SELECTIVE OR INDIVIDUAL SIGNALS.

BY THOMAS D. LOCKWOOD.

Among the many subordinate branches of invention in auxiliary appliances which surround and form a suitable setting for that grand central figure, the Electric Speaking Telephone, none represents more painstaking thought, has been more thoroughly ransacked, or has constituted a more attractive pursuit than the study of selective signaling.

The problem it presents is both electrical and mechanical, is sufficiently difficult to create the excitement always attending the pleasures of the chase, and sufficiently promising and hopeful of a practically successful issue to be retentively fascinating. Hence its solution has been attempted alike by prominent and capable electricians, by practiced electro-mechanicians and by amateurs; has, from the laboratory and workshop point of view, already many times been achieved in as many different ways, although commercially it yet hangs like the fabled bundle of hay, just a little in advance of the enthusiastic aspirant who strives to clutch it.

THE USE OR FUNCTION OF SELECTIVE SIGNALS IN TELEPHONY.

The business of the average user of the telephone keeps a line employed but for a very small part of the entire business day, and for the remainder of the time the line wire is idle and earning absolutely nothing. If by any means it could be made possible to place several sub-stations in connection with the same circuit, without materially affecting the efficiency of the service rendered, it is obvious that the earning power of the circuit would be largely increased. But a call-bell or other signal is clearly necessary in order that the attention of the station may

be attracted when some other station desires to communicate, and as we add stations to a circuit we also necessarily add call-bells; thus introducing two practical objections, viz.:

1. A most incessant and annoying ringing, because a call sent to any station is heard at all stations.
2. The necessity of distinctive signals, whereby when the bell at any station is rung the attendant may know whether the call is for his or for some other station.

At this juncture the selective signal steps in, and its special work or function may be thus stated: That two or more stations being electrically connected with the same circuit, the call-bell at any predetermined or desired one of such stations may be operated, and the call given there, to the exclusion of the call-bells at the other stations, which at the same time remain quiescent, or are silent. We therefore see that the thing to be done is not merely to ring a bell over an electrical circuit; but to select and ring from a distant point a *given* bell on a circuit with which more than one are connected; and at the same time to ensure that the bells at the other stations which are not intended to be rung, shall not be rung.

This statement of function justifies the term "*selective signal*" which I have adopted, and which I conceive to be more appropriate than the old term "individual signal" because more descriptive.

HISTORICAL SKETCH OF SELECTIVE SIGNALS.

The idea of producing a practical selective signal is not (as might from the introductory remarks of this paper have been supposed) one which made its first appearance subsequent to the advent of the telephone.

Appliances possessing the same characteristics, appeared in England many years ago, and several forms have from time to time been patented in that country for use in connection with telegraphy, which closely resemble some of the forms which within the last ten or twelve years have been re-invented and patented here.

One of these¹ is based upon combinations of a plurality of line wires, two or more of which extend from a terminal to each two sub-stations.

1. Br. Patent 12039, January 25, 1848, H. and E. Highton.

A second¹ involves two wires together with the use of both directions, and varying strengths of current; and states itself to be "for sounding any particular alarm in a set of telegraph stations."

The third,² quoting from the published abstract, is for "transmitting secret intelligence to any one or more stations without the use of extra wires. At each station a metallic disk suitably inlaid with non-conducting portions, is brought to the required position in order to complete the circuit or not, by any electromagnetic step-by-step movement, thus excluding or including the telegraph instrument at any particular station or set of stations as required."

Three other British patents prior to 1876 are of this class, one of which³ speaks of "an apparatus comprising a main line, a series of independent branch or station lines at each end, and clocks at both ends working synchronously, which, by means of revolving cams, place the main wire in consecutive connection with corresponding branches at the two ends for definite times."

Another⁴ speaks of "apparatus placed in a continuous circuit; the bell at any particular station being caused to ring by the simultaneous advance in all the line wire apparatus, of a cam disposed in a way peculiar to each station, which is instrumental in closing a local circuit by which the bell is sounded."

The final instance⁵ of this series is a mechanism in which a disk slotted or perforated at but one point, the location of such point differing for each station, opposes itself to the forward motion of an armature lever, at all times, except when the slot or hole is immediately opposite a pin on the end of the lever. This occurs at no two stations at the same moment, but when it does occur at any station, the pin passes into the slot and the armature is thereby permitted to complete its advance and to close a local circuit and ring a bell.

Several of these suggestions will no doubt be recognized as being found also in some of the more modern selective signal appliances.

In France, too, in connection with railway telegraphy, this

1. Br. Patent 12959, February 7, 1850, E. Highton.

2. Br. Patent 13427, December 27, 1850, Dering.

3. Br. Patent, No. 3006, December 1, 1863, Wilde.

4. Br. Patent, No. 910, March 31, 1865, De Bonneville.

5. Br. Patent, No. 1801, June 11, 1869, Lyttle.

class of invention was formerly very popular; and as might be expected, is not neglected by that indefatigable chronicler, the late Count du Moncel, who devotes considerable space to the subject in the "*Exposé des Applications de L'Electricité.*"¹

It is unnecessary to recapitulate much of what he states, and it is perhaps sufficient to say that the plans of no less than thirteen different inventors are described, in which the achievement of selective signaling is at least aimed at; and that some of them evince as thorough an appreciation of the merits of the question, as do many of the appliances patented for the same purpose in America since 1876; while one or two actually are based upon ideas which are found in comparatively recent patents also.

In the plan of Lamothe, for example, which is discussed by M. du Moncel, the gong which is to be struck is by one electro-magnet brought within range of a bell hammer, which then by a second electro-magnet is caused to strike the bell.

Another inventor, Bizot, has a plan for selectively ringing bells by means of pendulum hammers placed at the different stations, and adjusted at each station to a different length.

An electro-magnet at each station in the main circuit controls the swing of the pendulums by its alternate magnetizations and demagnetizations brought about by the makes and breaks of the main line current; these being effected by a vibratory circuit breaker at the transmitting station, operated by a similar electro-magnetic pendulum there, which can be adjusted when desired, to the same length as the pendulum at any one of the other stations which it is desired to operate. Only that one to which it is adjusted, will be operated; the others remaining inert. By so arranging *all* of the station pendulums that they can be adjusted, any station is enabled to selectively signal any other.

This apparatus I have described at considerable length, because it is founded on the harmonic principle which later was introduced into telegraphy, and because it contemplates the use in selective signaling of that principle, subsequently more elaborately worked out by German and American inventors and described in their several patents.²

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1. *Exposé des Applications de L'Electricité*, Vol. iii, 1874, pp. 510-528.
 2. German Patent, No. 1944, Maron, December 5, 1877.
Br. Patent, No. 5078, Blake, December 11, 1879.
U. S. Patent, No. 251,097, Currier, Dec. 20, 1881 and others.

Martorey's system, which likewise is described by M. du Moncel, also contains the elements of many subsequent forms. In it, by an electro-magnetic step-by-step motion, an escapement wheel having a number of teeth at least equal to the number of stations on the circuit, to give the signal, is brought to a given position by a given number of pulsations, differing for each station. All the teeth are metallic, and all, except one, are insulated. That one connects with the axis and mechanism, and is part of the alarm circuit. When brought into position, the ringing circuit which it appears is open normally at two points, is closed at one of these points, and at this juncture a single impulse sent over a second wire closes the second break in the local circuit, causing the bell to ring.

In addition to the foregoing examples of the condition of the art, it is not, I conceive, out of order to point out that the principles which govern printing telegraphy are closely related also to selective signaling. Consider for example, the House, Hughes, and Phelps telegraphs, and the form of stock quotation recorders now so universally employed; in all of these a given letter or figure is brought to a suitable point and is then pressed by a final operation against the paper to make the impression.

Now a little careful thought will show that the two problems:

A. To bring a number of typewheels at different stations all to the same predetermined point, and then press the paper against them so that the same letter will be printed at all stations, and

B. To bring a number of wheels at different stations carrying local circuit closing devices (placed at a different point for each wheel) all to the same predetermined point, where any particular one of them will be in position to close its local, and ring its bell when the press movement is made; are not in principle by any means far distant from each other.

They are further related, in that both must have a unison, zero, or starting point, to which they can be brought periodically for a fresh start, to forestall a lack of harmony between the different stations, or to provide means for bringing back an errant wheel which has strayed away from the path of electro-mechanical rectitude.

A good stock of knowledge thus was at the disposal of those interested, even at as early a date as 1876, when the career of the telephone was only beginning. We had the electro-magnetic

ratchet and pawl, step-by-step, movement. We had electrically controlled clocktrains.

It was old to trip clockwork electrically; and also to use wheel circuit changers. The unison device in connection with step-by-step devices was old, and its use well known; the relay and its function of closing local alarm circuits was already a classic; wire combinations of various sorts were customarily employed; and the harmonic field had already been well threshed by Helmholtz, Bizot, La Cour, Varley, Gray, Bell, and others.

Why then was it not easy to make at once a thoroughly satisfactory and efficient selective call?

One reason is, that the average inventor or would-be inventor generally refuses, tacitly it is true, to recognize that there is any material of which he may make use. He does not know the state of the art; does not want to know the prior art; does not care anything about the prior art, and often feels affronted when he is necessarily brought face to face with it; and then he gives utterance to the pathetic plaint that "the people of former times were a dishonest race, they have stolen all my new inventions."

It is however clear from what has been stated, that the principles which underlie the problem in its many phases had to a great extent been elucidated, and that much had been done in working out scores of electro-mechanical contrivances, capable of being utilized in apparatus embodying such principles; and for these reasons there has in this branch of electro-mechanics been little scope for the exercise of original broad invention, and consequently little reasonable expectation of substantial pecuniary reward, even for him who might produce a thorough practical success in selective signaling.

These considerations have without doubt had effect in preventing many inventors and mechanics of the first rank, or of great experience, from vigorously grappling with what was left of the problem. Yet from January 1879 to December 1891, 161 U. S. patents were granted for forms of Telephonic Selective Signaling appliances, all of which I have examined.

A careful analysis shows that quite a large number of general plans have been proposed, and that each of these has been developed in several ways, with greater or less care, and to many degrees of perfection. Several sub-methods can be utilized in

many of the general plans, and in a number of cases attempt has been made to provide for several additional functions.

Though at one or two points selective signals embodying a few of these different plans are even yet employed, every telephone man knows that it cannot truly be asserted that success has attended such appliances.

One reason why, has been detailed. Some other reasons may now be given.

1. Some forms of promising selective apparatus have been put into use before being mechanically perfected, and their faultiness has given a figurative black eye to the entire race.

2. Some have been inherently defective, either in principle or construction.

3. Many as soon as crudely devised, have been employed as beasts of burden on which to organize a heavily capitalized stock company, and it has therefore been the great object of the advocates of these, to sell stock, instead of to make a practically successful apparatus.

4. To be commercially successful, a selective signal for a telephone system must be of low cost. In every form which has been put out and which has come under my observation, this requirement has been too prominently insisted upon, and the attempt has been made first of all to make not merely a *low priced*, but a really *cheap* signal. This attempt, I may note, *en passant*, has met with uniform success.

5. Excellency has not been insisted upon.

6. In many instances the apparatus has been required to do too much, or to perform too many functions, and has therefore become complicated; and

7. Usually the places where such signals have been tried, have also been places where intelligent supervision has been at a minimum.

Under the above circumstances, good results need not have been expected, and although they were expected, they did not arrive; and the user, after trying successively many of the different kinds of signals from time to time placed before him, has with the few exceptions already noted; discarded all; and for a long time now has refused to listen further to the voice of the charmer; alleging and with some show of reason, that "the only trustworthy individual signal is an individual line."

DESIRABILITY OF SELECTIVE SIGNALS.

This epigrammatic saying is however in some sort losing its attractiveness, in face of the multitude of conductors which it implies; and to a keen observer of the signs of the telephonic times, it is evident that a very extensive return to party lines in some form will by and by be inevitable; at all events for residential districts, and from this point of view, it appears that the demand for a simple and trustworthy, but not costly, selective signal is as great as ever, and that, if such a thing is made, and its merits proved, many more party lines could and would be arranged and satisfactorily operated.

To reach practical success, by which is meant to devise a really trustworthy selective signal, economical, simple and easily kept in order, invention is not so much needed—keeping the prior art in mind—as is electro-mechanical skill to mould a homogeneous and perfect apparatus from the immense amount of material we have to choose from; an apparatus in fact which will operate perfectly, not only when the several circuit signals are ranged up alongside each other on the testing room wall, where a screw may be adjusted here, a spring tightened there, and a bell hammer rod bent in another place; but equally well when they are distributed over the circuit, and all at a distance from the operator.

And to aid the adventurer who intends to construct such an apparatus, I will outline the principles upon which this class of work in its several proposed plans, have so far been founded, reference being made in brackets to a single U. S. patent exemplifying each of the several plans.

GENERAL PLANS.

1. *To operate the several signals at each sub-station on a circuit with differing strengths of current.*

Bells depending for their proper operation on a margin of current are however generally untrustworthy. [U. S. Patent—No. 221,512, Nov. 11, 1879, Buell.]

2. *Signals arranged to respond to currents of opposed direction.*

This implies of course polarized bells, and for a line with but two stations, it is probably as good an arrangement as can be provided. [U. S. Patent—No. 218,153, August 5, 1879, Anders.]

3. *Signals involving changes both in strength and direction of currents.*

These are apt to be unreliable for the same reason as are those of No. 1. [Patent No. 242,408, May 31, 1881, Anders and Vail].

4. *Electro-magnetic step-by-step devices, acting to bring the sub-station signals to a ringing point differing for each section, and then to close a local, branch, or shunt circuit, including the local bell, to operate ringing mechanism, or in some way to introduce the bell magnet into the circuit.*

Figure 1, taken from a patent of E. N. Dickerson, Jr., illustrates a ratchet and pawl step-by-step movement operating to close a local circuit in which is placed the bell. Successive pul-

Fig. 1.

sations sent from the central station, cause the electro-magnet m in the main line circuit to attract its armature a , which after each pulsation is pulled back by a suitable spring (not shown).

The non-conducting wheel w on which presses the two springs e and f , has at one point on its periphery an inlaid piece of metal z . When the wheel is rotated till the plate z comes under the two springs, the local circuit of the battery b is closed through the bell magnet m , and the bell B , which in practice would be vibratory, rings.

The wheel w can be adjusted on its shaft s , so as to be in a different position at each station, and is operated by the main magnet through its armature a , lever d , pawl p , and ratchet wheel r , the retaining pawl q holding the shaft s between the several forward impulses.

There are of course many other ways of utilizing these principles, one being shown in Fig. 2, which is one of the drawings of a patent taken out by Messrs. Curtis and Crocker.

In it, the main line *L* comes to the binding screw *b*, passes by the wire *a* to the main electro-magnet *A*, which acts through its armature *h*, lever *H*, and pawl *I* on ratchet wheel *K*, held at any point by the retaining pawl *l*, and provided with a zero spring *p* and stop *o*. The ratchet wheels *K* are metal and at a point on their disk surfaces, differing for each station, have a non-conducting piece *n* let in, flush with the said surface.

A contact spring *m* presses also on the conducting surface.

Fig. 2.

After passing the magnet *A*, and continuing by wire *a'* to a key *R*, used to call the central station, the circuit divides, one branch passing through the magnet *c* of the call-bell and thence by way of the bell hammer lever *c*, back contact *d*, and point *f*, to the terminal *g* and thence to the outgoing line *L'*.

The second branch passes by wire *m* from the point of division to the contact spring *m*, thence to the ratchet wheel and through the mechanism and by the wire *m'* to the reuniting point *f*, binding screw *g* and outgoing line. Thus as long as the contact spring *m* presses on the metal face of the ratchet wheel, the bell magnet is short-circuited; but when as the wheel

is revolved, the end of the spring presses on the non-conducting piece *n*, the shunt circuit is broken and the bell introduced and rung.

This general plan No. 4 has been much favored by inventors, admits of almost indefinite variation, and is easily associated with auxiliary devices such as unisons, "busy" signals, and lock-outs for apparatus at other stations. If mechanism properly designed and made, be employed, there is no reason why satisfactory results might not be expected. Cheap apparatus has however invariably been tried and the system besides is slow. [No. 212,792, March 4, 1879, E. N. Dickerson, Jr. No. 230,530, July 27, 1880, Curtis and Crocker].

5. *Clockwork Bells.*

a. Those in which a constantly running clock-train brings the bells at the different stations into circuit successively, or re-

Fig. 3.

moves a mechanical holder from their hammers ; when only they can be rung. These are not reliable ; it being impossible to keep the clocks together ; the clocks also require too frequent winding. [Patent 223,469, January 13, 1880, Bliss].

b. Those in which at each station is a normally stopped clock-train. All clocks are started by the same initial pulsation, and bring their signals to ringing points, or their bells into circuit at different times.

This idea is one of the most practical that has been advanced, and if the apparatus is well designed, and put together in a good mechanical form, it ought to do good work ; unfortunately first-class apparatus is costly enough to remove the gilt from the economical side of the selective signal.

This plan is indicated by the diagram Figure 3, in which however the clockwork is not shown. In the diagram, *h* is supposed to be the signal transmitting, and *s* the signal receiving

station, at each of which is a metal circuit wheel *B*, by which in conjunction with the circuit springs *s* and *v*, the bells *b* are when at rest short-circuited. At the transmitting station is a circuit closing key *K*, a battery *V* having one pole united to earth or return *G*, and the other extended to the front contact *V'* of the key, and a duplicate *W*, of the several sub-station instruments.

The first pressure of the key through suitable mechanism starts the clock-works at all stations, and introduces the bells at

Fig. 4.

each station successively, as the wheels *B* bring their notches under the springs *v*. The wheels are in the present instant supposed to be slow moving, and to have six ringing notches for each complete revolution. They can by suitable mechanism be stopped on each notch to ring a given bell as long as may be desired; and they come to rest after one notch at all stations has passed under its spring.

Of course the notches are arranged to pass under the springs at different times for the several stations, and this is indicated

in the figure, where the bell at the nearest station is introduced into the circuit; the springs *v* of the others being at different positions on the periphery of the wheel. [Patent 232,442, Sept. 21, 1880, Blake].

c. Those in which a normally quiescent clock-train is controlled by an electro-magnetic escapement, and permitted to move by successive beats, as a key at the central station alternately makes and breaks the circuit. [Patent 228,047, May 25, 1880, Eaton].

This could doubtless be made to work all right by putting excellent apparatus into it, but like nearly all step-by-step devices, would generally be slow.

Note.—All of the sub-divisions of class 5, may either have the signaling device directly in the main circuit, or in a local circuit to be closed by the action of the main circuit.

6. *Bells in which all the hammers move forward to strike at the same time, but except the desired one are prevented from striking by an interposed mechanical obstacle, which in the bell of the wanted station is removed.*

This has been faithfully tried. It was operated by an electro-magnetic ratchet and pawl, and was uncertain in operation. It also developed another fault: viz, that even the bells which are not to respond, make a considerable rattling. [Patent No. 219,059, Sept. 2, 1879, Anders.]

7. *Bells in which the ringing is done by circuit arrangement, or conductor combinations. Two series of circuits may radiate from a central to a number of substations, and one of each series caused to enter all stations. No two stations however have the same two circuits. Only when the current traverses both circuits does the bell ring at the station they enter.*

This is very promising. It can not however be applied to a multiple switch-board system. It requires relays and a local circuit bell; but no specially constructed apparatus.

It is also very speedy, the single pressure of a given key will always ring a given bell, and no mistake can be made.

This system is roughly illustrated by the diagram, Fig. 4, in which each outgoing conductor is shown to intersect each other conductor at some one sub-station, and thus afford facilities for producing a selective signal for 45 stations by using but 10 main lines.

For example, if it be desired to signal station 41, it will be necessary to manipulate the lines *G* and *I*.

The diagram Fig. 5, more fully illustrates one way in which the idea is worked out, although there are several plans, all of which are more or less advantageous.

A battery B, branches its two poles to each of a series of keys k , each of which controls the terminals of two lines; for example, key k may control terminals of A and B, k^2 those of A and C, and so on.

Fig. 5.

At each sub-station two lines both enter and pass respectively through relays, and the concurrent action of the two relays at any station is required to ring the bell, since the bell circuit is led through the armature levers and their front contacts of both.

Taking the conductors in pairs, the number of possible combinations is represented by the expression $\frac{n^2 - n}{2}$ and that num-

ber of separate stations can be selectively signaled by the use of n wires. [Patent No. 219,188, Sept. 2, 1879, Vail; Patent No. 224,855, Feb'y 24, 1880, Vail.]

8. *Bells working on the principles of harmonic telegraphy.* At each station the spring, pendulum or reed carrying the bell hammer is tuned to respond to a different note or rate of vibration.

The central station transmitting device is adjustable, and can have its rate made to correspond with that of any sub-station bell. When set in operation the coinciding bell only will ring.

Operated always by experts, and carefully constructed and adjusted, these might do well. They are, however, too sensitive; tend to become operative as their proper number of vibrations is approached, and in some degree become irregular with temperature changes.

Fig. 6 illustrates the idea, and shows a central and three sub-stations.

At the central station is a battery z , and three pendulum circuit breakers formed into a single apparatus x' . Each breaks and makes the circuit at a different rate of speed.

The main circuit passes through the magnets A of the different sub-stations successively, each magnet having a reed armature to which a pendulous bell hammer is attached, the normal rate of vibration thereof corresponding to that of some one of the transmitting circuit-breakers. At the end of the circuit is shown a second transmitter x^2 , with which, if desired, the sub-stations may be provided.

It has an adjustable pendulum bob, y^2 , which can be moved to correspond with that of any bell which it is desired to ring, and which, then being set in vibration, is responded to by such bell. [Patent No. 251,097, Dec. 20, 1881, Currier.]

9. *Sub-station signals in which galvanometers identically constructed and calibrated, make the same deflection with a given current; to ring the bells different currents are sent, which produce different deflections. Each, of course, has its ringing deflection at a different point, which may by a mercury cup close a local circuit.*

These signals ought to work fairly well, if sufficient care and cost be put into them. [Patent No. 262,252, Aug. 8, 1882; Southworth.] It would not be difficult to add several other classes to this list, but those which have been mentioned are the most important.

The plans of greatest promise are:

A. Those which by clockwork (as in 5*b*) are brought to a ringing point differing for each, the clockwork being then stopped, and the ringing done by a different kind of current. This is virtually the same plan of operation as is employed in the stock quotation printing telegraphs; and is reliable, but when adapted to do the work well, costly.

B. Those which as in class 7, require the co-action of two circuits.

Either of these when adopted should be worked in connection with a local battery.

Probably in practice it will be found advantageous to have a separate circuit distinct from the telephone circuit, on which a great number of selective signals may be connected.

Many sub-methods and appliances have to be thought of in considering this subject; whether we will be content to ring sub-stations from the central station only, or on the other hand give each sub-station the power of signaling others on the same circuit.

If step-by-step apparatus be employed to successively bring the station appliances to their ringing points, some means is required to prevent the bells of intermediate stations from giving a signal as they are passed. Sometimes the time element may here be utilized. But a better way is to have the call-bell in a local circuit open at two points; to let the advance of the apparatus close one of these, and then send a different kind of current to close the other.

We have to consider also whether the introduction of line-in-use signals, unison apparatus, call sending appliances, and telephone lock-out apparatus, are sufficiently important to be added.

The unison or zero device in some form may be considered as an essential auxiliary in all progressive signals, whether of the clockwork or step-by-step orders. Even the most perfect mechanism slips occasionally, and as in the stock printing systems where instruments "throw out" or get out of step with each other, a suitable zero at which all can periodically be brought to rest, and start even, must be certainly required. A "busy" signal which indicates at each station whether the line is in use at any other is useful, but not essential. And lock-out apparatus, usually provided by closing a shunt circuit round the call sending mechanism and telephones, at all stations on a circuit, except the one

Fig. 7.

or two which are actually communicating, is also highly advisable in order that privacy and freedom from interruption may be maintained.

But, while some of these devices are necessary, and all useful if reliable, the contriver from this time forward, must keep at all times before his eyes, the undoubted fact that selective signals where heretofore tried, have uniformly been handicapped by being too intimately associated with too many such auxiliary devices, and must be correspondingly cautious about the way in which they are added.

Some such mode as is depicted in Fig. 7 is best for this purpose.

In the figure, *m* is a clock tripping magnet; *r* the magneto generator for sending outgoing calls, *b* the station bell, and *m* and *n* two metallic wheel commutators mounted on, and electrically connected with the same shaft *B*. Arranged to press on the periphery of *m* is a contact spring *v'* and similarly placed with respect to *n*, is a spring *v*.

When the station mechanism is at rest, it is desirable to have the generators in the line circuit, but the bells out. Accordingly, the bell is short-circuited through the disk *n*, spring *v*, and wires 14 and 5; while a possible shunt circuit round the generator through disk *m*, spring *v'*, and wires 1 and 14 is open, the spring *v'* being over the notch.

The notches of *m* are placed alike at all stations, but those of *n* differ at all stations; and therefore as soon as the shaft *B* begins to move, when the driving clock-train is tripped, the shunt circuit is established round all the station generators, and no station can interrupt by an attempt to send a call signal.

Such a device is well enough because it can generally be added without at all impeding the operation of the signal proper, and in any case constitutes a perfectly proper adjunct to the equipment of a party line. But when associated with selective signals the greatest care is necessary to provide that the arrangement is such that the auxiliary appliance may not prove a drag on the signaling mechanism.

Selective signals require a fair field and all the favor they can get.

DISCUSSION.

PROFESSOR CROCKER :—Mr. Chairman, Mr. Lockwood asked me to say a word in discussion of his paper, but I fail to see where there is any room for discussion. It is very complete and puts on record in a clear and satisfactory form, a certain branch of the electrical art which has quite an extensive application. As Mr. Lockwood says, it is not confined to the telephone. The ability to call up one particular office or point on a single circuit containing many such offices or points is certainly very useful. I thought so some thirteen years ago, and patented the method referred to by Mr. Lockwood. It was my maiden effort in electrical invention and I am pleased to see that it still exists. But I was not aware, until I read Mr. Lockwood's paper, that it had not sunk entirely into oblivion. The perfection of the apparatus is the essential point in this matter. It is not a very difficult thing to think of a method. In fact, there are almost too many possible methods.

If the ability of the inventors and makers of this apparatus had been concentrated on one method, I think the results would have been better. One very interesting point is the fact that in 1881 and 1882 it looked as if such devices were entirely unnecessary, simply because each man wanted his separate circuit. Now, in 1892, we are coming back to the position that we had before that time—that is, where the selective signal is useful again. That cycle of change in electrical engineering is quite interesting. We see the same thing in the case of the alternating current which twenty or thirty years ago was the standard form. Then it disappeared for more than ten years, and then reappeared again.

The necessity or desirability of putting a number of offices on one line is apparent to any one who goes into a telephone station and sees the multiplicity of connections required where there are several thousand subscribers from a single station. That would appear to be an almost essential reason for adopting some form of selective signal system for at least a portion of the subscribers.

MR. LOCKWOOD :—Mr. Chairman, if there are no other gentlemen who wish to say anything on this subject, I would like to add one word which has been called to my mind by what Professor Crocker said. I cordially agree with what he said about the necessity of concentration of attention upon one line, and that the results would no doubt have been greater had that been done. But I should like to add to that, that it largely depended upon which method several inventors concentrated their attention, and I do not think that any amount of concentration of ability devoted to that method in which hammers were brought upward, all at the same time, but prevented from striking by the opportune presentation of a mechanical obstacle, would have produced a good signal system.

THE CHAIRMAN :—The paper on “Series Electric Traction,” having already been read by title, if there is any discussion on that we will take it up now.

MR. UPTON :—Mr. Chairman, I believe I am right in saying that it was the intention to have the discussion on the coming papers go together. There are three papers all on electric railways which should be read and the discussion follow at one time.

MR. MARTIN :—That would be a great saving of time, Mr. Chairman, and I move that the three papers on traction be read, and that we have the discussion upon them all at the same time.

[Motion seconded and carried.]

The following papers, by Mr. H. Ward Leonard, of New York, on “A New System of Electric Propulsion,” and by Prof. George D. Shepardson and Mr. E. P. Burch, of the University of Minnesota, Minneapolis, Minnesota, on “Electric Railway and Motor Tests,” were then read by the author.

THE CHAIRMAN:—At the time when Mr. Perry's paper was called, as he was not present it was read by title. Being upon the subject of electric traction it is directly in line with the papers which have already been read, and Mr. Perry perhaps would like to summarize in a brief way the particular points in that paper before the discussion takes place.

The paper on "Series Electric Traction," by Mr. Nelson W. Perry, of New York, was then read by the author.