THE FRENCH RAILWAY ELECTRIC TELEGRAPH.

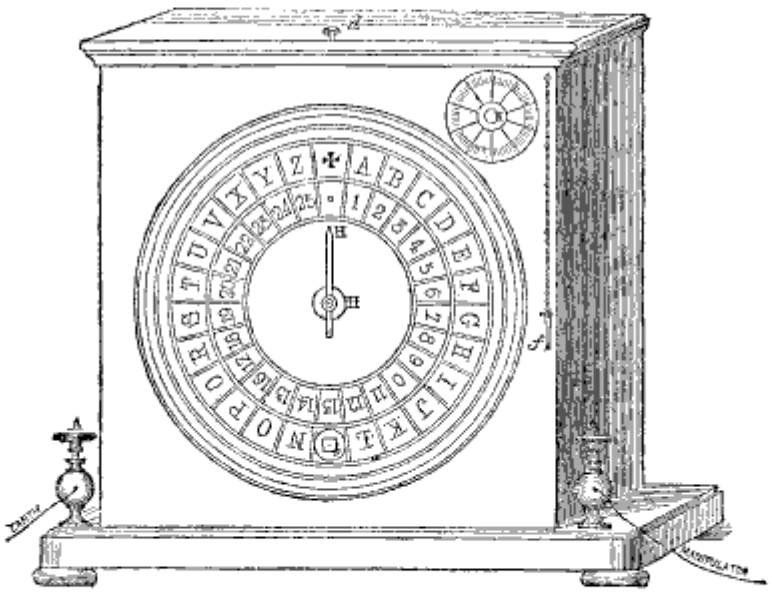
CHAPTER XXV.

Principles of the French Railway Telegraph—Description of the Receiving Instrument—The Manipulating Apparatus—Process of Manipulation between Stations—Portable Apparatus for Railway Service—Bregnet's Improvement.

PRINCIPLES OF THE FRENCH RAILWAY TELEGRAPH.

This apparatus is founded upon the principle of the movement of a clockwork, which turns an exterior needle, fixed to the same axis with an escapement wheel, the rotation of

Fig. 1.



which is stopped by an anchor. A soft iron armature, moveable in front of an electro-magnet, communicates an oscillatory movement to that anchor, which, at every movement, lets a tooth of the wheel pass. The exterior dial bears letters, signs, or figures, and the needle may stop before any one of them. The whole is contained in a case, in which the dial alone is exposed to view. The model of the apparatus illustrated and explained in this chapter, is the same as that used in the telegraphic bureaux of France. The same system, a little modified, I noticed on the Belgian railways. It has proved to be of the greatest utility in the service, and every railway has in perfect organization this system of telegraph, having an office or bureau at every station.

DESCRIPTION OF THE RECEIVING INSTRUMENT.

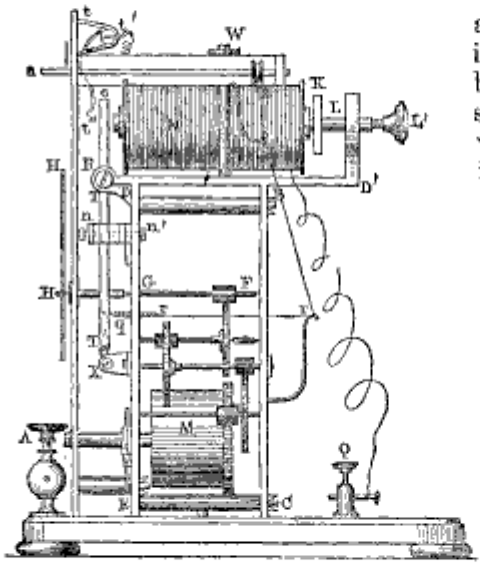
The receiver of this telegraph will be seen in fig. 1; it is inclosed within its cover. The dial has 26 divisions; the upper is a cross, and the other divisions are the alphabet. The first 25 numbers are placed on the interior of the dial-plate. The needle, H H′, is made of mica or steel, nicely balanced, and fixed frictionally on the axis of an escapement wheel. At the upper part, on the right hand, is a little dial, of which the axis *a* acts with the recoil spring of the armature. The two screws or binding posts, A A′, serve to fix the wires by which the current enters and leaves. At the place of the letter M in the alphabet is a square, *b*, by means of which the clock-work is wound up. When the current is not passing, the needle may be advanced, by pressing on the button or thumb-key *d*, situated at the upper part of the case.

In fig. 2 is represented a side view of the vertical projection of the apparatus. Fig. 3 is a horizontal projection, and fig. 4 is a perspective view of the armature, the anchor, and the escapement wheel. In all the figures, the same objects are represented by the same letters. The clock-work movement is comprised between two copper plates, B C and D E. The little barrel, M, contains a large spring, and its axis corresponds to the exterior square represented at *b*, in fig. 1.

The axis of the upper wheel, F G H, bears an index needle, H H′, and the escapement wheel, concealed in fig. 2 by the armature-rod, but visible at L, in fig. 4. The electro magnet N, figs. 2 and 3, is placed above the clock movement, on a copper plate, D D′. It is held by two vertical posts, and a copper strip, W W′. The two soft iron rods of the electro magnet, held together by a third rod, K, are independent of the spools, and can be moved by means of the screw-adjuster L L′. In order

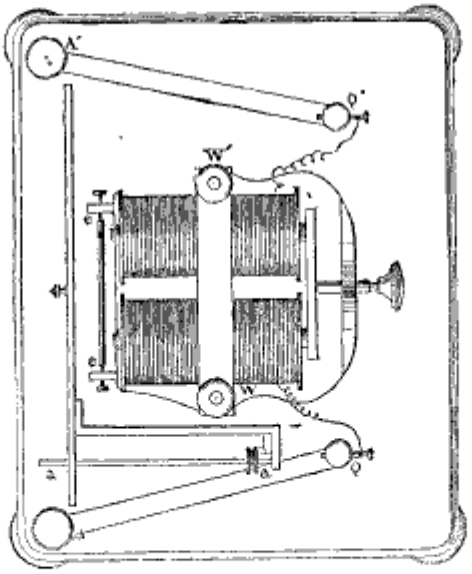
to move forward or draw back the electro magnet, it is sufficient to turn the screw for the purposes respectively. The extremities of the covered wire spools terminate at two screws, or binding-posts, Q Q′, which, by means of two metal strips, communicate with the exterior binding-screws, A A′.

Fig. 2.



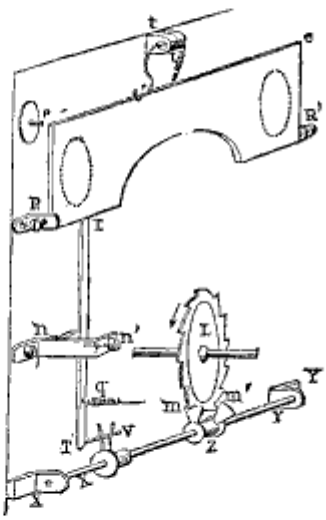
The armature R *e*, placed in front of the electro magnet, is moveable around the two screws, R and R′. The rod T T′, fig. 4, suspended from the middle, carries at its lower part a little horizontal point T V, engaged in a little fork, which is attached to the axis X Y; finally in the middle of this rod, at Z, is formed two little slips, *m* and *m′*, situated in planes differing from each other, and below the escapement wheel L, which has 13 teeth.

Fig. 3.



By means of the clockwork, the escapement wheel is caused to turn in the direction indicated by the arrow, but one of its teeth is stopped by the point *m*. When the current passes, the armature is attracted by the electro-magnet. The rod causes the axis x y to turn a little. The slip *m* withdraws, and permits the tooth to pass, which strikes against the strip *m'*. It rests thus, until the moment when the current ceases to pass, when the armature returns to its first position. The strip *m'*, being withdrawn, permits a tooth of the wheel to pass, and another tooth is stopped by the strip *m*.

Fig. 4.



The exterior needle, fixed to the same axis, turns then with each complete oscillation of the armature through $\frac{1}{72}$ of the dial, and for each half oscillation through $\frac{1}{144}$ of the dial. Thus, when the current traverses the wire of the electro-magnet, the needle advances through one division; if it is over the cross, it comes opposite letter A. When the current is interrupted, the needle advances again, and places itself in front of the letter B, and so on. In order that it may make a complete circuit, 13 emissions of the current are necessary.

The two little screws, *n* and *n'*, being fixed to a copper piece, which unites the plate D E, limits the play of the rod T T'. The recoil spring is a little spiral spring attached at *q* to the rod of the armature; it is terminated by a wire, *r r' a'*, which is coiled upon a little pulley at *a'*, the axis of which is prolonged to the exterior of the box or case as far as to *a'*.

At the upper part of the dial is a little rod *t t'*, which, when pressed down, turns around an axis, and gives motion to the bent strip *t' t''*, and this strip then presses the armature against the electro magnet, and produces an effect similar to the passage of the current. It is by lowering the exterior thumb-button *d*, fig. 1, that this movement is produced.

The apparatus is put in an operating state by means of two little screws, *n* and *n'*, which should be so tightened as to give to the rod of the armature the least possible play, allowing it, nevertheless, sufficient play to permit one of the teeth of the escapement-wheel to pass at each movement. It then remains

to regulate the motion of the needle, according to the intensity of the current. The electro magnet may be advanced or withdrawn, and the recoil-spring may be tightened from the exterior by means of the little key *f*, fig. 1. The apparatus is known to be regulated, when the needle turns regularly under the action of a series of rapid interruptions of the current. Sometimes the strips *m* and *m'*, fig. 4, are a little too far apart, and at a single movement of the armature, several teeth of the escapement wheel pass; in such cases, the two strips must be brought nearer together, or the screws *n* and *n'* must be put farther apart. When the play of the armature is too much, it may happen that the strips *m* and *m'* may both be, at a given moment, on the same side of the escapement wheel; the clock movement being no longer held, the wheels turn with great rapidity, until the spring has exhausted its action. When this part of the apparatus is touched, the little barrel M should be held by the hand, to prevent a rupture of the great spring and of the needle.

THE MANIPULATING APPARATUS.

The manipulator, fig. 5, is formed of a square plate, upon which rests a brass dial, bearing on its circumference, in front, notches, the same as the letters on the receiving apparatus, and disposed in the same order.

A crank, A B, pointed at the centre of the plate, gives motion to a spirally grooved wheel, which is partly shown in fig. 5. The regular sinuosities of this wheel are equal to the number of characters on the dial. The rotation of this wheel produces a to-and-fro movement of the lever I O P, which is moveable around the point O, and of which the extremity P is terminated by a little spring P D, which touches alternately the two screws P, and P', which are fastened to C, the little copper pieces, as shown in fig. 5. Whenever the crank is over an even number, the lever presses on the binding screw P'; when the crank is over an odd number, the lever presses on the binding screw P. During a complete revolution of the crank, the lever touches the binding screw P 13 times and P' 13 times.

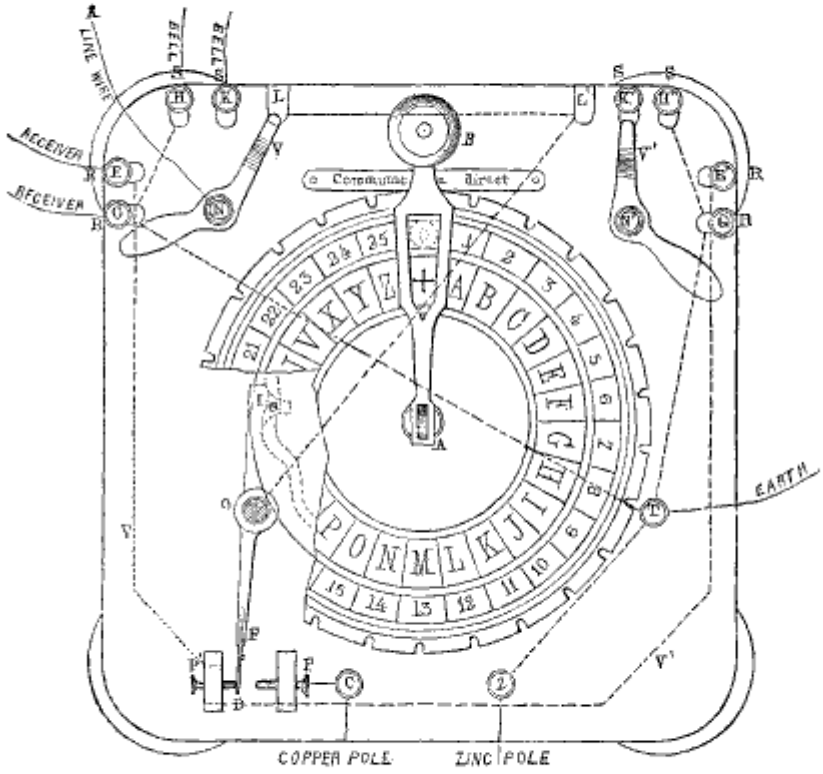
N V and N' V' are two springs moveable around N and N', and can be made to press upon any of the strips, L K R and L' K' R'. Metallic communications are established beneath the plate between the different binding screws, which are seen on the manipulator: P communicates with C; P' with E and E'; Z with T G G' H and H'; L and L' with the axis O of the lever: C is made to communicate with the copper pole of the battery, Z with the zinc pole, and T with the earth. The two wires of the re-

ceiving apparatus are attached at G and E, or at G′ and E′, and the line wire is attached at N and N′.

At H K and H′ K′ are fastened the bell wires. The two commutators N V and N′ V′, enable the operator to employ a single manipulator in two different directions. When it is desired to correspond, the spring N V is placed in contact with L.

In the position of fig. 5, the current coming from the line X, follows the route N L L′ O F P′ V E, traverses the receiving apparatus, and returns to E, when it goes to the earth by the wire G T. In order to transmit, the crank, A B, is turned, and by placing it on the letter A, the spring, O D, comes into contact with the binding screw, P, the current leaves the copper pole of the battery, follows the route C P F O L′ L N, and passes to the corresponding station in the direction of X. It produces an attraction of the armature and the needle of the receiving apparatus, and advances over the letter A. On placing the crank over B, the lever, O B, resumes its position, the current is in-

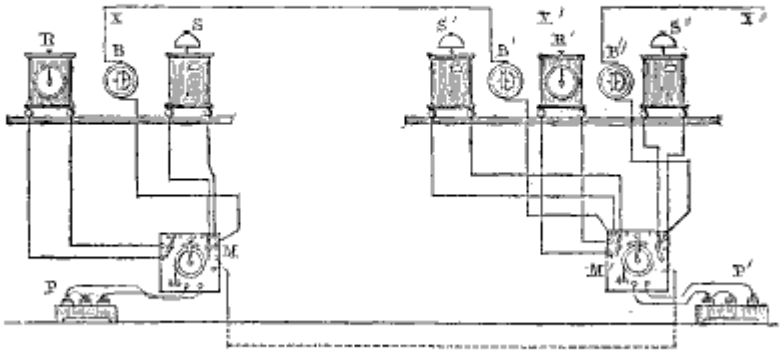
Fig. 5.



terrupted, and the needle at the station in communication advances through a new division and places itself above B. If the needle of the receiving apparatus and the crank of the manipulator are upon the cross, and if the crank be then turned rapidly and stops it at any letter desired, the needle of the receiving apparatus at the extremity of the line, will indicate the same letter.

When, instead of turning the crank according to alphabetical order of the letters, it is turned backward, the indicating needle of the station in communication continues to turn in the same direction, and the letters received do not agree with those sent. To re-establish an agreement between them it is necessary to bring the crank back to the cross on the one hand, and to make the needle advance by means of the thumb button, *d*, until it is over the cross.

Fig. 6.



In a state of rest the spring, N, ought to press upon the contact, K, so that if the current comes over the line it may traverse the bell apparatus, and thence to the earth by the wire H G T. The line is put in direct communication with the earth by placing the spring, N V, upon the contact, H, a precaution taken in stormy weather. If two lines terminate at N and N′, the two neighboring stations are put in direct communication by placing the two commutators N V and N′ V′ upon the strip marked *communication direct* in fig. 5.

PROCESS OF MANIPULATION BETWEEN STATIONS.

A single manipulator and a single receiving apparatus will suffice for corresponding successively with two different stations, provided there are two bell apparatuses, in communication with the buttons H and K, H′ and K′. Fig. 6 shows the position of two stations in communication with each other, X

and x′, of which x is the first station, in communication with x′, the second station, and x′ with the third station x″, P P′ are the batteries; M M′ the manipulators; R R′ the receivers; S S′ S″ the bell apparatuses, to be described hereafter; B B′ B″ are the galvanometers, which are constantly in the circuit and indicate the passage of the current.

In the normal position, the commutators or circuit connectors are placed on the contacts which communicate with the bell apparatus; the needles of the receivers, and the cranks of the manipulators, are upon the cross.

When an operator of a station wishes to send a dispatch, he places the commutator attached to the wire by which he wishes to transmit, upon the contact points L and L′, fig. 5, and sends the current by turning the crank. The operator of the station in communication, having been warned by the movement of his bell, places his commutator in the same way, and indicates, by a turn of the crank, that he is ready to receive. The operator of the other station sends his dispatch, letter by letter, turning the crank regularly, and stopping for a moment upon each letter he wishes to send. If he happens to pass a letter which he ought to have sent, he must be careful not to turn backward, but continue turning until he arrives at the letter by passing the cross. To avoid confusion, he ought to stop at the cross after each word. When the transmission is completed he turns the crank and stops it at the letter z, and then brings it back to the cross. The signal z is called the final.

The operator of the receiving station, if he has understood the dispatch, responds immediately by giving the two letters c o. At both stations the operators then place their commutators back upon the bell apparatus.

It is said that an expert operator can easily send from 60 to 70 letters per minute. If the dispatch contains numbers expressed in figures, indication thereof is given by stopping the crank twice over the cross, indicating that the following signals are to be taken from the figures. When in the course of the transmission, the signals become unintelligible, the receiving operator makes a turn of the crank, to inform the transmitting station of the fact, and he stops a moment to make the needle of his receiver come back to the cross, an operation which takes place at the same time at the sending station. He then passes the two letters R z, meaning "Repeat," which letters are placed immediately succeeding the last word understood. He then comes back to the cross and waits for the continuation of the dispatch, by the sending operator.

The needle of the apparatus sometimes does not turn regu-

larly; the transmission is then imperfect, and the apparatus must be properly adjusted. In such a case, one of the operators requests the other to turn his crank, when he tightens or loosens the recoil-spring, by means of the little key used for that purpose, until the needle moves regularly; this process completes the adjustment. The other operator then corrects his instrument by the same process, the adjusted station sending a current to the other, by the turning of the crank.

In order to transmit to a more distant station, call is made for the "communication direct," which is effected by turning the crank, following it by the name of the station wanted, and the number of minutes desired for the business is also mentioned. The station notified of this wish, answers E O, and immediately places the two commutators or circuit connectors upon the metallic strip, if "*communication direct.*"

The next succeeding station is notified in the same manner, which also makes the connection direct. In the same manner the successive stations are notified.

An operator ought always to answer to the call which is made, immediately. If occupied in another direction he passes the two letters A Z, which means "wait." When he is ready he should notify the other station.

To simplify the transmission, conventional tables of signals have been made combining figures 2 by 2, indicating certain phrases, as 5.17, "the train is starting." Notice is sent beforehand that these signals will be sent.

The manipulator may have several commutators similar to N V and N′ V′ and may serve to communicate in more directions than two, provided there is a special bell apparatus for each line. Nevertheless, it has been found injurious to multiply the commutators, for the reason that they are not readily understood by the employés of the railway, who take part in the telegraphic service as a secondary affair.

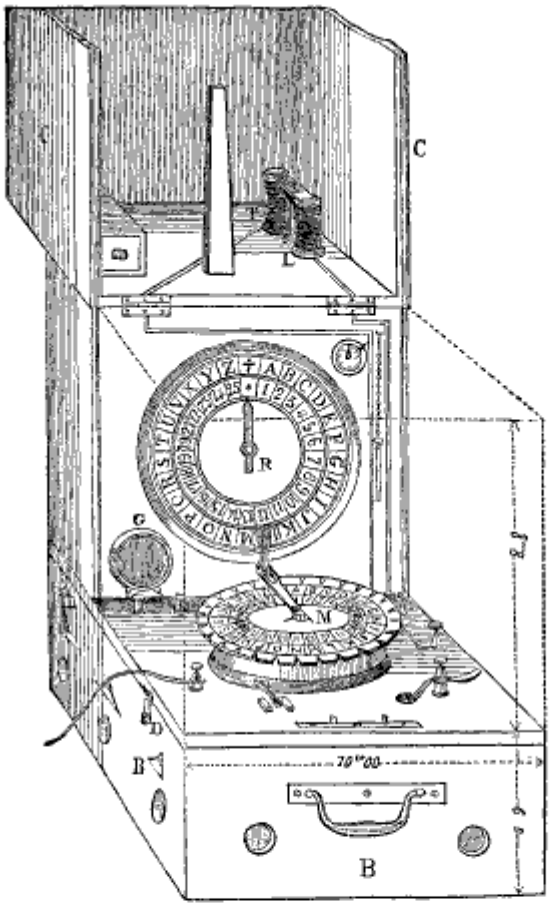
The dial plate apparatus leaves no record, no traces of what has been sent, consequently the reading of the signals requires the closest attention. Its movements are quiet, and the eye must be devoted to the signals and nothing else. The manipulation is so simple, that a person inexperienced in telegraphing may, at once, comprehend the system, at least be able to send dispatches. This apparatus will always be very useful for railways, and also where the telegraph is a mere auxiliary.

PORTABLE APPARATUS FOR THE RAILWAY SERVICE.

Fig. 7, represents the portable apparatus constructed by M. Breguet for the French railway service. It is very small, as

will be seen by the dimensions marked upon the figure. This instrument is designed to be carried in one of the cars of a train, and it is so arranged that it can be readily attached to the line wires. The dial, R, is the same as represented by fig. 1. The dial, M, is the key-board and crank represented by fig. 5. The upper part, c c, is fastened with hinges, and can be let down so as to cover the apparatus M and R, forming a square box, and in size some 8 by 10 inches.

Fig. 7.



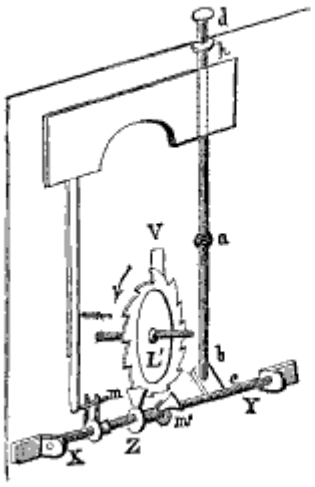
I do not consider it necessary to explain the manner of operating this apparatus, as the same explanations given of the preceding figures apply to this instrument. It is smaller than the

ordinary office apparatus, but in its construction it is the same. In case its use becomes necessary, by a train, the line wire is cut and connected through the instrument, and thus, means of communication is speedily formed with an office to the right or to the left, as the case may be. The arrangement is simple and easy to be operated. The contrivance exhibits much ingenuity, particularly in the simplicity of its manipulation.

BREGUET'S IMPROVEMENT.

In regard to the clockwork indicated by fig. 4, Mr. Breguet has made a very valuable improvement, as will be seen by fig. 8.

Fig. 8.



In the description given of fig. 1, it was stated that by pressing the button *d*, the respective instruments would be brought in unison of action by making some 13 revolutions and stops. Mr. Breguet's plan economizes time, and more speedily accomplishes the end desired.

By pressing lightly on the button *d*, the needle is made to move one single notch, by pressing it strongly it passes instantly to the cross, or zero, of the index plate. The button, placed at the top of the apparatus, instead of moving a little strip pressing on the armature, as in fig. 4, it is placed at the extremity of a long vertical rod, as seen in fig. 8. The spiral spring *h* holds up the axis, x y bears, together with the escapement anchor z, a little horizontal strip *b c*, which presses against the extremity of the rod *d a b*. When the button *d* is pressed upon lightly, the strip *c b*, as they make the axis x y, and the escapement anchor z to turn at each pressure, a tooth of the wheel L escapes, and the indicating needle advances one division. If, on the contrary, the strip *c d* is pressed forcibly, it is lowered, and lets the tooth *m'* pass beyond the escapement-wheel L, the wheel then being entirely disengaged, rapidly turns, bearing with it the needle. The rotation stops promptly, because the axis L bears a point v, which hits against a projection *a* of the rod *d b*.

At the moment when the rod *d b* is raised a little, the pro-

jection *a* disengages the stop v, but the slip *m'* of the escapement anchor engages again with the teeth of the wheel L, and, finally, when the rod rises entirely, the tooth *m'* comes in its turn to stop the movement, and the receiver is in its normal state.

The stop of the wheel L always takes place in the same position as occupied by the needle, and if it corresponds exactly, when the needle is in front of z, it is clear that, by lowering the rod forcibly, and letting it spring back quickly, the needle is brought from any position whatever to the cross. The needle will pass over the z during the very short time that the strip *m'* requires to come back in front of the wheel L'.

Experts are of the opinion that the rod of the armature might be a little modified, so that the little fork and the rod may incline with the anchor. It is terminated by a spring, which does not prevent it from causing the anchor x v to oscillate. It is the action of the spring which brings back the anchor z to its ordinary position, when the rod *d a b* ceases to press upon the strip *c b*.