Oct. 20, 1925.

1,557,633

G. S. VERNAM

TRANSLATING DEVICE

Filed April 21, 1920

4 Sheets-Sheet 1

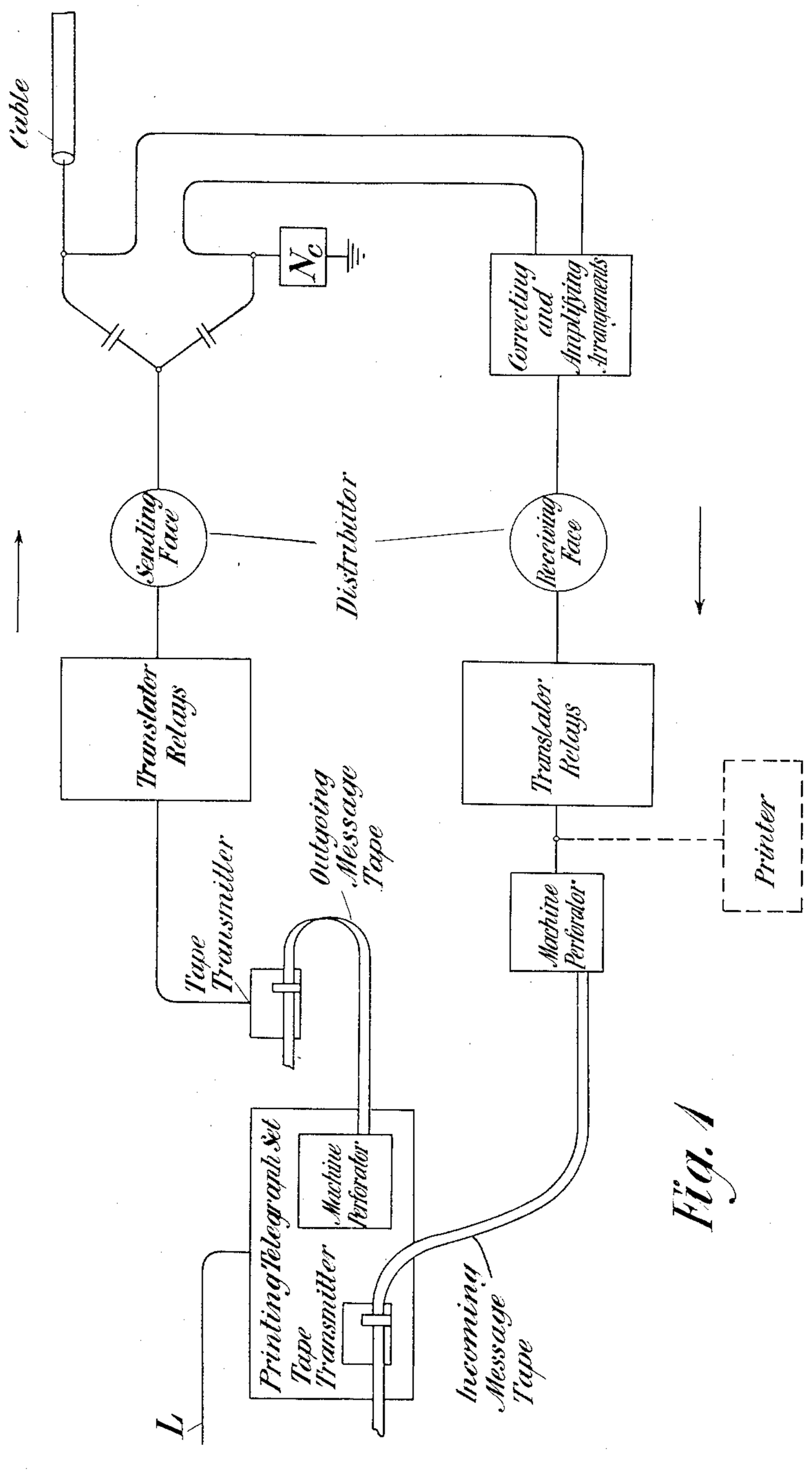

Fig. 1

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Filed April 21, 1920 4 Sheets-Sheet 2

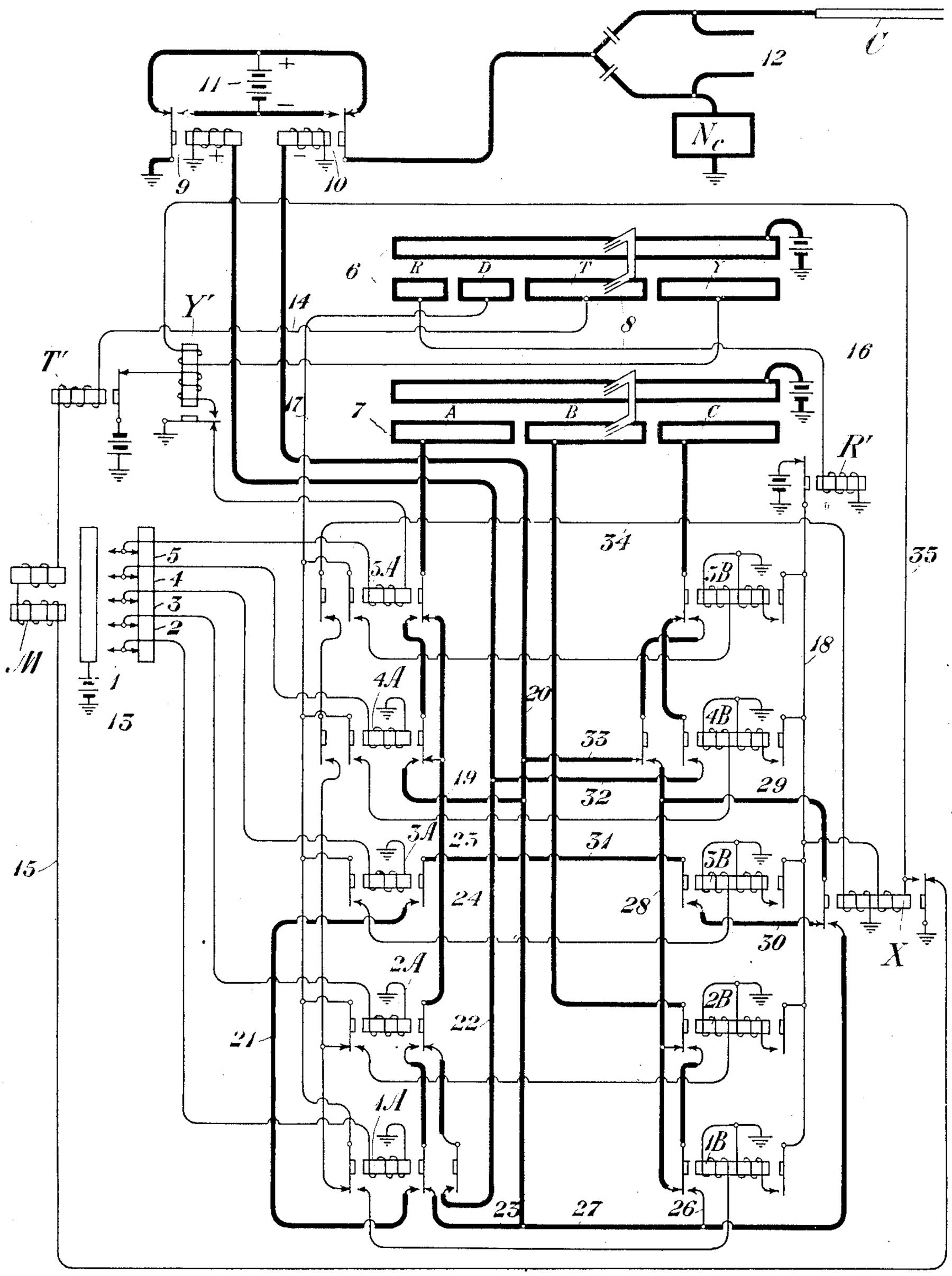

Fig. 2

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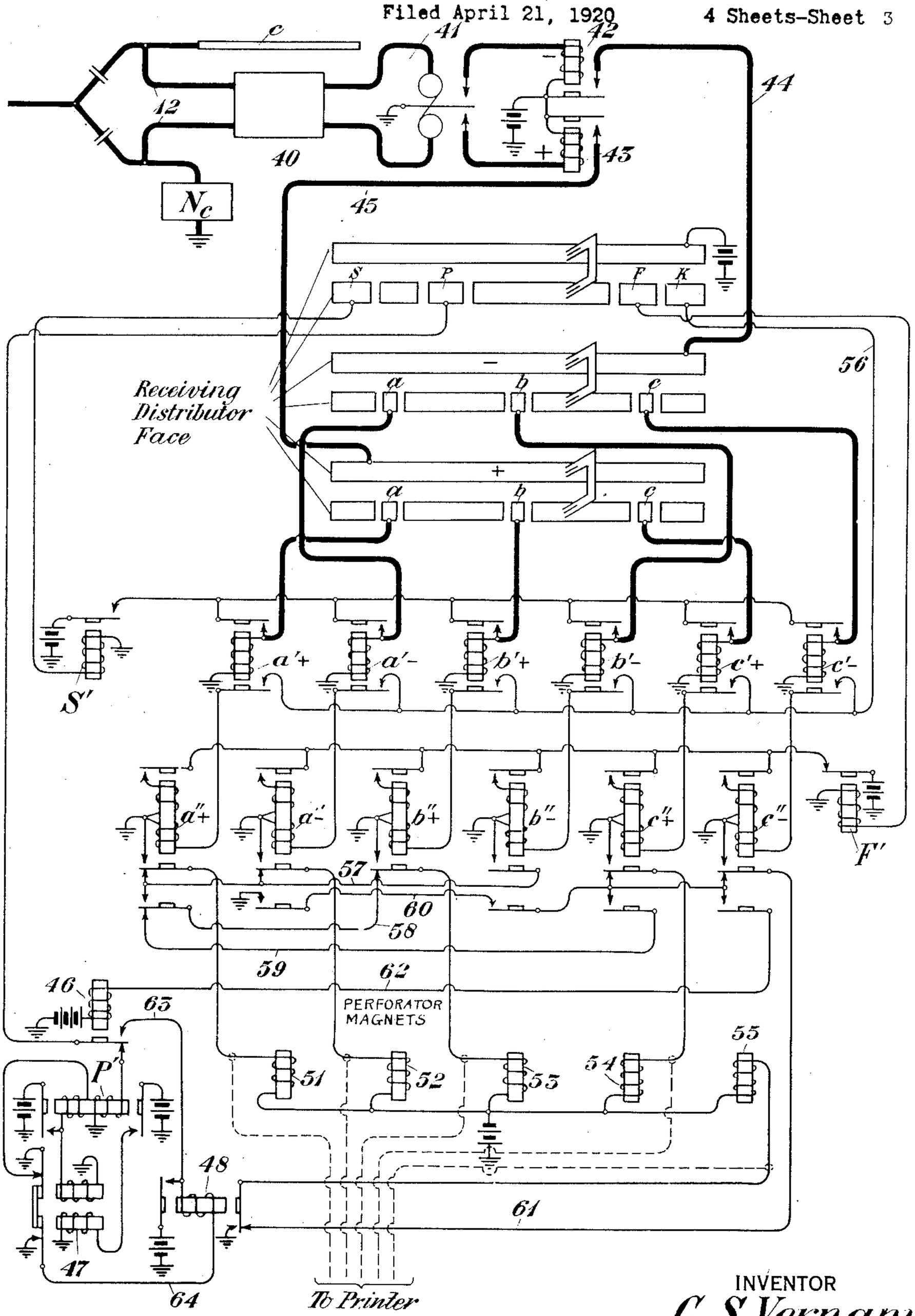

Fig. 3

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Filed April 21, 1920 4 Sheets-Sheet 4

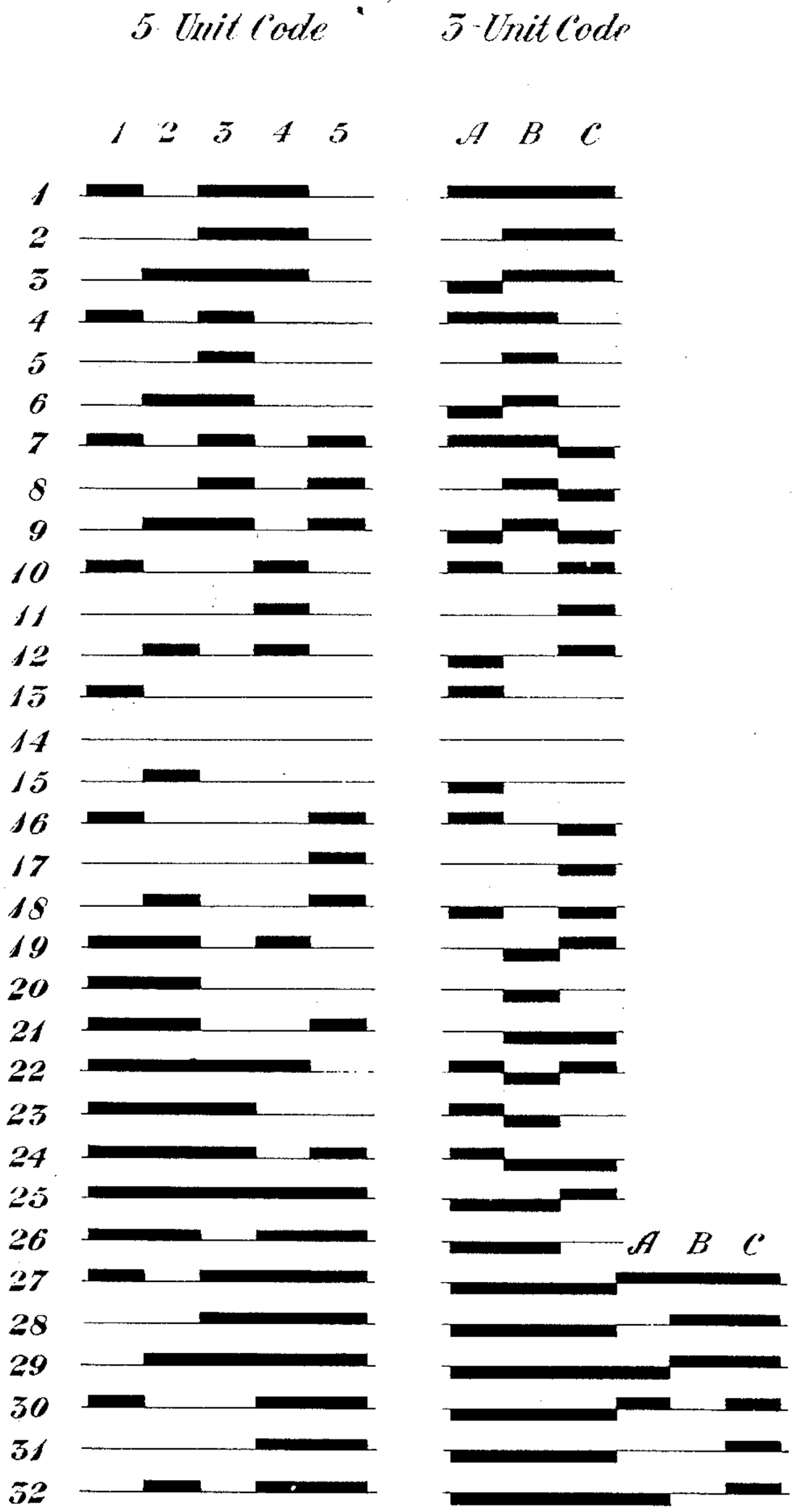

Fig. 4

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Patented Oct. 20, 1925. 1,557,633

UNITED STATES PATENT OFFICE.

GILBERT S. VERNAM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSLATING DEVICE.

Application filed April 21, 1920. Serial No. 375,602.

To all whom it may concern:

Be it known that I, GILBERT S. VERNAM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Translating Devices, of which the following is a specification.

This invention relates to transmission systems over which messages are transmitted by code impulses and relates more particularly to a method of and means for automatically translating a code suitable for use over one portion of the system, such as a land telegraph line, into a code more adaptable for use over another portion of the system, such as a submarine cable.

In the usual type of machine or printing telegraph system the messages or characters may in practice be transmitted thereover by means of the well known Baudot or five unit code, in which each character is represented by a combination of five "marking" or "spacing" impulses, which may comprise a combination of five positive or negative impulses if desired. When messages or characters are transmitted over a submarine cable, however, the transmission characteristics of the cable, which differ from those of the telegraph line, make it undesirable to utilize the usual five unit printer code and accordingly a special cable code is provided which is more adaptable for use with the submarine cable. One of the codes which has been found readily adaptable for submarine cable work is a three unit code comprising positive and negative impulses and intervals of no current at all. As in many instances long submarine cables are worked in conjunction with considerable lengths of land line, it is desirable to have at the cable stations machinery for transposing the messages automatically from one code into the other, particularly from the five-unit into the three-unit code. It is a cardinal feature of this invention to provide improved arrangements for accomplishing this result. Other features and objects of the invention will appear more fully from the following detailed description of the invention.

The invention may be more fully understood from reference to the accompanying drawing in the Figures 1, 2, 3, and 4 of which are illustrated arrangements embodying the invention. Fig. 1 illustrates schematically the arrangements of the invention as utilized at a station interconnecting a land telegraph line with a submarine cable. In Fig. 2 are shown in detail the arrangements for transposing from the telegraph code into the cable code, while in Fig. 3 there is illustrated arrangements in detail for transposing incoming cable messages into code suitable for transmission over the land telegraph line. In Fig. 4 is shown a key utilized between the two codes.

In the schematic arrangement shown in Fig. 1 the messages or code impulses will come in over line L in the five-unit code and will operate a machine perforator of a printing telegraph set, which will perforate the message characters in code on a tape. This tape will be run through a tape transmitter which operates in conjunction with a plurality of translator relays and the sending face of a distributor and transposes the five-unit code impulses into three-unit code impulses suitable for transmission out over the cable line. The details of the above arrangement are shown in Fig. 2. The messages or code impulses coming in over the cable, which are in the three-unit code, will be amplified if desired and received on a well known type of cable relay and then transmitted to the receiving face of a distributor which operates in conjunction with a plurality of translator relays to transpose the three-unit code impulses into five-unit code impulses. These five-unit code impulses may operate a printer if desired, or may be utilized to operate a machine perforator which will perforate the code impulses on a message tape. This message tape may then be run through a transmitter connected to the telegraph line. The details of the above arrangement are more fully illustrated in Fig. 3.

In the arrangements of the invention a certain key has been adopted between the five-unit and the three-unit code which is illustrated in the comparative tables of Fig. 4. The left-hand column shows the 32 signal combinations of the five-unit code. The shaded areas indicate intervals of + (positive) current, while the spaces between them indicate intervals of either 0 or — (negative) current. The shaded areas also correspond to the holes in the tape which operate the contacts in the tape transmitter as indicated by the numbers at the top, i. e.; the first signal would operate tape transmitter contacts 1, 3 and 4; the second signal would operate contacts 3 and 4, etc. The right-

hand column shows the signal combinations for the three-unit code. In the three-unit code there are only 27 signal combinations and accordingly the last 6 signals in the five-unit code are represented in the three-unit code by two successive signals, the first of these in each case being the all negative signal (— — —), the second being the signal for the corresponding five-unit code signal with the fifth impulse omitted; i. e. the second three-unit signals for signals 27, 28, and 29 are the same as the three-unit signals for signals 1, 2, and 3; also the second signals for 30, 31, and 32 are the same as those for 10, 11, and 12.

A certain relationship exists between the two codes, which relationship for the first 18 signals in each code is as follows:

5-unit code transmitter contacts operated.	3-unit code polarity of impulse.		
	A	B	C
1	+		
2	—		
3		+	
4			+
5			—

The above relations hold good for all signal combinations except those operating contacts 1 and 2 together or 4 and 5 together. For all these signal combinations, the middle or "B" impulse in the three-unit code is negative.

Signals 19 to 26 inclusive will operate transmitter contacts 1 and 2. For these signals the relations between the two codes are as follows:

5-unit code transmitter contacts operated.						3-unit code polarity of impulse.		
Signals						A	B	C
19	1	2		4			—	+
20	1	2					—	
21	1	2			5		—	—
22	1	2	3	4		+	—	+
23	1	2	3			+	—	
24	1	2	3		5	+	—	—
25	1	2	3	4	5	—	—	+
26	1	2		4	5	—	—	

The remaining signals, 27 to 32 inclusive, all operate both contacts 4 and 5 but fail to operate either contact 1 or contact 2. These signals cause the apparatus to transmit the signal "— — —" followed by a second signal in the three-unit code as previously explained.

The above described relations between the five-unit and three-unit codes were adopted because they permitted the use of a comparatively simple relay arrangement. However it is to be understood that other arrangements between the two codes might be adopted without departing from the spirit of the invention.

In all reference heretofore to five-unit code and three-unit code, the following is pointed out to define more clearly what is meant by the above terms. In the five-unit code, each signal combination consists of five units, these units being chosen from current impulses such as either marking or spacing impulses and intervals of no current at all. In a three-unit code, each signal combination (reference here being had to the great majority thereof, such as the first 26) is composed of only three units, these units being chosen from current impulses such as either marking or spacing impulses and intervals of no current at all. Accordingly, in each of the above codes or systems the unit may be either a current impulse of varied character or an interval of no current at all, the one code having signal combination with five of such units apiece and the other code having signal combinations with three of such units apiece.

The invention may be more fully understood from the following description of the operation of transposing the messages coming in over the telegraph line in five-unit code into the three-unit code suitable for transmission out over the cable, reference being had to Fig. 2 of the drawing. The cable C is balanced by an artificial line or network N_c and is shown connected in the usual duplex manner with a receiving circuit 12, which will be described later, and with a transmitting circuit. The transmitting circuit is completed through battery 11 by either one of the relays or pole changers 9 and 10 in such a manner that if relay 9 operates a + impulse will be transmitted over the cable; if relay 10 operates a — impulse will be transmitted; and if neither relay operates the cable circuit will be connected to ground. The relays or pole changers 9 and 10 are operated by impulses from the segments 6 and 7 of the distributor controlled by the translating relays 5_A, 4_A, 3_A, 2_A, 1_A, and 5_B, 4_B, 3_B, 2_B, 1_B. These translating relays in turn are controlled by circuits through the contacts of the tape transmitter 13, which is operated by a tape perforated by signal combinations coming in over the telegraph line in the five-unit code. In the drawing the distributor face is shown with the segments 6 and 7 in a straight line, but it is understood that they would normally be arranged in concentric rings and the brushes 8 would be mounted on a rotating arm.

When the upper brush of the distributor crosses segment T the following circuit will be completed; from battery connected to upper segment 6, brush of distributor, segment T, conductor 14, winding of relay T′, winding of magnet M, conductor 15, contact and armature of relay X, to ground. The closing of this circuit will operate magnet M which will force all the contacts 1, 2, 3, 4, 5, of transmitter 13 against the right-hand

bus-bar and step the tape ahead one step. When the brush passes off of segment T, magnet M will be released and a combination of the contacts 1, 2, 3, 4, 5, will be operated corresponding to the holes in the tape. These contacts will move over to the left-hand bus-bar, to which is connected battery, and will close circuits for operating the correspondingly numbered relays 1_A to 5_A, setting up the same signal combination on them. It is pointed out at this time that when the brush crosses segment Y the relay Y′ will not be operated as both ends of its operating winding are connected to battery. When the brush crosses segment R a circuit will be closed over conductor 16 and through the winding of relay R′, thereby operating relay R′. The operation of relay R′ will release any of the relays 1_B, 2_B, 3_B, 4_B, 5_B, that may have been previously operated, as these relays upon operation are locked up over circuits including the armature and contact of relay R′, as will appear later. When the brush crosses segment D, battery will be connected over conductor 17 to the armatures of relays 1_A to 5_A and if any of these relays have been operated by the contacts of transmitter 13, the correspondingly numbered relays in the group 1_B to 5_B will also be operated by the battery connected to conductor 17. In other words the signal combination originating in transmitter 13 will now be set up on both groups of relays.

While the upper brush is crossing segments R and D, the lower brush will be crossing segment A. This will connect battery to the right-hand armature of relay 5_A and cause the pole changers 9 and 10 to transmit the first of the corresponding three-unit code impulses as will be described later. While the upper brush crosses segment T, the lower brush will cross segment B and connect battery to the left-hand armature of relay 2_B, thus transmitting the second impulse of the three-unit code signal. While the upper brush crosses segment Y, the lower brush will cross segment C and connect battery to the armature of relay 5_B, thus transmitting the third impulse of the three-unit code signal. These operations will appear more fully later. The transmitter magnet M and the left-hand group of relays, 1_A to 5_A, will be released and operated again (thereby setting up a new signal combination) while these last two impulses of the three-unit code are being transmitted, but the signal combination set up on the right-hand group of relays, 1_B to 5_B, will be unaffected as these relays upon operation are locked up through their right-hand windings and contacts and over conductor 18 and contact and armature of relay R′ to battery. The above method of connection allows for a certain "overlap" in operation, i. e. it permits the transmitter to be operated and the tape stepped forward to set up the next signal combination before the three-unit signal for the previous character has been completely transmitted.

The polarity of the first or "A" impulse of the signal combination in the three-unit code is controlled by the right-hand contacts of relays 1_A to 5_A. If the relays 4_A and 5_A are both operated, segment A will be connected over conductors 19 and 20 to the negative pole changer 10, thereby operating pole changer 10, and accordingly the A impulse will be negative, as will be the case for signals 25 to 32 inclusive. If one of either relays 4_A or 5_A is not operated, as would be the case for signals 1 to 24 inclusive, segment A will be connected over conductor 24 to the armature of relay 2_A and the polarity of the impulse to be transmitted will depend on impulses 1, 2, and 3 in the five-unit code. Now if relays 1_A and 2_A are both operated, as would be the case for signals 19 to 24 inclusive, the circuit from segment A will be extended over conductor 21 to the contact of relay 3_A, and if relay 3_A is operated the circuit will be further extended over conductor 25 to conductor 22 and positive pole changer 9, thereby operating pole changer 9 and causing a positive impulse to be transmitted out over the cable. However if the relay 3_A is not operated at this time the cable circuit will be grounded while the brush is on segment A. If relay 2_A is not operated and relay 1_A is operated, as would be the case for signals 1, 4, 7, 10, 13 and 16, then segment A will be connected directly to conductor 22 and thence to the positive pole changer 9 and the A impulse will be positive. If neither relay 2_A nor relay 1_A is operated, as would be the case for signals 2, 5, 8, 11, 14 and 17, the circuit of segment A will be open and accordingly the cable circuit will be grounded while the brush is on segment A. If relay 2_A is operated and relay 1_A is not operated, as would be the case for sginals 3, 6, 9, 12, 15 and 18, segment A will be connected over conductor 23 to conductor 20 and thence to the negative pole changer 10 and accordingly the A impulse will be negative. From the above description it will appear that the A impulse will always be transmitted according to the key illustrated in Fig. 4.

The polarity of the second or "B" impulse of the signal combination in the three-unit code is controlled by the left-hand contacts of relays 1_B, 2_B, 3_B, and X. Relay X will be operated only by one of the last six signals, signals 27 to 32 inclusive, and its operation will be described later. Therefore these six signals will be disregarded for the present. As the relays 1_B, 2_B, and 3_B are controlled by impulses 1, 2, and 3 of the five-unit code, it is evident that for the

first 26 signal combinations the polarity of the B impulse in the three-unit code will depend on impulses 1, 2, and 3 in the five-unit code. If relays 1_B and 2_B both operate, as would be the case for signals 19 to 26 inclusive, segment B will be connected over conductors 26 and 27 to conductor 20 and thence to the negative pole changer 10 and accordingly the B impulse transmitted over the cable will be negative. If either or both of relay 1_B and 2_B fail to operate, segment B will be connected over conductors 28 and 29, back contact of relay X, and conductor 30 to the contact of relay 3_B. If relay 3_B operates, as would be the case for signals 1 to 9 inclusive, the circuit for segment B will then be extended over conductor 31 to conductor 22 and thence to the positive pole changer 9 and the B impulse transmitted over the cable will be positive. However, if the relay 3_B does not operate, as would be the case for signals 10 to 18 inclusive, the circuit for segment B will remain open and the cable circuit will be grounded. Accordingly from the above description it will appear that the B impulse will always be transmitted according to the key illustrated in Fig. 4.

The polarity of the third or "C" impulse of the signal combination in the three-unit code is controlled by the left-hand contacts of relays 5_B, 4_B, 3_B, and X. The operation of relay X will be described later and the last six signals, signals 27 to 32 inclusive, can be disregarded for the present. If neither relay 4_B nor relay 5_B operates, as would be the case for signals 4, 5, 6, 13, 14, 15, 20 and 23, the circuit of segment C will be open and neither of the pole changers will be operated and the cable circuit will be grounded while the brush is on segment C. If relay 4_B operates but relay 5_B does not operate, as would be the case for signals 1, 2, 3, 10, 11, 12, 19 and 22, then segment C will be connected over conductor 32 to conductor 22 and thence to the positive pole changer 9 and the C impulse transmitted over the cable will be positive. On the other hand, if relay 5_B operates but relay 4_B does not operate, as would be the case for signals 7, 8, 9, 16, 17, 18, 21 and 24, then segment C will be connected over conductor 33 to conductor 20 and thence to the negative pole changer 10 and the C impulse transmitted over the cable will be negative. In the case of signals 25 and 26 the relays 4_B and 5_B will both be operated and the circuit for segment C will be extended over conductor 29, back contact of relay X, and conductor 30 to the contact of relay 3_B. Accordingly in the case of these two last mentioned signals the polarity of the C impulse will depend on relay 3_B. If relay 3_B operates, as in the case of signal 25, the circuit for segment C will be extended over conductor 31 to conductor 22 and thence to the positive pole changer 9 and the C impulse transmitted over the cable will be positive. On the other hand, if relay 3_B does not operate, as would be the case for signal 26, the circuit for segment C will be open and the cable circuit will be grounded. From the above description it will appear that the C impulse in the three-unit code will always be transmitted according to the key illustrated in Fig. 4.

If any one of the last six signal combinations, such as signals 27 to 32 inclusive, is set up on relays 1_A to 5_A a circuit will be prepared for operating relay X. This circuit may be traced from segment D, over conductor 17, back contacts of either relay 1_A or relay 2_A, front contacts of relays 4_A and 5_A, and over conductor 34 to the operating winding of relay X. Accordingly relay X will operate when the brush crosses segment D. Relay X will lock itself over the following circuit; from ground, right-hand armature and contact of relay X, locking winding of relay X, conductor 18, armature and contact of relay R', to battery and ground. The operation of relay X will open the previously traced circuit for the operating magnet M and will prepare a circuit over conductor 35 for later operating relay Y'. When the brush now crosses segment T the transmitter magnet M will not operate and therefore the same signal combination will remain on the transmitter contacts and relays for two revolutions of the brush arm. During the first of these revolutions the negative pole changer 10 will be connected to all three segments A, B, and C, in the following manner; to segment A through the front contacts of relays 4_A and 5_A and over conductors 19 and 20; to segment B over conductors 20 and 27, left-hand front contact of relay X, conductors 29 and 28, and thence either through the back contact of relay 2_B or else through the back contact of relay 1_B and the front contact of relay 2_B; to segment C over conductors 20 and 27, left-hand front contact of relay X, conductor 29 and thence through the front contacts of relays 4_B and 5_B. Therefore during the first revolution of the brush the "— — —", or all negative signal will be transmitted in the three-unit code.

When the upper brush crosses segment Y the relay Y' will be operated over a circuit through its upper winding, over conductor 35, contact and armature of relay X, to ground. Relay Y' will lock itself through its lower winding and the operating of relay Y' will open at its lower armature the operating circuit for relay 5_A, thus releasing relay 5_A. The deenergization of relay 5_A will open the previously traced operating circuit for relay X. When the brush crosses seg-

ment R the relay R′ will be operated and its operation will release the relays 1_B, 2_B, 3_B, 4_B, 5_B, and X, which relays, as has been pointed out, were locked up over the contact and armature of relay R′. The deenergization of relay X will restore to normal the previously traced circuit for magnet M, so that when the brush now crosses segment T, the magnet M will operate and will step the tape ahead. On this revolution of the brush the relays 5_A and 5_B will not be operated as the circuit for relay 5_A is held open by relay Y′. The second of the two signals in the three-unit code for the signal combinations 27 to 32 inclusive will now be transmitted according to the key illustrated in Fig. 4. When the brush now crosses segment T, the relay T′ will be operated as well as magnet M and the operation of relay T′ will release relay Y′, thus restoring the circuit of relay 5_A to normal. This will have no effect on the signal being transmitted during this revolution but will restore the circuit to normal for the next revolution.

From the above description it will be seen that the arrangements of the invention will transpose the five-unit signals coming in over the telegraph line into three-unit signals for transmission over the cable line in accordance with the key illustrated in Fig. 4.

The arrangements of the invention adapted for transposing the messages coming in over the cable in three-unit code into five-unit code suitable for transmission over the telegraph line are illustrated in detail in Fig. 3. The receiving circuit 12 includes a cable relay 41 and correcting and amplifying arrangements 40. As these arrangements are well known in the art a detailed illustration thereof will be omitted. The cable relay 41 in turn operates two line relays 42 and 43, relay 42 being operated by negative (—) impulses and relay 43 being operated by positive (+) impulses. The contacts of the line relays are connected over conductors 44 and 45 to two of the solid rings of the receiving distributor face and thence through the revolving brushes to the segments connected to a series of selecting relays $a'+$, $a'-$, $b'+$, $b'-$, $c'+$, $c'-$. It is pointed out that the brushes on the sending face of the distributor illustrated in Fig. 2 will rotate in synchronism with the brushes on the receiving face of the distributor illustrated in Fig. 3. Any well known arrangement may be utilized to accomplish this purpose. These selecting relays will operate and lock up in the usual manner and thus store any signal combinations received over the cable. Associated with and controlled by these selecting relays is a second set of relays such as relays $a''+$, $a''-$, $b''+$, $b''-$, $c''+$, $c''-$. These relays in turn control the operation of the magnets 51, 52, 53, 54, and 55 of a perforator, or a printer if desired, as will be pointed out later. The rings of the distributor are illustrated as arranged in straight lines, but it is understood that they would be arranged in practice in concentric rings. The segments of the distributor are shortened so that only the center portion of each of the received impulses will affect the selecting relays. This arrangement prevents false operation of the selecting relays in case the incoming signals are distorted.

An extra set of rings, herein illustrated as the upper set, is provided for timing certain of the operations. When the brush crosses segment F, the relay F′ will be operated momentarily and it will release any of the relays, such as $a''+$ to $c''-$, which may have previously been operated and locked up over the contact of relay F′. When the brush crosses segment K, battery will be momentarily connected over conductor 56 to the lower contacts of all the selecting relays, such as relays $a'+$ to $c'-$. This will cause the signal combination previously set up on said selecting relays to be transferred to the lower group of relays which will lock themselves to battery over the contact and armature of relay F′. When the brush crosses segment S the relay S′ will be operated and, as the selecting relays lock up over the contact of relay S′, all of the selecting relays will be released. The apparatus will then be ready to receive the impulses of the next signal while the previous selection is being translated and perforated. This arrangement provides for an "overlap" in the receiving apparatus as well as in the sending apparatus previously described.

The lower contacts of the lower group of relays, such as $a''+$ to $c''-$, are wired to the selecting magnets 51, 52, 53, 54, and 55, of a machine perforator in such a way that whenever a three-unit code combination is set up on the relays, the perforator selecting magnets will set up the corresponding five-unit code signal. This arrangement will be described in more detail later. The perforator selecting magnets in a well known manner operate "selecting fingers" (not shown) in the perforator so as to interpose them between the punches and a punch hammer operated by a punch magnet. This punch magnet is illustrated as 47 and is controlled by the relay P′ which operates when the brush crosses segment P. The relay P′ locks itself and holds closed a circuit for the punch magnet 47 until the latter has operated and perforated holes in the tape corresponding to the selection set up on the selecting magnets. When the punch magnet 47 operates it opens a contact which releases the relay P′ and this in turn releases the punch magnet itself. The signal combination set up on the perforator selecting magnets however is not released until the brush crosses segment F.

The method of transposing the three-unit signals into the five-unit code is as follows. referring to the key illustrated in Fig. 4 it will be seen that the first selecting magnet, magnet 51, must operate whenever the first or "A" impulse of the three-unit code is positive (+), as would be the case for signals 1, 4, 7, 10, 13, 16, 22, 23, and 24. Selecting magnet 51 is therefore wired to the armature of relay $a''+$ and will operate whenever this relay operates. If relay $a''+$ does not operate, the circuit of magnet 51 will be extended over conductor 57 to the armature of relay $b''-$ and magnet 51 will therefore operate whenever the second or B impulse is negative, as would be the case for signals 19, 20, 21, 25 and 26.

Selecting magnet 52 is wired to the armature of relay $a''-$ and accordingly will operate whenever the first or A impulse of the three-unit code is negative, as would be the case for signals 3, 6, 9, 12, 15, 18, 25 and 26. If the relay $a''-$ does not operate, the circuit for magnet 52 will be extended over conductor 57 to the armature of relay $b''-$ and the magnet will therefore operate also in the case of signals 19, 20, 21, 22, 23 and 24.

Selecting magnet 53 is wired to the armature of relay $b''+$ and will therefore operate in the case of signals 1 to 9 inclusive. The circuit for magnet 53 also may be extended over conductor 58 to the lower armature of relay $a''+$ and thence over conductor 57 to the armature of relay $b''-$ and accordingly magnet 53 will operate for signals 22, 23, and 24 in which the first or A impulse is positive and the second or B impulse is negative. Selecting magnet 53 will also operate in the case of signal 25 over a circuit through the back contact of relay $b''+$, conductor 58, back contact of relay $a''+$, conductor 59, front contacts of relays $c''+$ and $b''-$, and over conductor 60 to the front contact of relay $a''-$.

Selecting magnet 54 is wired to the armature of relay $c''+$ and therefore operates on signals in which the third or C impulse is positive, as would be the case for signals 1, 2, 3, 10, 11, 12, 19, 22 and 25. In order to cause magnet 54 to operate also in the case of signal 26, its circuit is extended through the back contacts of relays $c''+$ and front contact of relay $b''-$, over conductor 60, to front contact of relay $a''-$, to ground.

Selecting magnet 55 is wired through the back contact of relay 48 over conductor 61 to the armature of relay $c''-$. It will therefore operate on signals in which the third or C impulse is negative, as would be the case for signals 7, 8, 9, 16, 17, 18, 21 and 24. It will also operate in the case of signals 25 and 26 over a circuit which may be traced through the back contact of relay $c''-$, front contact of relay $b''-$, conductor 60, front contact of relay $a''-$, to ground.

The last six signals, 27 to 32 inclusive, in which the first three-unit signal is the all negative, or — — —, signal will now be considered. The operating circuit for the relay 46 is traced as follows; from ground and battery, winding of relay 46, conductor 62, front contacts of relay $c''-$ and $b''-$, over conductor 60, front contact of relay $a''-$, to ground. Accordingly it will be seen that the relay 46 will be operated whenever the relays $a''-$, $b''-$, and $c''-$, are operated by the all negative (— — —) signal in the three-unit code. The operation of relay 46 opens the operating circuit for relay P' and therefore the combination set up on the selecting magnets will not be perforated. When the brush crosses segment P however a circuit will be completed over conductor 63, winding of relay 48, conductor 64, contact of magnet 47 to ground, thereby operating relay 48, which will become locked up over its left-hand contact and armature to battery. The operation of relay 48 will in turn operate the selecting magnet 55. This causes a fifth impulse to be added to the next combination set up on the selecting magnets. The next revolution of the brushes will set up on the relays a combination which ordinarily corresponds to signals 1, 2, 3, 10, 11, or 12, but due to the fifth impulse added there will now be set up on the selecting magnets the proper one of the last six signal combinations, such as signals 27 to 32 inclusive. Relay 46 will be released when the — — —, or all negative signal clears out and relay 48 will be released upon the subsequent operation of punch magnet 47. The circuit will then be restored to its normal condition.

From the above description it will appear that all of the signal combinations coming in over the cable in three-unit code will be transposed by the arrangements of the invention into signal combinations in the five-unit code in accordance with the key illustrated in Fig. 4.

While a certain arbitrary key, as illustrated in Fig. 4, has been utilized and while the arrangements of the invention have been disclosed in certain specific arrangements which are deemed desirable, it is understood that other keys may be utilized and also that the invention is capable of embodiment in many and widely varied forms other than those specifically disclosed without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A transmission line, transmitting apparatus associated therewith adapted to transmit three-impulse combinations thereover in accordance with a three-unit code, a transmitter operated in accordance with five-impulse combinations of a message trans-

mitted in a five-unit code, a series of relays controlled by said transmitter, a second series of relays controlled by said first series of relays, locking circuits for said second series of relays, means controlled by said first series of relays for determining the character of the first impulse of the three-unit combination to be transmitted by said transmitting apparatus over said line, means operating subsequent to said determination for releasing said first series of relays, means controlled by said second series of relays for determining the character of the second and third impulses of said three-unit combination, and means operating subsequent to said last mentioned determination for opening said locking circuits.

2. A transmission line, receiving apparatus associated with said line adapted to receive the three-impulse message combinations coming in thereover, said receiving apparatus including a plurality of selecting relays upon which an incoming three-impulse message combination may be set up, a recording device upon which may be set up five-impulse message combinations, and circuit arrangements completed over the contacts of said selecting relays for controlling said recording device.

3. A transmission line, receiving apparatus associated with said line adapted to receive the three-impulse message combinations coming in thereover, said receiving apparatus including a series of selecting relays upon which an incoming three-impulse message combination may be set up, a second series of relays controlled by said selecting relays upon which the three-impulse message combination may be stored, a recording device upon which may be set up five-impulse message combinations, and circuit arrangements completed over the contacts of said second series of relays for controlling said recording device.

4. A transmission line, transmitting apparatus associated therewith adapted to transmit three-impulse message combinations thereover, a transmitter operated in accordance with five-impulse message combinations, a plurality of relays controlled by said transmitter for controlling the operation of said transmitting apparatus, receiving apparatus associated with said transmission line and adapted to receive the three-impulse message combinations coming in thereover, said receiving apparatus including a plurality of relays upon which said three-impulse message combinations may be set up, a recording device upon which may be set up five-impulse message combinations, and circuit arrangements completed over the contacts of said last mentioned relays for operating said recording device.

In testimony whereof, I have signed my name to this specification this 19th day of April 1920.

GILBERT S. VERNAM.