

Nov. 5, 1946.

A. E. JOEL, JR

2,410,446

PULSING SYSTEM

Filed March 2, 1944

2 Sheets-Sheet 1

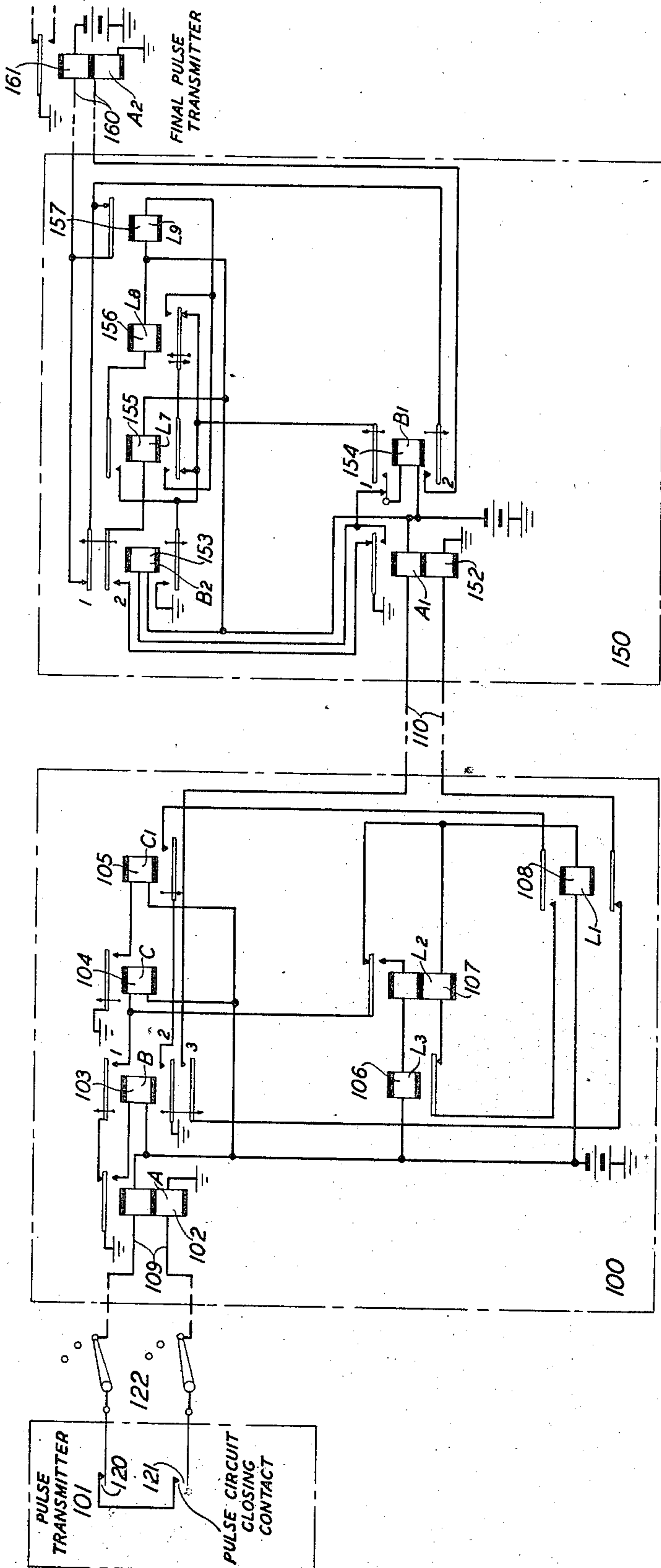


FIG. 1

INVENTOR
A. E. JOEL, JR.
BY *M. R. McTunney*
ATTORNEY

Nov. 5, 1946.

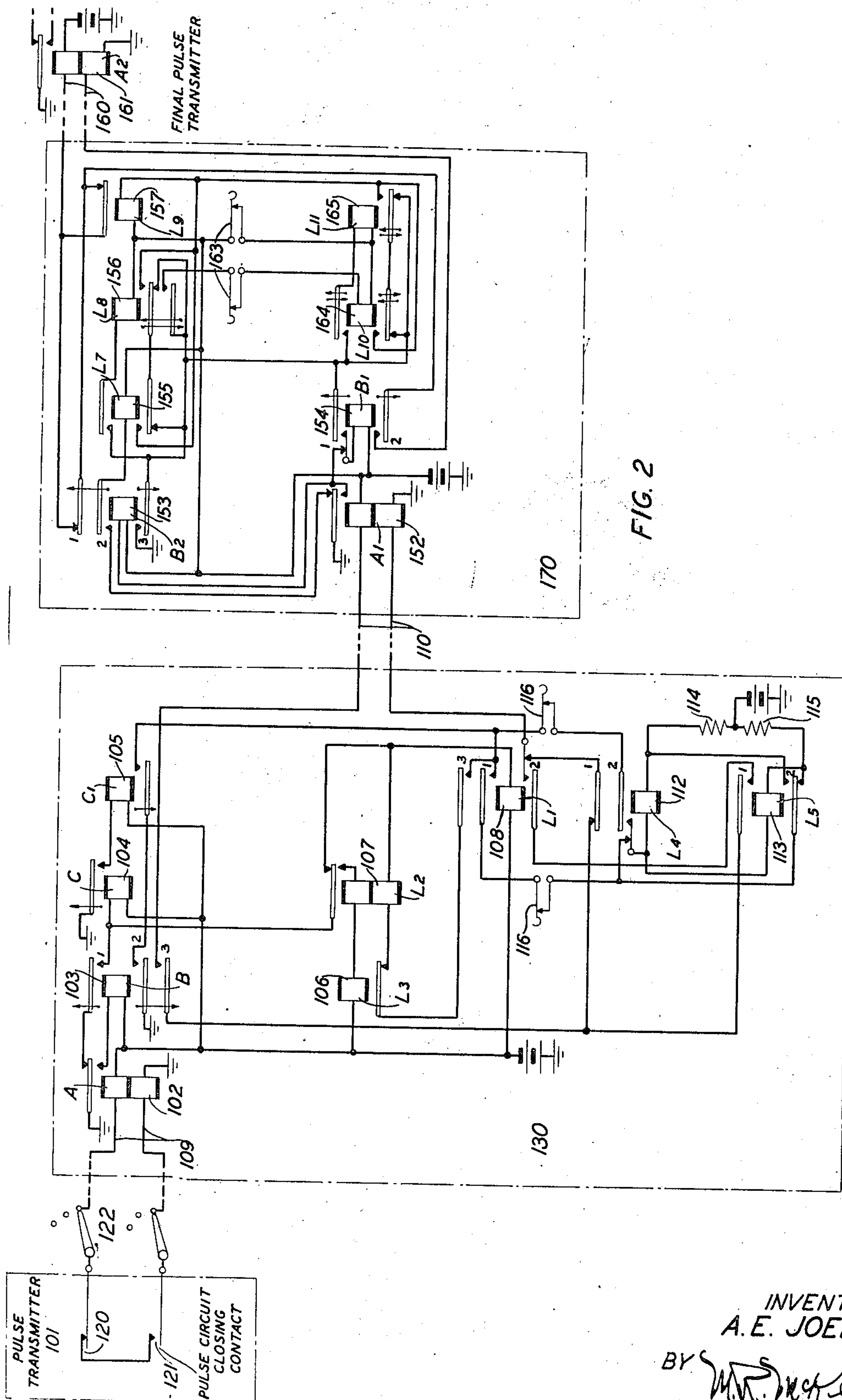
A. E. JOEL, JR

2,410,446

PULSING SYSTEM

Filed March 2, 1944

2 Sheets-Sheet 2



INVENTOR
A. E. JOEL, JR.

BY *W. R. McFadden*
ATTORNEY

UNITED STATES PATENT OFFICE

2,410,446

PULSING SYSTEM

Amos E. Joel, Jr., New York, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application March 2, 1944, Serial No. 524,669

5 Claims. (Cl. 177—380)

1

This invention relates to signaling systems and more particularly to pulsing devices for such systems.

The object of the present invention is an improvement in pulse transmitting mechanisms.

A feature of the invention consists in a pulse storing and transmitting device arranged to transmit one pulse over a line responsive to storing a given number of pulses received from a pulse transmitter or for transmitting one pulse responsive to receiving one pulse from the pulse transmitter.

Another and related feature of this invention consists in a pulse receiving and transmitting device arranged to multiply by a given value a series or plurality of pulses received over a line and to transmit said increased number of pulses and also arranged to omit multiplying a single pulse or an odd last pulse of a series of pulses received over said line, thus responsively transmitting a single pulse.

Another and related feature of this invention consists in a high speed pulsing system for operating electrical mechanisms connected by long lines employing pulse receiving and transmitting devices at the originating and terminating ends of the line for dividing the number of pulses received by a given denominator, transmitting the quotient pulses over said line, and multiplying the quotient pulses by said given denominator, thus transmitting only a limited number of pulses over the long line but transmitting the same number of pulses at the distant end of the line as received by the device at the originating end.

Another and related feature of this invention is a system including means for dividing the greater portion of the whole number of pulses by a given denominator and transmitting the quotient pulses over said line, means at the terminating end for multiplying this number of pulses by said given denominator, and means at the originating end for transmitting the remainder odd pulses, the means at the terminating end serving to transmit said odd pulses without multiplying them by said given denominator.

The foregoing and other features of the invention will be described more fully in the following specification which should be taken in connection with the accompanying drawings and appended claims.

Referring to the drawings:

Figs. 1 and 2 illustrate the signaling system as used with a two-wire line in which Fig. 1 is arranged to transmit half the number of pulses over a line as received from a pulse transmitter and multiplies by 2 the number of pulses received over the line and Fig. 2 divides the number of pulses by 4 in order to send one pulse over the line for each 4 received from a pulse transmitter

2

and multiplies these pulses by 4 in a distant receiving mechanism.

The pulsing devices for the signaling system of the invention will be applied to a telephone system but may be used in different types of signaling systems.

Referring to Fig. 1, the pulse transmitter 101 and the pulse receiving and transmitting device 100 comprising relays 102 to 108, inclusive, may be located in one telephone office and connected by a long two-conductor line 110 to the pulse receiving and transmitting device 150 comprising relays 152 to 157, inclusive, in another telephone office. The pulse transmitting relay 161 may also be located in the distant office for operating switch controlling mechanisms. The long line 110 may be a telephone transmission line of well-known character and may be automatically connected to lines 109 and 160 which may also be transmission lines. Such lines may be used for the transmission of pulses and for voice transmission as shown in Patent 2,236,246 issued to G. V. King et al. March 25, 1941, and Patent application Serial No. 495,487, filed by J. W. Dehn July 20, 1943 now Patent 2,355,908, granted August 15, 1944.

The pulse transmitting contact 120 and the pulse circuit closing contact 121 may be of the character shown in the outward pulsing circuit of the sender shown in the aforementioned patent application to J. W. Dehn, or in other pulse transmitters wherein a contact such as contact 121 is closed when the outgoing line is taken for use, thus operating a line pulsing relay such as relay 102 which is released for the transmission of a pulse when the pulsing contact 120 is opened but otherwise remains operated during the entire pulsing period.

By reference to the pulsing circuit of the aforementioned patent application to J. W. Dehn it will be found that the speed of the pulse transmitter is automatically regulated according to the mechanism to be operated in a distant office. High speed pulsing is employed over trunks or lines for the operation of sender mechanisms in distant offices. This effects a saving in holding time in the pulse transmitting mechanism, the line, and all mechanisms associated therewith for completing telephone connections. A slower speed of pulsing is used when the distance is great between the originating and distant office and the interconnecting line is longer than may be used for high speed pulsing or the mechanism in the distant office is of a character which will not satisfactorily follow the high speed pulses. The high speed or low speed pulsing transmitter may be automatically regulated by routing relays or other devices which control the connection of the pulse transmitter and later the incoming lines to lines such as line 109 extending to other offices in a manner shown in

the aforementioned patent application to J. W. Dehn. Switches such as switch 122 diagrammatically shown, may be used for such connections.

The pulsing system shown in Fig. 1 is arranged to transmit one pulse over the long line 110 responsive to two high speed pulses transmitted by the pulse transmitter contact 120. The pulses received in the distant office over the line 110 are multiplied by the relay mechanism 150 and two pulses are transmitted over line 160 to pulse transmitting relay 161 responsive to each pulse over the line 110. An exception is made automatically by the mechanism 100 when the digit comprises an odd number of pulses or only one pulse. In the latter instance the one pulse or the last pulse of a digit containing an odd number of pulses is transmitted over the long line 110 and the mechanism 150 of the distant office is controlled so that it does not multiply this pulse and thus transmits a single pulse over line 160 to cause a single release of the pulse transmitting relay 161.

The closure of contact 121 when the line is taken for use operates relay 102 which operates relay 103 by the closure of its contact. Relay 103 in operating closes the line 110 through its contact 3 to establish a circuit for relay 152 in the distant office. This circuit may be traced from ground through the lower winding of relay 152, lower conductor of line 110, lower contact of relay 108, contact 3 of relay 103, upper conductor of line 110 and upper winding of relay 152 to

battery. The operation of relay 152 closes an obvious circuit for operating relay 153 and also an obvious circuit for operating relay 154 which locks to ground on the lower contact of relay 153. The operation of relay 154 establishes a circuit for pulse transmitting relay 161 through its contact 2. It will be noted that the circuit for relay 161 extends through the contacts of relay 157 and contact 1 of relay 153 in parallel and thus relay 161 may be released by the operation of relay 157 if relay 153 is operated but not when relay 153 is released.

The mechanisms 100 in the originating office and 150 the distant office are now prepared for receiving and transmitting pulses. Each opening of the pulse transmitter 120 causes the release of relay 102 but since relay 103 is slow to release it remains operated during this open period of the pulsing contact. For the sake of simplicity of description and to make the progressive operation of the relays in each office easier to follow, the following table of operations is given illustrating the relay action in pulse receiving and transmitting device 100 following each pulse from contact 120 of transmitter 101 for transmitting half the number of pulses over the line 110 and the responsive action in the pulse receiving and transmitting device 150 for transmitting twice as many pulses as received over line 110.

This table illustrates the action responsive to 4 pulses over line 109 from transmitter 101, 2 pulses over line 110 and 4 pulses over line 160 for controlling transmitting relay 161.

Pulse transmitter	100	Line 110	150	Final pulse transmitter
Contact 121 closed	102 operated 103 operated		152 operated 153 operated 154 operated	161 operated
Contact 120 opened 1st pulse	102 released 104 operated 105 operated 108 operated	Line open, 1st pulse	152 released 155 operated 157 operated—line 160 opened. 156 slow operated 157 released	161 released 1st pulse 161 operated
Contact 120 closed	102 operates 107 operates, lower winding in series with 108.	Line held open		
Contact 120 opened 2d pulse	102 releases 107 locks to 102 106 operates 108 releases	Line closed	152 operates 155 releases 157 operates 156 slow releases 157 releases	161 releases 2d pulse 161 operates
Contact 120 closed	102 operates 107 releases 106 releases	Line held closed		
Contact 120 opened 3d pulse	102 releases 108 operates	2d pulse over 110 Line open	152 releases 155 operates 157 operates 156 slow operates 157 releases	161 releases 3d pulse 161 operates
Contact 120 closed	102 operates 107 operates in series with 108	Line held open		
Contact 120 opened 4th pulse	102 releases 107 locks 106 operates 108 releases	Line closed	152 operates 155 releases 157 operates 156 releases 157 releases 152 remains operated. 153 remains operated. 154 remains operated.	161 releases 4th pulse 161 operates
Contact 120 closed, remains closed.	102 operates and remains operated. 107 releases 106 releases 104 releases slow 105 releases slow	Line held closed, no pulse.		

5

The following illustrates the action of the pulsing system when a digit comprises only one pulse:

Pulse transmitter	100	Line 110	150	Final pulse transmitter
Contact 121 closed	102 operated 103 operated		152 operated 153 operated 154 operated	161 operated
Contact 120 opened 1st pulse	102 released 104 operated 105 operated 108 operated	One pulse Line opened	152 released 155 operated 157 operated 156 slow operated 157 released	161 released one pulse 161 operated
Contact 120 closed, remains closed	102 operated 107 operated in series with 108 104 releases slow 105 releases slow 108 releases 107 releases	Line closed	153 releases slow 154 remains operated 155 released 156 released 152 operated 153 operated	161 remains operated No pulse

6

clear as outlined in the foregoing tables with the possible exception of the operation of relay

The following illustrates the action of the pulsing system when a digit comprises three pulses. The first two pulses are transmitted the same as shown in the table for a four-pulse digit, i. e., two pulses by the pulse transmitter, one pulse over line 110 by the pulse receiving and transmitting mechanism 100 and two pulses by the pulse receiving and transmitting mechanism 150 over line 160. The odd third pulse is transmitted in the following manner:

Pulse transmitter	100	Line 110	150	Final pulse transmitter
Contact 120 opened 3rd pulse	102 releases 108 operated	2nd pulse over 110 Line opened	152 releases 155 operated 157 operated 156 slow operates 157 releases	161 releases 3rd pulse 161 operates
Contact 120 closed, remains closed	102 operates, remains operated 107 operates in series with 108 104 releases slow 105 releases slow 108 releases 107 releases	Line closed	153 releases 154 remains operated 155 releases 156 releases 152 operates remains operated 153 operates	161 remains operated No pulse

It is apparent from the foregoing that relay 103 is slow enough in releasing to remain operated during the pulsing period when relay 102 is released and thus relay 103 remains operated during the complete pulsing period which may comprise a number of digits. Relays 104 and 105 are operated responsive to the first release of relay 102 and are slow enough in releasing to remain operated when relay 102 is operated during the pulsing period for one digit but after the pulses have been transmitted for each digit relays 104 and 105 release during the interdigital period since relay 102 remains operated a longer time between digits than between pulses. With reference to the distant office receiving and transmitting relays it is also apparent that the slow release relay 153 remains operated during the complete pulsing period which may comprise a number of digits except when the last pulse of a digit is an odd pulse. In this case as shown in the third table the line 110 is held open for a long enough period to cause the release of relay 153 but not for a long enough period to cause the release of both relays 153 and 154. It will be seen that relay 154 is originally operated to close the operating circuit for the pulse transmitting relay 161 and locked to ground on contact 3 of relay 153 and thereafter relay 154 remains operated during the pulsing period which may comprise a plurality of digits.

The operation of the pulse receiving and transmitting mechanism 100 is believed to be

20 107. By reference to the tables outlining the operation of the relays for the first and third pulses it is seen that relay 108 is operated when relay 102 is released. The circuit for relay 108 extends from ground on the back contact of relay 102, back contact of relay 107, winding of relay 108 to battery. This opens line 110 causing the release of relay 152 as shown in the table. The operation of relay 108 establishes a circuit for relay 107 ground on contact 2 of relay 103, con-

45 tact of relay 105, contact of relay 108, contact of relay 106, lower winding of relay 107, winding of relay 108 to battery. This circuit is not effective for operating relay 107 until relay 102 again operates since a ground shunt extends from the back contact of relay 102 released through the back contact and winding of relay 107. Thus relay 107 has ground on both winding terminals and does not operate. Upon the operation of relay 102 the first circuit established from ground on contact 2 of relay 103 operates relay 107 in series with relay 108, the latter relay remaining operated. When relay 102 is again released responsive to the second or fourth opening of pulsing contact 120 as shown, relay 107 is locked through its contact and upper winding and relay 106 is operated in this locking circuit. The operation of relay 106 opens the circuit through the lower winding of relay 107 and the winding of relay 108. This causes the release of relay 108 which now closes line 110 and operates relay 152 for the second pulse over line 160. Relay 102 again operates when contact 120 is closed which opens the locking circuit for relay 107 and the operating circuit for relay 106 and both relays release. At this time relay 102 has been twice released and reoperated by pulsing contact 120 but relay 152 has been released once by one pulse over line 110 and is now reoperated.

By reference to the table it is apparent that the one release of relay 152 causes an open and closed period of line 160 and thus causes relay

7

161 to release and reoperate to transmit one pulse. The operation of relay 152 also causes an open and closed period of line 160 and thus causes relay 161 to release and reoperate to transmit another pulse in response to one pulse over line 110.

As will be seen from the tables, the original operation of relay 152 causes the operation of relay 153 and thereafter the release of relay 152 operates relay 155 which establishes circuits for both relays 156 and 157. Relay 156 is slow enough in operating to lag behind the operation of relay 157 which is a fast operating relay. The time lag of relay 156 behind relay 157 is approximately the time period of one pulse. This causes relay 157 to operate from battery through its winding, contact 2 of relay 155 operated, contact of relay 156 released to ground on contact 3 of relay 153. Line 160 is thus opened by the operation of relay 157 causing the release of pulse transmitting relay 161. The operation of relay 156 opens the circuit for relay 157 which causes the reoperation of relay 161. Since line 110 is held open until after two pulses have been received by the device 100, relays 155 and 156 remain operated. The line 110 is closed by the release of relay 108 which terminates the period of one pulse over line 110. This causes relay 152 to again operate which releases relay 155. Relay 157 now operates over a circuit through the contact of relay 156 operated and contact 2 of relay 155 released since relay 156 has the same time lag in releasing as in operating. The operation of relay 157 again opens the line 160 causing the release of relay 161 and thus two pulses are transmitted by relay 161 for

8

one received over line 110. The release of relay 156 causes the release of relay 157 for terminating the pulsing period of relay 161.

As already set forth, the above applies to a series of pulses which may be divided by a given denominator with the quotient pulses transmitted over line 110 and multiplied by the denominator by the mechanism 150. A single odd pulse is transmitted as described by one open and closed period of transmitter contact 120 which releases and reoperates relay 102 causing one open period of line 110 and one open period of line 160. Since relay 102 is thereafter held operated the line 110 remains open and relay 152 remains released until relays 104 and 105 release. Under this condition relay 153 momentarily releases to hold line 160 closed through its contact 1 and release relays 155 and 156 so that when relay 152 is reoperated a second pulse will not be transmitted over line 160 to release relay 161. Relay 152 is reoperated when relay 108 is finally released.

Fig. 2 illustrates the same circuit arrangement as Fig. 1 with relays 112 and 113 added to the pulse receiving and transmitting circuit in the originating office and relays 164 and 165 added to the pulse receiving and transmitting circuit in the distant terminating office for transmitting one pulse over line 110 responsive to each four pulses originated by transmitter 101 and for transmitting four pulses over line 160 causing four releases of relay 161 responsive to each pulse transmitted over line 110.

The following table shows the progressive action of the relays of Fig. 2:

Pulse transmitter	130	Line 110	170	Partial pulse transmitter
Contact 121 closed	102 operated 103 operated		152 operated 153 operated 154 operated	161 operated
Contact 120 opened 1st pulse	102 released 104 operated 105 operated 108 operated 112 operated lock to 103	Opens line 110—1st pulse Line 110 held open	152 released 155 operated 157 operated 156 sl-operated 157 released 164 sl-operated 157 operated 165 sl-operated 157 released	161 released—1st pulse 161 operated 161 released—2nd pulse 161 operated
Contact 120 closed	102 operated 107 operated in series with 108			
Contact 120 opened 2nd pulse	102 released 107 locked to 102 106 operated 108 released removes shunt from 113 113 operated	Line 110 held open by ct 1-112		

Pulse transmitter	100	Line 110	160	Partial pulse transmitter
Contact 120 closed	102 operates 107 releases 106 releases			
Contact 120 opens 3rd pulse	102 releases 108 operates 112 releases	Closes line 110 through contact of 113	152 operates 155 releases 157 operates 156 slow releases 157 releases	161 releases 3rd pulse
Contact 120 closes	102 operates 107 operates in series 108			
Contact 120 opens 4th pulse	102 releases 107 locks to 102 106 operates 108 releases 113 releases	Line 110 held closed by contact 2 of 108 and 112	164 slow releases 157 operates 165 slow releases 157 releases	161 releases 4th pulse 161 operates
Contact 120 closed	102 operates 107 releases 106 releases			

The operation continues for the fifth, sixth, seventh and eighth pulses according to the above table or for any multiple of four pulses from the pulse transmitter 101.

It is apparent from the above table that in the circuit arrangement of Fig. 2, relays 152 to 108 and relays 152 to 157, inclusive are operated and released in the same manner as described for the circuit arrangement of Fig. 1. However, the first operation of relay 108 opens the line 110 for releasing relay 152 and also establishes an operating circuit for the added relay 112 from ground on contact 2 of relay 103 and relay 112 in operating locks to ground on this same contact. Relay 112 opens line 110 through its contact 1 so that the line remains open when relay 108 is released by the action of the other relays as previously described when the second pulse is sent by transmitter contact 120. While relay 108 is operated a shunt through contact 2 of relay 113 and contact 1 of relay 108 prevents relay 113 from operating but the release of relay 108 removes this shunt causing the operating circuit for relay 113 to be effective. This operating circuit extends from battery through resistance 115, winding of relay 113, contact 2 of relay 112, contact of relay 105, contact 2 of relay 103 to ground. Relay 113 prepares a shunt for releasing relay 112 which is made effective upon the next operation of relay 108 and also prepares a closing path for line 110 which is effective upon the next operation of relay 108. By reference to the table it will be seen that the second operation of relay 108 takes place when the third pulse is sent by transmitter contact 120.

During the open period of line 110 relay 152 of the pulse receiving and transmitting device 170 is released. Relay 153 remains operated during this period since the time for transmitting two high speed pulses from transmitter contact 120 is substantially the same as the time for transmitting one pulse at the slower speed. Relays 155, 157 and 156 are operated as previously described and relay 157 is released upon the operation of relay 156 and the action of these relays transmits the first pulse over line 160 causing the release and reoperation of relay 161. The operation of relay 156 in addition to releasing relay 157 establishes a circuit for slow-operating relay 164. The time lag in operating relay 164 permits relay 157 to release and relay 161 to reoperate. Relay 164 closes a circuit for again operating relay 157 from battery through the winding of relay 157, contact of relay 164 operated, contact of relay 165 released, to ground on contact 3 of relay 153. Relay 161 is thus released a second time when line 160 is opened by the operation of relay 157. Relay 164 establishes an obvious circuit for relay 165 which opens the operating circuit for relay 157, causing its release.

Returning to the receiving and transmitting device 130 it will be seen that relay 108 operates responsive to the third pulse sent by transmitter contact 120, causing the closure of line 110, the operation of relay 152 and the release of relay 112. Line 110 is closed through contact 2 of relay 108 operated, contact 1 of relay 113 operated and contact 3 of relay 103 operated. After the fourth pulse is sent by transmitter contact 120 relay 108 is released but since relay 112 was previously released the line 110 is held closed through contact 1 of relay 112 and relay 152 continues to be operated. The release of relay 108 now causes the release of relay 113 by opening its contact 1 and the circuit restores to normal during the operated

period of relay 102 in readiness for the next series of four pulses.

The third and fourth pulses are transmitted by the receiving and transmitting device 170 when relay 152 is operated by the closure of line 110 as above outlined and as shown in the table. It will be recalled that relays 155, 156, 164 and 165 were operated for the transmission of the first two pulses over line 160. The operation of relay 152 releases relay 155 and a circuit is thus established for operating relay 157 for sending the third pulse. The release of relay 156 releases relay 157, again closing line 160 and reoperating relay 161. The release of relay 156 causes the release of relay 164, again establishing a circuit for relay 157 for opening line 160 for the fourth pulse. The release of relay 165 follows the release of relay 164 which releases relay 157 to close line 160 after the fourth pulse. It may be seen that the device 170 is transmitting pulses over line 160 at the same time that the device 130 is receiving pulses from the transmitter 101 and therefore they are both in readiness for the next series of pulses substantially at the same time.

The devices are made flexible by the use of keys 116 and 163 shown in Fig. 2. When key 116 is in its normal positions as shown, the pulse receiving and transmitting device 130 is arranged to divide the number of pulses received from the pulse transmitter 101 by the denominator four and when key 116 is operated it will divide the pulses received by the denominator two. In each case the quotient pulses are transmitted over line 110. With key 163 in its normal position as shown, the pulse receiving and transmitting device 170 is arranged to multiply the quotient pulses by the denominator four and when key 163 is operated it will multiply the quotient pulses by the denominator two. The above, of course, applies to numbers of pulses which may be divided and multiplied by a common denominator and single pulses or the last odd pulse of a series of pulses are transmitted by the devices as herein described. It is, of course, apparent that any number of single pulses may be transmitted by the devices by using a set period of time between pulses, which period, for example, could be commensurate with the normal interdigital period used in telephone practice.

What is claimed is:

1. In a pulse transmitting system, a pulse sending transmitter operable to transmit trains of pulses of variable numbers of successive pulses in each train, a first pulsing mechanism, a second pulsing mechanism, a line interconnecting said first and second pulsing mechanisms, means for connecting said pulse sending transmitter to said first pulsing mechanism, means in said first pulsing mechanism automatically operable in response to the number of pulses in a train received from said transmitter for transmitting a smaller number of pulses over said line than received from said sending transmitter or for transmitting the same number over said line as received from said sending transmitter, and means in said second pulsing mechanism for transmitting, in response to each train of pulses received over said line from said first pulsing mechanism, a train of the same number of pulses as sent by said sending transmitter.

2. In a pulse transmitting system, a pulse sending transmitter operable to transmit trains of pulses of variable numbers of successive pulses in each train, a first pulsing mechanism, a sec-

ond pulsing mechanism, a line interconnecting said first and second pulsing mechanisms, means for connecting said pulse sending transmitter to said first pulsing mechanism, means in said first pulsing mechanism automatically operable in response to the number of pulses in a train received from said transmitter for transmitting a single pulse over said line responsive to receiving a series of pulses from said transmitter and a single pulse over said line responsive to receiving a single pulse from said transmitter, and means in said second pulsing mechanism for transmitting, in response to each single pulse received over said line from said first pulsing mechanism, a train of the same number of pulses as sent by said sending transmitter responsive to receiving said single pulses over said line.

3. In a pulse transmitting system, a pulse sending transmitter, a first pulsing mechanism, a second pulsing mechanism, a line interconnecting said first and second pulsing mechanisms, means for connecting said pulse sending transmitter to said first pulsing mechanism for transmitting a series of pulses thereto, means in said first pulsing mechanism for dividing the number of pulses in said series by a given denominator and for transmitting the quotient pulses and a remainder pulse over said line, and means in said second pulsing mechanism for multiplying said quotient pulses received over said line by said denominator, for preventing the multiplying of said remainder pulse and for transmitting therefrom the same number of pulses as contained in said series.

4. In a pulse transmitting system, a high speed pulse transmitter, a first pulse receiving and transmitting mechanism, a second pulse receiving and transmitting mechanism, a line be-

tween said first and second pulse receiving and transmitting mechanisms, means for connecting said pulse transmitter to said first pulse receiving and transmitting mechanism, means in said first pulse receiving and transmitting mechanism for transmitting over said line each alternate pulse received from said transmitter including an odd numbered pulse when a series of pulses terminates with an odd numbered pulse, and means in said second pulse receiving and transmitting mechanism for transmitting two pulses responsive to each pulse received over said line excepting said last odd numbered pulse and for transmitting only one pulse responsive to receiving said last odd numbered pulse.

5. In a pulse transmitting system, a high speed pulse transmitter, a first pulse receiving and transmitting mechanism, a second pulse receiving and transmitting mechanism, a line between said first and second pulse receiving and transmitting mechanisms, means for connecting said pulse transmitter to said first pulse receiving and transmitting mechanism, means in said first pulse receiving and transmitting mechanism arranged for transmitting over said line each alternate pulse of a digit received from said transmitter and arranged for transmitting only one pulse over said line when the digit comprises a single pulse, and means in said second pulse receiving and transmitting mechanism arranged for transmitting two pulses responsive to each single pulse received over said line when a digit comprises an even number of pulses and arranged for transmitting a single pulse when a digit comprising only a single pulse is transmitted over said line.

AMOS E. JOEL, JR.