Sept. 15, 1925. 1,553,417

G. S. VERNAM

PRINTING TELEGRAPH SYSTEM

Filed April 7, 1920 2 Sheets-Sheet 1

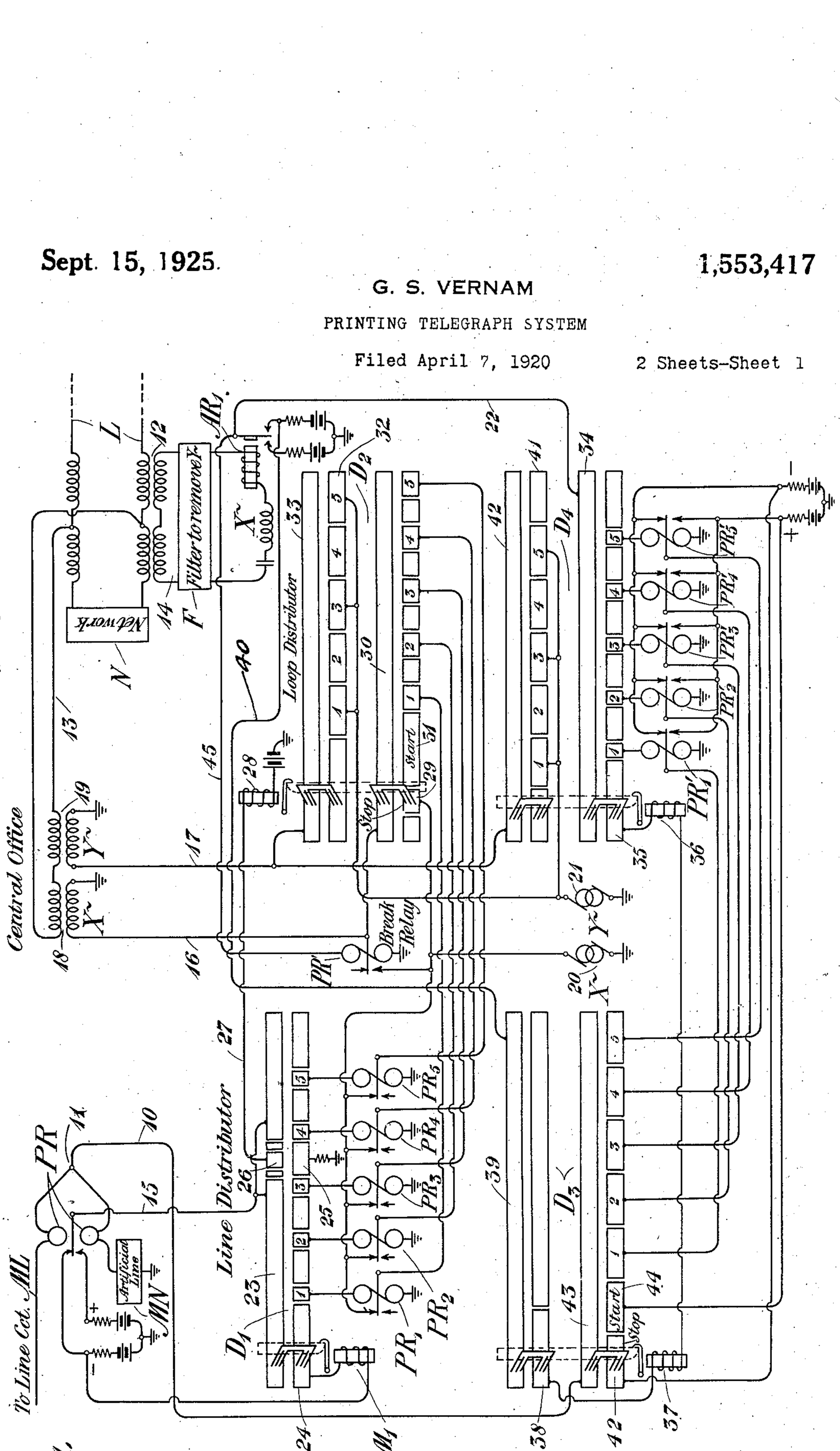

Fig. 1.

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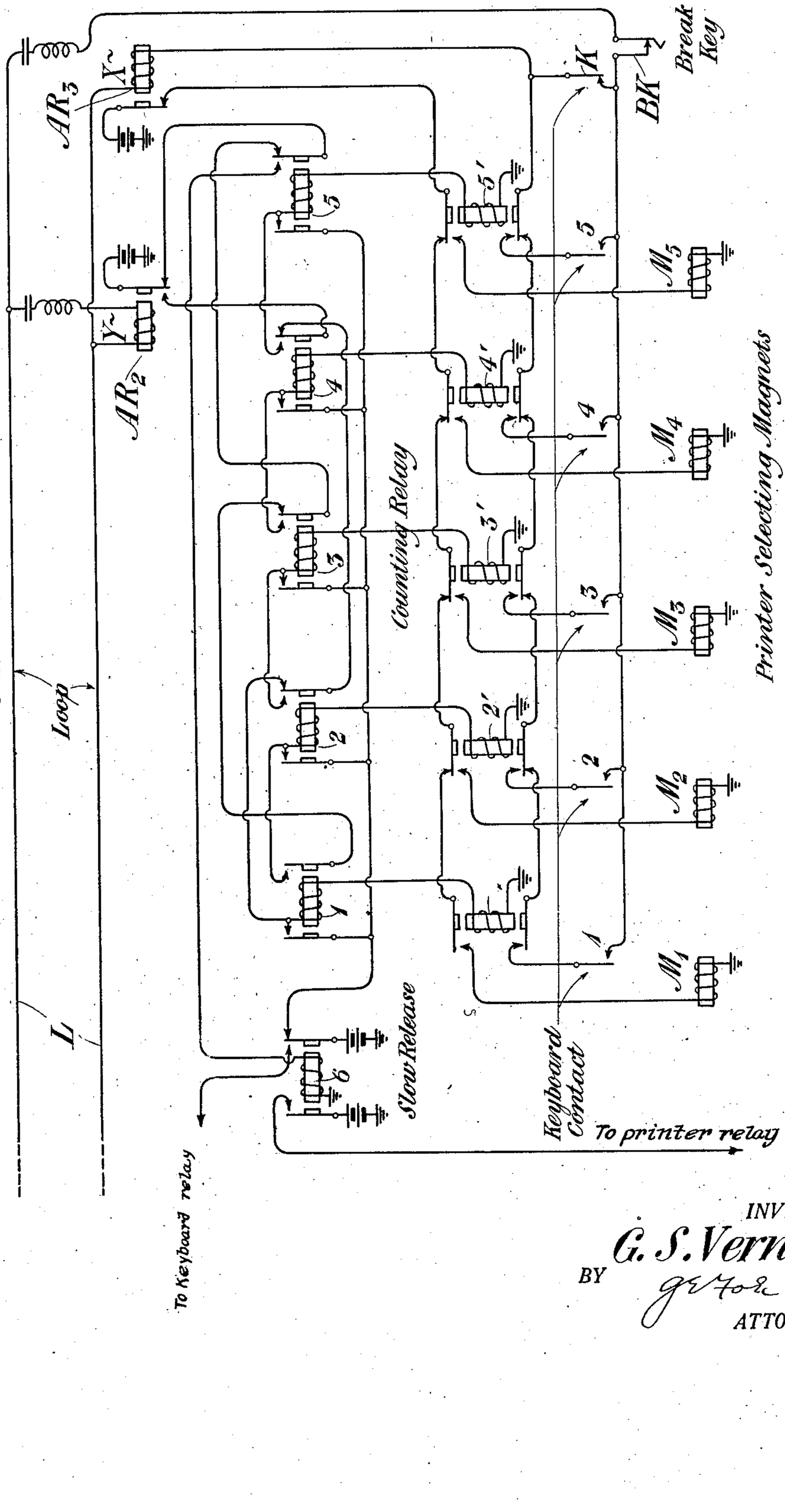

Fig. 2

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Patented Sept. 15, 1925. 1,553,417

UNITED STATES PATENT OFFICE.

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

PRINTING-TELEGRAPH SYSTEM.

Application filed April 7, 1920. Serial No. 371,963.

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 Printing-Telegraph Systems, of which the following is a specification.

This invention relates to signaling systems, and more particularly to systems for transmitting printing telegraph signals.

One of the objects of this invention is to provide means whereby printing telegraph signals may be transmitted from a central office on the main line over a loop to a local subscriber's station without the use of rotary distributors at the local station.

Another object of the invention is to produce a printing telegraph system in which the printing telegraph code signals may be transmitted over the local loop by means of alternating carrier currents, as distinguished from transmission by interrupted direct currents or successive positive and negative pulses.

Another object of the invention is to provide a printing telegraph system in which code combinations, such, for instance as the well known Baudot code, may be transmitted by carrier currents of two frequencies.

Another object of the invention is to provide a printing telegraph system in which a counting relay arrangement may be used as a distributor, the counting relays being operated by a carrier current of one frequency and the marking signals being transmitted by a carrier current of another frequency.

Still another object of this invention is to provide an arrangement whereby the impulses making up a code combination may be repeated from the main transmission line over a local loop at a different rate of speed, and out of synchronism with the impulses incoming from the main line.

The above objects, as well as other objects of the invention are realized in the arrangement set forth in the following description, and illustrated in the accompanying drawing, of which Fig. 1 comprises a circuit diagram of the repeater, and Fig. 2 a separate diagram of the substation.

Referring to the drawing, ML designates a main transmission line, over which printing telegraph signals may be transmitted in the usual manner. At a central office the main line terminates in the usual form of differential duplex arrangement, the main line ML being balanced by an artificial line MN, and a polarized receiving relay PR being connected to the main line and artificial line in such a manner as to be neutral with respect to outgoing transmission which is applied over the circuit 10 to the main line at the junction point 11 between said main line and the artificial line MN.

In order that signals incoming from the line ML may be transmitted to a local receiving station, a loop L is provided, such loop extending from the central office to the substation, where it is associated with printing apparatus, as described hereinafter. At the central office, the loop L terminates in a well known form of balanced transformer 12, and a balancing network N. Currents outgoing over the line L from the central office are applied to the line L over a circuit 13 connected to the midpoints of the line windings of the transformer 12, while currents incoming from the line L are inductively applied to a receiving circuit 14 associated with the transformer 12.

The code combinations used in transmitting printing telegraph signals may be repeated from the main line to the local loop and vice versa through an arrangement comprising a number of rotary distributors. For transmission from the line ML to the loop L, a distributor D_1 is associated with the main line, and distributor D_2 is associated with the loop. The distributor D_1 is connected with the polarized receiving relay PR of the main line over a circuit 15, while the distributor D_2 is connected to the loop L through conductors 16 and 17 associated with the transmitting circuit 13 through transformers 18 and 19 respectively. Since the signals are to be transmitted over the loop L through the agency of alternating carrier currents, two sources 20 and 21, having frequencies of x cycles and y cycles respectively may be applied to the conductors 16 and 17 under the control of the distributor D_2. The code combinations are preferably transmitted over the main line ML through the agency of positive and negative direct current impulses in accordance with the well known Baudot code, and in order to translate the impulses incoming from the

line ML into carrier currents for transmission over the loop L, a set of five polarized receiving relays PR_1, PR_2, PR_3, PR_4 and PR_5 are associated with the receiving segments of the distributor D_1.

The distributors D_1 and D_2 are preferably of the well known start-stop type, and need not operate synchronously or at the same speed, the system being so arranged that the distributor D_2 may rotate at a speed equal to or greater than that of the distributor D_1 so long as the speed of the distributor D_2 shall not be greater than approximately twice the speed of the distributor D_1.

In order to repeat signals from the loop L to the main line ML, a start-stop distributor D_3 is associated with the main line ML, and a start-stop distributor D_4 is associated with the loop L. The distributor D_4 is associated with the loop L over a circuit 22 connected to a contact of an alternating current receiving relay AR_1 connected in a tuned bridge of the circuit 14. The circuit of the relay R_1 is tuned to the frequency x, and in order to prevent currents of frequency y from being transmitted to the relay AR_1, a filter arrangement F is included in the circuit 14. This filter may be of any well known type, such, for instance, as a filter of the general character disclosed in U. S. patent to George A. Campbell 1,227,113 issued May 22, 1917. The distributor D_3 is associated with the main line ML through the conductor 10 previously referred to.

Distributors D_3 and D_4, like the distributors D_1 and D_2 already described, need not rotate at the same frequency, as the circuit is so arranged that the signals will be properly repeated if the distributor D_4 rotates at a frequency equal to or greater than that of the distributor D_3 so long as it does not exceed about twice the speed of the latter distributor. In order to translate the carrier signals received from the loop L into positive and negative impulses for transmission over the line ML a set of five polarized relays PR_1', PR_2', PR_3', PR_4' and PR_5' are connected to the receiving segments of the distributor D_4.

At the substation of the loop L a receiving printing apparatus is associated with the loop through a counting relay distributing arrangement. The receiving apparatus of the printer is indicated schematically as consisting of a set of five selecting magnets M_1, M_2, M_3, M_4 and M_5, which under the control of the counting relays respond to the individual elements of the code combination and control the printing operation in a well known manner. The details of the printer are not shown, as the printer may be of any well known type capable of responding to the Baudot code. The transmitting portion of the printer is shown schematically as consisting of a set of five keyboard contacts numbered 1 to 5 inclusive for transmitting various code combinations to the loop L under the control of the counting relays. A common keyboard contact K is also provided for initiating the transmission of the code combination in a manner hereinafter described.

The counting relay arrangement comprises a series of five locking relays numbered 1 to 5 inclusive, and a series of five switching relays numbered 1′ to 5′ inclusive the last set of relays being arranged to control the circuits of the printer magnets M_1 to M_5 inclusive as well as the circuits of the keyboard transmitter contacts. The successive operation of the counting relays is controlled by an alternating current relay AR_2 included in a tuned bridge across the loop L. This bridge is tuned to be responsive to currents of frequency y and the function of the currents supplied by the source 21 at the central office is, therefore, to supply a carrier current for controlling the stepping or successive action of the counting relays. The actuation of the printer magnets, on the other hand, is controlled by a second alternating current relay AR_3 which is included in a tuned bridge across the loop L, said tuned bridge also having serially inserted therein the common keyboard contact K and a break key BK whose purpose will be more fully described later. This bridge is preferably tuned to currents of frequency x, so that the currents transmitted over the loop L from the source 20 serve to control the actuation of the printer magnets and, as will be described later, to cause the response of the receiving elements of the repeater apparatus at the central station in response to the actuation of the keyboard contacts.

Further details of the apparatus will now be clear from a description of the operation, which is as follows:

In a printing telegraph system employing start-stop distributors, seven impulses are transmitted for each code combination. These seven impulses may comprise a positive starting impulse followed by five impulses which may be variable combinations of positives and negatives for determining the character to be printed, these five impulses being followed by a negative stop impulse. In practice, the negative stop impulse will be continuously transmitted over the main line ML from a distant station so long as the distributor at the distant station is not being operated in transmitting characters. During the continuance of this impulse the polarized receiving relay PR holds its armature against the contact which is connected to negative battery. As soon as the distributor at the distant station is released, a positive starting impulse is transmitted, and the polarized relay PR shifts

its armature to the contact which is connected to the positive battery, so that a circuit is closed from positive battery over the contact of the relay PR, over the segment 23 of the upper ring of the distributor D_1, through the brush and over the segment 24 of the lower ring of the distributor through the release magnet RM_1 to negative battery. The release magnet is thereby operated and releases the brush arm of the distributor so that the brush passes successively over the five impulse segments of the lower ring of the distributor D_1. As the brush passes over the first segment, a positive or negative impulse will be transmitted over the conductor 15 from the polarized relay PR depending upon whether a marking or spacing impulse is being received at that moment from the main line. This impulse will operate the polarized relay PR_1 connected with the first segment of the distributor D_1, and will shift its armature to its upper or lower contact. If the received impulse is a positive impulse, it being assumed that positive impulses are marking impulses, the armature of the relay PR_1 will be shifted to its upper contact, which is connected to the source 20, so that an alternating potential of frequency x will be connected from the source 20 over the upper contact of the relay PR_1 to the first segment of the lower ring of the distributor D_2. Similarly, as the brush of the distributor D_1 passes over the succeeding segments 2, 3, 4 and 5, the corresponding polarized relays are operated in accordance with the character-determining impulses which are being transmitted over the main line ML at that moment. Let us assume that the first, third and fifth impulses following the starting impulse are positive, and that the second and fourth are negative spacing impulses; accordingly the relays PR_1, PR_3 and PR_5 will shift their armatures to their upper contacts, while the relays PR_2 and PR_4 will shift their armatures to their lower contacts, providing the several armatures are not already resting in the positions indicated, it being understood that the armatures will remain in any position to which they are shifted until they are moved to the opposite position by an opposite impulse. An alternating potential of frequency x is now connected over contacts of the first, third and fifth polarized relays to the first, third and fifth segments of the lower ring of the distributor D_2.

At the instant the brush arm of the distributor D_1 passed between the third and fourth segments of the lower ring, a circuit was closed from ground over segment 25, the brush arm of the distributor, segment 26, over conductor 27, through the winding of start magnet 28 of distributor D_2 to battery. The start magnet 28 is energized over this circuit, and releases the brush arm of the distributor D_2 which moves over the face of the distributor and transmits the carrier currents corresponding to the code combination in a manner to be described presently. It will be noted that the circuit of the start magnet 28 was closed at about the time the brush arm of the distributor D_1 had passed through one-half of its revolution, so that the distributor D_2 is not released until the distributor D_1 has passed through one-half of its cycle. The distributor D_2 cannot be permitted to rotate slower than the distributor D_1, but if it rotates at the same rate it will be observed that as the code impulses come in from the line ML and are stored up on the polarized relays PR_1, PR_2, etc., the first stored impulse will not be transmitted to the loop L by the distributor D_2 until the third impulse, exclusive of the starting impulse, has come in from the line ML. The brush arm of the distributor D_1, after passing over the fifth segment passes on to the starting segment 24 where it engages with the latch controlled by the release magnet RM_1. The release magnet is at this moment de-energized because at this same instant a negative stop impulse is being received over the line ML. Should a starting impulse of a new code combination immediately follow this stop impulse the distributor will be released to set up a new code combination. While the distributor D_1 will, therefore, proceed to set up a new combination on the polarized relays before the distributor D_2 has transmitted all the impulses of the code combination previously set up, it will be noted that if the two distributors are rotated at the same rate of speed, the impulses stored on the first three relays will have been transmitted by the distributor D_2 before the distributor D_1 is released the second time. In other words, the distributor D_2, while several impulses behind the distributor D_1 as regards the code combination being transmitted, will be several impulses ahead of the distributor D_1 with respect to the succeeding code combination. Should the distributor D_2 rotate at a slower rate than the distributor D_1, however, the brush arm of the latter might overtake that of the former and change a combination previously set up on the polarized relays PR_1 to PR_5 inclusive before said combination had been completely transmitted by the distributor D_2.

It is also possible to operate the distributor D_2 at any speed greater than that of the distributor D_1 so long as the distributor D_2 does not rotate so fast that its brush arm will pass over its fifth segment before the brush arm of the distributor D_1 has had time to pass from segment 25 over the fifth segment of the lower ring. If the speed of the distributor D_2 should be greater than

this, one or more impulses stored up by the distributor D_1 might be lost before the distributor D_2 had an opportunity to transmit them to the loop L. The distributor D_2 may be operated at any speed between the two limits above indicated without mutilating the signals to be repeated from the main line to the loop. This is advantageous in practical operation, since it becomes unnecessary to maintain the distributors D_1 and D_2 in synchronism, and the operations of storing up impulses by the distributor D_1 and of transmitting the stored impulses by the distributor D_2 become independent in point of time.

When the brush arm of the distributor D_2 is at rest, a circuit is closed from generator 20 over the stop segment 29 of the lower ring of the distributor D_2, brush and ring 30 of said distributor and over conductor 16 through the primary winding of the transformer 18 to ground. Currents of frequency x are, therefore, impressed upon the circuit 13 and are transmitted over the loop L to maintain the alternating current relay AR_3 at the substation in operated condition. Upon the release of the brush arm of the distributor D_2 by the energization of the magnet 28 as already described, the brush arm passes from the stop segment 29 to the start segment 31, thereby opening the circuit previously described from the source 20. The currents of frequency x are no longer transmitted over the loop L, and the relay AR_3 is accordingly released. As the brush arm of the distributor D_2 passes over the first segment of the ring 32, a circuit is closed from generator 21 over said first segment through the brush of the distributor and ring 33 thereof, and thence over conductor 17 through the primary winding of the transformer 19 to ground. Alternating current of frequency y is now transmitted to the circuit 13 and over the loop L operating the alternating current relay AR_2 at the substation. Relay AR_2 closes a circuit from battery over its front contact, over the right hand back contact of counting relay 4, right hand back contact of counting relay 2, through the winding of counting relay 1, and through the winding of switching relay 1′ to ground. Relays 1 and 1′ are energized, and at its left hand front contact relay 1 closes a locking circuit from battery over the right hand back contact of slow release relay 6, over the left hand front contact of relay 1, and through the windings of relays 1 and 1′ to ground. Relay 1′ upon being energized, closes its upper and lower contacts.

A moment after the brush arm of the distributor D_2 came in contact with the first segment of the ring 32 of the distributor, the brush arm passed over the first contact of the lower ring of said distributor, thereby closing a circuit from source 20 over the upper contact of polarized relay PR_1, first segment of the lower ring of distributor D_2, brush of the distributor, ring 30, over conductor 16 and through the primary of transformer 18. Currents of frequency x are, therefore, transmitted over the loop L to operate the relay AR_3 an instant after the relay AR_2 had been operated. Relay AR_3, therefore, transmits a marking impulse to the printer magnet M_1 from battery over the front contact of relay AR_3, over the upper back contacts of relays 5′ to 2′ inclusive, over the upper front contact of relay 1′, through the winding of magnet M_1 to ground.

As the brush arm passes from the first to the second segment of the ring 32 of distributer D_2, the circuit from the generator 21 is opened, and currents of frequency y are no longer transmitted over the loop L. The relay AR_2, therefore, releases its armature and a circuit is now closed from battery over the back contact of said relay, back contacts of counting relays 5 and 3, and over the front right hand contact of counting relay 1 through the windings of counting relay 2 and switching relay 2′ to ground. Relays 2 and 2′ are locked up over the right hand back contact of slow release relay 6 and the circuit controlled by the relay AR_3 is shifted by the switching relay 2′ to the magnet M_2 over the upper front contact of said relay 2′. In the case of the assumed code combination being transmitted, it will be remembered that the second impulse of the five character forming impulses was a spacing impulse. The polarized relay PR_2, therefore, shifted its armature to its lower contact. Consequently, as the brush arm of the distributor D_2 passes over the second segment of the lower ring, no circuit is closed from source 20 to the transformer 18. Relay AR_3 at the substation is, therefore, de-energized during the period that the relay AR_2 is de-energized, and consequently the magnet M_2 of the printer is not operated.

As the brush arm passes over the third contact of the ring 32, currents of frequency y are transmitted over the loop and operate the relay AR_2 to close a circuit over the right hand back contact of counting relay 4, and right hand front contact of counting relay 2, through the windings of relays 3 and 3′. These relays are energized and lock up, the relay 3′ shifting the connection controlled by the relay AR_3 from the printer magnet M_2 to the printer magnet M_3. The third character-forming impulse was a positive impulse, and consequently currents of frequency x are transmitted over the third segment of the lower ring of the distributor through the loop L_3, thereby energizing the relay AR_3. The latter relay closes a

circuit over the upper front contact of the switching relay 3′ for the magnet M_3, thereby operating said magnet.

In a similar manner the relay AR_2 is de-energized as the brush arm of the distributor passes over the fourth segment closing a circuit for the relays 3 and 4′, said relay AR_2 being energized as the brush arm passes over the fifth segment to operate the relays 5 and 5′. The relays 4 and 4′ were energized at the time the fourth character-forming impulse was being repeated to the loop L, and as this impulse was a spacing impulse the magnet M_4 was not operated. The fifth impulse being a marking impulse, the magnet M_5 was energized by the relay AR_3 after the relays 5 and 5′ pulled up their armatures.

Immediately after the brush arm of the distributor passed off of the fifth segment of the ring 32, it came to rest by engaging with the catch controlled by the starting magnet 28. At the same time the circuit of the generator 21 was opened so that currents of frequency y are no longer transmitted to the loop L. The relay AR_2 at the substation is, therefore, released and completes a circuit from battery over its back contact, right hand front contact of counting relay 5 and through the winding of slow release relay 6. Relay 6 upon being energized closes at its left hand front contact a circuit for the relay or magnet (not shown) which sets into operation the printing mechanism selectively controlled by the printer magnets M_1 to M_5 inclusive to print the selected character in a manner well understood. The relay 6 at its right hand contact opens the locking circuits for the counting relays 1 to 5 inclusive, the switching relays 1′ to 5′ inclusive, so that the circuits of these relays are restored to normal ready to receive a new code combination. The brush arm of the distributor D_2 upon coming to rest causes currents of frequency x to be transmitted over the loop L in a manner already described, thereby maintaining the relay AR_3 at the substation in energized condition.

In case it is desired to transmit printing signals from the substation over the loop L to the main line ML the keyboard transmitter will be operated by pressing the key corresponding to a desired character in a well known manner. In response to this operation, certain of the keyboard contacts 1 to 5 inclusive will be operated, and the common keyboard contact k will be opened. Let it be assumed that the first, third and fifth keyboard contacts are operated. In the normal condition of the circuit with the contact of the key k closed, the loop L is just balanced by the network N, so that currents of frequency x transmitted from the source 20 over the circuit 16 in the manner already described, divide equally between the loop and the artificial line without producing any material effect upon the circuit 14. Upon opening the contact k however, the loop L is unbalanced and currents of frequency x are transmitted to the circuit 14 and through the filter F to the alternating current relay AR_1 which is in a tuned circuit responsive to currents of frequency x. Relay AR_1 upon being energized, closes a circuit from positive battery over its front contact, over conductor 22, ring 34 of the distributor D_4, brush arm and segment 35 of said distributor, through the winding of starting magnets 36 and 37 of distributors D_4 and D_3 respectively, over the segment 38, brush arm and ring 39 of the latter distributor, and thence over conductor 40 to negative battery. Starting magnets 36 and 37 are energized over the circuit above traced, and release the brush arms of distributors D_3 and D_4, which proceed to pass over the various segments of the two distributors.

Upon the brush arm of the distributor D_4 passing on to the first contact of its ring 41, a circuit is closed from source 21 over said segment, the brush and ring 42 of distributor D_4 and thence over the conductor 17 through the primary winding of transformer 19 to ground. Currents of frequency y are therefore, transmitted over the loop L and operate the relay AR_2 which closes the circuit of the counting relay 1 and switching relay 1′ in a manner already described. Upon the energization of the relay 1′, the bridge through the relay AR_3 is closed over the lower back contacts of switching relays 5′ to 2′ inclusive, over the lower front contact of switching relay 1′ and the first keyboard contact. The loop L is now balanced and currents of frequency x are no longer transmitted to the circuit 14. The relay AR_1 is accordingly de-energized. At this moment the brush arm of the distributor is passing over the first segment of the lower ring of the distributor D_4, and consequently the circuit is closed from negative battery over the back contact of the relay AR_1, over conductor 22, ring 34, brush arm and first segment of the distributor D_4 to the winding of the polarized relay PR_1' to ground. Relay PR_1' is energized to shift its armature to its lower contact if not already in this position, thereby connecting positive battery to the first segment of the lower ring of distributor D_3.

The brush arm of the distributor D_4 now passes from the first segment of ring 41 to the second segment, so that current of frequency y is no longer transmitted to the loop L. Relay AR_2, is, therefore, de-energized, and operates counting relay 2 and switching relay 2′. The loop through the relay AR_3 is, thereby shifted from the first

keyboard contact to the second keyboard contact, which in the instance assumed is open. Consequently the loop L is unbalanced, and current of frequency x is transmitted to the circuit 14 operating the relay AR_1. The latter relay shifts its armature to its positive contact and as the brush of the distributor D_4 passes over the second segment of the lower ring operates the polarized relay PR_2' to shift its armature to its upper negative contact if not already in this position, thereby placing negative battery on the second segment of the lower ring of the distributor D_3.

In a similar manner the relay AR_2 is alternately energized and de-energized as the brush arm of the distributor D_4 passes over the remaining segments of the ring 41, and under the control of the counting and switching relays the control of the loop through the relay AR_3 is transferred successively to the remaining keyboard contacts so that the remaining polarized relays PR_3' to PR_5' inclusive are operated to connect positive battery to the third and fifth segments, and negative battery to the fourth segment of the lower ring of the distributor D_3. As the brush of the distributor D_4 passes off of the fifth segment of the ring 41 the frequency y is no longer transmitted over the loop L and the relay AR_2 is de-energized, thereby operating the slow release relay 6 over a circuit already described. Relay 6, upon being energized opens the locking circuits of the counting relays and switching relays, and at its right hand front contact connects battery to the keyboard relay (not shown), which unlocks the keyboard contacts and restores them to normal ready for the setting up of another code combination. The brush arm of the distributor D_4 in the meantime has come to rest in engagement with the catch of the release magnet 36.

It will be remembered that the brush arm of the distributor D_3 was released at the same instant as the brush arm of the distributor D_4, and consequently has been passing over the segments of the various rings at the same time that the operations above described were taking place. With the brush arm of the distributor D_3 in its normal condition, negative battery is connected over the segment 42 of the lower ring, brush arm and ring 43 of the distributor D_3 and over conductor 10 to the main line ML, thus transmitting the prolonged stop impulse to the main line. As soon as the brush arm of distributor D_3 passes from the stop segment 42 to the start segment 44, positive battery is connected to the main line over a similar circuit, thereby transmitting the start impulse to release the distributor at the distant station. As the brush arm passes over the first, second, third, fourth and fifth segments of the lower ring, the five character-forming impulses are transmitted under the control of the polarized relays PR_1' to PR_5' inclusive, thereby transmitting a character-forming combination corresponding to that set up by said relays.

The distributor D_3 may rotate at the same speed as the distributor D_4, in which case the impulses set up by the polarized relays of the latter distributor will be transmitted immediately after they are set up by the distributor D_3, which will be moving in approximate synchronism with the distributor D_4. The distributor D_3, however, cannot rotate faster than the distributor D_4 as in this case it might complete a full revolution and pass off of its fifth segment before the fifth character-forming impulse had been set up on the relay PR_5', thereby resulting in a mutilation of the signal. The distributor D_3 on the other hand, may rotate at any desired speed slower than that of the distributor D_4 as the latter cannot be released in response to the setting up of a new code combination at the keyboard until the brush arm of the distributor D_3 has come to rest, for it will be noted that the circuit of the release magnets 36 and 37 passes over the initial segment 35 of the distributor D_4 and the initial segment 38 of the distributor D_3 in series, so that both brushes must be in normal position before either brush can be released. It is not desirable, however, to have the distributor D_3 rotate less than half the speed of the distributor D_4, since in practice distributor D_4 will be on the same shaft as the distributor D_2 and when released will rotate at the same speed as the latter, and consequently to have the distributor D_3 rotate at a slower speed than that indicated would unnecessarily slow down the transmission of signals. Furthermore, in practice, distributor D_3 would be on the same shaft as the distributor D_1, and would rotate at the same speed, so that the same relative difference in speed between the distributors D_3 and D_4 exists as between the distributors D_1 and D_2.

Should the operator at the substation desire for any reason to transmit at a time when signals are being received from the main line ML, the break key BK will be operated, thereby unbalancing the loop L, so that as soon as currents of frequency x are transmitted to the circuit 13 at any period in the rotation of the distributor D_2 these currents will be transmitted to the circuit 14 due to the unbalanced condition, thereby operating the relay AR_1. Said relay in shifting its armature to its positive contact closes a circuit over conductor 45 for the polarized relay PR' which shifts its armature to its lower contact, thereby completing a circuit from the source 20 over said contact, and over conductor 16 to the pri-

mary winding of the transformer 18 independently of the distributor D_2. Consequently, currents of frequency x will be transmitted to the circuit 14 to maintain the relay AR_1 operated as long as the break key is held open and the loop maintained unbalanced. The opening of the circuit of the relay AR_3 by the break key will, of course, mutilate the code combination at that moment being set up by the counting and switching relays, as well as any further code combinations transmitted over the main line before the distant operator observes the break signal.

The actuation of the relay AR_1 above described also completes a circuit previously traced for the release relay 36 and 37 of the distributors D_4 and D_3. The brushes of the distributors D_3 and D_4 are accordingly released and rotate over their segments. As the break key maintains the loop L unbalanced, and relay AR_1 operated, positive impulses are transmitted to all five of the polar relays PR_1' to PR_5' inclusive as the brush arm of the distributor D_4 rotates, and negative battery will be applied to the five character determining segments of the distributor D_3. Consequently, instead of a continuous negative impulse a code combination consisting of a positive starting impulse, five negative character-forming impulses and a negative stop impulse is transmitted over the main line ML to the distant station. This code combination may be utilized at the distant station to operate a signal such as a lamp in a well known manner, or, by printing a special character, or by merely operating the printer at the distant station, to indicate to the operator at such station that the operator at the substation desires to break in and transmit. The code combination above described will be transmitted as long as the break key BK is held open. The operator at the local station upon restoring the break key, and observing that the local printer is no longer operating, will understand that the distant operator has stopped sending and the local operator may then proceed to transmit in the regular manner.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention, as defined in the following claims.

What is claimed is:

1. In a printing telegraph system, a circuit for the transmission of printing telegraph signals by direct current impulses, another circuit for the transmission of printing telegraph signals by alternating carrier currents, and means for translating the direct current impulses of a code combination incoming over said first circuit into a code combination comprising a group of intervals some of which correspond to marking signals and others of which correspond to spacing signals, means to transmit alternating currents of one frequency over said second circuit during all of the intervals corresponding to one type of signal only, and means to transmit alternating currents of another frequency over said circuit during certain of said intervals regardless of the type of signal which they represent.

2. In a printing telegraph system, a circuit for the transmission of printing telegraph signals by means of a Baudot code, another circuit for the transmission of printing telegraph signals by alternating carrier currents, and means for translating the Baudot code combination incoming from said first circuit into a carrier current code combination comprising a group of intervals some of which correspond to marking signals and others of which correspond to spacing signals, means to transmit alternating currents of one frequency over said second circuit during all of the intervals corresponding to one type of signal only, and means to transmit alternating currents of another frequency over said circuit during certain of said intervals regardless of the type of signal which they represent.

3. In a printing telegraph system, a transmission circuit, a receiving printer and a receiving distributor comprising a series of counting relays, means whereby said counting relays may be successively operated in response to the transmission of currents of one frequency from a distant station, and means responsive to groups of oscillations of another frequency transmitted from the distant station to selectively operate the printer under the control of the counting relays.

4. In a printing telegraph system, a transmission circuit, a receiving printer associated therewith, counting relays for controlling the operation of said printer, and selective devices associated with the printer and having their circuits individually controlled by the counting relays, means for successively operating the counting relays in response to the transmission of currents of one frequency from the distant station, and means responsive to the transmission of groups of oscillations of another frequency from the distant station to selectively operate said selective devices as the circuits are closed by the counting relays.

5. In a printing telegraph system, a circuit over which printing telegraph signals may be transmitted by the Baudot code, another circuit over which printing telegraph signals may be transmitted by means of carrier currents, a receiving printer associated with said second circuit, counting relays for controlling said printer, means at the junction point of said circuits for translating the Baudot code into alternating currents

of not more than two frequencies, means whereby said counting relays are successively operated in response to the transmission of alternating currents of one frequency, and means responsive to groups of oscillations of the other frequency for selectively operating said receiving printer under the control of the counting relays.

6. In a printing telegraph system, a circuit over which printing telegraph signals may be transmitted by means of the Baudot code, another circuit over which printing telegraph signals may be transmitted by means of alternating currents, a receiving printer associated with said second circuit and counting relays for selectively controlling said printer, selective devices associated with said printer having circuits individually controlled by said counting relays, means at the junction point of first and second mentioned circuits for translating the Baudot code into carrier currents of not more than two frequencies for transmission over the loop, means responsive to the transmission over the second circuit of alternating currents of one frequency successively operating the counting relays and means responsive to the transmission of groups of oscillations of the other frequency, for selectively operating said selective devices as the circuits are completed by the counting relay.

7. In a printing telegraph system, two transmission circuits, means for repeating from one of said circuits to the other, said means comprising an intermittently operating distributor associated with one of said circuits and an intermittently operating distributor associated with the other of said circuits at the junction point of said circuits, one of said distributors functioning to register code combinations transmitted over one of said circuits, and the other distributor functioning to transmit said registered combination to the other circuit, said distributors being operated non-synchronously.

8. In a printing telegraph system, two transmission circuits, means for repeating from one of said circuits to the other, said means comprising an intermittently operating distributor associated with one of said circuits and an intermittently operating distributor associated with the other of said circuits at the junction point of said circuits, one of said distributors functioning to register code combinations transmitted over one of said circuits, and the other distributor functioning to transmit said registered combination to the other circuit, said distributors being operated at different speeds.

9. In a printing telegraph system, two transmission circuits, means for repeating from one of said circuits to the other, said means comprising an intermittently operating distributor associated with one of said circuits and an intermittently operating distributor associated with the other of said circuits at the junction point of said circuits, one of said distributors functioning to register code combinations transmitted over one of said circuits, and the other distributor functioning to transmit said registered combination to the other circuits, said distributors being operated during successive but partially overlapping intervals for repeating the same signal.

10. In a printing telegraph system, a main transmission line and local receiving loop, means for repeating signals from said main line to said loop and vice versa, said means comprising a pair of intermittently operating distributors associated with the main line and a pair of intermittently operating distributors associated with the loop at the junction point of said main line and loop, one of the distributors associated with the main line functioning to register signals transmitted thereover, a corresponding distributor associated with the loop functioning to transmit said registered signals to the loop, the other distributor associated with the loop functioning to register signals transmitted over the loop and a corresponding distributor associated with the main line functioning to transmit said last mentioned registered signals to the main line, said distributors associated with the main line being operated non-synchronously with respect to those associated with the local loop.

11. In a printing telegraph system, a main transmission line and local receiving loop, means for repeating signals from said main line to said loop and vice versa, said means comprising a pair of distributors associated with the main line and a pair of distributors associated with the loop at the junction point of said main line and loop, one of the distributors associated with the main line functioning to register signals transmitted thereover, a corresponding distributor associated with the loop functioning to transmit the registered signals to the loop, the other distributor associated with the loop functioning to register signals transmitted over the loop and a corresponding distributor associated with the main line functioning to transmit registered signals to the main line, said distributors associated with the main line being operated at a different speed from those associated with the local loop.

12. In a printing telegraph system, a main transmission line and local receiving loop, means for repeating signals from said main line to said loop and vice versa, said means comprising a pair of intermittently operating distributors associated with the main line and a pair of intermittently operating distributors associated with the

loop at the junction point of said main line and loop, one of the distributors associated with the main line functioning to register signals transmitted thereover, a corresponding distributor associated with the loop functioning to transmit the registered signals to the loop, the other distributor associated with the loop functioning to register signals transmitted over the loop and a corresponding distributor associated with the main line functioning to transmit registered signals to the main line, said distributors associated with the main line and local loop being operated at successive intervals with respect to each other.

13. In a printing telegraph system, a main line over which printing telegraph signals may be transmitted by means of current of one character, a local loop over which printing telegraph signals may be transmitted by means of current of another character, and means associated with said main line and loop at their junction points for translating the signals transmitted by one character of current into currents of the other character, said means comprising a distributor associated with the main line and a distributor associated with the loop, one of said distributors controlling the circuits of the other.

14. In a printing telegraph system, two transmission circuits, means for repeating from one of said circuits to the other, said means comprising an intermittently operating distributor associated with one of said circuits and an intermittently operating distributor associated with the other of said circuits at the junction point of said circuits, one of said distributors functioning to register code combinations transmitted over one of said circuits, and the other distributor functioning to transmit said registered combination to the other circuit, and means to operate said distributors non-synchronously but with their periods of operation partially overlapping.

In testimony whereof, I have signed my name to this specification this 6th day of April 1920.

GILBERT S. VERNAM.