

March 28, 1944.

R. S. BAILEY

2,345,317

SATELLITE TELEGRAPH SWITCHING SYSTEM

Original Filed Aug. 6, 1938

3 Sheets-Sheet 1

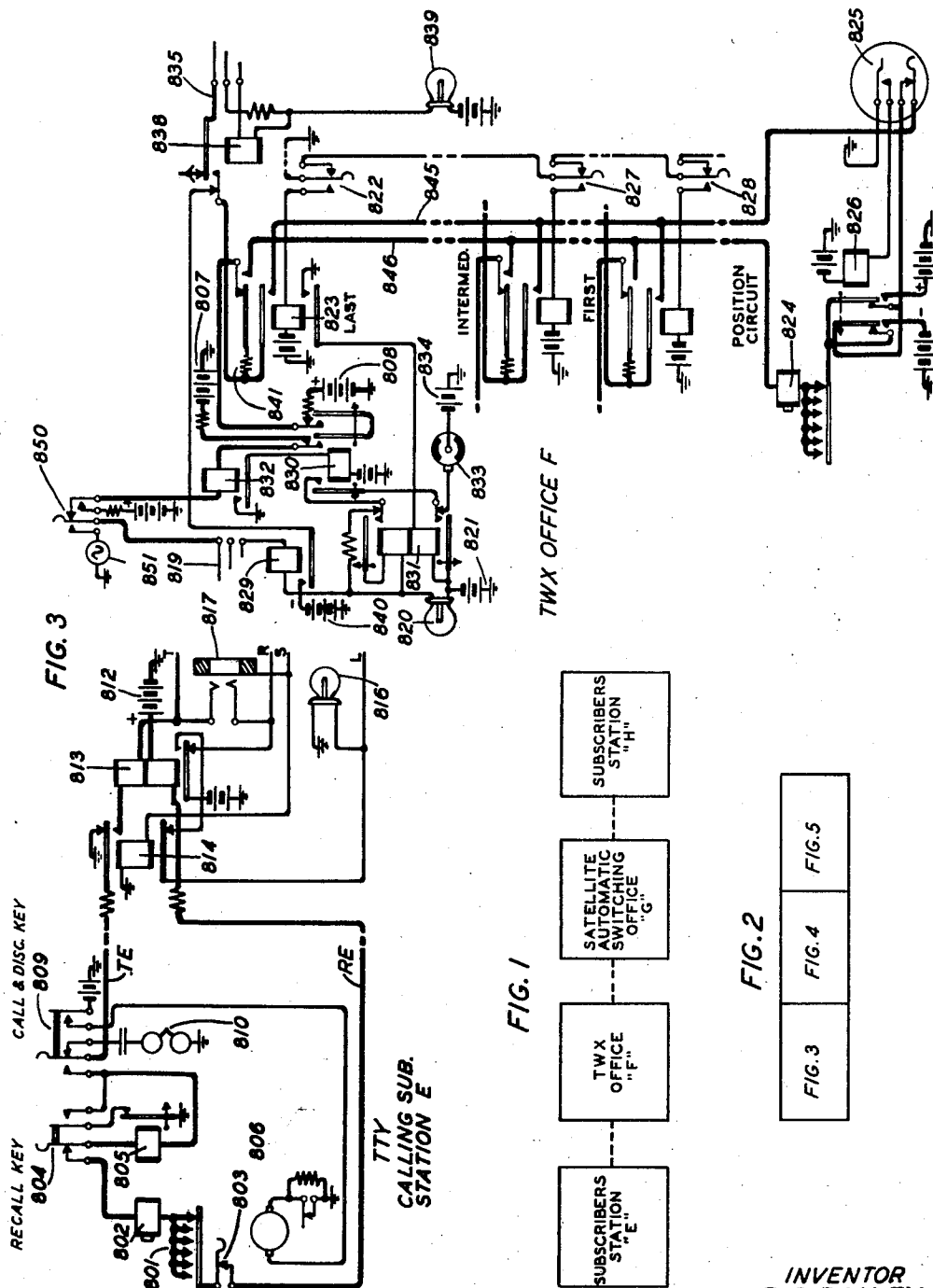


FIG. 1

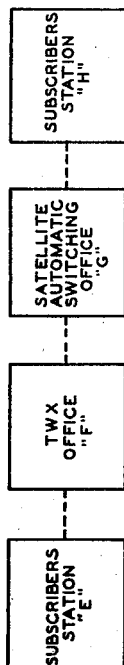
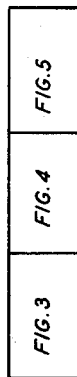


FIG. 2



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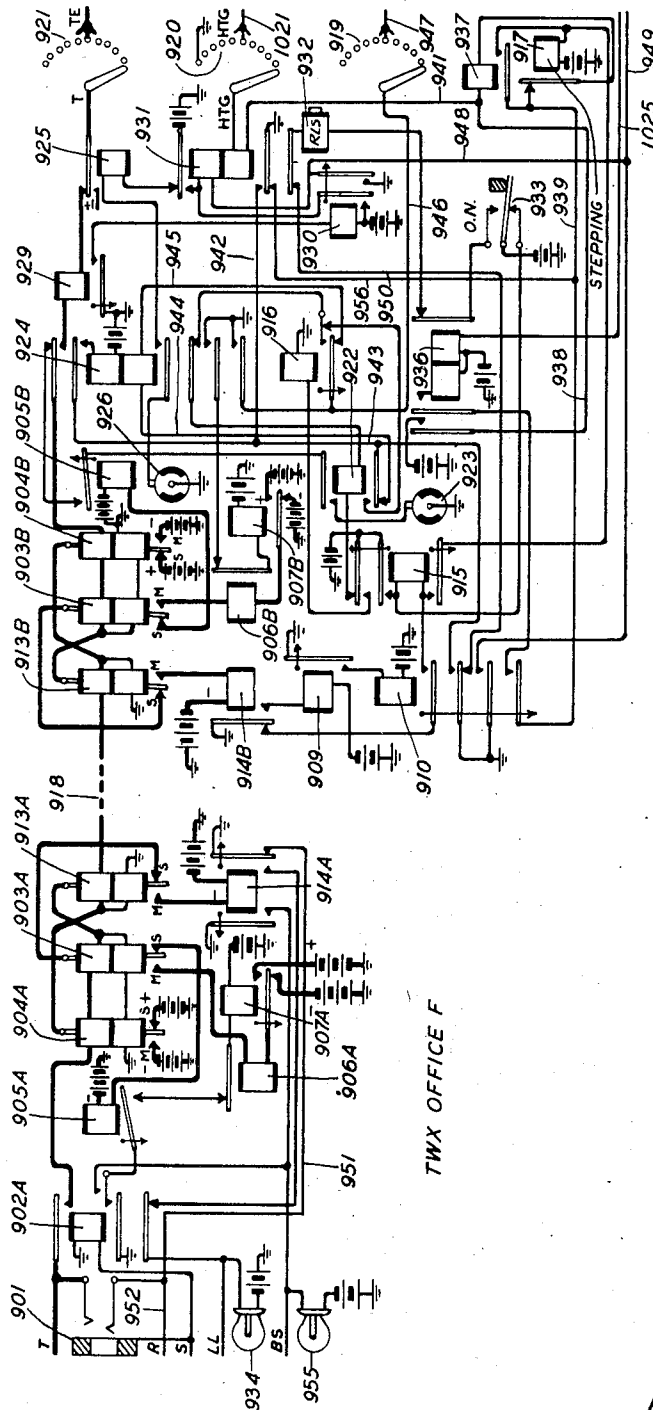
2,345,317

SATELLITE TELEGRAPH SWITCHING SYSTEM

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3 Sheets-Sheet 2

FIG. 4



TWX OFFICE F

SATELLITE OFFICE G

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SATELLITE TELEGRAPH SWITCHING SYSTEM

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3 Sheets-Sheet 3

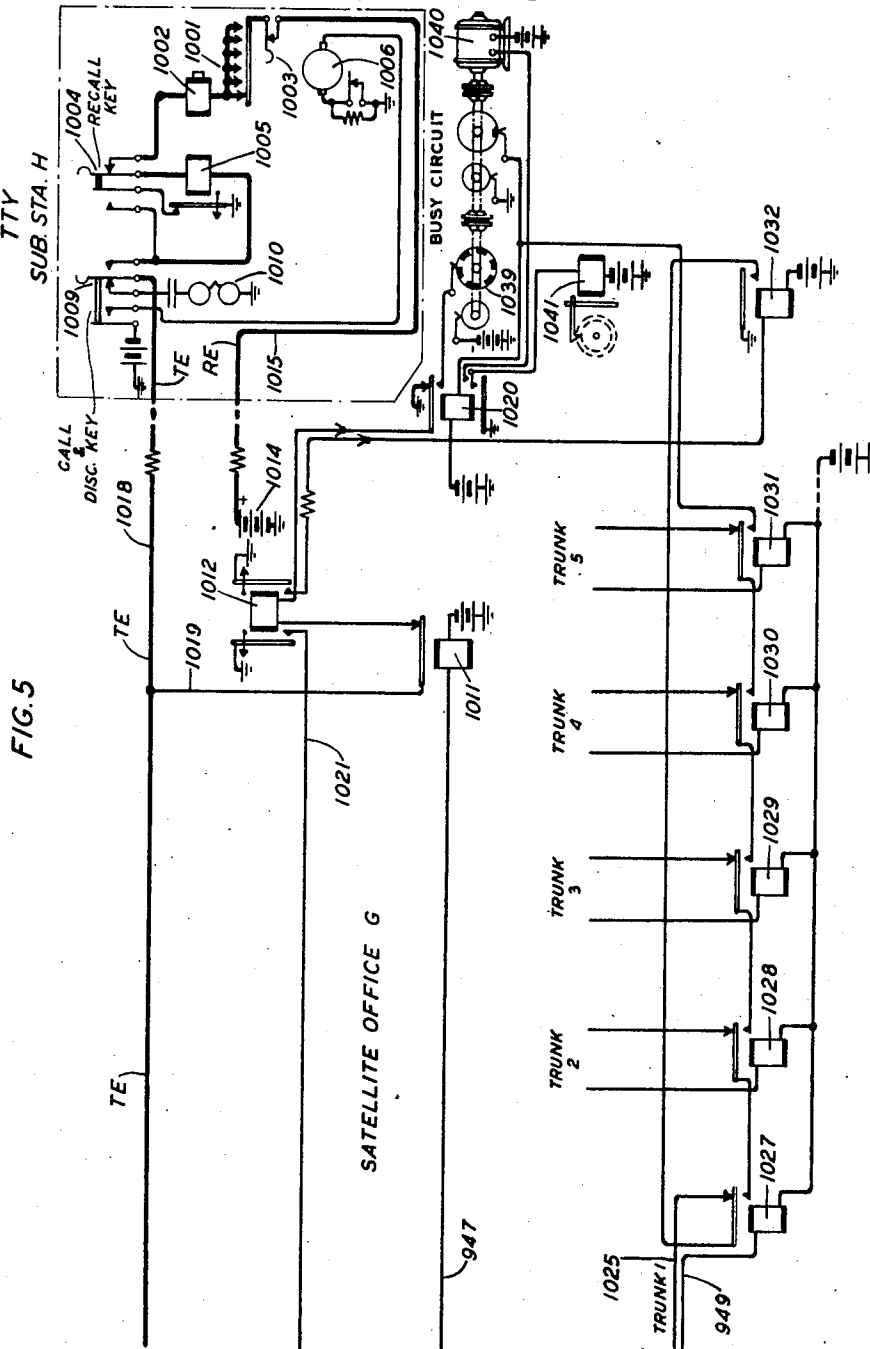


FIG. 5

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2,345,317

SATELLITE TELEGRAPH SWITCHING
SYSTEM

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Original application August 6, 1938, Serial No.
223,431. Divided and this application May 17,
1941, Serial No. 393,864

27 Claims. (Cl. 178—2)

This invention relates to teletypewriter systems and more particularly to automatic switching for establishing and maintaining connections in teletypewriter systems.

This is a division of application Serial No. 223,431, filed August 6, 1938.

An object of this invention is to provide a system for giving service to a number of teletypewriter subscribers or branch offices over a group of trunks, less in number than the number of subscribers, to a central telegraph exchange; this is accomplished in the embodiment disclosed by means of a satellite or automatic switching office between the subscribers' lines and the trunks. The expression subscriber's station is used in its generic sense of an outlying office.

Upon a subscriber's call the object is accomplished by an allotter circuit which assigns an idle trunk extending to the central office to a subscriber and connects his line thereto whereby a call signal at the central office is caused to appear in the same manner as in connection with a call upon a line directly terminating at the central office.

Upon a call to a subscriber the central office operator utilizes a dial to actuate a selector switch at the satellite office to select and test the subscriber's line and connect it to the calling trunk if the line is idle.

Among the objects of the invention are to accomplish these results by an organization of simple nature whereby full supervision is possible, trunks may be allotted expeditiously, subscribers' lines may be selected accurately over trunks used by a central office operator to make calls, and automatic release under control of the central office operator may be effectively accomplished.

A specific feature of the invention is a break limiter in a cord circuit; another specific feature is a recall key having a break limiter attached thereto.

Another specific feature is that all jacks employed in the system are of the multiple appearance type with multiple busy lamps so that a plurality of operators may cooperate in setting up and disconnecting communication paths.

Another feature is that a conventional numerical dial device is used preferably in series with the operator's teletypewriter for sending selecting pulses to select subscribers' stations; also that the dialing is accomplished over telegraph trunks which may contain repeaters of standard type, although the invention is not limited to the use of repeaters. When repeaters are used they re-

peat the dial pulses in the same way as they repeat telegraphic signaling pulses.

The trunk channels are preferably of the differential duplex type although two-path polar could be employed and the trunks may include carrier or radio links with any of the usual equipment employed or commonly available for employment therein.

Another feature of the invention is to reduce the duration of telegraphic "breaks" upon the trunk so that the duration of the recall and the "break" signal durations may be correspondingly reduced. Furthermore, disconnect, recall, and break signals may be distinguished.

Other objects and features will be readily understood from the following description and appended claims when taken in conjunction with the accompanying drawings of which:

Fig. 1 illustrates in block diagram a teletypewriter system in which a call is established between a subscriber's station connected to a TWX office F and a subscriber connected to a radial, or a satellite, automatic switching office G. TWX is an abbreviation for teletypewriter exchange. If a subscriber connected to the TWX office F desires to be connected to a subscriber connected to satellite office G, the operator at the TWX office F establishes a connection by controlling remotely the automatic switching equipment at the satellite office. When the subscriber connected to the satellite office G, such as station H, desires to communicate with a subscriber connected to the TWX office F, the automatic switching equipment at the satellite office is actuated by the establishment of a calling condition at the subscriber's station H to connect the station to the operator at the TWX office F. The subscribers' stations, TWX office and satellite switching office are indicated by labeled block diagrams in the drawings;

Fig. 2 shows the order in which Figs. 3, 4 and 5 may be connected together to form a complete communication path;

Fig. 3 shows a teletypewriter subscriber's station set at station E connected to the subscriber's station equipment at the TWX office F and an operator's cord circuit for connecting the operator's position circuit with the subscriber's line equipment;

Fig. 4 shows the toll line equipment at the TWX office F connected by means of a toll line to the automatic switching toll line equipment at the satellite office G; and

Fig. 5 shows a sequence or allotter circuit and subscriber's line equipment at the satellite switch-

ing office G connected to a teletypewriter subscriber's station set at station H.

The system shown in Figs. 3, 4 and 5 utilizes telegraph toll lines which are normally spacing when idle with automatic signaling and full supervision.

The teletypewriter set at subscriber's station E is shown connected to the subscriber's station equipment at TWX office F by tip conductors TE and ring conductor RE.

Station E initiates a call

A call is initiated by the subscriber at station E upon the operation of call key 809. The operation of this key energizes the motor 806 causing it to operate during the entire time that the key is operated. Key 809 also closes a circuit from grounded positive battery 812, lead RE, break key 803, transmitting contact 801, magnet 802, left spring and contact of recall and disconnect key 804, through the winding of slow-release relay 805, operated spring and contact of call key 809, tip conductor TE, upper left armature and contact of relay 814, to ground. Relay 813 operates closing an obvious circuit for lighting lamp 816. The lighting of the lamp 816 indicates to the operator at TWX office F, that a call is waiting on this line.

Operator answers

The operator answers by inserting plug 819 into jack 817, and operating typing key 822. Assuming that the plug has been inserted before typing key 822 is operated, two circuits are completed, one from grounded negative battery 821, through lamp 820, through the winding of relay 829, sleeve conductors of plug 819 and jack 817, through the winding of cut-off relay 814 to ground. This circuit lights lamp 820 and operates relays 829 and 814. Relay 814, in operating, disconnects ground at its upper armature and completes in its place the circuit extending from grounded positive battery 812, through the equipment at station E, the upper armature and front contact of relay 814, upper winding of relay 813, tip conductors of jack 817 and plug 819, through the winding of relay 832 to grounded negative battery 807. Relay 832 operates thereby operating relay 830. Relay 830, in operating, removes grounded battery 807 and replaces it by grounded battery 840, via contacts of relays 823, 838 and 829. Also, relay 830, in operating, connects at its left-hand armature and contact interrupter 833, via contacts of relays 831 and 830, in a shunt path across lamp 820. At each closure of interrupter 835 the lamp will be extinguished and at each opening it will be lighted. The flashing of lamp 820 is an indication that key 822 has not been operated.

When the operator operates key 822, an obvious operating circuit for relay 823 will be closed. Relay 823, in operating, will insert the operator's teletypewriter set 824 consisting of printer magnet and transmitting contact, and dial 825 in series with the subscriber's line in place of resistance 841. Relay 823, in operating, also closes at its lower armature and contact a circuit extending from ground through the lower winding of relay 831 to grounded battery 821. Relay 831 operates and at its upper and its lower armature and contact, closes a locking circuit for itself which circuit serves as a permanent shunt across lamp 820 causing the lamp to remain extinguished as long as relay 830 is operated and also after key 822 is released. If key 822 was operated be-

fore plug 819 was inserted in jack 817, relay 831 would have been operated and the interrupter would not have been cut in. The operator may have at her disposal a number of cord circuits, for the operator's set can be cut in only on one circuit depending upon which one of keys 822, 827, 828 or any other similar key, not shown, has been operated. The operator indicates her presence to the calling subscriber E by typing "OPR" and subscriber E types the call of the desired subscriber's station.

Operator completes to office G

The operator completes to office G by inserting plug 835 into jack 901. Relays 904A, 903A, 913A, 913B, 903B and 904B are differential polar relays and are held normally, in their idle condition, on their respective spacing contacts as shown, by current in their lower windings, the voltage polarity and direction of flow being such as to hold them in those positions. When plug 835 is inserted in jack 901, relays 838 and 902A operate over the sleeve conductors of plug 835 and jack 901. By inserting plug 835 into jack 901 a circuit will be closed extending from ground at the right contact and armature of relay 914A, conductor 951, ring conductors of jack 901 and plug 835, through lamp 839 to grounded battery. Lamp 839 lights. Relay 902A, in operating, will cut off call lamp 934 and light busy lamp 955. Relay 902A, in operating, also closes a circuit extending through the upper windings of relays 904A and 903A to operate the latter relays to their respective marking contacts. The operation of relay 903A to its marking contact will cause the release of relay 905A, which when released connects ground from relay 902A to a circuit which should extend over the armature and contact of relay 905A, armature and contact of relay 906A, through the winding of relay 907A to grounded battery. However, relay 903A, in operating to its marking contact, closes a circuit extending from grounded positive battery 812 which is connected to the subscriber's line extending through station E to the tip conductor of the cord circuit, through the upper windings of relays 904A and 903A, armature and spacing contact of relay 913A, armature and marking contact of relay 903A, through the winding of relay 906A, armature and back contact of relay 907A, grounded negative battery, and relay 906A operates to prevent relay 907A from operating. The condition is therefore established for a return signal from office G. Relay 904A, in operating to its marking contact, operates relay 913B to its marking contact.

Signal reaches office G

Relay 913B, in operating to its marking contact, opens the operating circuit for the normally operated relay 905B which now releases, and also operates relay 914B from ground, through the lower windings of relays 903B and 904B. Relay 914B, in operating, operates relay 909. Relay 909, in operating, operates relay 910. Relays 909 and 910 are of the slow-release type so as to remain operated for the duration of the dialing, or selecting, pulses. Relay 910, in operating, prepares a circuit to operate relay 915 from the back contact of relay 914B. Relay 910, in operating, removes ground at the next to its innermost armature and back contact from the operating circuit for release magnet 932 and applies this ground over the associated front contact to armatures of relays 922 and 924 and to the inner

lower front contact of hunting relay 931. The next to the outermost armature of relay 910, when operated, connects ground to the outer armature of relay 930. Also, the next to the outermost armature of relay 910 when operated, applies ground to lead 949 to operate relay 1027, which operates, thus making this trunk busy to outgoing calls. The outermost armature and contact of relay 910 prepare to apply ground to a hunting conductor in engagement with a terminal and wiper of bank 920 of a rotary selective switch, after such switch completes its selection, through the lower winding of hunting relay 931, through the winding of relay 937, armature and contact of stepping magnet 917, conductor 939, to the inner left armature of relay 936. The circuit at office G is now ready to receive the dialing pulses.

Dialing

It is not necessary for the attendant at office G to give the operator at office F a dialing signal since the fact that the operator at office F has possession of an idle trunk gives her complete control over all required apparatus. In fact, office G is unattended except for the usual maintenance staff, and may at times be entirely unattended. Each trunk at office G is equipped with a rotary selective switch having banks such as those designated 919, 920 and 921, a stepping magnet, such as that designated 917, off-normal contacts such as those designated 933 and a release magnet such as that designated 932.

The operator dials by operating her dial 825 to count by means of its off-normal contact the number of the desired station. The upper contact of the dial will operate relay 826 which, in operating, will split the subscriber's line circuit, applying negative battery to the subscriber's line and positive battery to the trunk, thus preventing the dial pulses from interrupting the telegraph path to the subscriber at station E. Relay 826 will remain operated until the dial is returned to normal. Relays 904A, 903A, 913A, 913B and 914B will follow the dialing pulses, while relays 909 and 910 will remain operated for the duration of the train of pulses. Upon closure of the first open of the pulse train relay 913B will operate to its spacing contact, and will release 914B to close its circuit extending from ground at the armature and back contact of relay 914B, innermost armature and contact of relay 910, through the winding of relay 915, normally closed contact of the off-normal contacts 933 to grounded battery. Relay 915 operates. Relay 915, in operating, locks up temporarily at its front contact and inner upper armature, to ground on the back contact of relay 914B. Relay 915 is also of the slow-to-release type and remains operated for the duration of the pulse train. Relay 915, in operating, operates at its outer upper armature and front contact an operating circuit for relay 916 which is also of the slow-to-release type. Relay 916, in operating, connects busy relay 922 to the wiper of switch bank 919 over a make contact of relay 916 and a back contact of relay 924. The operating circuit for relay 922 is, however, open at the contact of relay 915 at this time.

Relay 915, in operating, also connects ground at the armature of relay 914B to a circuit extending through the winding of stepping magnet 917 to grounded battery. Magnet 917 will respond to the train of pulses and assuming the train consists of five pulses, stepping magnet 917 will step

five times in accordance with the five pulses. At the end of the train, relay 913B will remain on its marking contact and relay 914B will remain operated, holding relays 909 and 910 operated when relay 915 will release because off-normal switch 933 has on the first step of the wipers in their respective banks 919, 920 and 921 opened its contacts. Relay 916 being of the slow-to-release type will remain operated for a time after the release of relay 915.

Called line busy

If the called line which is connected to terminal No. 5 on bank 919, is busy, ground will be present on the fifth contact of bank 947 over the fifth contact of one of the other selectors, the right armature and front contact of line relay 1012 which are in multiple to the line of station H. This ground will complete the circuit extending over conductor 946 from No. 5 terminal at bank 919 which is engaged by its respective wiper, conductor 946, lower armature and front contact of relay 916, contact and next to the innermost lower armature of relay 924, through the winding of busy relay 922, back contact and outer upper armature of relay 915 to grounded negative battery. Relay 922 will operate and when relay 916 releases, relay 922 will lock in a circuit extending over the make-before-break contacts of relay 916, front contact and lower armature of relay 922, front contact and next to the innermost armature of relay 910, to ground. Relay 922, in operating, will open at its lower armature and back contact the circuit including the winding of relay 924 which will prevent the operation of relay 924. Relay 922, in operating, connects at its front contact and upper armature a grounded interrupter 923 to a circuit extending over the armature and contact of relay 905B, back contact and outer upper armature of relay 924, through the upper windings, in series, of relays 903B and 904B, armature and marking contact of relay 913B, through the winding of relay 914B to grounded battery. Relays 903B and 904B will follow the interruptions which will cause relay 913A likewise to follow. The lengths of the open pulses are made adequately long so as to release the slow-to-release relay 914A upon each pulse. Relay 914A operates which will light lamp 839 and a subsequent release will extinguish the lamp. Therefore, lamp 839 will flash in accordance with these interruptions. Such flashing is an indication to the operator at office F that the subscriber's station H is busy, and therefore the operator so notifies the calling subscriber at station E who disconnects and the operator removes plug 839 from jack 901. The plug may be removed from the jack during either a closure or an opening of the interrupter 923.

When the line is closed, the removal of the plug will release relays 838 and 902A. The release of relay 838 will maintain closed the subscriber's line circuit extending from station E, and the operator will receive a disconnect from the calling subscriber in a manner to be later described. The release of relay 902A will open the trunk circuit extending through the upper windings of relays 903A and 904A to cause them to operate to their respective spacing contacts. Relay 905A will operate and maintain relay 907A released. Relay 913B will operate to its spacing contact and cause the operation of relay 906B which operation will have no function at this time. Relay 913B, in operating to its spacing contact will release relay 914B, and in conse-

quence relays 909 and 910 will release after an interval. The release of relay 910 will release relays 922 and 1027, and establish a circuit for the release magnet 932 which will operate and restore the rotary selective switch to normal. The circuit of the release magnet will open when the off-normal contacts 933 are restored to normal. The release of relay 922 will cut off the grounded interrupter 923 and cause relays 903B and 904B to operate to their respective spacing contacts. These relays cause relay 913A to operate to its spacing contact and thereby releases relay 914A. The release of relay 914A extinguishes busy lamp 955. The circuit is now normal.

If the line is open at interrupter 923 when plug 835 is removed, the same procedure will follow except relays 903B and 904B will not have to wait for the removal of grounded interrupter 923, to operate to their respective spacing contacts.

Called line idle

If the called line is idle no ground will be on contact No. 5 of bank 919 but grounded negative battery will be present at the right of cut-off relay 1011 and therefore connected to a circuit extended through the winding of cut-off relay 1011, conductor 947 and the circuit heretofore traced for operating busy relay 922 which circuit will have grounded negative battery at both ends. Now when relay 915 releases, relay 922 will not operate but when relay 916 releases, a circuit will be provided extending from grounded negative battery at the right armature and back contact of relay 1012, through the winding of relay 1011, conductor 947, terminal No. 5 of bank 919, lower armature and back contact of relay 916, through the winding of relay 924, back contact and lower armature of relay 922, to ground at the front contact and next to the innermost armature of relay 910.

Relay 1011 will operate to prevent the operation of relay 1012 and relay 924 will operate. Relay 924, in operating, will lock through its upper winding under control of relay 910, and will connect at its outer upper armature and front contact the upper windings of relays 903B and 904B to terminal No. 5 of bank 921. Relay 924, in operating, applies at its outermost lower armature and contact a solid ground to the multiple of terminals No. 5 on all banks 919, and at its innermost lower armature and contact connects grounded interrupter 926 to the winding of relay 925. Relay 925 will follow the interruptions of the interrupter 926 and apply intermittent ringing current to the ringer 1010.

Subscriber answers

During the non-ringing interval of interrupter 926 when the subscriber answers by operating switch 1009, relay 929 will operate, which in turn will operate relay 930. Relay 930, in operating, will operate relay 931. Relay 931, in operating, will at its upper armature and front contact lock under control of relay 930 and at the same armature but at its back contact open the operating circuit for ringing relay 925 thus stopping the ringing. The closure of the subscriber's line circuit will operate relays 903B and 904B to their respective marking contacts. Relay 907B operates in a circuit extending from ground in connection with the outermost lower armature and contact of relay 924, contact and armature of relay 906B, through the winding of relay 907B to grounded battery, and therefore, inasmuch as relay 906B is released, provides negative marking

battery toward station H. Relay 906B is maintained released. Relay 903A, in operating to its marking contact, releases relay 905A thus causing relay 907A to operate. Relay 913A operates to marking position on marking current from office G. Relay 914A operates and opens at its right armature and contact the operating circuit for lamp 839 whereby the lamp is extinguished. Relay 907A and relay 914A are slow to release to the amount of about one-half second or at any rate they are slow but not quite as slow as relay 830. The connection is now complete and communication can take place from the subscriber at station E to the subscriber at station H. The operator retires by restoring key 822.

Transmission

In telegraphy as commonly practiced a line or channel of transmission has two conditions impressed upon it at the signal transmitting terminal with a resultant production of two conditions at a receiving terminal. These two conditions are "marking" and "spacing." Ordinarily the circuit line or channel rests in the marking condition and variable combinations of marking and spacing are used for communication. The spacing condition ordinarily does not persist for more than a very short time. Thus in a system employing a five-unit permutation code and start-stop transmission at a speed of six characters per second, the longest spacing condition employed is approximately $\frac{1}{6}$ of a second. When a receiving subscriber or customer wishes to interrupt transmission to him in a system of the present type he ordinarily does this by impressing upon the line a prolonged spacing condition. This is known as a "break" condition and may persist for several seconds or indefinitely, if nothing is employed to prevent such prolonged duration. In the present system "break limiters" are employed which function to limit the break impressed upon a communication channel to some predetermined maximum time duration, for example, of the order of 1 second. A break of this length is ordinarily effective to notify the transmitting operator to cease transmission but if it is not so effective the break condition may be repeated as often as desired, each successive break being limited to a predetermined maximum with an interval of marking condition in between. Any device or arrangement of this kind which limits the time of duration of a break condition is known as a "break limiter." Break limiters, although not known to have been previously employed very extensively, are in fact known, but novel and useful applications of them are made in the manner set forth in this specification.

Breaks of length effective to release relay 830 are not admissible during transmission except when a supervisory signal is to be produced at the light 820. Relay 830 should therefore be slow to the extent of one second or longer and breaks from key 803 should be shorter than this, although they may be repeated as often as desired. "Breaks" passing from trunk 918 toward the cord circuit of station F during transmission may be limited by relays 906A and 907A to some shorter time such as one-half second or less. "Breaks" passing from the trunk 918 toward station G are limited by relays 906B and 907B. No break condition during transmission should be allowed to operate relay 913B to spacing long enough to release relay 910 as such would cause a trunk disconnect; release of relay 929 during telegraphing, if it occurs, will not cause a disconnect or release

of a trunk unless relay 910 also releases, "breaks" from a subscriber at station H cannot cause a trunk disconnect; if adequately long, however, they may produce a recall indication by lighting lamp 839 or if continuous, as is proper upon subscriber H disconnecting, they will produce a disconnect indication at lamp 839. The break limiting action of relays 906B and 907B prevents breaks from trunk 918 long enough to release the trunk by releasing relay 929 unless station H has disconnected or is opening the line. Otherwise, the transmission over an established communication path is in accordance with customary practice, spacing conditions of telegraphic length created at either station E or station H appearing upon the teletypewriter of the other. These machines are of any convenient or usual design for sending and receiving start-stop permutation code with a normally closed line for marking condition. The operator may monitor, if desired, with no material effect upon transmission and she may also communicate in either direction over the circuit but she is not expected to send any or at the most but very short "break" signals and so her machine is indicated with no "break" key.

Calling subscriber disconnects

The calling subscriber can show a disconnect signal to the operator at office F by restoring key 809 to normal. The motor will stop and relay 832 will release after about an interval of one second. The release of relay 832 will release relay 830. Relay 830, in releasing, will split the line, closing the trunk circuit extending now to the distant subscriber at station H. Relay 830, upon releasing, opens at its left armature and contact the locking circuit for relay 831. Relay 831 releases thereby removing the shunt path around lamp 820 and the lamp lights. Thus the operator is notified of the disconnect.

Calling subscriber recalls

The subscriber may recall by operating key 809 before the operator at station F removes the cord circuit, relays 832 and 830 will operate successively. Key 822 and relays 823 and 831 are released as shown in the drawing. The interrupter 833 will be connected in a shunt path across lamp 830 and as interrupter 833 opens and closes the shut path, lamp 820 will flash. The subscriber may recall by operating key 804 which puts a break of somewhat over one second upon the line to release relay 830. The operator answering the recall will operate key 822 to again operate relay 831. The recall key 804 has a relay 805 associated therewith; this relay is normally operated but its operating path is opened upon a recall; it is slow to release and closes up the line after a time, regardless of how long the key is held.

Called subscriber disconnects

The called subscriber can disconnect by restoring key 1009. Relays 904B and 903B and 913A will remain on their respective spacing contacts for more than one second thus causing relay 914A to release and thereby light lamp 839. The operator upon observing lighted lamp 839 may remove the cord circuit.

Called subscriber recalls

The called subscriber may reoperate switch 1009 intermittently, allowing it to remain restored for over one second each time, thereby alternately extinguishing and lighting lamp 839.

Lamp 839 will follow the intermittent operation of key 1009 and the flashing will notify the operator to reenter the communication circuit by operating key 822.

Operator disconnects

The operator will remove plug 835 from jack 901. Relays 904A and 903A will operate to their respective spacing contacts, causing relay 913B to likewise operate to its spacing contact. Relay 913B, in its spacing position, will release relay 914B which will release long enough to release relays 909 and 910. Relay 910, upon releasing, will release relays 924 and 931. Relay 910, upon releasing, will close the operating circuit for the release magnet 932 which operates and restores the wipers of the selector banks to normal, and relay 929 is thereby released. Also, relay 931, upon releasing, will cause the release of relay 907B. Relay 907B being released, will cause relays 903B and 904B to operate to their respective spacing contacts, and the circuit is again normal.

Station H initiates a call

A call is initiated by station H upon the operation of key 1009. The operation of this key energizes the motor 1006, causing it to operate during the entire time that the key is operated. Key 1009, when operated, also closes the circuit extending from ground on the upper armature and back contact of relay 1020, through the winding of relay 1012, contact and armature of cut-off relay 1011, tip leads TE, key 1009, magnet 1002, transmitting contacts 1001, break key 1003, conductor 1015, grounded positive battery 1014. Relay 1012 operates. Relay 1012, in operating, applies ground over lead 1021 to the multiple terminals No. 5 on bank 920 of all selectors, corresponding to the subscriber's station H that is calling. Relay 1012 also causes relay 1032 to operate. Relay 1032 is connected in multiple to the lines of all subscribers' stations that are connected to office G. Relay 1032 applies ground to the contacts of relays 1027 to 1031. Should trunk No. 1 be idle then ground would be connected over the armature and back contact of relay 1027 to conductor 1025 of the first idle trunk to office F. As indicated before, if the trunk is busy, that one of the relays 1027 to 1031 corresponding to that trunk will be operated. Therefore the ground from relay 1032 will pass on to the first unoperated relay.

All trunks busy

If all the trunks are busy, the ground of the armature and contact of relay 1032 will pass through all these relays 1027 to 1031, that is, through all the operated armatures and front contacts of said relays, to operate relay 1020. The operation of relay 1020 will start the motor 1040 of the busy circuit which will send a pulse every few seconds from interrupter 1039 over conductor 1018 to the subscriber H to notify him that the trunks are busy. This busy circuit may be arranged to send a definite signal such as BY, to the subscriber. In any case, relay 1012 will not follow these signals, as it is of the slow-release type. All waiting subscribers will receive this signal. A register 1041 is provided for indicating a count of the number of times that the condition "all trunks busy" occurs.

A trunk is idle

If a trunk is idle, the ground at the operated armature of relay 1032 is connected via con-

ductor 1025, through the right-hand winding of relay 936 to grounded battery. Relay 936 will operate. Relay 936, in operating, will prepare for itself a locking circuit extending from grounded battery, through the left-hand winding, contact and inner left armature and outer lowermost armature and contact of relay 910, conductor 956 to ground at the back contact and inner lower armature of relay 931. At its right armature and contact relay 936 will open the circuit of the release magnet 932, and will apply at its outer left armature and contact grounded battery to a circuit extending through the winding of relay 937, armature and contact of stepping magnet 917, conductors 939 and 956 to ground at a back contact of relay 931. Relay 937 will operate and energize stepping magnet 917. Stepping magnet 917, in operating, will step the selector switch to terminal No. 1 and at its left armature and contact open the operating circuit for relay 937 which will release. The release of relay 937 will release the stepping magnet, again energizing relay 937, which again operates the stepping magnet. The stepping magnet will continue to step the rotary selective switch until the wiper of bank 920 reaches the terminal that is connected to ground at the left armature of relay 1012. When this occurs relay 931 will operate in a circuit extending from the wiper of bank 920, through the lower winding of relay 931, conductors 941 and 938, to grounded battery at the outer left armature and contact of relay 936 and at its inner lower armature and contact maintain open the operating circuit for the stepping magnet. All three banks will be on terminal No. 5 which corresponds to the calling subscriber's station H. If more than one subscriber were calling the selector switch would stop on the lowest numbered subscriber's station terminal.

The wiper of selector bank 919 receives grounded negative battery in a circuit extending from the right of relay 1011 and completes the circuit to ground via the back contact of relay 916, lower winding of relay 924, and operated inner lower armature and front contact of relay 931. Therefore, relays 1011 and 924 operate. Relay 924, in operating, applies at its outermost lower armature and contact a solid ground to the wiper associated with bank 919, and closes at its outer upper armature and front contact the subscriber's line, through the winding of relay 929, to the upper windings of relays 903B and 904B. Relay 929, in operating, operates relay 930 which locks relay 931 in an operated position. Relays 903B and 904B operate to their respective marking contacts thereby causing relay 913A to operate to its marking contact. Relay 913A on its marking contact, operates relay 914A which, in turn, lights line lamp 934 indicating to the operator that a call is waiting. Relay 1011, in operating, releases relay 1012 and consequently relay 1032. Operation of relay 930 caused the operation of relay 1027 which stays operated so long as relay 930 is operated. So long as relay 929 remains operated relay 930 will remain operated and relay 931 will remain operated and release magnet 932 cannot release the selector of this trunk. However, if another calling line has caused the operation of relay 1032 the relay 1027 will transfer the ground on the armature of relay 1032 to the conductor 1025 of the next trunk and cause it to be connected to the next calling line.

Operator answers

The operator answers by inserting plug 835 of the cord circuit shown into jack 901. Relays 838 and 902A will operate over the sleeve conductors of plug 835 and jack 901. Relays 838 and 902A, in operating, connect the upper windings of relays 903A and 904A through to grounded positive battery 808. Relay 902A extinguishes lamp 934. Relays 903A and 904A operate to their respective marking contacts. Relay 903A, in operating to its marking contact, releases relay 905A and causes relay 907A to operate thereby applying the proper transmitting potential.

The operation of relays 903A and 904A to their respective marking contacts causes relay 913B to operate to its marking contact thereby operating relay 914B. Relay 914B, in operating, operates relays 909 and 910. Relay 910, in operating, locks relay 924 in its operated position. Relay 907B, in operating, will also operate to apply proper transmission polarity. The operator announces her presence by typing "OPR" and receives the number of the called party. The operator has, of course, operated key 822 to cut in the operated teletypewriter set into the communication circuit.

Special conditions

According to standard operating procedure, if subscribers' lines seize trunks in a predetermined order the central office operators will choose trunks in a reverse order beginning at the opposite end of the series of trunks. Consequently, if enough trunks are provided it will be an exceptional case of reversely directed calls meeting upon the same trunk. However, such situations may occur. If upon a trunk call relay 910 operates, a path is closed through relay 1027, etc., of the particular trunk which transfers the ground at the armature of relay 1032 to a relay 1036 of some other trunk and a subscriber's call which closes the contact on relay 1032 subsequently is routed over another trunk. However, if, upon a subscriber's call from office H the relay 936 of a trunk becomes operated, the stepping magnet 917 steps off normal and relay 915 remains unoperated. Hence, the dial pulses, if any, sent by the central office operator do not reach the stepping magnet 917 and the magnet steps the selector to the contact of the calling line; moreover, relay 936 remains operated until the calling line is found because it has a locking path through the lower make contact of relay 910 and back contact of relay 931 until the calling line is found which extends the subscriber's call to the operator over the trunk. The operator must use a new trunk for her outgoing call.

Operator completes

The operator completes a call from a station such as station H to a station E by inserting plug 819 into jack 817. This action, as previously described, operates relays 829 and 814. The operation of these relays lights lamp 820 and as relay 830 is not operated, the ringer 810 is then connected through to grounded battery 807. The operator then operates ringing key 850 which actuates ringer 810. The subscriber answers by operating key 809 which causes relay 832 to operate, thereby operating relay 830. Lamp 820 is extinguished and the subscribers are cut through for communication. The operator retires by releasing key 822.

What is claimed is:

1. In a telegraph system comprising a central office, a satellite office, subscribers' telegraph lines

and trunks from the central office to the satellite office, an allotter circuit at said satellite office for assigning trunks to calling subscribers' lines in sequence, a selector for connecting one of said lines to one of said trunks in response to actuation of said selector, a telegraph impulse repeater in each trunk, and a circuit controlled by a transmission condition of a telegraph impulse repeater in a trunk connected to a line to maintain the connection of said trunk and said line through said selector.

2. In a system according to claim 1, wherein said central office comprises means including a dialing device for transmitting numerical selecting impulses from said central office to said satellite office, means for applying said impulses over said telegraph repeater of a given trunk to said selector, and means controlled thereby to select a line and connect said line to said given trunk for telegraphic intercommunication.

3. In a system according to claim 1, wherein said central office comprises means including a dialing device for transmitting numerical selecting impulses from said central office to said satellite office, means for applying said impulses over said telegraph repeater of a given trunk to said selector, and means controllable over said trunk from said central office through said trunk and telegraph repeater to operate a ringer at the subscriber's terminal of said selected subscriber's line.

4. A printing telegraph system comprising a central station equipped with a numerical dial device, a plurality of branch stations, printing telegraph equipment of the current-impulse type at said stations, a plurality of signaling channels terminating at said central station, switching means remote from the central station and responsive to current impulses for connecting one of said branch stations to any one of said channels, means including the connected one of said channels for controlling said switching means from the central station by impulses originated at said dial device whereby said certain channels are employed for both selecting and signal transmission purposes, other switching means for connecting any idle one of said same signaling channels to calling branch stations, and means at the branch stations for controlling said other switching means to effect connections between calling branch stations and the central station.

5. A printing telegraph system comprising a central station equipped with a numerical dial device, a plurality of branch stations, printing telegraph equipment at said stations, an intermediate switching station, signaling channels between said switching station and each of the other stations, switching means at the switching station for connecting any idle one of the central station channels to branch station channels, means for transmitting controlling impulses originated by said numerical dialing device over a central station signaling channel to operate said switching means to connect a branch station channel to said central station channel, means for controlling said switching means from a calling branch station to connect the channel extending to said branch station to an idle one of said central station signaling channels, and means operative after such connections have been completed at the intermediate switching station for operating the printing telegraph equipment at the connected stations over the same central station and branch station channel employed for setting up the connection.

6. A printing telegraph system comprising a

central station equipped with a numerical dial device, a plurality of branch stations, printing telegraph equipment at said stations, an intermediate switching station, signaling channels between said switching station and each of the other stations, switching means at the switching station for connecting central station channels to branch station channels, the channels between the switching station and the central station containing telegraphic impulse repeaters, means for transmitting controlling impulses originated by said numerical dialing device over a central station signaling channel to operate said switching means to connect a branch station channel to said central station channel, means for controlling said switching means from a calling branch station to connect the channel extending to said branch station to an idle central station signaling channel, and means operative after such connections have been completed at the intermediate switching station for operating the printing telegraph equipment at the connected stations over the same central station and branch station channel employed for setting up the connection.

7. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels comprising duplex telegraph trunks including repeaters terminating at said central station and common to each of said branch stations, switching means for extending said channels to the branch stations, means at the branch stations to control said switching means to connect a calling branch station to an idle channel at the central station, said means comprising a numerical dial.

8. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels including two-way telegraph impulse repeaters terminating at said central station and common to each of said branch stations, switching means comprising a numerical dial for extending said channels to the branch stations, and means at the branch stations to control said switching means to connect a calling branch station to an idle channel to the central station.

9. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of telegraphic impulse signaling channels terminating at said central station and common to each of said branch stations, switching means for extending any of said channels to any one of the branch stations, said means comprising a numerical dial, and means at each of the branch stations to control said switching means to connect a calling branch station to any idle of said channels extending to the central station.

10. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels terminating at said central station and common to each of said branch stations, switching means comprising a numerical dial for extending said channels to the branch stations, means at the branch stations to control said switching means to connect a calling branch station to an idle channel to the central station, means for signaling over an established connection from the branch station to the central station by means applying telegraphic marking and spacing conditions and break conditions, and means associated with said established con-

nection to prevent the applying of a prolonged break condition from releasing said established connection.

11. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels terminating at said central station and common to each of said branch stations, switching means comprising a numerical dial for extending said channels to the branch stations, means at the branch stations to control said switching means to connect a calling branch station to an idle channel to the central station, said channels to the central station terminating thereat in multiple type jacks for establishing connections and establishing supervisory conditions in multiple.

12. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels terminating at said central station and common to each of said branch stations, switching means controllable by a numerical dial together with a dial for controlling the same for extending said channels to the branch stations, and means at the branch stations to control said switching means to connect a calling branch station to an idle channel to the central station, in combination with a link circuit at said central station adapted to extend the call, whether initiated to or by the branch station, beyond the central office in a direction away from the branch station.

13. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels terminating at said central station and common to each of said branch stations, switching means controllable by a numerical dial together with a dial for controlling the same for extending said channels to the branch stations, and means at the branch stations to control said switching means to connect a calling branch station to an idle channel extending to the central station, in combination with the link circuit at said central station adapted to extend the call, whether initiated to or from the branch station, beyond the central office in a direction away from the branch station, and means whereby after a call has been so extended to a point beyond the central office the branch station may place a recall signal for the operator at the central office.

14. A printing telegraph system comprising a central station, a plurality of branch stations, a plurality of trunks or channels terminating at said central station, said channels terminating at said central station including at least one telegraphic impulse repeater, switching equipment associated with each of said channels at a point remote from said central station, means at each of said branch stations for controlling said switching equipment from any of said branch stations to connect the calling branch station to said central station, and means including a numerical impulsing dial for controlling from the central station over one of said channels terminating at said central station the selection and connection to said channel of the line of a branch station.

15. A printing telegraph system comprising a central station, a plurality of branch stations, a trunk or channel terminating at said central station, selective switching equipment associated with said channel remote from said central sta-

tion, said equipment including means responsive to dial impulses sent from said central station for directly controlling said selecting equipment, printer means for communicating over said trunk or channel, and means whereby impulses from said dial and impulses of telegraphic code sent from said printer means at said central office toward a branch station alternate the line of said trunk or channel from marking to spacing in a similar manner but according to their respective codes.

16. A printing telegraph system comprising a central station, a plurality of branch stations, a plurality of trunks or channels terminating at said central station, switching equipment associated with each of said channels remote from said central station, means for controlling said switching equipment from any of said branch stations to connect a calling branch station to said central station, a numerical dial at said central station, means operative under the control of impulses transmitted by said numerical dial at said central station to control the connection of any of said branch stations to any of said trunks or channels, said trunks or channels being equally available for calls originated by branch stations or by the central station.

17. In a printing telegraph system, a plurality of outlying offices, printing telegraph equipment at each of said offices, a line circuit extending from one of said offices, a selector switch associated with said circuit having a plurality of bank contacts and a movable switch member for engaging the same, a trunk circuit to a central office terminating at said selector switch, and means for initiating a call from said central office over said trunk circuit from said central office to the printing telegraph equipment at a selected one of the other offices, means for controlling said selector switch including means for impressing numerical code controlling impulses upon said trunk circuit to control the stepping of said switch by impulses transmitted over said trunk circuit to engage a contact at which a particular line circuit terminates, means for controlling said selector switch from said office over said line circuit to connect said trunk circuit to said line circuit for intercommunication between said office and said central office over said trunk circuit, said trunk circuit being equally available for establishment of the calls in either direction.

18. A telegraph switching system comprising a switching office, a plurality of lines terminating thereat each provided at a remote point with a teletypewriter set, a plurality of trunks extending therefrom to a central exchange office, a circuit controlling connection in a predetermined order of the first idle one of said trunks to a calling line, a numerical dial, and instrumentalities operative by numerically coded impulses sent over one of said trunks by said dial for controlling the connection of one of said lines to a calling one of said trunks in a back and forth intercommunicative relation.

19. A telegraphic communication system comprising a subscriber's line extending from a subscriber's station to a satellite switching office, a trunk extending from said satellite switching office to a central office, means for controlling the connection in a predetermined order of the first idle one of said trunks the calling line, numerical dial code controlled instrumentalities controlling the connection of one of said lines to a calling trunk, and means operative on the con-

nection of said line to a calling trunk to impress upon and relay alternating ringing current over said line to actuate a ringer at the subscriber's station.

20. In a telegraph switching system, a subscriber's station including a teletypewriter with a driving motor connected to a line extending to a remotely controlled office, a plurality of trunks extending from said office to a central office, a switch by operation of which said subscriber may start the motor at his station teletypewriter, means operably controlled by operation of said switch to start said motor to also seize an idle trunk and extend the line of said subscriber to said central office over said trunk, in combination with numerical code controlled instrumentalities whereby said central office by remote control may select and connect to said trunk the line from said subscriber's station.

21. A telegraph switching system comprising a plurality of trunks, a subscriber's line associable with any one of said trunks through a satellite office, a calling switch by which a calling subscriber causes his line to be associated with one of said trunks, means whereby numerical code dialing impulses may be transmitted over said trunk to control the connection of the subscriber's line with said trunk at said satellite office, a break signal transmitting instrument at said subscriber's line, means whereby operation of said break signal instrument for recalling purposes prevents the release of said trunk from the subscriber's line connected thereto.

22. In a teletypewriter switching system comprising a plurality of lines and a plurality of trunks, a sequence circuit for assigning any one of said trunks in response to a call on one of said lines, numerical dial code controlled means operable over any one of said trunks for controlling the connection of one of said lines to one of said trunks, a source for producing a series of impulses capable of reception on a teletypewriter of significant information, means for automatically applying impulses from said source to a calling one of said lines when no trunk is available for assignment.

23. In a teletypewriter switching system, a first channel of telegraphic impulse transmis-

sion, a second channel of telegraphic impulse transmission, means for maintaining said channels in intercommunicative relationship, slow-acting means for causing the disconnecting of said channels from said relationship, circuit varying instruments whereby said slow-acting means is controllable from one of said channels, and other means for timing the control from said channel to prevent such slow-acting means from causing the disconnecting.

24. In a teletypewriter switching system, selective devices for connecting two channels of telegraphic communication together for intercommunication, a numerical dial for remotely actuating said devices to connect said channels, means controlled by a telegraphic impulse condition upon one of said channels to disconnect said channels, and slow-acting instrumentalities for preventing said impulse condition from being applied to said means long enough to cause said disconnection.

25. In a telegraphic switching system, selective devices for associating channels together for intercommunication, a numerical dial for actuating said devices, means for actuating said devices from one of said channels for disconnecting said channels, and instrumentalities controlled by a telegraphic impulse condition of the other of said channels to determine whether said means shall be effective to disconnect said channels.

26. In a telegraph switching system, means for connecting two telegraph lines together, disconnect means for disconnecting said lines from each other, operable means for controlling said disconnect means from a remote point, and a break limiter locally located with respect to said disconnect means and associated with one of said lines when connected together for preventing disconnection.

27. In a satellite telegraph switching system, trunks and lines, means for connecting one of said trunks to one of said lines, means for impressing a break signal condition upon said interconnected trunk and line, and a telegraphic break limiter operative under a certain condition to limit the duration of the effect of said break condition for preventing disconnection of said trunk and line from each other.

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