to describe the Chappé sempahore telegraph according to the modern mode of operating it. The description is from the best authorities, and I presume it will be sufficiently clear, to enable any one to understand the system in its most complete sense.

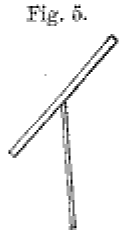
The Chappé telegraph is composed of three pieces: one is large and called a regulator, and two small ones, which are called indicators. The regulator A B, fig. 1, is a long rectangular piece, 13 inches wide and 14 feet long, and from 1½ to 2 inches thick. At its centre, and in the direction of its centre, it is traversed by an axis, which traverses also a mast or vertical post D D at its upper extremity. The regulator, thus situated and elevated little over 14 feet above the roof T T, can turn freely on its axis, and describe a circle of which the plane is vertical. It can therefore give as many signals as it can represent distinguishable diameters of a circle; but to avoid all confusion Chappé wisely reduced its telegraphic positions to four, and it can never take any other but the four, namely, the vertical, horizontal, right oblique, and left oblique; the oblique forming an angle of 45 degrees. It would be impossible to find four positions better defined and more distinct. They are represented in figs. 2, 3, 4 and 5.

Fig. 4.



The two indicators A C and B C, fig. 1, are also two rectangular pieces, six feet long, one foot wide, and of a thickness a little less than that of the regulator. They are attached to the two ends of the regulator as the figure represents.. Each indicator has at its extremity A and B an axis which traverses the regulator at the same point. The extremity C C is free and moveable, each indicator can therefore describe a circle, of which the plane is parallel to the plane of the circle, which the regulator may describe; thus, in this manner, all the signals are made in the same way, vertical and perpendicular to the line of vision.

Fig. 5.



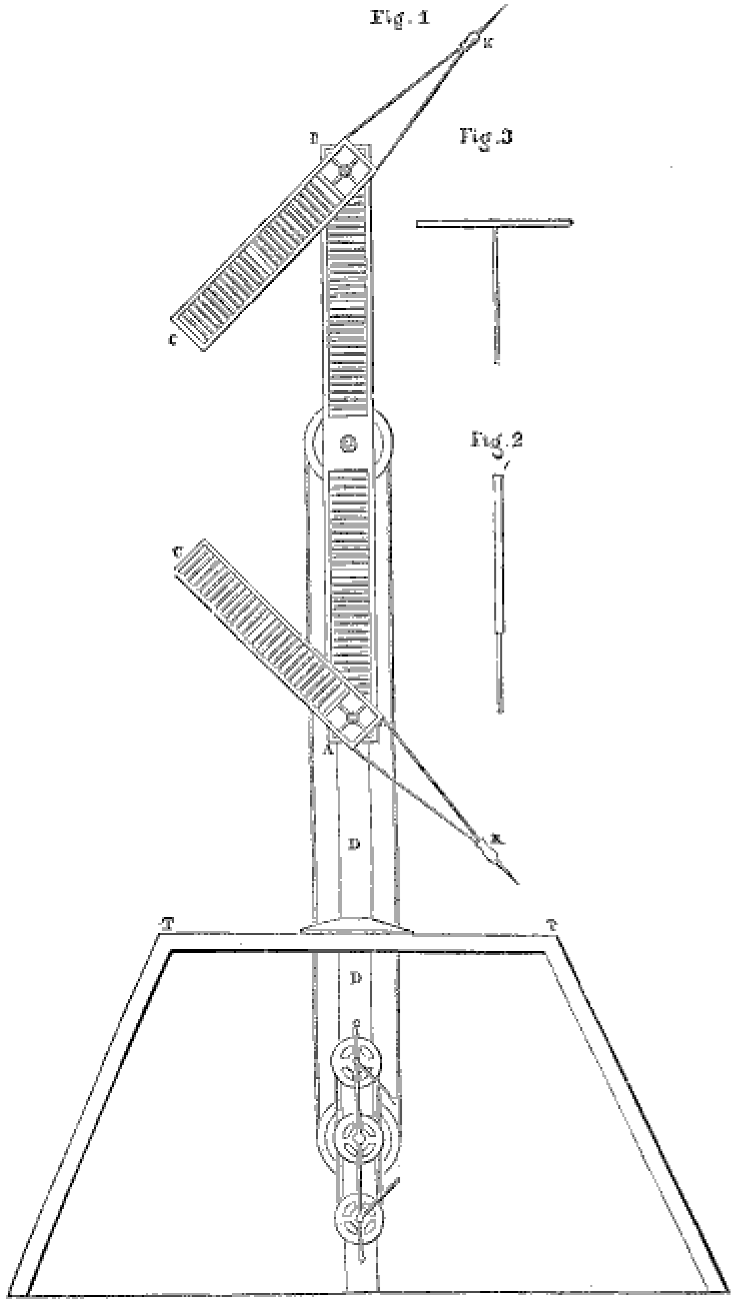


Fig. 1
Fig. 3
Fig. 2
B
C
C
A
K
K
D
D
T
T

The regulator having its axis of rotation at its centre of form and gravity, remains indifferently in whatever position it is put; but the indicator, revolving on an axis placed at one of the ends, are free, and are disposed to fall toward the earth. To counteract this tendency, the visible branches of the indicators B C and A C are counterbalanced by a weight placed on a branch invisible at distance A K and B K. This branch at first formed of two rods of iron ⅜ of an inch in diameter, fixed at the extremities B and A of the indicators, was soon changed into a single rod, by forming with the two an acute angle.

Toward its extremity the branch has a counterpoise K of lead, which keeps the indicator in equilibrium in all its various positions around its axis. It is understood that the two indicators should be of the same weight, and that their axis should be at equal distances from the axis of the regulator.

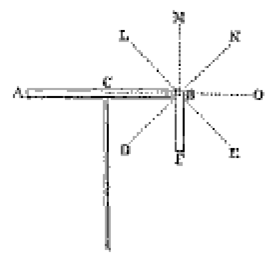
The distance from the centre of rotation of the regulator to the centre of rotation of the indicators is 6½ feet, that from the centre of rotation of the indicators to their movable extremities is 5½ feet; when, therefore, the two indicators are turned inwardly, their moveable ends are two feet apart. The regulators and the indicators are made like a window shutter with alternate slot or bar, and aperture, one half of the bars setting to the right and the other half to the left, to divide the force of the wind, and to produce light and shade.

The assemblage of these three pieces forms a complete whole, elevated in space, and sustained by a single point of support, namely, the rotating axis of the regulator, which axis turns with a hug sufficiently tight to stand at any given point, at the upper extremity of the post through which the said axis traverses horizontally. The mast, or post sustaining the telegraph, ought to be very solid and strong. It may be double, but whether single or double, the surface which is presented to the eye ought always to be much less than the width of the regulator and indicator, to avoid confusion. The line presented by this elongated surface is nevertheless useful as the datum line, since it always indicates the direction of the vertical line. This post is furnished with iron pins on each side to serve as a ladder by which to ascend.

ORGANIZATION OF THE CHAPPE SIGNAL ALPHABET.

The regulator should only occupy four positions: the *vertical*, fig. 2; the *horizontal*, fig. 3; the *right oblique*, fig. 4; and the *left oblique*, fig. 5; each separated from the other by an angle of 45 degrees.

Fig. 6.



Let us now suppose the regulator placed in a horizontal position, and having a single indicator B F, describe a circle around its axis B, and by stopping it at every 45 degrees we thus give to it 8 different positions in regard to the regulator B A. Of these 8 positions, 6 are angular B L, B M, B N, B F, B E, and B D. Two are parallel B C and B O. This last position has been abandoned, because as it is merely a prolongation of the regulator, it is not seen distinctly.

The 7 relative positions of the indicator and of the regulator thus give 7 distinct indexes, all combining to form the desired signals. For whatever be the position of the regulator, the indicator is always placed in a horizontal, or vertical, or right oblique, or left oblique position, respectively. Of these seven signals, one, C B, confounds itself with the regulator, and is called zero. Two, B L and B D, form with the regulator an angle of 90 degrees, and two, B N and B F, an angle of 135 degrees. It is necessary, therefore, to find simple means of distinguishing them. In the method adopted for the formation of signals, the indicator in the positions B L, B M, and B N, has always its free extremity turned toward the sky, and its other extremity toward the earth, in the positions B F, B E, and B D. In designating angles, the words sky and earth will be used to avoid prolixity. On the other hand, it would be tedious to say 45 degrees sky, 90 degrees sky, 135 degrees sky or earth. These different terms have been adopted to economize in the language. The terms used are zero, 5 sky, 10 sky, 15 sky, 15 earth, 10 earth, 5 earth, and they are written as indicated in fig. 7.

Fig. 7

" 8

" 9

The regulator being fixed in any of the four positions which it can take, a single indicator produces with it 7 distinct and separate signals. It is evident that the indicator placed at the left of it, will produce the same number, and these are called the same, except they are described as at the left of the indicator as seen in fig. 8.

Now, if we consider the signals which may result from the combination of the seven signals of one indicator with the seven signals of the other indicator, we shall see that if one of the indicators is placed at zero, and the other is passed through its seven positions, we shall obtain, in the first place, the double horizontal, or rather the *horizontal closed line*, then, zero 5 sky, zero 10 sky, zero 15 sky, zero 15 earth, zero 10 earth, and zero 5 earth, as seen in fig. 8.

Elevating and keeping at "5 sky" one of the indicators, we shall have 5 sky zero, two 5 sky, 5 and 10 sky, 5 and 15 sky, 5 sky and 15 earth, 5 sky and 10 earth, 5 sky and 15 earth, which makes 7 other signals, as seen in fig. 9.

Elevating and keeping at "10 sky" one of the indicators, we will obtain seven more signals, and so on, until the seven signals of one indicator have been combined with each of the seven signals of the other, giving in all 49 signals, without changing the position of the regulator; but the regulator takes four different positions, giving four different values to the 49 signals, and raising the whole number of possible signals to 196, furnished by the Chappé semaphore telegraph. These signals are clear, simple, and easy to name and to write. It is impossible to commit an error, on a clear day, in seeing, designaing, or writing them. One grave difficulty, however, presented itself in communicating, that is, how to designate to the neighboring station that the signals formed were correct, and how to indicate the time to repeat them.

The brothers Chappé decided that no signals should be formed, with the regulator in a horizontal or perpendicular position; that all signals should be formed on the *right oblique* or *left oblique*. They also decided that no signal should have value until the regulator should be returned to a vertical or horizontal position.

In this way the operator who sees a signal formed on the right or left oblique, notices, and prepares himself to repeat it back to the station; but he does not record it. As soon as he sees it carried to the horizontal or vertical position, he knows it to be correct, and he immediately writes it down, and then repeats it to the same station. This manœuvre is called "verifying the signal." From that time each signal formed on each oblique takes a double value. Since it may be carried to the horizontal or vertical line, 49 signals, there can be received 98 significations in passing from the right oblique to the horizontal or vertical line; and the same for the left oblique, in all 196 signals. Nevertheless, the signals of the two obliques would not be intelligible if the signals of the right oblique were not different from those of the left oblique; for both being brought to the horizontal or vertical line, they being in all respects similar, would really represent only 98 signals, unless we noticed the direction in which they are moved to a horizontal or vertical position.

As the necessity of the telegraph requires a great portion of the signals for the purposes of regulation and police of the line, the rest of the signals being devoted exclusively to the transmission of dispatches, these two classes of signals, being perfectly distinct, cannot be placed in the same journal of business. The signals formed on one oblique are, therefore, devoted to the administration of the line, and those on the other oblique are devoted to the correspondence. There are thus 98 regulation signals, and 98 dispatch signals, which are all written on horizontal and vertical lines, but written separately in the journal book, marked out for the registration of the respective services. The signals take their names when they are formed on the obliques, as seen in fig. 10, and it is important to remark that the designation of a signal must commence always from the upper extremity of the regulator. The signals are never written as in the table, fig. 10, but always on the horizontal lines, as in fig. 11, or in the vertical line, as in table, fig. 12. The station master writes them as he sees them, but never until he is sure they are correctly understood. It now remains to be explained how the mechanism which produces these signals is operated. To one not familiar with signaling, lthe process may seem surrounded with complications, and tardiness of action. Such, however, is not the case; and a knowledge of the more modern electric needle system of telegraphing would prove the error. But as to the rapidity in transmission, the facts hereafter stated will more fully demonstrate that the Chappé telegraph is not a slow process of communicating intelligence, but that it has subserved well the purposes contemplated by its patriotic and enthusiastic founder.

Fig. 10.

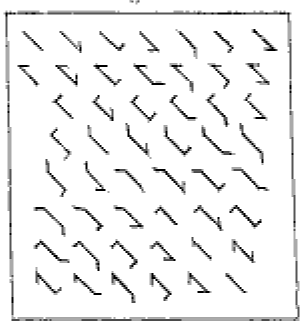


Fig. 11.

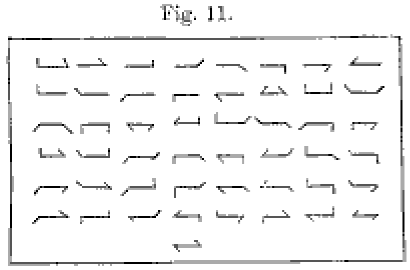
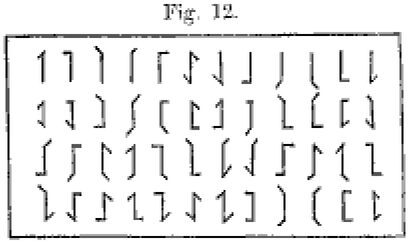
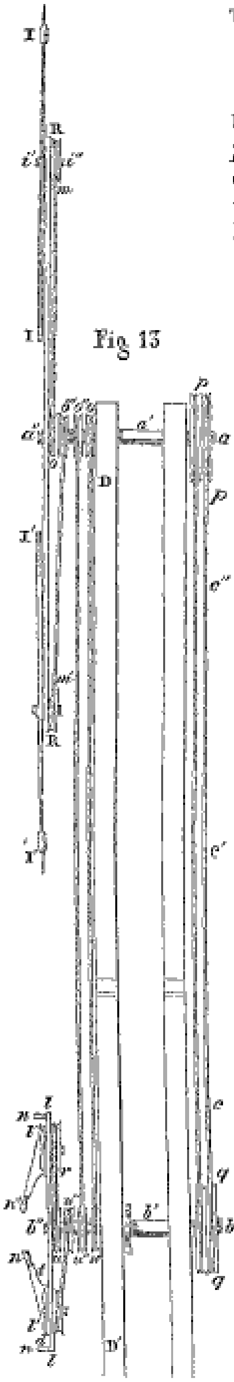


Fig. 12.





THE PROCESS OF MANIPULATING THE CHAPPE TELEGRAPH.

The axis *a a′ a″*, fig 13, which commands the regulator, is turned by a pulley, *p*, fixed at its extremity, *a*, opposite to that of *a″*, which carries the regulator; this pulley, from 16 to 18 inches in diameter, contains two deep grooves, and under this pulley in the interior of the post about three feet from the ground is another similar one, *q*, which also has two grooves. The second pulley, *q*, is also fixed at the extremity *b*, of an axis *b b′ b″*, which traverses horizontally the interior prolongation of the post D D′, figures 1 and 13. In order to receive upon a square *b″*, a double lever *l l*, which serves to place it in rotation, as well as the pulley fixed at its other extremity. This lever, or double right-hand crank, is about three-and-a-half feet long, and is terminated by two wooden handles situated at right angles from each other, *m m*. Let us suppose now that the lever which represents a diameter, and describes a circle, the plane of which parallel is to that of the circle described by the regulator; let us suppose, I say, that this lever is fixed, in the first place, parallel with the regulator, and at the moment we transmit to the pulley *p* the rotatory movement, which it will give to the pulley *q* by means of two tightly-strained bright wire cords, of which one passes to the right of the two pulleys in one of their two grooves, and the other to the left in the other groove. Suppose now that the free extremities of these two cords are fastened at the bottom of their respective grooves, after having surrounded the upper and lower pulleys by at least half the circumferences, it is evident that the movement described by the lever *l l* will be transmitted by the axis *b b′ b″* to the pulley *q*, which will transmit it exactly by means of the two cords *c c′ c″* to the pulley *p*; and that this latter will transmit by the axis $a\ a'\ a''$ to the regulator R R, and to all the parts which it carries, and that the regulator will also follow the movement of the lever $l\ l$, and remain perfectly parallel with it. It is also evident that the lever and the regulator may describe at least a circle, because the cords are wound upon each pulley for each half of a circumference at each extremity. As a substitute for the cords, and to give them easily the proper tension which the movement causes them to lose, the middle portion of them, which is never required to pass over the pulley, are iron rods with screws, by which they may be lengthened or shortened at pleasure. These rods are terminated above and below by hooks which hold the cords by a single ring in the end of the cord. The extremity of the cords which answer to the pulleys, traverses the bottom of the groove, through a hole made for that purpose, and is attached to a spoke of the pulley which is shortened or lengthened by means of a screw. By this very simple system a station-master may change very rapidly the cords or the rods, and lengthen or shorten them at pleasure. The rods or cords pass through the roof of the house, through holes, in such a way as to avoid friction as much as possible.

To communicate movement to the indicators, the mechanism is the same as above described, only a little more complicated or extended, because there must be two return cords, one from the extremities, the lever $l\ l$ at its axis b'' and the other from the axis of the regulator a'' to its extremities R R. In the second place the rotary movement must be transmitted to two different and independent circles. Let us consider in the first place, the transmission of the movement to a single indicator.

The indicator is governed by an axis $i'\ i''$, which also governs the pulley with two grooves m; this pulley is fastened to the pulley o' by two metallic cords, which renders all their movements dependent and identical; the pulley o' forms a single piece with the pulley o; these two pulleys are united by a hollow axis traversed by the axis of the regulator $a\ a'\ a''$, around which it turns freely. The pulley o, and consequently the pulley o' receives all its movements from the pulley u', which receives them from the pulley u, to which it is connected by a hollow axis, which turns upon the axis $b\ b'\ b''$ of the lever; the pulley u receives its movement from the pulley r; this last pulley is controlled by an axis which traverses the lever $l\ l$, in which it turns; the extremity l'' of this axis is fixed to one lever forming the ray $l''\ u''$; this lever, or handle or hand, in describing a circle, causes the pulley r to describe a circle in the same direction, which causes the same result to the pulley u, which in its rotation draws the pulley u', and this rotation is transmitted to the pulley o, which communicates it to the pulley o', and this latter causes the pulley m to turn, which causes the regulator I I to describe a complete circle in the same direction as the hand $l'' n''$ has done. By causing this hand to describe a circle, in an oppesite direction, it is easily seen that the indicator will do the same thing. Let us now follow the transmission of the movement to the second indicator.

By causing the hand $l' n'$ to turn, the pulley r' is made to turn, which causes the pulley u''' to turn. This pulley forms a single piece with its neighboring pulley u'', and both turn by means of one common hollow axis; around the common hollow axis of the two pulleys u u', the pulley u'', transmits the movement to the pulley o'', united by a hollow axis to its neighbor o'''. This hollow axis turns, also, around the hollow axis common to the pulleys o' and o. The pulley o''' puts in rotation the pulley m', which makes the indicator i' i' describes identically the same movement which the hand $l' n'$ had made.

If we observe, now, that the large lever l l makes the regulator describe movements similar to its own, and that it draws by these movements the rays $l' n' l'' n''$, without changing the relations established between them and itself, and that the indicators cannot change their relative positions with the regulators, but by change of relation with the said rays of the grand lever, without changing the relation of the said rays to the grand lever, we shall easily understand.

1st. That the rays $l' n' l'' n''$, making any angle with the diameter l l, the indicators I I I' I' will make precisely the same angles with the regulator R R.

2d. Whatever be the horizontal, vertical, right oblique, or left oblique, in which we put the lever l l, the regulator will take the same position; and, as this same movement affects no change in the value of the angles formed by $l' n' l'' n''$ with l l, the indicators will also remain invariably in their angles with the regulator.

Thus the interior mechanism gives a constant and exact image of the exterior mechanism, and the signals are always reproduced with precision before the eyes of the operator.

In order that the angles of the indicators and of the regulators should be invariably fixed, the hands $l' n' l'' n''$ are furnished with a spring and a tooth. This spring is designed to make the tooth t enter into the notches of the steel dividing circle d. These divisions are seven in number, of 45 degrees each. The axis of the large lever also carries a divisor of 8 notches; but while the divisors of the two hands are fixed in relation to the axis which traverses them, said divisor of the large lever is fixed upon the axis and turns with it. When we wish to hold the regulator on account of high wind, or for other cause, we place a kind of bolt fixed in the post to enter one of these notches, and this bolt stops all movements of the regulator.

As the indicator ought always to remain motionless, when the regulator is moved after a signal is made, the spring above mentioned always holds the tooth of the hand fixed in the notch of the divisor when said hand has been placed in such a way that the operator is obliged, when he wishes to change the position of an indicator, to draw the hand toward himself in order to disengage the tooth, and to let go of the hand when the tooth has arrived opposite the new notch in which the tooth is to be fixed. From these facts it will be seen that the mechanism of the Chappé telegraph is a model of simplicity and precision. It fulfills the conditions of rapidity, clearness, and variety in execution.

Let us suppose that the telegraph is at rest in the position represented in fig. 13, which position is called the *vertical closed*, and that the operator enters his office in the morning; he commences by applying his eye alternately to first one, and then the other of his neighboring telegraph stations, to see if either of them are giving a signal, and, in the meantime, he arranges on his desk, pen, ink, and record-book.

As soon as he sees one of the two stations move, he draws the bolt which holds the large axis at rest, and puts one hand upon the upper handle of the great crank, and then looks at the signal which has been formed.

If the regulator is to be carried to the right oblique, or left oblique, which is indispensable, he pushes the upper extremity of the handle to the right or left, aiding the movement at the same time by pushing the lower extremity with his leg, at the same time he puts his other hand upon the small lower crank $l' n'$ in order to commence moving the indicator; the regulator being once set in motion, he lets go the upper handle in order to take hold of the handle $l'' n''$, and move the second indicator, thus the signal being formed, he stops it on the oblique which belongs to it. He thus looks through his telescope to the station whence the signal came, to see if said signal has been carried to the horizontal or to the vertical. If it has been carried, he knows it to be correct, and accordingly records it as he sees it horizontal or vertical in the square of signals of correspondence; if it has been formed on the other oblique, he records the hour and minute at which the labor commences; and lastly, he makes his own signal, and watches to see if the station to which he communicates the dispatch repeats and carries it correctly. If he is sure that the signal has been well understood and properly reproduced, he turns to the first telescope, repeats the signal which he sees on the oblique, waits till it is carried to the horizontal or vertical, in order to record it, repeats it in his turn, watches if it is correctly taken by the other station, and the operation thus continues indefinitely.

CELERITY OF DISPATCHING BY THE CHAPPE TELEGRAPH.

The greatest speed which can be attained in the passage of signals without producing confusion, is three signals a minute, whence it follows that 20 seconds is necessary to execute all the steps of a signal, to record it, and to verify it. All the signals, however, do not require this period of time, as there are half signals. These half signals are four in number—the double zero or vertical closed, the closed or double horizontal zero, the right oblique closed and left oblique closed. These are all made in their place, and it is only necessary to fold in the two indicators. These demi-signals are very useful, because they serve to distinguish groups of signals; and, because, being frequently necessary, they waste less time than a signal execution, of which requires several steps and movements. The movements of the regulator are so easy, when the machine is in good order, and there is no wind, that generally the operator can, by using the two hands to develop the indicators, at the same time bring the regulator to the position which it is to occupy.

The complete operation of a signal is as follows: 1st. Observe the signal which is formed on the oblique. 2d. Form it. 3d. Observe if it is carried to the horizontal or to the vertical. 4th. Carry it in a corresponding manner. 5th. Record it. 6th. See if the next station reproduces it exactly. These six steps ought to be equal in duration of time; if it were otherwise a signal would be badly observed by the two stations corresponding. We also remedy inequalities of strength and of agility, in the operators, by directing that there must never be a change of a signal carried, before the station to which it is communicated has also carried it.

Suppose a passage of 3 signals a minute, the different steps ought to be thus divided: for observing, 4 seconds; forming on the oblique, 4 seconds; observing the carrying, and carrying, 4 seconds; recording, 4 seconds; and verifying with the next station, 4 seconds: total, 20 seconds.

This rapidity of three signals a minute is far from being constant. It can only be depended upon when the weather is fine, when the operators are well disposed, experienced, and faithful.

Chappé said, that when the weather was fine, and the fogs and haziness of the atmosphere are not a hindrance to vision, the first signal of a communication ought not to occupy more than 10 or 12 minutes in passing from Toulon to Paris, cities situated 215 leagues or 475 miles apart, and connected by a telegraph line of 120 stations; but Chappé added, that if we suppose a continuous correspondence between Paris and Toulon, there would ordinarily arrive at Toulon but one signal a minute.

To recapitulate, the Chappé telegraph gives 98 primitive signals for the correspondence, and 98 primitive regulating and indicating signals. These two classes of signals, although alike, must not be confounded, because they are formed one on the left oblique, and the other on the right oblique; and because they are recorded one in the regulation column, and the other in the column of correspondence. This record I have arranged in the following form, viz.:

No. of Signals.	Regulations and Office Signals.		Signals of Correspondence.	
	Right Oblique.	Left Oblique.	Right Oblique.	Left Oblique.
	How Carried.	*How Carried.*	*How Carried.*	*How Carried.*

These signals may succeed each other with the rapidity of 3 per minute. They form figures easy to observe, easy to record, and without an effort of the mind; the machine is solid, light, and elegant. A man of moderate intelligence is entirely competent to manage the correspondence.

To show the immense superiority of the Chappé telegraph over all other aerial telegraphs which have been devised or temporarily established, either before or since his time, it would be sufficient to describe them and notice their resources; and we shall see that none of them, if we except the Swedish telegraph invented by Edelcrantz, can be said to have subserved the purposes of science or telegraphic art. In France, where the most perfect model has been before their eyes, all efforts made previous to the time of Chappé were but rude approaches to the Chappé system, and but one of those efforts still in existence. The system of Chappé produced, as a first and inevitable result, a diminution of just one third in rapidity of the signals. By analyzing its movements it is easy to anticipate such a result; but it is more easy to be convinced of it by taking such a position as to have a view of the towers of St. Sulpice. Upon one of these towers is the Chappé telegraph, and upon the other, the telegraph devised by Mr. Flocon, the third administrator of the telegraph. By watching these two telegraphs for an hour, and counting exactly the number of the signals, it will be seen that the Chappé telegraph gives exactly three signals, while the other gives two. A second objection to Mr. Flocon's telegraph is, that it requires a greater degree of intelligence to operate it; consequently it is more liable to fault in transmitting correspondence and in recording them. The regulator is placed upon a vertical mast or post, and the indicators are attached to the extremities of a fixed horizontal bar; all the signals are therefore given horizontally. We must observe the regulator separately, in order to know if we understand whether the signals belong to the right oblique or to the left oblique, and we must record them vertically or horizontally. If they are to be recorded vertically, we must then make an abstract of what we have seen, and after arranging the figure in the head, then make a draft of it. The telegraph, modified by Mr. Flocon, nevertheless offers one advantage, that of being less difficult to operate when the wind is light; but, it is said that it is not by means of new machines, or retrenchments, or additions to them, as perfected by Chappé, that the aerial telegraphing can be improved. The true and only way of progress in semaphore telegraphing is to find the means of multiplying the number of primitive signals; to combine these signals in such a way as to express, with the least motion and in the shortest time possible, the greatest quantity of numbers; to represent by these numbers as many ideas as possible, and to double the period of correspondence by continuing it through the night.

The greatest effort and the most active inventive talent have been thwarted in every effort to make an aerial telegraph effective at night, and even Chappé admitted its impracticability after the most arduous labors to consummate the object. Like result has followed the labors of others down to the present time.

"We may at present," says Mr. Jules Guyot, from whom much of this description has been copied, "without changing anything in the exactitude of the signals, and without changing anything in the mechanism that produces them, double their number. We may raise them to 82,944 words; parts of, or the whole of phrases, by two signals expressed by 4, 5 and 6 movements; and we may devise plans to establish the Chappé telegraph by night as it is by day. Thus the resources of the telegraphic art are far from being exhausted, and to accomplish these ends the inventive mind can be directed."