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COMMUNICATION SYSTEM

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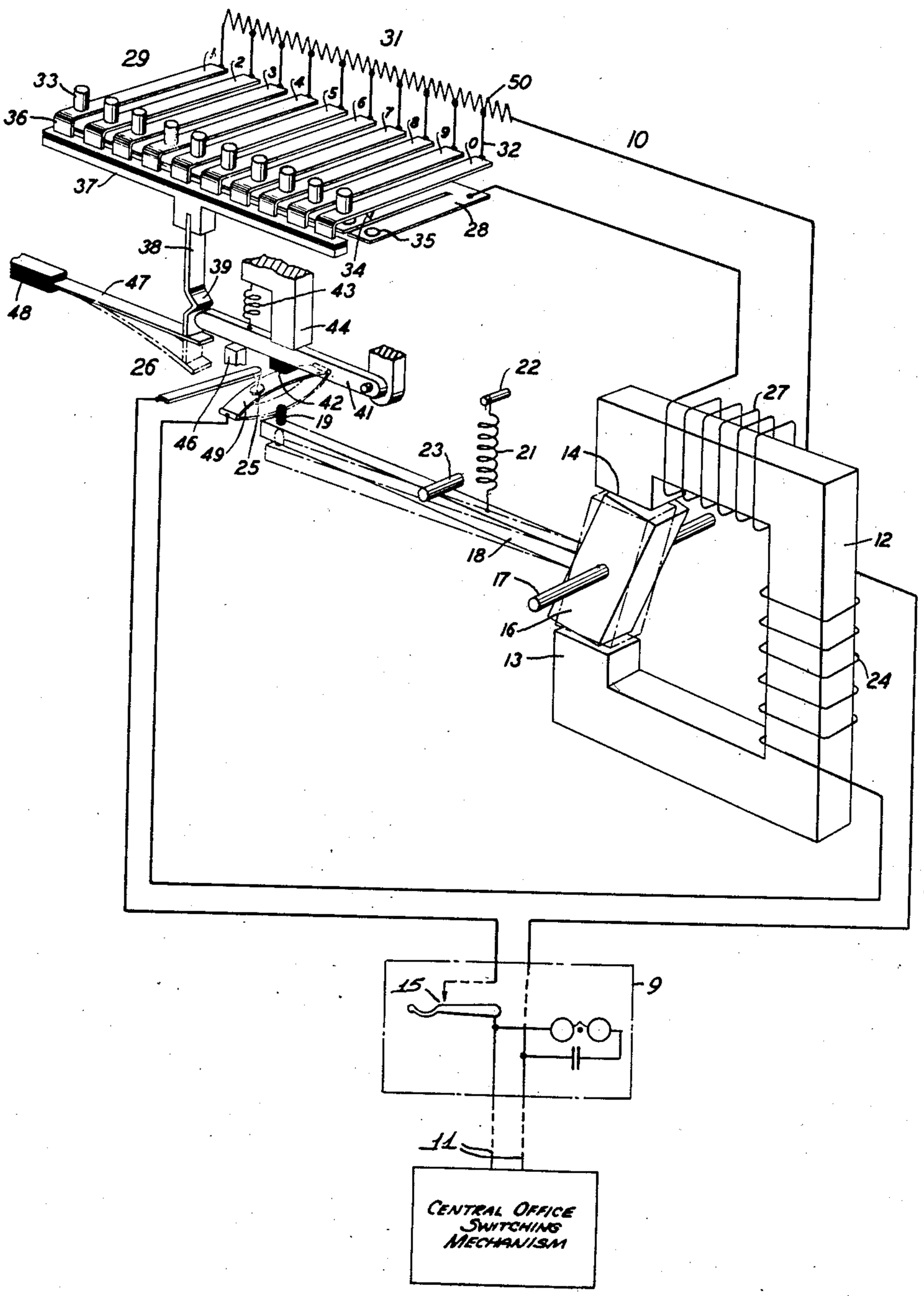

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COMMUNICATION SYSTEM

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This invention relates to communication systems and particularly to a signaling means for use therein.

An object of the invention is to provide a novel signaling device for controlling the switching equipment in a central office.

Another object of the invention is to provide an improved calling device for controlling the central office switching mechanism at a higher rate of speed with consequent reduction in the subscriber's signaling time.

A further object is to provide a signaling device in which a single impulse is transmitted for each digit.

With the above objects in view, an embodiment of the invention discloses a signaling device which, when operated, transmits to the central office a characteristic signal pulse of variable duration dependent upon the desired digit instead of the customary series of equal impulses for each digit dialed.

The signaling device contemplated for use in this invention is of the electromagnetic type and comprises an electromagnetic core having a primary coil connected to a telephone line in series with a manual circuit breaking switch and a secondary coil connected to any one of ten values of resistance through a series of ten digital keys, each operated key connecting a predetermined resistance thereto, key 1 inserting the maximum resistance and key 0 the minimum resistance into the secondary coil circuit. A movable element or armature of the electromagnet is provided for conditioning the circuit breaking switch, which in its inoperative position is closed because of the action of a biasing spring attached to the armature. When a telephone subscriber raises his handset from the mounting, the primary coil thereof is energized and the armature in turn is attracted to a position which allows freedom of movement for the circuit breaking switch. The subscriber in proceeding with his call initiates an impulse of current by actuating one of the digital keys, which opens the line circuit by means of the circuit breaking switch and which connects a resistance, the value of which is dependent upon the key punched, to the secondary coil of the electromagnet. Interruption of the primary coil induces an electromotive force in the secondary coil which sets up a magnetic flux sufficient to hold the spring biased armature attracted for a period corresponding to the digital key operated. Retraction of the armature completes the impulse by closing the circuit breaking switch, which conditions the line

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circuit for the next impulse of current to be transmitted by the subscriber. Duration of the signaling impulse is variable and is determined by the amount of resistance connected across the secondary coil 27 by the actuated digital key, actuation of key 1 providing the shortest impulse and actuation of key 0 providing the longest impulse.

The invention can be more readily understood by reference to the following detailed description in connection with the drawing which shows one embodiment thereof.

There is shown diagrammatically a telephone subscriber's station 9 of the usual type and a signaling device 10 connected by a pair of line wires 11 to a central office switching mechanism. Signaling device 10 comprises a U-shaped electromagnetic core 12 having a pair of projecting poles 13, 14, an armature 16 of soft iron rotatably disposed between said poles by means of a shaft 17, and an arm 18, which is secured to armature 16 in any suitable manner, having near its free extremity an insulated finger 19. Arm 18 is biased to its normal position, as shown in solid, by a retractile spring 21 which is secured at one end to arm 18 and at the other end to a stud 22. Stop pin 23 restricts the biasing action of spring 21 upon arm 18. Armature 16 provides a closed magnetic circuit in conjunction with poles 13, 14 of core 12 when arm 18 is in its operated position, as shown dash-dotted, under the influence of the pull exerted by the magnetic flux in core 12, which will be explained in greater detail hereinafter. Around core 12 is wound a primary coil or winding 24, one end of which is connected to one side of line 11 and the other end of which is connected through a back contact 25 of switch 26 to the other side of line 11. Switch 26 may be of the customary spring type of manual circuit breaker, which can be rapidly snapped from a closed to an open circuit basis or from an open to a closed circuit basis, and is so arranged that it is closed when armature 16 is released by the magnetic flux ceasing to overcome the pull of biasing spring 21, as will be described hereinafter.

A secondary coil or winding 27 is also wound around core 12, one end of the coil being connected to a common base plate 28 of key-set 29 while the other end of coil 27 is connected to one end of resistance 31, which is subdivided serially into ten sectional resistances of variable value, as described hereinafter, by connecting taps 32 thereof to corresponding key levers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 of key-set 29. The lowest resistance value is connected to key lever 0, the

next higher resistance value is connected to lever 9, and in this sequence the resistance sections are connected until the entire resistance 31 is connected to lever 1. Resistance 31, as illustrated, is intended to be merely representative and it is of course understood that individual resistances of proper value may be so used. Each of levers 1 to 0, inclusive, is provided with a button 33, a contact 34 for engagement with a contact 35 secured to common base-plate 28, and a turned-over portion 36 for actuating a movable insulated plate 37, which has a plunger 38 attached thereto. A cam 39, formed on plunger 38 near the free end thereof, is arranged for engagement with the free end of a pivotal bar 41, which has an insulated projection 42 on the under side and intermediate the ends thereof for actuating switch 26. Bar 41 is biased to the upward position by spring 43, stop 44 limiting the extent of the upward travel and stop 46 limiting the extent of the downward travel thereof. The lower end of plunger 38 engages a leaf spring 47, which is attached to an insulated support 48 in any suitable manner and which is adapted to maintain plunger 38 in an upwardly biased condition. The detailed construction of key-set 29 is not further illustrated as switches of this type are of known design.

For operation of key-set 29, pressure on any of the series of buttons 33 first causes engagement between contacts 34 and 35 and then through the cooperation of plunger cam 39, bar 41 and projection 42, movable insulated spring 49 of switch 26 is snapped open to the position shown in dot-dash lines. Bar 41 is restricted in its downward movement by stop 46 so that cam 39 continues to a position underneath the free end of bar 41, which thereupon because of the tension of spring 43, is retracted to its normal position, thus clearing the way for restoral of spring 49, as will be hereinafter described. Release of pressure on button 33 enables leaf spring 47 to restore plunger 38 to its normal position as shown.

For a better understanding of the invention, the principles applicable to electromagnetic relay operation will be compared with those applicable to the device disclosed herein. It is well known in telephone relay practice that relays may be made slow in operating and releasing by causing a current to be induced which in turn produces a magnetic field in opposition to the original changing field and prevents the resultant magnetic field of the relay from building up or dying down as rapidly as the current in the relay coil. This is done by means of a short-circuit winding on the relay in which currents are induced to prevent the current in the regular winding from building up its field or dropping off its field as rapidly on opening the circuit. Thus in operating, the full strength of the field, which is required to pull up the armature of the relay, is not obtained until after a definite lapse of time.

The above principle is applied to this invention wherein primary winding 24 corresponds to the regular winding of a relay and secondary winding 27 corresponds to the short-circuited winding of the relay. While variations in the operating and releasing periods of the relay are obtained mechanically by varying the gap between the armature and core thereof, variations in the release of armature 16 of signaling device 10 are obtained by connecting resistances of variable amounts to secondary winding 27 thereof through operation of the corresponding digital keys of key-set 29. The interval during which line 11 is opened, following operation of a digital key, depends upon the time constant of the circuit comprising winding 27, the sectional value of resistance 31 connected to winding 27, and on the fraction of its initial value to which the magnetic flux must fall in order for finger 19 to close switch 26. The flux may be kept reasonably constant by designing core 12 so that it is always saturated by the line current. The time constant varies inversely as the resistance value connected to winding 27. Therefore by providing resistance values, which correspond to the various digital keys, as submultiples of the overall resistance value, the intervals can be made proportional to the digital numbers. In other words, digital key 1, which inserts the maximum resistance, produces the minimum open circuit condition in line 11; key 2, which introduces one-half of the resistance of key 1, produces twice the open circuit period of key 1; key 3, which introduces one-third of the resistance of key 1, produces three times the open circuit period of key 1; and in like manner continuing to key 0, which inserts one-tenth of the resistance of key 1 and produces ten times the open circuit period of key 1.

Thus a novel and useful method of indicating a number is provided whereby the subscriber controls the duration of an interval which is observable at a central office and which is convertible thereat through well-known means into a numerical indication. A practical advantage of this method lies in the fact that if the interval can be made short, the appropriate signals can be transmitted very quickly, thereby reducing the subscriber's signaling time.

The detailed operation of signaling device 10 will now be described. Let it be assumed that the subscriber wishes to initiate a call and that line circuit 11 is open at handset switch contact 15 by virtue of the handset (not shown) being on its mounting, switch 26 is closed, arm 18 is biased to its upper position by spring 21, and armature 16 being attached to arm 18 is likewise biased from that of a magnetically closed circuit in conjunction with poles 13, 14. The subscriber in removing the handset from the mounting establishes, in the customary manner, a direct current circuit including primary winding 24 in series with contact 25 of switch 26, handset switch contact 15, and the central office switching mechanism over line 11. The resultant current flow through primary winding 24 sets up in core 12 a magnetic flux, which is sufficient to rotate armature 16 and arm 18 in opposition to spring 21, so that the opposite faces of armature 16 are approximately parallel with the faces of poles 13, 14, respectively, thereby closing the magnetic path therethrough. Finger 19 is also rotated with arm 18, the operated positions of armature 16, arm 18, and finger 19 being shown in dot-dash lines. While in the operated position, finger 19 is thus clear of movable spring 49 of switch 26. The subscriber next pushes a button 33 of any one of the digital keys of key-set 29, say key lever 0, which first engages contacts 34, 35 connecting resistance element 50 of resistance 31 across secondary winding 27, and then actuates plunger 38. Movable spring 49 is snapped to its open circuit position by plunger 38 in combination with cam 39, bar 41, and projection 42, as hereinbefore described, and as shown by the dot-dash lines, whereby the above-traced line circuit is opened. The line current stops abruptly but it is to be noted that armature 16 does not im-

mediately retract to its biased position under the tension of spring 21. Instead, a value of current substantially equivalent to the line current is set up in winding 27, through induction from primary winding 24, which maintains the magnetic flux in core 12 constant for the moment. This prevents a surge of voltage across primary winding 24. The current in secondary winding 27 and magnetic flux in core 12 then decrease exponentially at a rate determined by the above-described time constant of the secondary circuit. When the magnetic flux in core 12 falls to a value where its pull on armature 16 is overcome by the pull of biasing spring 21, armature 16 is retracted to its biased position and while returning to this position causes finger 19 to strike spring 49, which snaps back and closes the line circuit at contact 25. The line current immediately rises to a value determined by the resistance of primary winding 24, the magnetic flux in core 12 remaining unchanged due to an equivalent current set up in secondary winding 27, which then dies out and permits the flux to build up to the value corresponding to the line current. The subscriber then releases button 33 which opens the circuit of secondary winding 27 by separating contact 34 from contact 35 and which permits plunger 38 to be restored to its normal position by leaf spring 47, as hereinbefore described. The signaling device 10 is now in condition for the next number or series of numbers that may be transmitted, as required, in the above-described manner. It is to be noted that button 33 is kept in the operated position during the impulse interval in order to prevent the subscriber from prematurely opening secondary winding 27 before the entire pulse had been transmitted.

While the features of this invention have been disclosed with reference to a specific embodiment only, it is, of course, understood that various modifications may be made in the details of construction without departing from the scope of this invention as defined in the appended claims.

What is claimed is:

1. In combination, an electromechanical switch, a magnetic circuit in said switch, means for producing flux in said magnetic circuit, a control circuit for said switch, means in said control circuit including a plurality of impedance elements properly proportioned with respect to each other for varying correspondingly the flux flowing in said magnetic circuit, and means for selecting any one of said impedance elements and for concurrently rendering said flux producing means ineffective, whereby the time of operation of said switch is predetermined for a fixed interval.

2. In combination, an electromechanical switch, a magnetic circuit in said switch, means for generating a flux in said magnetic circuit, a control circuit for said switch, means in said control circuit including a plurality of impedance elements properly proportioned with respect to each other for varying correspondingly the flux flowing in said magnetic circuit, and means for selecting any of said impedance elements and for concurrently rendering said flux generating means ineffective, whereby the operating time of said switch is predetermined for a plurality of fixed intervals of variable duration.

3. An electromechanical switch comprising an electromagnet, an armature associated with said electromagnet, a primary inductance coil for generating a magnetic field of a fixed value wound around said electromagnet, a time control circuit including a series of resistances and a secondary inductance coil wound around said electromagnet for controlling operation of said switch, and means for establishing the time constants of said control circuit at a plurality of fixed values, said means including a keyset operable to select any one of said resistances and to concurrently open said primary coil, whereby magnetic fields of different definite durations for modifying the time of operation of said switch are set up.

4. A signal transmitter for transmitting variable length pulses over a line circuit comprising, in combination, an electromagnet having a core, primary and secondary windings carried by said core and an armature, pulsing contacts serially including said primary winding in the line circuit to effect the operation of said armature, manually operable means for operating said contacts to disconnect said primary winding from said line circuit, the operation of said contacts initiating the transmission of a pulse over the line circuit and the deenergization of said electromagnet, means also responsive to the operation of said manually operable means for including a resistance in series with said secondary winding concurrently with the operation of said contacts whereby the deenergization of said electromagnet is delayed for an interval of time, the length of which is determined by the magnitude of the said resistance, and means controlled by the armature of said electromagnet when deenergized for restoring said contacts, the restoration of said contacts terminating the transmission of the pulse.

5. A signal transmitter for transmitting variable length pulses over a line circuit comprising, in combination, a normally closed contact whose opening determines the start of a pulse and whose reclosure determines the end of a pulse, and means for controlling said contact comprising an electromagnet having two inductively related windings mounted on the core thereof, one of said windings being serially included in the line circuit by said normally closed contact, manually operable means for operating said contact to open circuit condition and for concurrently closing said other winding through a resistance, the magnitude of which determines the length of the pulse transmitted over the line circuit, whereby the magnetic condition of said electromagnet which prevailed prior to the operation of said contact is maintained through the inductive interaction of said windings for an interval of time commensurate with the value of resistance connected to the said other winding incident to the operation of said manually operable means, and means including an armature controlled by said electromagnet for reclosing said contact at the end of the said interval of time.

6. A time duration signaling device for a telephone switching system comprising means for establishing a predetermined line signaling condition of selectable duration, said means comprising, in combination, a line circuit, a local selecting circuit inductively coupled to said line circuit, a contact maintaning said line circuit in closed condition, manually operable means for operating said contact to open said line circuit, and means controlled by said inductively coupled circuits for operating said contact to close said line circuit.

7. In an electromagnetic signal transmitter, the combination with a line circuit of an energy storage element serially connected with said line circuit, a switch for interrupting said line circuit, flux generating means inductively coupled with

said storage element for controlling said switch, a series of resistances for varying the impedance of said generating means, digital keys for operatively connecting said resistances to said flux generating means and for operating said switch, and flux responsive means held actuated for a period corresponding inversely to the value of said resistance connected to the generating means circuit, said flux responsive means effective to retract said switch to its original position at the end of said period.

8. A device for producing impulse signals in an electrical circuit comprising a switch contact, an electromagnet having an armature for closing said contact, an energizing circuit for said electromagnet including a primary winding and said contact, a control circuit for said electromagnet including a secondary winding and a resistance adaptable for connection in series with said secondary winding, said resistance being subdivided into predetermined elements, and separate means for connecting any of said resistance elements with said secondary winding and for concurrently opening said contact to initiate an impulse signal, whereby said armature after a predetermined time, dependent upon the resistance element selected, recloses said contact to complete said impulse signal.

9. A device for producing impulse signals of variable duration in an electrical circuit comprising an electromagnet having an armature, an

energizing circuit for said electromagnet including a primary winding and an impulse contact, a control circuit for said electromagnet including a secondary winding and a resistance adaptable for connection in series with said secondary winding, said resistance being subdivided into predetermined elements, and a key-set for connecting any of said resistance elements with said secondary winding and for concurrently opening said contact to initiate an impulse signal, whereby said armature is effective to close said contact to complete said impulse signal after a predetermined time, dependent upon the resistance element selected.

10. An impulse signaling device comprising an impulse switch contact, manual means for opening said contact to initiate an impulse, electromagnetic means for reclosing said contact, said electromagnetic means comprising a primary winding in series with said contact, a spring biased armature under control of said winding for closing said contact, and a time control circuit including a secondary winding and a series of resistance elements for controlling the time of reclosure of said contact, said manual means also operative for connecting a particular one of said resistance elements in circuit with said secondary winding concurrently with the opening of the contact, whereby the length of said impulse is predetermined for a fixed interval.

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