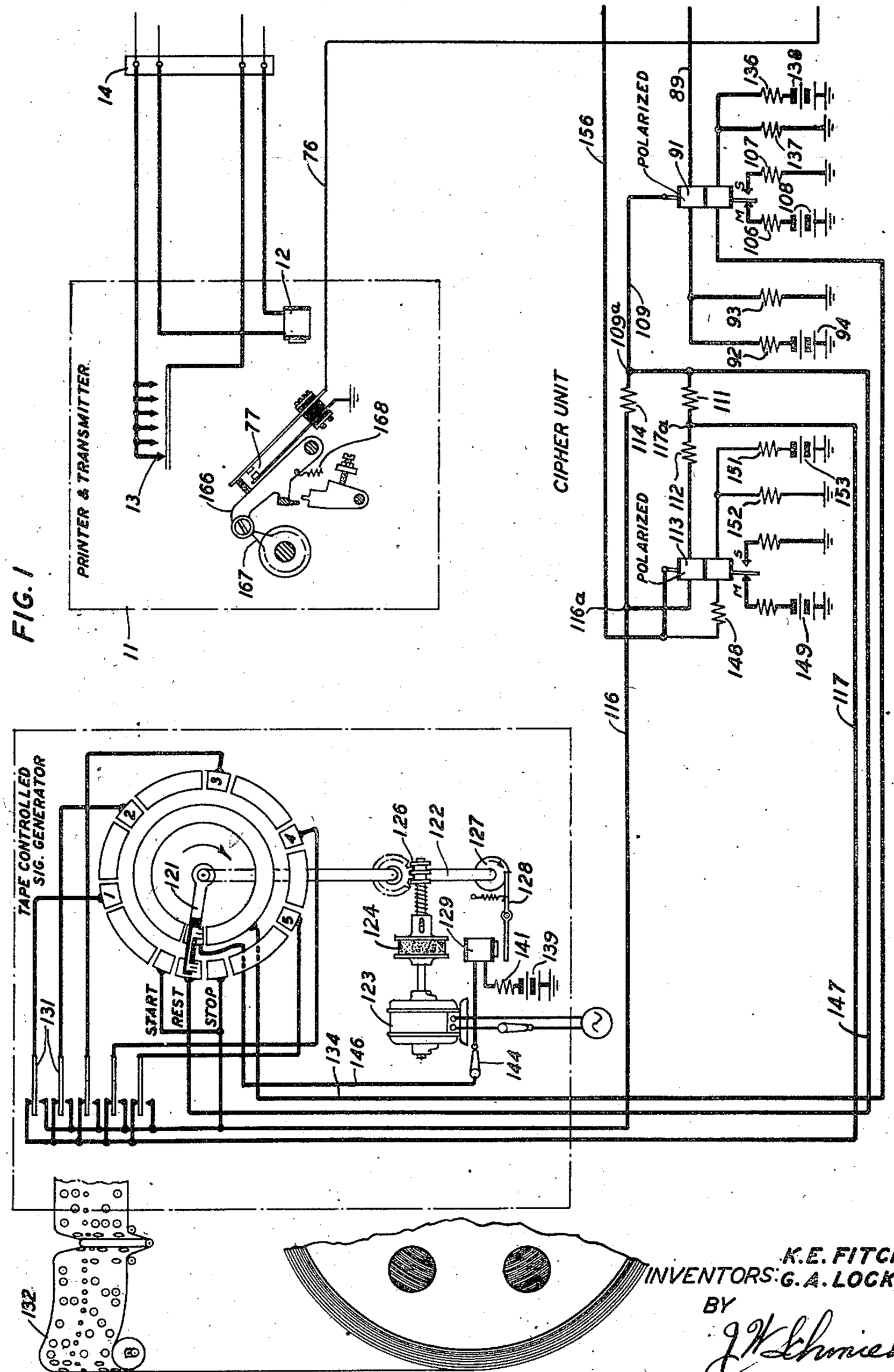
Aug. 13, 1946. K. E. FITCH ET AL 2,405,569

CRYPTOGRAPHIC TELEGRAPH SYSTEM

Filed March 18, 1942 3 Sheets-Sheet 1

FIG. 1



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CRYPTOGRAPHIC TELEGRAPH SYSTEM

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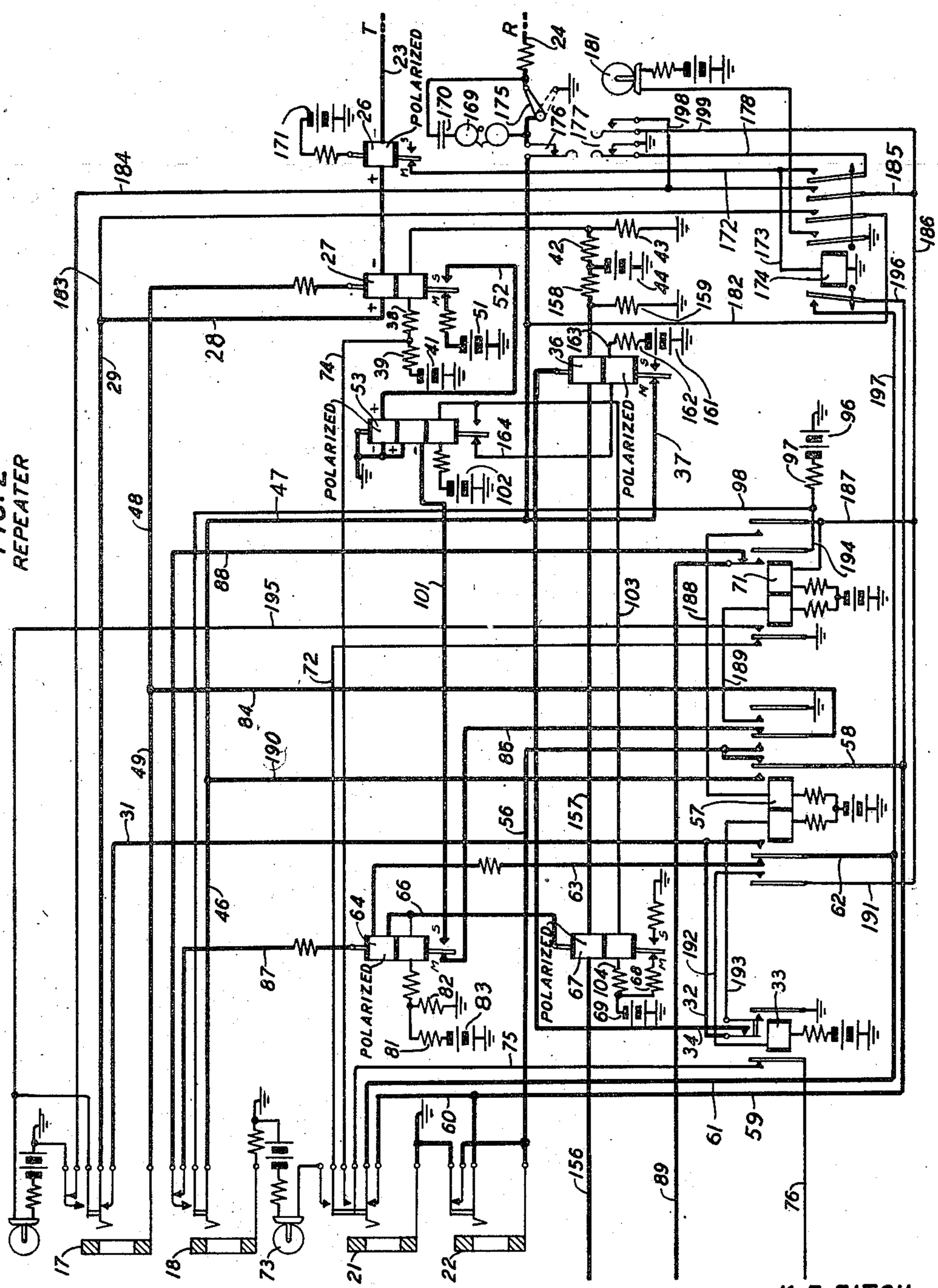
FIG. 2
REPEATER



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CRYPTOGRAPHIC TELEGRAPH SYSTEM

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FIG. 3

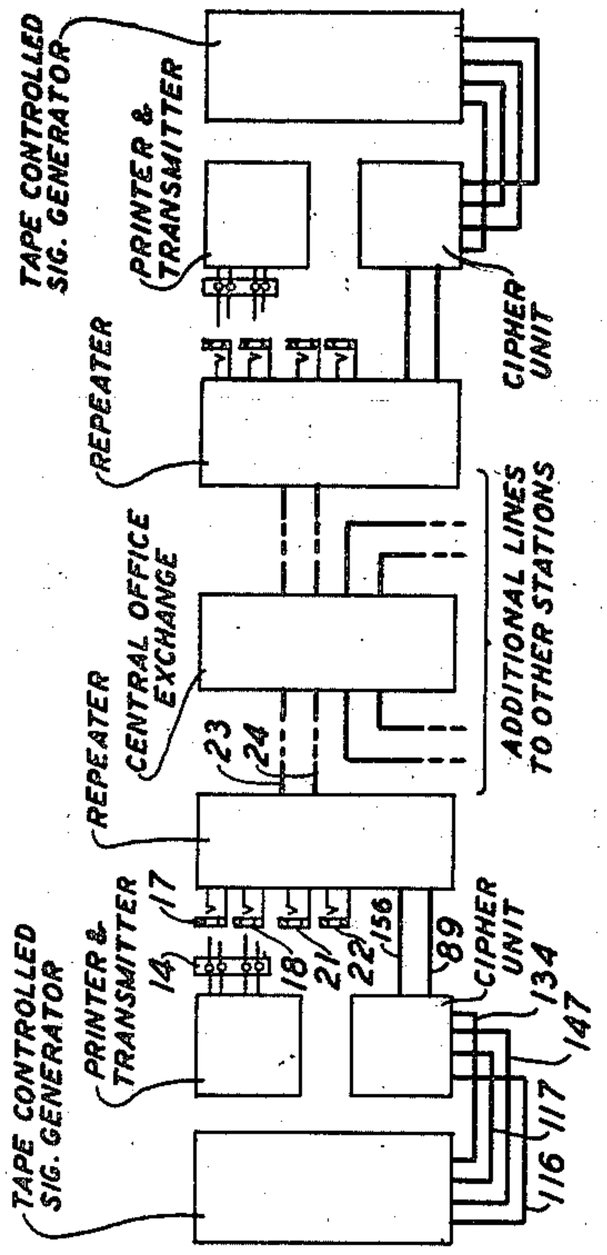

FIG. 4

CIPHER UNIT

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Patented Aug. 13, 1946 2,405,569

UNITED STATES PATENT OFFICE

2,405,569

CRYPTOGRAPHIC TELEGRAPH SYSTEM

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Application March 18, 1942, Serial No. 435,178

34 Claims. (Cl. 178—22)

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This invention relates to telegraph apparatus and systems and particularly to a cryptographic or cipher system.

Systems of this general type are exemplified by a number of patents in the prior art, such as Patent 1,310,719, granted July 22, 1919, to G. S. Vernam, which discloses a transmitting distributor for transmitting signals evolved by the interaction of message signals set up by a keyboard transmitter and cipher signals set up by a tape sensing mechanism, and a receiving distributor for delivering to a five-magnet receiving printer signals evolved by the interaction of signals impressed on a telegraph line, whether by local or remote transmitting distributor, and cipher signals set up by the same tape sensing mechanism. Another patent which shows a cipher system employing notched discs instead of a tape controlled sensing mechanism for setting up the cipher signals is British Patent 442,602 of Creed and Company, Ltd., filed August 17, 1934, accepted February 12, 1936.

An object of the present invention is to initiate code signals indicative of message material by means of keyboard controlled contacts mechanically actuated for successive impulses and simultaneously to modify said signals impulse by impulse according to cipher code signals.

Another object of the invention is to modify received signals or signals initiated for transmission by one signal modifying instrumentality solely by distinguishing automatically between transmission and reception.

A further object of the invention is to disassociate the signal modifying instrumentality from the signal initiating and receiving devices upon the transmission or reception of a break signal.

The invention features a perforated tape controlled signal generator operable in start-stop manner and producing start-stop signals for modifying received signals or signals initiated for transmission.

The invention also features a repeater associated with a telegraph signal receiving and transmitting station which includes a reversing relay, controlled in accordance with the reception of signals or the initiation of signals for transmission, for routing received signals into the signal modifier from which modified signals are impressed upon the receiving recorder and for routing signals initiated for transmission into the signal modifier from which modified signals are impressed upon the telegraph channel for transmission.

In accordance with the preferred embodiment

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of the invention, the system includes a pluralit of signal transmitting and receiving station which may be interconnected over telegraph line through a central office exchange which ha switchboard facilities. Each station has a receiv ing telegraph printer and a keyboard controlle transmitter and each station may have in addi tion to or in lieu of the keyboard transmitter perforated tape controlled transmitter. The re ceiving printer and the transmitter are connecte to a repeater to which the incoming telegrap line is also connected. There is also associate with the repeater a cipher unit which consist essentially of a signal responsive input relay, a output relay, and a tape controlled signal gen erator. The signal generator has in storage substantial quantity of previously prepared tap containing signal perforations representing char acters preferably in an unintelligible sequenc Upon the operation of the keyboard transmitte to generate signal impulses representing a cha acter of a message the signaling impulses ar applied through the repeater to the signal re sponsive input relay of the cipher unit. Th signal generator of the cipher unit is started i response to the start impulse of the signal initiat ed by the keyboard to generate a ciphering cod signal under the control of the storage tape i timed relation to the response of the input rela to the impulses initiated by the keyboard trans mitter. The output relay is controlled jointl by the input relay and by the tape con trolled ciphering signal generator in such man ner that impulses of one type, such as spacin shall be generated in response to like impulse and impulses of another type, such as mark ing, shall be generated in response to unlik impulses simultaneously received by the inpu relay and generated by the tape controlled signa generator. The signals generated by the outpu relay are impressed through the repeater on th telegraph line. A relay associated with the re peater is operable in response to the initiation o signals at the keyboard transmitter for routin the signals to the input relay of the cipher un rather than directly through the repeater to th telegraph line.

Signals received over the telegraph line ente the repeater, and the routing relay operates i response to the reception of signals, as distin guished from the initiation of signals, to rou the received signals to the input relay of th cipher unit. The received signals are those ge erated by the output relay of cipher unit at th station from which the signals are being receive

the tape in the tape controlled signal gen-
ors at both stations is identical and is ad-
ed one step for each character transmitted
eceived so that identical signals are always
ented to the tape sensing elements of the
al generators. The signals received and ap-
l to the input relay of the cipher unit control
output relay of that unit jointly with the
controlled signal generator to reproduce the
sage signal initiated by the remote trans-
er. This deciphered signal is applied through
repeater to the printing recorder.

or a complete understanding of the invention
rence may be had to the following detailed
ription to be interpreted in the light of the
mpanying drawings wherein:

g. 1 is a schematic circuit diagram showing
message transmitter and recorder and the
er unit in accordance with the present in-
ion;

g. 2 is a schematic circuit diagram showing
repeater according to the preferred embodi-
t of the invention;

g. 3 is a diagrammatic representation of a
plete communication system including a plu-
y of stations of the type shown in Figs. 1 and
be selectively interconnected through a cen-
office exchange; and

g. 4 is a schematic circuit diagram showing a
lified form of cipher unit.

eferring now to the drawings and particularly
Fig. 1, the apparatus contained within the
en line rectangle 11 represents a combined
iving telegraph printer and keyboard trans-
er which may be of the type shown in Patent
4,164, granted April 18, 1933, to S. Morton
l. The disclosure of this patent is incorpo-
d herein by reference as part of the present
ification. In Fig. 1 the printer is indicated
bolically by the selector magnet 12 and the
board transmitter for transmitting start-stop
nutation code signals is represented by the
smitting contacts 13. The selector magnet 12
onnected to the sleeve terminals of a double
14 and the transmitting contacts 13 are con-
ed to the tip contacts of the double plug 14.
double plug 14 is adapted to be inserted into
s 17 and 18 or 21 and 22 of a repeater shown
ig. 2.

he pair of jacks 17 and 18 and the pair of
s 21 and 22 represent the station side of the
eater. The opposite side which is the line
of the repeater is entered by telegraph line
ductors 23 and 24. Line conductor 23 is con-
ed through the winding of a break relay 26
through the upper or operating winding of a
r line receiving relay 27 from which a circuit
be traced through conductors 28 and 29, tip
tact spring of jack 17 and contact spring
ch it engages when plug 14 is not inserted in
s 17 and 18, conductors 31 and 32, normally
ed contacts of a relay 33 which the right-hand
ature is operable to open, conductor 34, arma-
and marking contact of the line sending
y 36 which is also a polar relay, and con-
or 37 to telegraph line conductor 24. From
it will be apparent that when plug 14 is not
rted into jacks 17 and 18, the telegraph line
ductors 23 and 24 terminate in the repeater
he loop circuit just traced without any local
ce of signaling current, from which it follows
telegraph battery is connected at the remote
of the telegraph line to provide current for
aling. The lower or biasing winding of relay
as one side connected through resistors 38

and 39 in series to the negative terminal of battery 41, the positive terminal of which is grounded, and the other side of the biasing winding is connected to one end of each of resistors 42 and 43 which form a potentiometer and which have their opposite ends connected to the negative terminal of grounded battery 44 and to ground, respectively. Current flowing in the biasing winding of relay 27 seeks to drive the armature to spacing position but in the rest condition of the apparatus current supplied over the telegraph conductors 23 and 24 and through the operating winding of relay 27 overcomes the effect of the biasing winding and holds the armature in marking condition.

Upon the insertion of plug 14 into jacks 17 and 18, conductor 31 becomes disconnected from conductor 29 at the tip contact spring of jack 17 so that the loop circuit between relay 26 and the armature of relay 36 is broken. In its place a loop is completed through the tip of the upper plug, transmitting contacts 13, tip of the lower plug, tip contact spring of jack 18 and conductors 46 and 47 to line conductor 24. Upon the operation of transmitting contacts 13 under the control of the keyboard transmitter, the loop which interconnects line conductors 23 and 24 is interrupted in correspondence with signals to be transmitted thus generating marking and spacing signals of current and no-current conditions respectively. When the loop is interrupted to produce a spacing condition, current in the operating winding of relay 27 is interrupted so that the biasing winding becomes effective to drive the armature to the spacing contact. The armature of relay 27 is connected through conductors 48 and 49 to the sleeve of jack 17 and thence through the sleeve of the upper plug, selector magnet 12, sleeve of the lower plug to the sleeve of the jack 18 which is connected to ground. The marking contact of relay 27 is connected to the negative terminal of battery 51, the positive terminal of which is grounded, and the spacing contact is connected through conductor 52 and the upper winding of a relay 53 to ground. With the armature of relay 27 engaging its marking contact, current flows to energize selector magnet 12 which is the marking condition. When the armature of relay 27 goes to spacing, the circuit of selector magnet 12 is grounded at both ends so that no current flows through selector magnet 12 or through the upper winding of relay 53. This is the spacing condition of selector magnet 12.

From the foregoing, it will be apparent that relay 27 serves as a line relay to control the operation of selector magnet 12 in response to signals received over the telegraph line comprising conductors 23 and 24 and also serves as a local repeating relay to repeat to magnet 12 signals generated locally by the transmitting contacts 13. It will be noted that signals generated by the contacts 13 are impressed directly upon the line conductors 23 and 24 and are not repeated for transmission purposes but only for home record purposes. It will also be noted that the system provides for signal transmission in either direction over line conductors 23 and 24 but not for simultaneous transmission in both directions. The tip spring of jack 17 is mechanically but not electrically associated with a spring above it which is engageable with a grounded contact when plug 14 is inserted in the jacks 17 and 18 and which is connected to one side of a lamp 52, the other side of which is connected to grounded battery. Thus when plug 14 is en-

gaged with jacks 17 and 18, lamp 52 will be lighted to indicate that the type of message transmission hereinbefore described is available.

Referring now to the jacks 21 and 22, a circuit may be traced when plug 14 is not inserted in the jack from ground on the spring of jack 22 which is mechanically associated with but electrically isolated from the tip spring of that jack through the contact which the spring engages when no plug is inserted in the jack, conductor 56, back contact and inner right-hand armature of relay 57, conductors 58, 59 and 60, lowermost contact spring and tip spring contact of jack 21, which engages the lowermost contact when plug 14 is not inserted into jacks 21 and 22, conductors 61 and 62, inner left-hand armature and back contact of relay 57, conductor 63, upper or operating winding of polar relay 64, conductor 66, armature and marking contact of polar relay 67, and resistor 68 to the negative terminal of battery 69, the positive terminal of which is connected to ground. Current flows in this circuit in the direction to hold the armature of relay 64 on its marking contact. Conductor 56 is also connected to the sleeve of jack 22 so that when plug 14 is inserted into jacks 21 and 22, the circuit just traced is enlarged to include the selector magnet 12 and transmitting contacts 13, and extends from ground on the sleeve of jack 21 through the upper sleeve contact of plug 14, selector magnet 12, lower sleeve contact of plug 14, sleeve of jack 22 from which ground on the upper contact spring is now disconnected, conductor 56, back contact and inner right-hand armature of relay 57, conductors 58 and 59, tip spring of jack 22, tip of the lower plug of double plug 14, transmitting contacts 13, tip of the upper plug of double plug 14, tip contact spring of jack 21, conductors 61 and 62, inner left-hand armature and back contact of relay 57, operating winding of relay 64, conductor 66, armature and marking contact of relay 67, resistor 68, to grounded battery 69. From this it will be observed that when plug 14 is inserted in jacks 21 and 22, selector magnet 12 is placed in series with transmitting contacts 13 so as to respond directly to permutational operation of the transmitting contacts, whereas when the plug was inserted in jacks 17 and 18, signals generated by the transmitting contacts 13 were repeated to selector magnet 12 by relay 27.

The tip spring of jack 21 mechanically operates two contact springs to complete by means of the uppermost of these springs a circuit from ground on the left-hand armature of a relay 71, through its back contact, conductor 72, closed upper contacts operated by the tip spring of jack 21, lamp 73, to grounded battery, thus lighting the lamp to indicate the type of transmission that is now available, namely, cipher transmission. At the lower of the two sets of contacts closed by the operation of the tip contact spring of jack 21, a circuit is prepared from the junction of resistors 38 and 39, through which current for the biasing winding of relay 27 is supplied, over conductor 74, the closed contacts associated with jack 21, conductor 75, back contact and left-hand armature of relay 33, and conductor 76 to normally open contacts 77 which are operable by a locking bail for the keyboard transmitter in a manner which will be described later, together with the function of the circuit just traced.

Upon the operation of transmitting contacts 13 to initiate the transmission of a code signal, the

circuit through the operating winding of rela 64 is opened for the start impulse and for eac spacing impulse and is reclosed for each markin impulse and for the stop impulse. The biasin winding of relay 64 is energized in a circuit be ginning at the interconnected resistors 81 an 82, the opposite ends of which are connected t negative battery 83 and ground respectivel; Resistors 81 and 82 form a potentiometer fro which the circuit extends through the biasin winding of relay 64, conductor 66, armature c relay 67, which at this time is held on the mark ing contact, resistor 68 and battery 69. Th biasing winding of relay 64, as thus energize seeks to move the armature to the spacing con tact but is prevented from so moving the arma ture when current flows through the operatin winding of the relay. However, upon the inter ruption of the circuit through the operatin winding due to the permutational operation c transmitting contacts 13, the biasing winding c relay 64 becomes effective to move the armatur to the spacing contact.

With the armature of relay 64 on the markin contact, a circuit may be traced from grounde battery 51 through the marking contact an armature of line receiving relay 27, conductor 48 and 84, middle right-hand armature and bac contact of relay 57, conductor 86, marking con tact and armature of relay 64, conductor 87, fixe contact and movable spring operable in make before-break manner by a contact spring me chanically operable by the tip contact spring o jack 18, conductor 88, fixed contact and movabl front contact operable by the inner right-han armature of relay 71, conductor 89, operating winding of polar input relay 91 of a cipher uni (Fig. 1), to the potentiometer comprising re sistors 92 and 93 and through those resistors t the negative terminal of battery 94, the positive terminal of which is grounded, and to ground respectively. It is to be noted at this point tha the circuit just traced is interrupted at the make-before-break contacts of jack 18 when plug 14 is inserted in the jacks 17 and 18 but that a substitute circuit for holding the operating winding of cipher unit input relay 91 energized, to hold its armature on the marking contact, is completed from the negative terminal of grounded battery 96 (Fig. 2) through resistor 97, conductor 98, the make contacts operable by the tip spring of jack 18, conductor 88, make-before-break contacts of relay 71, conductor 89, operating winding of relay 91, to resistors 92 and 93 in parallel.

The circuit from the battery 51 associated with the marking contact of relay 27 through the armature and marking contact of relay 64 and the winding of relay 91 is interrupted when relay 64 responds to spacing signals generated by contacts 13 and the armature of relay 64 leaves the marking contact, and a substitute energizing circuit for relay 91 is completed from ground on the upper terminal of the middle winding of relay 53 through that winding, conductor 101 to the spacing contact of relay 64 and through the armature of that relay and the previously traced circuit to the operating winding of relay 91. Due to the substitution of ground on the spacing contact for the negative battery connection on the marking contact and armature of relay 27, the flow of current through the operating winding of relay 91 is reversed. This current also traverses the middle winding of relay 53 in a direction to move the armature of that relay from the left-

d to the right-hand contact. No current has
t flowing through the upper winding of relay
nd conductor 52 because that conductor ter-
ates at the spacing contact of relay 27 and
rdingly the operation of the armature of
y 53 to its right-hand contact is unopposed.
lower winding of relay 53 has one terminal
nected to the negative terminal of grounded
ery 102 and the other terminal connected to
right-hand contact of relay 53 from which a
uit also extends through conductor 103, bias-
winding of relay 67 and resistor 104 to the
ative terminal of battery 69. No current
's in this circuit with the armature of relay
on its left-hand contact because batteries 69
102 are in opposition. However, with the
nded armature of relay 53 on its right-hand
tact, circuits in parallel are established for
lower winding of relay 53 to battery 102 and
the biasing winding of relay 67 to battery 69.
flow of current through the lower winding of
y 53 is in a direction to hold the armature on
right-hand contact. The flow of current
ough the biasing winding of relay 67 is in a
ction to hold the armature of that relay on
marking contact so that it cannot be moved to
cing regardless of reversals which may occur
he operating winding.

Referring now to Fig. 1, it will be noted that
armature of relay 91 is operable between
rking and spacing contacts which are con-
ted through resistors 106 and 107, respectively,
he negative terminal of grounded battery 108
l to ground, respectively. The armature of
ay 91 is connected by conductor 109 to one
ner 109*a* of a triangular bridge network which
prises one side or arm containing resistor 111,
econd side or arm containing resistor 112 and
operating winding of polar output relay 113,
l a third side or arm containing resistor 114.
m the point of interconnection of the operat-
winding of relay 113 and resistor 114, desig-
ed as the bridge corner 116*a*, conductor 116
ends to a set of five contacts of a tape trans-
ter distributor and these will be assumed to
the spacing contacts. From the point of in-
connection of resistors 111 and 112, designated
bridge corner 117*a*, conductor 117 extends to
other five contacts of the transmitter distrib-
r and these will be assumed to be the marking
ntacts.

The tape transmitter distributor is somewhat
ilar to a tape controlled transmitter distrib-
r disclosed in Patent 2,055,567, granted Sep-
nber 29, 1936, to E. F. Watson, and the dis-
sure of the Watson patent is incorporated
rein by reference as part of the present speci-
ation. However, the distributor has a consid-
bly different arrangement of signal generating
gments, as will be described hereinafter.

The distributor has a brush arm 121 which is
rried by a rotatable shaft 122 to which rota-
n is imparted from motor 123 through friction
tch 124 and gears 126. A stop cam 127 is se-
red to shaft 122 and is arranged to be arrested
armature lever 128 of electromagnet 129 when
e magnet is deenergized. Upon the energiza-
n of magnet 129, the end of armature lever
8 presented toward cam 127 is rocked out of
cking relation to the cam whereby shaft 122
released for rotation. Brush arm 121 carries
o electrically interconnected brushes which
idge outer and inner segmented rings.

The inner ring of the distributor is electrically
ntinuous except for a short conductive seg-

ment insulated from the main body of the ring and the inner brush carried by brush arm 121 is in engagement with the short segment when brush arm 121 is held at rest by the cooperation of armature lever 128 with cam 127, the segment may be called a rest segment. The outer segmented ring has a short segment which is a companion to the rest segment of the inner ring and subtends the same angle. Immediately ahead of and behind the rest segment of the outer ring are short conductive segments which represent the start and stop impulses respectively. The start segment is the first to be engaged by the brush after leaving the rest segment and the stop segment is the last to be engaged by the brush before coming into engagement with the rest segment. The remainder of the outer ring contains five uniformly spaced short conductive segments which correspond to the five code impulses of a permutation code combination and these segments are connected to the five contact tongues 131, which are permitted to move into engagement with their upper or marking contacts when the sensing pins (not shown) by which they are controlled encounter perforations in the tape 132, and are held in engagement with their lower or spacing contacts when their associated sensing pins encounter imperforate portions of tape 132. The start and stop segments are connected to conductor 116 which extends to the left-hand side of the operating winding of output relay 113, as previously set forth. The inner ring of the distributor exclusive of the rest segment is connected by conductor 134 through the lower winding of input relay 91, which is employed as a locking winding, and through resistors 136 and 137 in parallel to the negative terminal of battery 138, the positive terminal of which is grounded, and to ground respectively.

With distributor brush 121 in the rest position, the two rest segments are bridged by the brushes as previously stated and a circuit may be traced from ground on the positive terminal of battery 139 through the battery, resistor 141, winding of start magnet 129 of the distributor, closed switch 144, conductor 146, inner and outer rest segments of the distributor, conductors 147 and 109, and armature of relay 91 where negative battery 108 on the marking contact normally opposes negative battery 141 and holds start magnet 129 deenergized but where ground connection is now applied through resistor 107 and the spacing contact since it has been assumed that relay 91 has gone to spacing in response to the start impulse of a signal combination initiated by transmitting contact 13. Start magnet 129 therefore becomes energized over the circuit just traced and releases the distributor brush 121 for rotation.

The brushes first encounter the start segment where a circuit is completed from the potentiometer comprising resistors 136 and 137 through the locking winding of relay 91, conductor 134, inner ring and start segment of the distributor, conductor 116 to bridge corner 116*a* and then in branching paths through resistor 114 to bridge corner 109*a* and through the operating winding of relay 113 and resistors 112 and 111 comprising the other two bridge arms to bridge corner 109*a*, rejoining through conductor 109, armature of relay 91, spacing contact of that relay, and resistor 107 to ground which is at the positive potential of battery 138. The flow of current is through the operating winding of relay 113 in the direction to operate its armature to the spac-

ing contact and through the locking winding of relay 91 in the direction to hold the armature of relay 91 on its spacing contact during the interval that the brush traverses the start segment, so that the armature of that relay cannot return to marking even if one of the transmitting contacts 13 should become closed for a marking impulse and restore current through the operating winding of relay 91 in the direction to restore the armature to the marking contact. Current in the locking winding of relay 91 is always paramount to current in the operating winding and the armature of the relay can be shifted under the control of the operating winding only when no current is flowing in the locking winding. Since current flows in the locking winding of relay 91 only during the brief interval that the brushes traverse a segment in the outer ring of the distributor, the locking winding will not prevent a marking or spacing pulse of normal length in the operating winding of relay 91 from operating the armature.

The armature of output relay 113 is connected through resistor 148 and the lower or locking winding of output relay 113, and resistors 151 and 152 which form a potentiometer, the former being connected to the negative terminal of battery 153, the positive terminal of which is grounded, and the latter being connected to ground. Current through the holding winding of relay 113 is always in the direction to hold the armature in engagement with the contact to which it has been moved and through which a holding circuit has been completed from the negative terminal of battery 149 on the marking contact or from ground on the spacing contact, but current in the holding winding is subordinate to current in the operating winding so that upon a reversal of current through the operating winding the armature will be moved in spite of the holding current in the lower winding and a new holding circuit will be established tending to hold the armature in the new position. It is to be noted that current is always flowing through the holding winding of relay 113 in one direction or the other, whereas current flows in the holding winding of relay 91 only when the distributor brushes are traversing a conductive segment in the outer ring, excluding the rest segment.

The armature of output relay 113 is also connected through conductor 156, operating winding of relay 67 (Fig. 2), conductor 157, operating winding of line sending relay 36 to a potentiometer consisting of resistors 158 and 159, the former of which is connected to the negative terminal of battery 44 and the latter of which is connected to ground. With the armature of relay 113 on its spacing contact, current through the operating windings of relays 67 and 36 is thus reversed. It has been set forth previously that upon the operation of the armature of relay 53 to its right-hand contact, resulting from the initiation of signal transmission at transmitting contacts 13, the relay 67 became biased to hold its armature in the marking position so that reversals in its operating winding will not drive the armature to spacing. This is necessary in order to prevent relay 67 from reversing the biasing current for relay 64 and thus interfering with the operation of that relay under the control of transmitting contacts 13. It will be noted that the circuit of the biasing winding of relay 36 extends from the negative terminal of grounded battery 161 through resistor 162, conductor 163, biasing winding of relay 36 and conductor 164 to the left-hand

contact of relay 53. Since the armature of this relay is now held to the right-hand contact by current through the lower winding of the relay, there will be no current in the biasing winding of polar relay 36 and the armature of relay 36 is controlled solely by the operating winding, moving the armature to spacing, which is a dead contact, when relay 113 is spacing, and restoring the armature to marking when relay 113 is marking. The condition of the repeater circuit with respect to line conductors 23 and 24 just before the relay 36 is operated to spacing is that a previously described loop circuit is bridged across the line conductors 23 and 24 from conductor 23 through relay 26, the operating winding of relay 27, conductors 28 and 29, tip spring contact of jack 17 and contact now engaged by the tip spring contact, conductors 31 and 32, closed contacts controlled by the right-hand armature of relay 33, conductor 34, armature and marking contact of relay 36, and conductor 37 to line conductor 24. Upon the operation of the armature of line sending relay 36 to spacing position, this loop is opened, thus placing the line conductors 23 and 24 in spacing condition.

It will be noted that upon movement of the armature of sending relay 36 to spacing, current is interrupted in the operating winding of receiving relay 27. Reference is again made to contacts 77 (Fig. 1) the closure of which will connect ground over conductor 76, left-hand armature and back contact of relay 33, conductor 75, contacts of jack 21 now closed, conductor 74 and resistor 38 to one terminal of the biasing winding of relay 27. The opposite side of the biasing winding of relay 27 is connected to the potentiometer which comprises resistors 42 and 43, so that current flows in the opposite direction in the biasing winding of relay 27. The armature of relay 27 is thus biased to the marking position and will not go to spacing when relay 36 impresses a spacing condition on the line conductors. Contacts 77 are normally open but are closed by the operation of a locking bail 166 which is rocked in counter-clockwise direction by a spring 168 under the control of a cam 167 associated with the cam assembly which controls the operation of transmitting contacts 13. Cam 167 is shown in the rest position and is rotated one revolution for each code combination generated by transmitting contacts 13. This feature is more fully disclosed in Patent 2,018,368, granted October 22, 1935, to R. A. Lake, and particularly in Fig. 5 of that patent. The disclosure of the Lake patent is incorporated herein by reference as part of the present specification. Contacts 77 are closed during the generation of a signal combination by transmitting contacts 13 and therefore during the generation of a modified signal combination by the output relay 113 of the cipher unit under the joint control of input relay 91, which is controlled by transmitting contacts 13, and the tape controlled signal generator. This disablement of relay 27 is necessary when signals are being generated by relay 36 because otherwise relay 27 would follow the signals so generated, and upon movement of its armature to the spacing position, would complete the energizing circuit for the upper winding of relay 53 over conductor 52. The upper winding of relay 53 when so energized is superior to the lower winding and will restore the armature to its left-hand position, thus changing the current in the biasing windings of relays 36 and 67 and interfering with the transmission of signals under the control of ci-

pher unit output relay 113. It will be apparent that when signals are being impressed directly upon telegraph line conductors 23 and 24 through jacks 17 and 18, the relay 27 is not prevented from following these signals and repeating them to the selector magnet 12 as previously described, for the reason that jacks 21 and 22 at that time have no plug inserted therein and the contacts associated with jack 21 for interconnecting conductors 74 and 75 are open so that the contacts 77 then have no effect upon the biasing winding of relay 27.

It will be assumed that following the transmission of the start impulse, the first three message code impulses generated by transmitting contacts 13 are marking, spacing, marking, and that the first three ciphering code impulses set up by the tape 132 in the sensing contacts 131 are marking, marking, spacing. Relay 91 will be restored to its marking contact in response to the first message code impulse to apply negative battery connection through its armature to conductor 109. The transmitting contact tongue connected to the first code segment in the outer distributor ring will be in engagement with its upper or marking contact under the control of its tape sensing pin and will connect that segment over conductor 117 to bridge corner 117*a*. As the brushes traverse the first code segment of the outer ring of the distributor, a circuit may be traced from the potentiometer comprising resistors 136 and 137 through the locking winding of relay 91, conductor 134, inner ring of the distributor, first code segment of the outer ring, first tape sensing contact tongue and upper or marking contact, conductor 117 and in branching paths through resistor 111 to conductor 109 at bridge corner 109*a* and through resistor 112, operating winding of relay 113 and resistor 114 to conductor 109. It will be noted that resistor 114 is now effectively in series with relay 113 and resistor 112, and resistor 111 is in parallel with those three elements. Current flows in the opposite direction through resistors 111 and 114 than it did when the start impulse was transmitted and accordingly the current in the locking winding of relay 91 during the interval that the brushes traverse the first code segment is in the direction to hold the armature of that relay on its marking contact. The reversal of the flow of current is due to the application of negative battery to the armature of relay 91 through its marking contact instead of the grounded positive connection on its spacing contact. Whereas in the case of the transmission of the start impulse, the circuit was completed over conductor 116 to the bridge corner 116*a*, the circuit is now completed over conductor 117 to the bridge corner 117*a*. Thus the path through the operating winding of relay 113 to the armature of relay 91 has been reversed and the polarity of battery applied to the armature of relay 91 has been reversed so that the direction of flow of current through the operating winding of relay 113 has not been changed and its armature remains on the spacing contact wherefore the armature of relay 36 remains on its spacing contact and transmits as the first code impulse applied to line conductors 23 and 24, a spacing signal. It may therefore be stated that when transmitting contacts 13 generate a marking signal and the tape controlled signal generator generates a marking signal, the resulting signal transmitted to the line by output relay 113 is a spacing signal. It is also to be noted that when the transmitting contacts generated the start signal which was of spacing nature the distributor generated the equivalent of a spacing condition independently of the tape sensing mechanism, due to the fact that the start segment is connected directly over conductor 116 to bridge corner 116*a*, so that the output relay 113 generated a spacing signal. It is apparent from this that when transmitting contacts 13 and the distributor, alone or under the control of tape contacts 131, generate like signals, whether marking or spacing, the resulting signal transmitted to the telegraph line under the control of output relay 113 is of spacing nature.

It has been assumed that the second code impulse generated by transmitting contacts 13 is of spacing nature and that the second code impulse generated by the tape controlled signal generator is of marking nature. Input relay 91 of the cipher unit moves to spacing and connects ground to conductor 109. The circuit for the operating winding of relay 113 is traced from the potentiometer comprising resistors 136 and 137 through the locking winding of relay 91, conductor 134, the inner ring of the distributor through the brushes carried by brush arm 121, the second code segment in the outer ring, the second transmitting contact tongue which engages its upper or marking contact and thence over conductor 117 to bridge corner 117*a*. The path is the same as that described in the preceding paragraph, but the polarity on conductor 109 is now grounded positive instead of negative, thus reversing the flow of current through the operating winding of relay 113 and driving the armature to the marking contact. The reversed current through the locking winding of relay 91 during the interval that the brushes traverse the second code segment locks the armature on the spacing contact to guard against return of the armature to marking position should the current through the operating winding be changed at this time. The armature of relay 113 establishes a flow of current through the locking winding of that relay for positively holding the armature in the marking position after interruption of the current through the operating winding, which flows only during the brief interval that the distributor brushes traverse the code segment. The negative or marking battery applied over conductor 156 through the operating winding of relay 67, conductor 157 and the operating winding of relay 36 moves the armature of the last-mentioned relay to marking position, thus reclosing the loop across line conductors 23 and 24 for the transmission of a marking impulse. As previously stated relay 67 does not respond at this time to the reversal of current through its operating winding as the marking and spacing impulses are transmitted because it is held in the marking position by its biasing winding from the armature and right-hand contact of relay 53. It is observed from the foregoing that with a spacing impulse generated by the transmitting contacts 13 and a marking impulse simultaneously generated by the tape controlled signal generator, the output relay 113 of the cipher unit transmits a marking impulse.

It has been assumed that the third code impulse transmitted by the contacts 13 is of marking nature and that the signal generated through the third code segment of the tape controlled signal generator is of spacing nature. Relay 91 responds to the marking signal generated by contacts 13 by moving its armature to the marking position, thus connecting the negative terminal of

battery 108 to conductor 109. The circuit for the operating winding of output relay 113 is now traced from the potentiometer comprising resistors 136 and 137 through the locking winding of relay 91, conductor 134, inner ring of the distributor, brushes carried by brush arm 121, the third code segment of the outer ring of the distributor, the third transmitting contact tongue, which is assumed to be engaging its spacing or lower contact, and thence over conductor 116 to bridge corner 116*a*. By comparison with the circuit for the operating winding of relay 113 traced in the preceding paragraph, the circuit branching point is now bridge corner 116*a* instead of bridge corner 117*a*, representing a reversal with respect to relay 113, but the battery connection at conductor 109 derived from the armature of relay 91 has also been reversed so that the magnetic field in the relay 113 remains unchanged and the armature remains on its marking contact. The third signal impressed upon the line conductors 23 and 24 is therefore of marking nature. Summarizing the transmitting conditions set forth in this paragraph and in the immediately preceding paragraph, when the signals simultaneously generated by transmitting contacts 13 and the tape controlled signal generator are unlike, the signal impressed upon the telegraph line conductor under the control of output relay 113 is of marking nature. The impulses impressed on the line conductors have been start (spacing), spacing, marking, marking.

The fourth and fifth code impulses will be transmitted to the line conductors 23 and 24 under the joint control of contacts 13 and the tape controlled signal generator and thereafter contacts 13 will generate the stop impulse which is of marking nature, thus driving the armature of relay 91 to the marking contact. The brushes carried by brush arm 121 will at this time traverse the stop segment of the outer ring which is connected to conductor 116. The distributor is thus generating the equivalent of a spacing impulse while the relay 91 has responded to a marking impulse from contacts 13 and since these conditions are dissimilar, the armature of relay 113 will be moved to the marking position and through relay 36 will impress a marking condition on line conductors 23 and 24, which is the true stop signal condition.

It will have been noted that when the relay 91 responded to the start impulse of spacing nature, relay 113 was driven to spacing as the distributor traversed the start segment, and that when relay 91 responded to the stop impulse of marking nature, relay 113 was driven to marking as the distributor traversed the stop segment. It may, therefore, be stated as a part of the theory of operation that only the code impulses are ciphered, as determined by the tape sensing contacts, and that in the case of the start and stop impulses, the start and stop segments are so associated directly with the bridge circuit as to cause relay 113 to follow relay 91.

With the relay 91 in the marking position responding to the stop signal from transmitting contacts 13, negative battery is applied over conductors 109 and 147 to the rest segment in the outer ring of the distributor when the two brushes of the brush arm 121 encounter the rest segments and as this battery is opposed by the negative battery 139, start magnet 129 of the distributor is not energized and the brush arm 121 is arrested.

As shown in Fig. 3, the line conductors 23 and 24 extend to a central office exchange, which has

been so labeled in Fig. 3, from which other pairs of line conductors extend to other stations exactly like the one shown in Figs. 1 and 2, one of which has been shown at the right of Fig. 3 with the several elements labeled in correspondence with the elements of the station shown at the left of Fig. 3 and the latter station is intended to represent the one shown in Figs. 1 and 2. A central office exchange which may be employed for interconnecting telegraph stations in the system according to the present invention is shown in Patent 2,237,154, granted April 1, 1941, to G. A. Locke et al., and the disclosure of that patent is incorporated herein by reference as part of the present specification. Since all of the outlying stations are identical, it has been deemed unnecessary to produce on additional sheets of drawings, a mirror image of Figs. 1 and 2 to describe the operation of a station in receiving signals transmitted from the station shown in Figs. 1 and 2. Instead the operation of receiving a signal will be described with reference to Figs. 1 and 2 as if the signal had originated at the station shown at the right of Fig. 3 for example. An important fact to be noted regarding the transmission of signals between any two stations in a system such as that shown in Fig. 3 is that the perforated tape 132 shall be identical at all stations and when a connection has been set up through the central office exchange for intercommunication between two stations in cipher signals, the perforated tapes shall be placed in the signal generators at the two stations with identical code combinations presented in the tape sensing positions and with identical sequences of signals in storage and awaiting presentation to the tape sensing pins. The manner in which a connection is set up for intercommunication between two stations and the manner in which the use of tapes 132 is agreed upon will be described later.

For the purpose of the following description, it will be assumed that the station shown in Figs. 1 and 2 has ceased transmitting to a remote station and is about to receive signals from the remote station, that the first ciphered signal to be received is identical with that which the station previously transmitted, namely, consisting of a start impulse, a first code impulse of spacing nature, second and third code impulses of marking nature, two unidentified code impulses and a stop impulse of marking nature. This corresponds to the signal the transmission of which by relay 36 has been described heretofore. It will also be assumed that the signal which will be generated by the tape controlled signal generator concurrently with the reception of the signal over telegraph lines 23 and 24 is identical with that, the generation of which was previously described, namely, a start impulse of spacing nature, first and second code impulses of marking nature, third code impulse of spacing nature, fourth and fifth code impulses unidentified and the stop impulse of marking nature.

Due to the fact that transmission from the stations shown in Figs. 1 and 2 merely ceased, the relay 53 remains on its right-hand contacts, thus leaving the relay 36 without biasing current and the relay 67 biased in the marking direction so as to be unresponsive to current reversals in its operating winding. Since signals are not being initiated, contacts 77 are opened and normal biasing current is flowing through the biasing winding of relay 27, seeking to move the armature to the spacing position.

The start impulse is received as a no current

condition on the line conductors 23 and 24, to which the line receiving relay 27 responds by moving its armature to the spacing position. A circuit is completed from ground through the upper winding of relay 53, conductor 52, spacing contact and armature of relay 27, conductors 48 and 84, middle right-hand armature and back contact of relay 57, conductor 86, marking contact and armature of relay 64, conductor 87, upper closed contacts of jack 18, conductor 88, stationary contact and movable front contact operable in make-before-break manner by the inner right-hand armature of relay 71, conductor 89, operating winding of cipher unit input relay 91, to the potentiometer comprising resistors 92 and 93. The current in the upper winding of relay 53 dominates the armature in spite of the current through the lower winding and moves the armature to the left-hand contact. This removes the ground connection from conductor 103 extending to the biasing winding of relay 67, leaving the battery 102 in opposition to the battery 69 through the biasing winding of relay 67 and through the lower winding of relay 53 so that no current flows in this circuit and relay 67 is without bias, thus rendering it responsive to current reversals through its operating winding. Through the armature of relay 53 and its left-hand contact, biasing current is restored to the lower winding of relay 36 and this biasing current is sufficient to hold the armature of relay 36 on its marking contact irrespective of current reversals through its operating winding.

In the relay 91 the effect of the current supplied through the spacing contact of relay 27 is to move the armature of relay 91 to the spacing contact, thus reversing the polarity supplied over conductor 147 and through the rest segments of tape controlled signal generating distributor to start magnet 129, to cause the magnet to be energized and to release the distributor brush 121 for rotation. The outer brush traverses the start segment which as previously stated is connected over conductor 116 to the bridge corner 116*a*, and relay 113 follows relay 91 to spacing condition. The armature of relay 113 connects ground, which is the positive battery polarity, over conductor 156 through the operating winding of relay 67, conductor 157, operating winding of relay 36 to the potentiometer comprising resistors 158 and 159. Relay 36 is biased so as to be unresponsive to this reversal of current but relay 67 now has no current in its biasing winding and accordingly the reversed current in the operating winding is effective to move the armature to the spacing position. Before movement of the armature of relay 67 to its spacing contact, current from negative battery 69 through resistor 68, marking contact and armature of relay 67, conductor 66, biasing winding of relay 64 to the potentiometer comprising resistors 81 and 82 was in a direction to cause the biasing winding of relay 64 to urge the armature to the spacing position but the armature was dominated and held in the marking position by current through the operating winding from battery 69 through resistor 68, marking contact and armature of relay 67, conductor 66, operating winding of relay 64, conductor 63, back contact and inner left-hand armature of relay 57, conductors 62 and 61, tip contact spring of jack 21, tip of the upper plug section of double plug 14, transmitting contacts 13, tip of the lower plug section, tip spring of jack 22, conductors 59 and 58, inner right-hand armature and back contact of

relay 57, conductor 56, sleeve of jack 22, sleeve of the lower plug section of double plug 14, selector magnet 12, sleeve of the upper plug section and sleeve of jack 21 to ground. The current in this circuit also holds selector magnet 12 energized which is the marking condition. With the operation of the armature of relay 67 to the spacing position under the control of output relay 13, the ground connection on the spacing contact is placed in opposition to the ground on the sleeve of jack 21, thus terminating the flow of current in the circuit just described including the operating winding of relay 64 and the selector magnet 12. The selector magnet is thus deenergized which is the spacing condition. The ground connection on the spacing contact of relay 67 also reverses the current in the biasing winding of relay 64, so that that winding now urges the armature of relay 64 to remain in engagement with the marking contact and since no current flows in the operating winding, this urge is unopposed and the armature remains as stated. The disablement of relay 64 by reversal of its biasing current prevents it from attempting to follow the signals applied through its operating winding to selector magnet 12. Were it not for this disablement the armature of relay 64 might go to spacing thus, reoperating relay 53 to its right-hand contact, the effect of which would be to disable relay 67 and to qualify relay 36 to follow and repeat to the line conductors 23 and 24 signals generated by output relay 113 and intended to operate selector magnet 12.

Following the reception of the start signal, the first code impulse, which has been presumed to be of spacing nature, is received and relay 91 remains on its spacing contact. The first code impulse generated by the tape controlled signal generator is assumed to be marking and since this impulse is unlike the received impulse, relay 113 goes to marking and reoperates relay 67 to marking, thus reestablishing an energizing circuit for selector magnet 12. The signal received by the selector magnet is the reverse of that received by input relay 91 but is like the first code impulse previously described as having been generated by transmitting contacts 13. The second received code impulse has been assumed to be of marking nature, thus restoring relay 91 to its marking contact and the second code impulse generated by the tape controlled signal generator has also been assumed to be of marking nature. This impulse is like the received impulse and accordingly relay 113 goes to spacing and operates relay 67 to spacing which applies a spacing condition to the selector magnet 12. The third code impulse received has been assumed to be of marking nature, so that relay 91 remains on its marking contact. The third code impulse generated by the tape controlled signal generator has been assumed to be spacing, which is unlike the received code impulse and accordingly relay 113 is operated to its marking contact, operating relay 67 to its marking contact to reestablish the energizing circuit for selector magnet 12. The fourth and fifth code impulses are thereafter received and selector magnet 12 is operated under the joint control of the cipher unit input relay 91 and the tape controlled signal generator. The stop impulse is of marking nature and operates the relay 91 to its marking condition. As has been previously set forth, the stop segment of the tape controlled signal generator is connected directly over conductor 116 to bridge corner 116*a*, to cause relay 113 to be operated to the marking position under the con-

trol of relay 91 and selector magnet 12 is similarly operated.

It will now be understood that when a signal which has been generated under the control of the transmitting contacts 13 is routed through the cipher unit before transmission, the code impulses are modified by the code impulses of a signal generated by the tape controlled signal generator and a modified signal consisting of a different combination of marking and spacing impulses is transmitted. This modified signal on being received is routed through a cipher unit and is again modified by a signal identical with the first modifying signal under the control of a tape controlled signal generator whereby the signal is restored to its original condition and will operate a receiving printer to record the character or symbol or to perform the function represented by the key lever which was operated in the keyboard transmitter to initiate the transmission of the signal. It will also be understood that the relay 53 is a reversing relay which is operated to one position or the other, in accordance with whether signals are locally generated for transmission or are received, to reverse the operative relation of the cipher unit to the repeater. This reversing control is effected by alternately disabling relay 36 and relay 67, the former being disabled when signals are being received so that signals derived from the output relay 113 of the cipher unit will not be repeated back into the telegraph line and the relay 67 being disabled when signals are being transmitted so that signals derived from relay 113 will not be repeated back into the local printer circuit. Auxiliary to this reversing control are the controls exercised over the biasing windings of relays 64 and 27 by the armature of relay 67 and the contacts 77, respectively, so that relay 64 will not interpret a spacing signal repeated by relay 67 to the selector magnet 12 as a spacing signal generated by the transmitting contacts 13, and the relay 27 will not interpret a spacing signal repeated to the telegraph lines 23 and 24 by the relay 36 as a spacing signal received from the telegraph line.

Each station preferably has ringer equipment connected between the telegraph line and the line side of the repeater. The ringer equipment includes ringer 169, condenser 170 in series therewith, and switch 175. The switch 175, when in the "off" or dotted line position, disconnects line conductor 24 from the repeater and connects the ringer and condenser between conductor 24 and ground, which is the shut-down condition, with ringer 169 responsively associated with conductor 24. When switch 175 is in the "on" or solid line position, line conductor 24 is connected to the repeater in short-circuiting relation to the ringer and condenser, and ground is disconnected from the ringer.

The procedure for setting up intercommunication between two stations of the type shown in Figs. 1 and 2 will now be described. The attendant at the station desiring to communicate with another station inserts double plug 14 into jacks 17 and 18 which afford the transmission of unciphered signals as previously set forth and operates switch 175 to the "on" position. An operator at the central office exchange answers the call, due to receiving an indication resulting from operation of switch 175 to the "on" position, ascertains by telegraph communication with the attendant at the calling station the identity of the called station, sets up the connection and transmits to the called station ringing current to operate

ringer equipment with which each of the stations may be provided. The attendant at the called station answers the call by operating key 175 to the "on" position and by inserting his double plug into the jack corresponding to jacks 17 and 18 which afford unciphered signal transmission and reception. The attendants at the two interconnected stations may now communicate by direct unciphered transmission and agree upon the exact identical points in their tapes 132 which will be placed in their cipher signal generators for the ciphering and deciphering of transmitted and received codes. This having been done, the attendants at both stations remove the double plugs from the jacks 17 and 18 and insert them into the jacks 21 and 22. Thereafter message material may be transmitted back and forth between the two stations and such message material will be in cipher so that if any unauthorized person taps into the telegraph line anywhere between the two interconnected stations with an ordinary receiving printer, or other permutation code recorder, he will receive ciphered signals which will produce unintelligible printed copy. The lamps 52 and 73 serve to inform an attendant at all times whether the connections and repeater conditions are arranged for unciphered or ciphered transmission and reception.

Relay 26 (Fig. 2), which has previously been identified as having its winding in series with the operating winding of the line receiving relay 27, has its armature connected to grounded battery 171 and its contact which is engaged by the armature when marking current is flowing in the line conductors 23 and 24 connected by conductors 172 and 173 through the winding of a slow-release relay 174 to ground. Relay 26 follows the signals in the telegraph line and interrupts the energizing circuit for relay 174 when responding to spacing signals but the releasing of relay 174 is sufficiently slow that it does not release in response to spacing intervals of a duration normally occurring in signal transmission but releases only in response to a long spacing signal such as may be produced by the opening of break key 176 which is included directly in the telegraph line circuit and has been shown in Fig. 2 associated with line conductor 24. The long spacing signal representing the break condition cannot be produced by the operation of break contacts sometimes included in series with the keyboard controlled transmitting contacts of the teletypewriter for the reason that the long spacing signal thus produced would be impressed upon the input relay 91 of the cipher unit and would be ciphered by that unit in accordance with the signal generated by the tape controlled signal generator to cause the transmission by the output relay 113 of a ciphered signal probably containing marking impulses which would restore the relay 26 to marking and prevent the release of relay 174. By opening the key 176 at either of two interconnected stations for an interval longer than the release time of relay 174, the relay 26 at both stations will go to spacing and remain for a sufficient interval to release their associated relays 174. At the station which has been transmitting and has the armature of its relay 53 on the right-hand contact, the relay 27 will respond to the long spacing signal if the transmitting contacts are then idle or when the contacts open at the end of the code signal then in process of transmission, and will move the armature of relay 53 to the left-hand contact, thereby disabling relay 36 and placing relay 91 (Fig. 1) in the steady

spacing condition and causing the received long spacing signal to be ciphered and the resulting code signal to be applied to selector magnet 12 under the control of relay 113. At the station which has been receiving and has the armature of its relay 53 on the left-hand contact, the cipher unit input relay 91 will respond to the long spacing signal under the control of line receiving relay 27 pending the release of relay 74 and the cipher unit will cipher the received long spacing signal under the control of the tape controlled signal generator and will apply the resulting signals to the selector magnet by the operation of relay 67. The character or characters recorded as a result of the ciphered break signal will be unintelligible but this is of no consequence since the break signal is usually originated by a receiving station in order to interrupt transmission from the transmitting station for such purpose as to request the repetitious transmission of certain message material which may not have been received correctly or to enable the receiving station to seize control of the communication circuit for the transmission of more urgent message material. The ciphering of the break signal will take place only until relay 174 has released, as will be apparent hereinafter.

At its extreme right-hand armature and back contact, relay 174 connects ground supplied through the break contacts of key 177 and conductor 178 to conductor 173 in shunt relation to relay 172, thus short-circuiting the relay so that it will not be energized when break key 176 is reclosed and the telegraph line is restored to marking condition, reestablishing connection from battery 171 to conductor 172 through the armature and marking contact of relay 26. At its innermost right-hand armature and back contact, the relay 174 completes the energizing circuit for a lamp 181 which becomes lighted to indicate that relay 174 has released and therefore that the break operation has been accomplished. At its armature and back contact adjacent to the innermost armature, the relay 174 connects a closed loop from line conductor 24, through conductor 182, armature and back contact of relay 174, conductor 183, conductor 28, operating winding of receiving line relay 27 and winding of relay 26 to line conductor 23. It will be noted that this loop short-circuits the armature and marking contact of line sending relay 36 but includes the operating winding of relay 27 whereby the relay 27 remains operative to receive signals from the telegraph line conductors but relay 36 cannot transmit signals to the line conductor.

The relay 174 completes a circuit from ground through the contacts controlled by jack 17 which are closed when plug 14 is not inserted in jacks 17, conductor 184, back contact and armature adjacent to the outermost right-hand armature of relay 174, conductors 185, 186 and 187, through the right-hand winding of relay 71 to grounded battery. Relay 71 completes a circuit from conductor 187, through its outer right-hand armature and front contact and through conductor 188 and the right-hand winding of relay 57 to grounded battery, for operating relay 57. Relay 71 completes a circuit from ground through its outer right-hand armature and front contact and through conductor 189 and the holding winding of relay 71 to grounded battery for holding the last-mentioned relay operated. Relay 57 also completes a circuit from conductor 186 through conductor 191, the outer left-hand armature and front contact of relay 57, conductor 192, and the winding of relay 33 to grounded battery for energizing relay 33. Relay 33 completes a circuit from ground through its right-hand armature and front contact and through conductor 193 and the holding winding of relay 57 for holding that relay energized.

Since the relays 71, 57 and 33 are energized in cascade in that order, the operations which they perform will be described in the same order. At the inner right-hand armature of relay 71 and front contact, which has make-before-break relation to a fixed contact, the negative terminal of battery 96 is connected over conductor 194 and conductor 89 extending to the input relay 91 of the cipher unit to hold that relay in the marking condition and following the completion of this circuit, conductor 88 which extends through contacts of jack 18 and conductor 87 to the armature of relay 64 is disconnected from conductor 89 so that relay 91 is no longer under the control of relay 64. This change of circuit connections is the same as that which results from the operation of the contacts associated with jack 18 when the double plug 14 is inserted into jacks 17 and 18, and upon the occurrence of this change the ciphering of the break signal, if that signal is still in transmission, will cease upon completion by the tape controlled signal generator of the cycle then in progress. At the left-hand armature of relay 71 to ground connection previously extended over the back contact and conductor 72 and through the upper contacts controlled by jack 21 for lighting lamp 73, is removed from that circuit and is applied over conductor 195 to lamp 52 whereby the lamp becomes lighted and lamp 73 becomes extinguished.

At the middle right-hand armature of relay 57, the conductive path extending from the armature of relay 27 over conductors 48 and 84 is transferred from the marking contact of relay 64 to conductor 56 over which a circuit extends through the sleeve of jack 22, sleeve of the lower plug section of plug 14, the selector magnet 12, sleeve of the upper plug section to ground on the sleeve of jack 21. This places the selector magnet 12 directly under the control of receiving relay 27 and removes it from series relation to the transmitting contacts 13, thus placing the selector magnet 12 in the same relation to receiving relay 27 that it has when plug 14 is inserted into jacks 17 and 18. At the inner right and left-hand armatures of relay 57 which represent the conductive paths extending from the two sides of the transmitting contacts 13 into the repeater, through the tip springs of jacks 21 and 22, conductive paths are extended over conductors 190 and 31, respectively, to line conductor 24 through conductor 47 and to line conductor 23 through the tip contact spring and associated contact of jack 17, through conductors 29 and 28 and the operating winding of relay 27. These two armatures of relay 57 thus complete the segregation of the circuit of transmitting contacts 13 from that of selector magnet 12 and establish the same relation of the transmitting contacts to the line conductors 23 and 24 that exists when plug 14 is inserted into jacks 17 and 18. It will be noted that the left-hand armature and back contact of relay 174 are connected by conductors 196 and 197 to the conductors 59 and 61, respectively, which extend to the transmitting contacts 13 so that the operation of transmitting contacts will have no effect upon relay 27 and line conductors 23 and 24 because the transmitting contacts are shunted by conductors 196

and 197 now interconnected at the left-hand armature and back contact of relay 174. At the normally closed contacts which are mechanically operable by the front contact of relay 33, conductor 32 is disconnected from conductor 34, thus removing the armature of relay 36 from its previous connection to line conductor 23 through conductor 31, closed contacts of jack 17, conductors 29, 28, and the operating winding of relay 27. At the left-hand armature and back contact of relay 33, the path from contacts 77 to the biasing winding of relay 27 is interrupted, so that relay 27 will not be prevented from following signals generated by transmitting contacts 13.

From the foregoing, it will be apparent that although the double plug 14 remains in jacks 21 and 22, circuit changes have been effected by the relays 33, 57, and 71 to provide for direct unciphered transmission as if plug 14 had been removed from jacks 21 and 22 and inserted in jacks 17 and 18, with the exception that due to the shunt across the transmitting contacts provided by the outer left-hand armature and back contacts of relay 174, the transmitting contacts 13 have been rendered ineffective to generate signals. Also lamp 73 has been extinguished and lamp 52 has been lighted to indicate that the system is now set up for unciphered transmission. Either of the interconnected stations is capable of receiving signals because the receiving relay 27 is effectively associated with the telegraph line conductors 23 and 24 but neither station is now capable of transmitting because of the shunt across the transmitting contacts 13.

Transmission from either of the interconnected stations necessitates the removal of the shunt across the transmitting contacts 13 and thus the reenergization of relay 174. This may be accomplished by operating the key 177 which removes the ground connection which has been short-circuiting the winding of relay 174 through its middle left-hand armature and back contact. In order for the signal transmission to take place in unciphered codes in accordance with the conditions which have been established by relays 33, 57 and 71, it is necessary to maintain these relays energized. Accordingly, the make contacts of key 177 are arranged to interconnect conductors 184 and 186 through conductors 198 and 199. The make contacts, when closed, provide a substitute energizing circuit for relay 33 which in turn holds relay 57 which in turn holds relay 71. Upon the reenergization of relay 174 from the marking contact of relay 26, the shunt across transmitting contacts 13 is removed and the loop from the line conductor 24 to the left-hand side of the operating winding of relay 27 is removed. The relay 36 is not thereby enabled to impress signals on the line conductors 23 and 24 because the armature has been isolated at the now open contacts mechanically operated by the front contact of relay 33. As a further result of the reenergization of relay 174, lamp 181 is extinguished and the shunt across the make contacts of key 177 at the back contact and armature adjacent to the right-hand armature relay 174 is opened so that the relays 33, 57 and 71 are being held only through the make contacts of key 177. When key 177 is subsequently reclosed, relay 174 will not be again released because the path for shunting its winding is opened at the middle left-hand armature and back contact and the relay can be released only under the control of relay 26.

It is not necessary to operate key 177 for either of the interconnected stations to receive and

record unciphered code signals from the other station but it is necessary to operate the key 177 in order to transmit unciphered code signals. Transmission back and forth between the interconnected stations under these conditions may involve requests for retransmission in cipher of portions previously transmitted in cipher or may convey information that the station which has been receiving has an urgent message for the station which has been transmitting to be transmitted in ciphered code. Before the system is returned to the ciphering condition, the attendants at the two stations should recheck as to the tapes 132 which control their ciphering signal generators and should agree on a resetting of these tapes as there is a possibility that the tapes at the two stations may get out of step during the transmission of the break signal. When all such intercommunication as is considered permissible to conduct in unciphered codes has been completed, the attendants at the interconnected stations will restore key 177 to normal condition. The restoration of the break contacts has no effect on the apparatus. The restoration of the make contacts interrupts the holding current for the relays 33, 57 and 71. Current through the relay 33 and through the operating windings of relays 57 and 71 is at once interrupted. The relays release in the reverse order from that in which they were operated, namely, the relay 33 interrupts the holding circuit for the relay 57 which releases and interrupts the holding circuit for the relay 71 which then releases. As the relays release, they reconvert the repeater connections from those for unciphered transmissions and reception and to those for ciphered signal transmission and reception and they extinguish lamp 52 and relight the lamp 73. Due to the order in which the relays 33, 57 and 71 are released and due also to the make-before-break relation of certain of their armatures and contacts, no circuit continuities which would, if interrupted, impress momentary spacing signals on the telegraph line conductors 23 or 24 or which might release the distributor of the tape controlled signal generator are disturbed, so that the stations are returned to the cipher code signaling condition with all elements and circuits prepared to cooperate in the transmission or reception of ciphered signals and with the tapes 132 properly in step.

Fig. 4 shows a modified form of cipher unit in which the modification consists in depriving the brush and segment distributor of control over the output relay 113 in connection with the generation by the relay 113 of a start impulse, and instead placing the relay 113 solely under the control of input relay 91 for the generation of that impulse. The modification has been accomplished by the addition of apparatus and circuit connections which will be described hereinafter. Fig. 4 fully duplicates the cipher unit apparatus and system shown in Fig. 1, and to the extent of such duplication, but disregarding the additional apparatus and circuit connections, the circuit connections of Fig. 4 are identical with those of Fig. 1 except that the distributor has no start segment, so that the only segment in the outer ring of the distributor that is connected directly to conductor 116 is the stop segment. This has permitted the lengthening of the rest segment either by interconnecting the start segment and the rest segment in the outer ring by a conductive strap or by substituting for the rest and start segments in the outer ring a single segment subtending the

angle which the two formerly subtended. The rest segment in the inner ring of the distributor has not been lengthened, from which it will be apparent that when the inner brush leaves the rest segment, the energizing circuit for start magnet 129 will be interrupted, as before.

The apparatus by which relay 113 has been placed solely under the control of relay 91 for the production of start impulses comprises polar relay 201 having a single winding, polar winding 202 having operating and biasing windings, normally open contacts 203 controlled by a cam 204 added to distributor shaft 122, and a timing condenser 206.

One end of the winding of relay 201 is connected through resistor 207 to conductor 147, and the other end of the winding is connected to one end of each of resistors 208 and 209, the other ends of which are connected to ground and to the negative terminal of grounded battery, respectively, and thus form a potentiometer. Since conductor 147 receives battery connection of negative or positive polarity over conductor 109 as the armature of relay 91 engages its marking or spacing contacts, respectively, relay 201 will directly follow relay 91.

The armature of relay 201 is connected through resistor 211 to ground and the marking contact is connected to the right-hand terminal of the operating winding of relay 202, the other terminal of which is connected through resistor 212 to the negative terminal of grounded battery 213. The biasing winding of relay 202 has one terminal connected through resistor 214 to the negative terminal of battery 213 and the other terminal connected to ground. Current in the biasing winding of relay 202 seeks to move the armature of that relay to the left-hand contact, but when the operating winding of relay 202 is receiving energizing current, that current dominates the armature of relay 202 and holds it in engagement with the right-hand contact. The right-hand terminal of the operating winding of relay 202 is also connected through variable condenser 206 and resistor 216 to ground. The armature of relay 202 is connected by conductor 217 to conductor 134 which extends to the biasing winding of relay 91 and to the inner ring of the distributor. The left-hand contact of relay 202 is connected by conductor 218 to conductor 116 which extends to the corner 116A of the bridge circuit in which the operating winding of relay 113 is connected.

When relay 91 goes to spacing in response to a start signal generated by the transmitting contacts 13 or received over the telegraph line, relay 201 also goes to spacing and disconnects ground supplied through resistor 211 from the operating winding of relay 202. The operating winding remains energized due to current which flows through resistor 216 for charging the condenser 206. When the condenser has become charged, the current in the operating winding of relay 202 dies out and the current in the biasing winding becomes effective to move the armature into engagement with the left-hand contact of the relay. This establishes a conductive path from the potentiometer comprising resistors 136 and 137 through the biasing winding of relay 91, conductors 134 and 217, armature and left-hand contact of relay 202 and conductors 218 and 116 to the corner 116A of the bridge circuit. Since the relay 91 is at this time in the spacing condition, the polarities applied across the bridge circuit are such that the armature of relay 113 is moved to the spacing contact to impress a spacing condition on the conductor 156.

In the first described embodiment of the invention, when the armature of relay 91 moved into engagement with the spacing contact in response to the start impulse, the energizing circuit for the start magnet 129 of the distributor was completed, whereby the distributor was released for rotation, and initiated the transmission of the start impulse. Since the distributor no longer has a start segment, but only a longer rest segment, the generation of the start impulse by relay 113 is not controlled by the distributor but is initiated solely under the control of relay 202. The charging time of condenser 216 and thus the time when the generation of the start impulse by relay 113 is initiated may be varied by varying the capacity of condenser 206 so that if desired, the start impulse may be initiated before the distributor brushes could have traveled far enough to engage a start segment if such segment were provided on the distributor as in the previously described embodiment of the invention, or even before the start magnet 129 has become operated. The starting of the distributor is the same in the present embodiment of the invention as in the embodiment first described, namely, the reversal of polarity on the armature of input relay 91 from which a conductive path for energizing start magnet 129 is traced over conductors 109 and 147, rest segments and brushes of the distributor, and conductor 146 to the start magnet.

Cam 204 which is secured to distributor shaft 122 presents a low portion to the contacts 203 of such length that the contacts open about the time that the brushes traverse the stop segment of the distributor, remain open during the rest condition and reclose just before the brushes encounter the first code impulse segment of the distributor. One of the springs of contacts 203 is connected through conductor 221 and resistor 211 to ground and the other spring of contacts 203 is connected through conductor 222 to the right-hand side of the operating winding of relay 202. Thus when contacts 203 are closed by cam 204, they reconnect ground to the right-hand terminal of relay 202 through conductor 222, contacts 203, conductor 221 and resistor 211 so that the operating winding of relay 202 is reenergized to move the armature of the relay out of engagement with its left-hand contact, even though relay 201 may remain on its spacing contact under the control of relay 91. The interconnection between conductors 116 and 134 in shunt relation to the spacing contact side of the tape controlled signal generator which the armature and left-hand contact of relay 202 had established is thus removed before the traversal of the first code segment by the brushes of the distributor, so that relay 113 is placed under the control of the distributor during the traversal of the code segments and relay 202 is prevented from reoperating to its left-hand contact although relay 201 continues to follow relay 91. When the distributor brushes reach the stop segment, at which time relay 91 is in the marking condition, contacts 203 reopen, thus restoring relay 202 to control by relay 201 which being at this time in the marking condtion holds the operating winding of the relay 202 energized, and the system is thus prepared for the transmission of the next start impulse.

Although particular embodiments of the invention have been disclosed in the drawings and described in the foregoing specification, it will be

understood that the invention is not limited to such specific embodiment but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a telegraph system, a first signal generator, a second signal generator operable concurrently with said first signal generator, means for interactively combining signals generated by said two signal generators to produce signals different from both of the interactively combined signals, a telegraph signal receiver, a telegraph line, and means for alternatively associating said combining means with said line and said receiver in receiving and transmitting relation respectively or with said first signal generator and said line in receiving and transmitting relation respectively.

2. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, a repeater connected between said message signal generator and said line having a relay responsive to signals generated by said message signal generator and a relay responsive to signals received over said line, means for interactively combining signals generated by said storage type of signal generator and signals impressed upon either of said relays to produce signals different from both of said interactively combined signals, and means controlled by either of said relays upon response to signals for reversin the cooperative relation of said combining means to said repeater.

3. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, a repeater connected between said message signal generator and said line having a relay responsive to signals generated by said message signal generator and a relay responsive to signals received over said line, means for interactively combining signals generated by said storage type of signal generator and signals impressed on either of said relays to produce signals different from both of said interactively combined signals, and means operable in one predetermined manner by said first-mentioned relay for associating said combining means in signal receiving relation to said first-mentioned relay and operable in a different predetermined manner by said second-mentioned relay for associating said combining means in signal receiving relation to said second-mentioned relay.

4. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph recorder, a telegraph line, a repeater connected between said message signal generator and said recorder on one side and said line on the other side, said repeater having a relay responsive to signals generated by said message signal generator and a relay responsive to signals received over said line, means for interactively combining signals generated by said storage type of signal generator and signals impressed on either of said relays to produce signals different from both of said interactively combined signals, and means operable in one predetermined manner by said first-mentioned relay for associating said combining means in signal receiving relation to said first-mentioned relay and in signal transmitting relation to said line and operable in a different predetermined manner by said second-mentioned relay for associating said combining means in signal receiving relation to said line and in signal transmitting relation to said recorder.

5. In a telegraph system, a first source of signals, a second source of signals, a third source of signals, means for interactively combining signals from said first source or said second source and signals from said third source, a signal recorder, means controlled by said combining means for controlling said recorder, a telegraph line, means also controlled by said combining means for controlling said recorder, a telegraph line, means also controlled by said combining means for impressing signals on said line, and means controlled by signals from said first source for disabling said recorder controlling means and alternatively controlled by signals from said second source for disabling said signal impressing means.

6. In a telegraph system, a station, a first source of signals thereat comprising a keyboard controlled signal generator, a second source of signals comprising a telegraph line, a third source of signals comprising a storage type of signal generator at said station, means for interactively combining signals from said first source or said second source and signals from said third source, a signal recorder at said station, means controlled by said combining means for controlling said recorder, means also controlled by said combining means for impressing signals on said telegraph line, and means controlled by signals from said first source for disabling said recorder controlling means, and alternatively controlled by signals from said second source for disabling said signal impressing means.

7. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means controlled by said combining means for impressing said different signals on said line, means for impressing a break signal on said line, and means responsive to said break signal for disassociating said combining means from said message signal generator and for disabling said message signal generator.

8. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means for impressing said different signals on said line, means for impressing a break signal on said line, and means responsive to said break signal for disassociating said combining means from said message signal generator, for associating said message signal generator directly with said line and for temporarily rendering said message signal generator incapable of generating signals.

9. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means for impressing said different signals on said line, means for impressing a break signal on said line,

means responsive to said break signal for disassociating said combining means from said message signal generator, for associating said message signal generator directly with said line and for temporarily rendering said message signal generator incapable of generating signals, and manually operable means for restoring signal generating capability to said message signal generator.

10. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means for impressing said different signals on said line, means for impressing a break signal on said line, means responsive to said break signal for disassociating said combining means from said message signal generator, for associating said message signal generator directly with said line and for temporarily rendering said message signal generator incapable of generating signals, and manually operable means for restoring signal generating capability to said message signal generator, said manually operable means being effective upon restoration to normal to reassociate said message signal generator with said combining means.

11. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, a telegraph line, a repeater associated with said line, means for associating said message signal generator directly with said line, and alternatively usable means for associating said message signal generator with said combining means through said repeater and for associating said combining means with said line through said repeater.

12. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, a telegraph line, a repeater associated with said line, means for associating said message signal generator directly with said line, alternatively usable means for associating said message signal generator with said combining means through said repeater and for associating said combining means with said line through said repeater, means for impressing a break signal on said line, and means responsive to said break signal when said alternatively usable means is in use for disassociating said combining means from said message signal generator and from said line and for associating said message signal generator directly with said line.

13. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, a telegraph line, a repeater associated with said line, a recorder, means for associating said message signal generator directly with said line and said recorder with said line through said repeater, and alternatively usable means for associating said message signal generator and said recorder in series therewith with said combining means through said repeater and for associating said combining means with said line through said repeater.

14. In a telegraph system, a message signal generator, a telegraph line, a repeater associated with said line, a recorder, and switching means for associating said message signal generator directly with said line and said recorder with said line through said repeater and for alternatively associating said message signal generator and said recorder in series therewith with said line through said repeater.

15. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, a telegraph line, a repeater associated with said line, a recorder, means for associating said message signal generator directly with said line and said recorder in series therewith with said combining means through said repeater and for associating said combining means with said line through said repeater, means for impressing a break signal on said line, and means responsive to said break signal when said alternatively usable means is in use for dissassociating said combining means from said message signal generator and from said line and for associating said message signal generator directly with said line and said recorder with said line through said repeater.

16. In a telegraph system, a message signal generator, a telegraph line, a repeater associated with said line, a recorder, means for associating said message signal generator directly with said line and said recorder with said line through said repeater, alternatively usable means for associating said message signal generator and said recorder in series therewith with said line through said repeater, means for impressing a break signal on said line, and means responsive to said break signal when said alternatively usable means is in use for associating said message signal generator directly with said line and said recorder with said line through said repeater.

17. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a storage type of signal generator having a sequence of non-message signals in storage therein for generating telegraph signals element by element in succession, a telegraph line, means for interactively combining signal elements generated by said two signal generators, and means controlled by said combining means for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator.

18. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a first single relay responsive to said signal elements, a storage type of signal generator having a sequence of non-message signals in storage therein for generating signals element by element in succession, a second single relay controlled joint-

ly by said first single relay and said storage type of signal generator for interactively combining signal elements generated by said message signal generator with signal elements generated by said storage type of signal generator, and means controlled by said first single relay for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator.

19. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means for impressing said different signals on said line, means for impressing a break signal on said line, and means responsive to said break signal for disassociating said combining means from said message signal generator, for connecting said message signal generator directly to said line and for temporarily shunting said line against control by said message signal generator.

20. In a telegraph system, a message signal generator, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means for impressing said different signals on said line, means for impressing a break signal on said line, means responsive to said break signal for disassociating said combining means from said message signal generator, for connecting said message signal generator directly to said line and for temporarily shunting said line against control by said message signal generator, and manually operable means for disabling said shunting means.

21. In a telegraph system, a message signal generator for generating start-stop telegraph signals impulse by impulse in succession, a storage type of signal generator having a sequence of non-message signals in storage therein for generating signals element by element in succession, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means controlled by said combining means for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator, and means for causing said combining means to produce the start impulses of said different signals independently of said storage type signal generator.

22. In a telegraph system, a message signal generator for generating start-stop telegraph signals, a storage type of signal generator having a sequence of non-message signals in storage therein, a telegraph line, means for interactively combining signals generated by said two signal generators to produce signals different from both of said interactively combined signals, means controlled by said combining means for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator, means for causing said combining means to produce the start impulses of said different signals independently of said storage type signal generator, and means for varying the time of initiation of said start impulses relative to the activation of said storage type of signal generator.

23. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a first single relay responsive to said signal elements, a storage type of signal generator having a sequence of non-message signals in storage therein for generating signals element by element in succession, a second single relay controlled jointly by said first single relay and said storage type of signal generator for interactively combining signal elements generated by said message signal generator and signal elements generated by said storage type of signal generator, means controlled by said first single relay for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator, and means controlled by said first single relay for causing said second single relay to generate the start impulses of said different signals independently of said storage type of signal generator.

24. In a telegraph system, a message signal generator for generating start-stop telegraph signals element by element in succession, a first single relay responsive to said signal elements, a storage type of signal generator having a sequence of non-message signals in storage therein for generating signals element by element in succession, a second single relay controlled jointly by said first single relay and said storage type of signal generator for interactively combining signal elements generated by said message signal generator and signal elements generated by said storage type of signal generator, means controlled by said first single relay for activating said storage type of signal generator in start-stop manner for each signal generating cycle of said message signal generator, means controlled by said first single relay for causing said second single relay to generate the start impulses of said different signals independently of said storage type of signal generator, and means for varying the time of control of said second single relay by said last-mentioned means relative to the time of activation of said storage type of signal generator.

25. In a telegraph system, first means for generating signal combinations each comprising a succession of impulses, second means for concurrently generating signal combinations each comprising a succession of impulses, means for interactively combining corresponding impulses of said concurrently generated code combinations, a telegraph line, and means for causing impulses resulting from said interactive combination of impulses to be impressed on said line.

26. In a telegraph system, means for generating signal combinations in a sequence comprising a message, each signal combination comprising a succession of impulses, means for concurrently generating signal combinations in a random sequence, each signal combination comprising a succession of impulses, means for interactively combining corresponding impulses of said concurrently generated code combinations, a telegraph line, and means for causing impulses resulting from said interactive combination of impulses to be impressed on said line.

27. In a telegraph system, first means for generating signal combinations comprising impulses succeeding one another at predetermined intervals, second means for generating signal

ombinations comprising impulses succeeding one nother at predetermined intervals, means for nteractively combining impulses generated in orresponding intervals by said first and second gnal generating means, a telegraph line, and neans for causing impulses resulting from said nteractive combination of impulses to be impressed on said line.

28. In a telegraph system, means for generting signal combinations in a sequence comprsng a message, each signal combination comprsng impulses succeeding one another at predeermined intervals, means for generating signal ombinations in a random sequence, each signal ombination comprising impulses succeeding one nother at predetermined intervals, means for nteractively combining impulses generated in orresponding intervals by said two signal genrating means, a telegraph line, and means for ausing impulses resulting from said interactive ombination of impulses to be impressed on said ine.

29. In a telegraph system, first means for genrating signal combinations comprising impulses ucceeding one another at predetermined interals, second means for generating signal cominations comprising impulses succeeding one anther at predetermined intervals, means for ineractively combining impulses generated in coresponding intervals by said first and second ignal generating means during the generation f said impulses, a telegraph line, and means or causing impulses resulting from said interctive combination of impulses to be impressed n said line.

30. In a telegraph system, a telegraph line, a olar relay having an operating winding, a bridge ircuit connected across said operating winding, neans for selectively connecting an electrical otential of either of two polarities to the midoint of said bridge circuit, means for selectively onnecting the return path for said electrical otential to either of the common terminals of aid operating winding and said bridge circuit, nd means controlled by said relay for impressing ignaling impulses on said line.

31. In a telegraph system, a telegraph line, a olar relay having an operating winding, a bridge ircuit connected across said operating winding, a telegraph signal generator adapted to cause an electrical potential of either of two polarities

to be connected to the mid-point of said bridge circuit, a second telegraph signal generator adapted to connect a return path for said electrical potential to either of the common terminals of said operating winding and said bridge circuit, and means controlled by said relay for impressing signaling impulses on said line.

32. In a telegraph system, a telegraph line, a polar relay having an operating winding, a bridge circuit connected across said winding, means for generating telegraph signals representing a message adapted to cause an electrical potential of either of two polarities to be connected to the mid-point of said bridge circuit, means for generating telegraph signals representing a random sequence of codes adapted to connect a return path for said electrical potential to either of the common terminals of said operating winding and said bridge circuit, and means controlled by said relay for impressing signaling impulses on said line.

33. In a telegraph system, a telegraph line, a polar relay having an operating winding, a bridge circuit connected across said operating winding, a source of electrical potential of either of two polarities and a return path therefor, selectively operable means for causing current to flow at either of said polarities through said operating winding and bridge circuit and return path, selectively operable means for causing each of said currents to flow in either direction through said operating winding, and means controlled by said relay for impressing signaling impulses on said line.

34. In a telegraph system, a telegraph line, a polar relay having an operating winding, a bridge circuit connected across said operating winding, a source of electrical potential of either of two polarities and a return path therefor, means for generating telegraph signals representing a message adapted to cause current to flow at either of said polarities through said operating winding and bridge circuit and return path, means for generating telegraph signals representing a random sequence of codes adapted to cause each of said currents to flow in either direction through said operating winding, and means controlled by said relay for impressing signaling impulses on said line.

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