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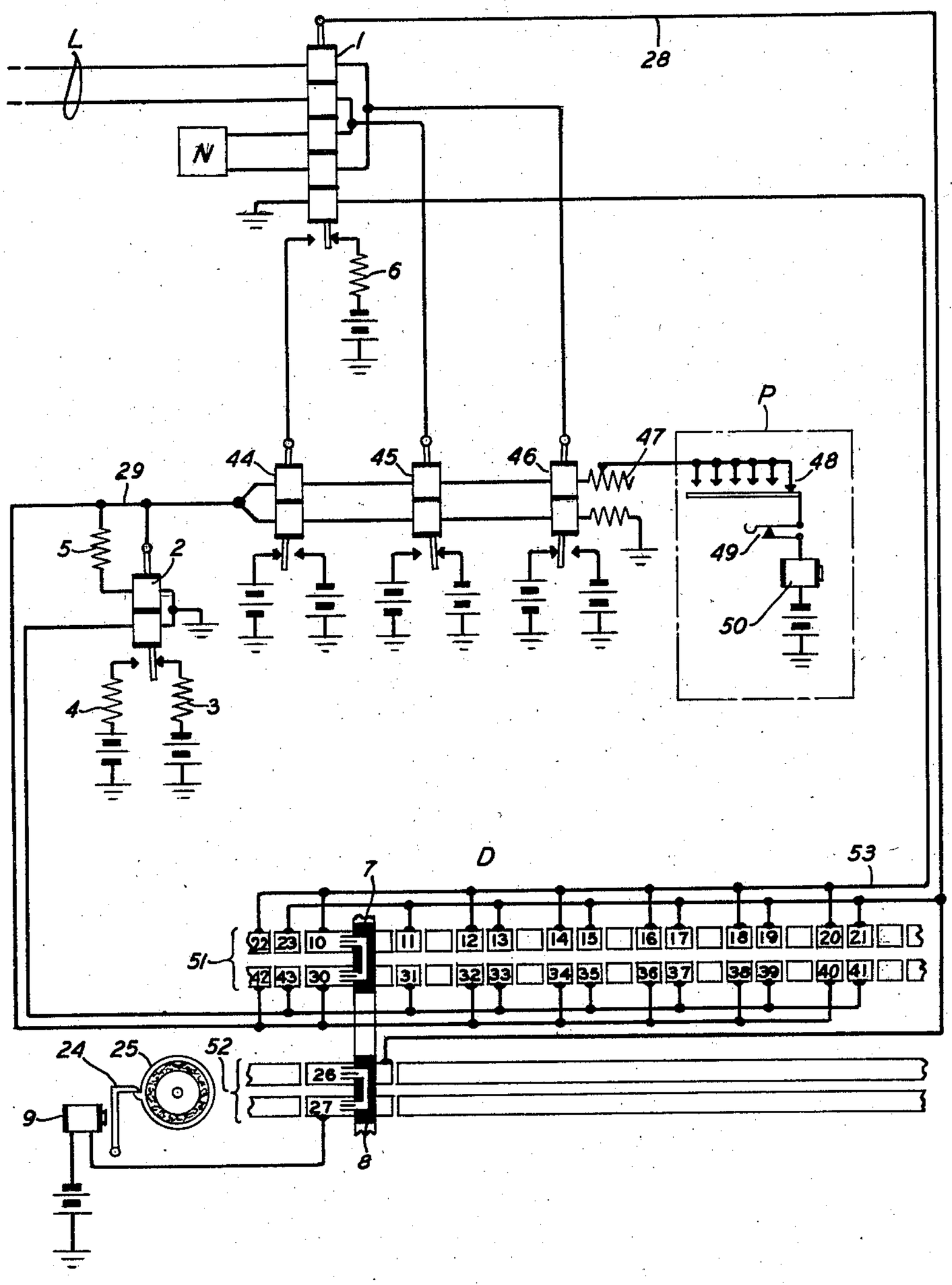

INVENTOR
G. A. LOCKE
BY J. W. Schmied
ATTORNEY

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INTERPOLATING TELEGRAPH RECEIVING SYSTEM

George A. Locke, Glenwood Landing, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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This invention relates to high speed synchronous telegraph systems in which short signal impulses are excessively attenuated and must be rebuilt, or regenerated, at a repeating or receiving station.

An object is to simplify and increase the reliability of the equipment at the repeater station for rebuilding short signal impulses.

In a telegraph system it is customary to transmit current impulses of different length and polarity in various combinations to represent different signal characters. Due to the excessive attenuation of high frequency waves on long transmission lines, the short, or unit length, impulses are sometimes attenuated to a point where they they cannot operate the receiving line relay although longer impulses are received with ample strength to control the relay.

To make possible signaling under such conditions, synchronous vibrating relay systems comprising relays, special rings on synchronous receiving distributors, and sometimes apparatus, such as condensers, had been employed. These restore, at the repeating or the receiving station, the short impulses that had been lost in transmission. The systems heretofore used have usually required multiplex rotary distributors of the continuously rotating type.

According to the present invention the unit length impulses are interpolated at the receiving or the repeating station by a pair of polar relays cooperating with a synchronous rotary distributor of the start-stop type. The invention is illustrated and described herein as applied to a terminal repeater operating with a two-wire metallic circuit between stations. It is understood that the invention is not restricted to the arrangement shown but may be readily adapted for use with four-wire metallic circuits, ground return differential, two and one-way polar, voice frequency carrier, and high frequency carrier systems.

Referring to the drawing, the terminal repeater illustrated comprises a line, or receiving, relay 1, a repeating and storing relay 2, a distributor D of the synchronous rotary start-stop type, a "break" relay 44, and two transmitting relays 45 and 46. Associated with the repeater is illustrated diagrammatically such portion of a printer P as is required to show the circuit of the printer magnet 50. The distributor D is provided with two sets of brushes, 7 and 8. These brushes, under control of clutch 25 and a driving motor (not shown), are caused to rotate across the face of their associated vibrating segment ring set 51 and distributor control ring set 52, respectively, both brushes making one complete revolution each time the clutch magnet 9 is energized.

To describe the operation of the repeater circuit in detail let it be assumed that transmission line L is closed at the distant end and that signal impulse transmission has not yet started. Under this condition a marking current is flowing over line L and through the line windings of the polarized receiving relay 1. The direction of flow of this marking current is such that its magnetic effect on receiving relay 1 causes the armature of that relay to be positioned to its right contact.

At this time, prior to the start of signal impulse transmission, the armature of the polarized repeating and storing relay 2 is positioned to its right contact and said relay is locked in that position in a circuit from negative potential, through resistance 3, right contact and armature of said relay, resistance 5, to ground through the upper winding of the relay. With the armature of relay 2 on its right contact a circuit is completed from the negative potential through resistance 3, over the right contact and armature of relay 2, conductor 29, vibrating segment 30, brush 7, vibrating segment 10, conductor 53, to ground through the lowermost winding of relay 1. This lowermost winding of relay 1 will hereinafter be referred to as the vibrating winding of that relay.

The direction of current flow through the vibrating winding of relay 1, in the circuit just traced, is such that the magnetic force exerted by the vibrating winding opposes the force being exerted by the line windings of the relay and tends to move the armature of the relay towards its left contact but, since the line winding current is more powerful than the vibrating winding current, the armature of relay 1 remains on its right or marking contact in response to the line marking current.

Assume now that the transmission of impulses over the line is started. The first impulse of any impulse series is the start pulse which is spacing, or positive, and of opposite polarity to the marking current. The polarity of the current through the line windings of relay 1 therefore is reversed, but before this reversal has completely taken place, and as soon as the magnetic effect of the preceding marking line current diminishes, the force being exerted by the vibrating winding becomes effective and causes the armature of relay 1 to move to the left contact of that relay. It will be obvious that the movement of the armature of relay 1 therefore occurs sooner than if

it had been dependent solely on the magnetic effect of the line windings of the relay in response to the line current reversal from marking to spacing.

With the armature of relay 1 on its left contact a circuit is completed from positive pole of battery over the left contact and armature of relay 44, left contact and armature of relay 1, conductor 28, start segment 26, brush 8, start segment 27, to negative pole of battery, through the winding of clutch release magnet 9, energizing said magnet which disengages latch 24 from clutch 25. Clutch 25 engages brushes 7 and 8 and causes these brushes to rotate across their associated ring sets. As brush 8 leaves segments 26 and 27 the circuit through magnet 9 is opened and the magnet deenergizes and permits latch 24 to restore to its original position where it will reengage clutch 25 after one revolution of brushes 7 and 8.

As brushes 7 and 8 continue to advance, brush 7 contacts segments 11 and 31 and a circuit is established from the positive pole of battery, over the left contact and armature of relay 44, left contact and armature of relay 1, conductor 28, segment 11, brush 7, segment 31, to ground through the lower winding of relay 2. The direction of flow and magnitude of the current in the lower winding of relay 2 is such that it overcomes the effect of the locking current flowing through the upper winding of the relay and the armature of relay 2 therefore moves from its right to its left contact in agreement with the movement of the armature of receiving relay 1 in response to the first incoming impulse over line L. With its armature on the left contact, relay 2 locks in that position in a circuit from positive pole of battery, through resistance 4, left contact and armature of relay 2, resistance 5, to ground through the upper winding of relay 2. The movement of the armature of relay 2 from the right to the left contact reverses the polarity of the potential over its armature and over conductor 29, through the upper windings of relays 44, 45 and 46, through rheostat 47, normally closed printer transmitting contacts 48, normally closed contacts of key 49, to negative pole of battery, through the winding of printer magnet 50. The first incoming impulse or start pulse has therefore been repeated by relay 2 to the printer P.

When brush 7 leaves segments 11 and 31 the circuit through the lower winding of relay 2 is opened. Relay 2 remains locked with its armature on its left contact previously set forth. As the distributor brushes continue to advance, brush 7 passes over a pair of inactive segments and then contacts segments 12 and 32 thereby completing a circuit from positive pole of battery, through resistance 4, left contact and armature of relay 2, conductor 29, segment 32, brush 7, segment 12, conductor 53, to ground through the vibrating winding of relay 1. The direction of this current flow through the vibrating winding of relay 1 is such that the relay armature tends to move to its right contact.

Assume now that the second incoming impulse, which is the first signal impulse, is of the same polarity as the first or start impulse. The direction of current flow through the line windings of relay 1 therefore remains unchanged and the armature of relay 1 remains on its left contact since the magnetic force exerted by the line windings is greater than that exerted by the vibrating winding.

When brush 7 contacts segments 13 and 33 a circuit is completed from positive pole of battery, over the left contacts and armatures of relays 44 and 1, conductor 28, segment 13, brush 7, segment 33 to ground through the lower winding of relay 2. Since relay 2 has previously locked with its armature on its left contact no change in the position of its armature occurs and the polarity of the potential connected to the winding of printer magnet 50, over the circuit previously traced, remains unchanged.

The circuit through the lower winding of relay 2 is opened as brush 7 leaves segments 13 and 33. The armature of relay 2 remains on its left contact since the relay is held in that position by the current flowing through its upper winding as hereinbefore set forth. Brush 7, after passing over a pair of inactive segments, next contacts segments 14 and 34 thereby completing the circuit from positive potential through resistance 4, over the aforementioned brush and segments, to ground through the vibrating winding of relay 1. The resulting current flow through the vibrating winding is in the direction which causes the magnetic force exerted by that winding to oppose the force exerted by the flow of spacing current through the line windings of relay 1.

Let it now be assumed that the third impulse incoming over line L is a marking impulse. The current flow through the line windings of relay 1 will therefore reverse in response to the change from spacing to marking polarity. As the effect of the magnetic force which was being maintained in the line windings of relay 1 by the preceding spacing current diminishes, the opposing force exerted by the vibrating winding predominates and the armature of relay 1 moves to the right contact. The positioning of the armature of relay 1 is therefore not dependent upon a reverse in the line winding magnetic force but is effected instead by the vibrating winding force which becomes effective as the existing line winding force diminishes upon a line current reversal. In the foregoing manner, a unit length impulse, which may have been attenuated to a degree where it is of insufficient length to produce a line winding magnetic force capable of changing the position of the armature of relay 1, is interpolated by the action of the vibrating winding of relay 1 in conjunction with the vibrating ring set 51 and brush 7 of distributor D, and the proper positioning of the armature of relay 1 is effected.

When the armature of relay 1 is positioned to its right contact, in response to the current in the vibrating winding of relay 1 to interpolate the third impulse as just set forth, the polarity of the potential on segments 11, 13, 15, 17, 19, 21 and 23, in the circuit over conductor 28 and the armature of relay 1, changes from positive to negative. After leaving segments 14 and 34, thereby opening the circuit through the vibrating winding of relay 1, brush 7 contacts segments 15 and 35 and completes a circuit from negative pole of battery, over segment 15, over brush 7 and segment 35, to ground through the lower winding of relay 2. The resultant current flow through the lower winding of relay 2 is greater than, and in the opposite direction to, the locking current flowing through the upper winding of that relay. The armature of relay 2 therefore moves from the left to the right contact in agreement with the position of the armature of relay 1. Negative potential through resistance 3, over the right contact and armature of relay 2, and through resistance 5 to ground through the

upper winding of relay 2 locks that relay in its right or marking position. The change in the polarity of the potential on conductor 29, by the repositioning of the armature of relay 2, reverses the polarity of the potential connected to the winding of printer magnet 50 thereby repeating the third incoming impulse to printer P.

As the brushes of distributor D continue to advance through the remainder of their complete revolution, the subsequent impulses incoming over line L are repeated to the printer P in a manner similar to that hereinbefore set forth for the first three impulses. Brush 7, in contacting segments 16 and 36, 18 and 38, 20 and 40, and 22 and 42, completes the circuit through the vibrating winding of relay 1. Under control of relay 2, which determines the polarity of the potential connected to segments 36, 38, 40 and 42, the direction of the flow of current through the vibrating winding of relay 1, upon each of the aforementioned closures through that winding, is such that the vibrating winding magnetic force at all times opposes the line winding magnetic force set up by the line current of the preceding impulse. The armature of the storing and repeating relay 2 is positioned, to agree with the position of the armature of receiving relay 1, for the fourth, fifth, sixth and seventh, or stop, impulses when brush 7 completes the circuit over segment pairs 17 and 37, 19 and 39, 21 and 41, and 23 and 43, successively. Upon each change in the position of the armature of relay 2, the polarity of the potential applied to the vibrating winding of relay 1 and to the winding of printer magnet 50 is reversed to correspond with the polarity of the incoming impulse.

The final impulse of each character impulse series, known as the stop impulse, is always a marking impulse and the armature of relay 1 always moves to or remains on its right contact at the conclusion of any series of incoming impulses. As brush 7 passes over segments 23 and 43 the armature of relay 2 is positioned to its right contact by the direction of the flow of current through its lower winding in the circuit to the negative potential over conductor 28 and over the armature and right contact of relay 1. The brushes of distributor D have now made a complete revolution and the released latch 24 re-engages clutch 25 thereby causing the distributor brushes to come to rest, brush 7 in contact with segments 10 and 30, and brush 8 in contact with the start segments 26 and 27. Negative pole of battery is again connected to the vibrating winding of relay 1 in the circuit traced through resistance 3, over the right contact and armature of relay 2, segment 30, brush 7, segment 10, and conductor 53. The winding of clutch release magnet 9 is again connected to the armature of relay 1 in the circuit over segment 27, brush 8, segment 26, and conductor 28. The repeater circuit is now in the identical condition set forth at the outset of this description at the point prior to the start of the transmission of the first series of incoming impulses. For each succeeding series of signal impulses the first, or start, impulse operates clutch release magnet 9 which causes the distributor brushes 7 and 8, under control of clutch 25, to make one complete revolution. Relays 1 and 2, in conjunction with the segments of distributor ring set 51 and brush 7, interpolate all unit length signal impulses and repeat the incoming signal impulses to printer P in the manner identical with that hereinbefore described for the first impulse series.

From the foregoing description it will be obvious that, since unit length impulses are locally regenerated and interpolated, an increase in the speed of impulse transmission or an increase in the length of the transmission line, may be realized by the use of this invention due to the fact that the unit length impulses can be shortened or attenuated beyond the point where they could effectively position the armature of receiving relay 1 solely by the magnetic force which they produce in the line windings of that relay.

What is claimed is:

1. In a telegraph system, the combination of a transmission circuit, a source of current for transmitting groups of impulses over said circuit, a relay comprising a line winding for receiving the impulses from said circuit and a second winding, an armature and current supply contacts cooperating therewith, a local circuit including said second winding arranged when energized to produce a magnetic effect on said armature sufficient to cause the movement thereof, electromagnetic means serving upon the operation thereof to energize said winding in said local circuit, means rotatably operated, for effecting the energization of said electromagnetic means and said local circuit winding whereby said armature is caused to reverse its position, and other means responsive to the energization of said line winding only by the first impulse of each group received over said transmission circuit for starting said rotatably operated means.

2. In combination with a telegraph system, a receiving relay comprising a line winding, an armature, current supply contacts cooperating therewith, local circuit electromagnetic means arranged to produce a magnetic effect on said armature sufficient to cause the movement thereof, a relay serving to control the energization of said local circuit, electromagnetic means, and a start-stop rotary device cooperating with said relay for energizing said local circuit electromagnetic means.

3. A system for receiving combinations of start, intermediate and stop impulses in which incoming signal impulses of unit length not received in effective amplitudes, are regenerated and incoming signal impulses of plural unit lengths are received in effective amplitudes, characterized in this that a line relay and a storing relay are alternately effective when unit length impulses are being received to operate each other through an intermittently rotatable device, said device being arranged to start to rotate through one revolution only in response to the first impulse of an incoming signal code combination and stop when the last impulse of said combination is received.

4. A system according to claim 3 wherein the intermittently rotatable device is a start-stop rotary distributor comprising two ring sets, one for controlling the starting and the stopping of rotation of said device and the other for causing said line and said storing relay to alternately operate during the interval that the device is rotating through one revolution when incoming unit length signal impulses are being received.

5. A system comprising a circuit for receiving incoming signal combinations of start, intermediate and stop impulses, a line relay having a plurality of windings for receiving said signal combinations from said circuit, an armature and contact for said line relay, an intermittently rotatable device comprising a plurality of receiving distributor ring sets and a rotatable member

therefore, an electromagnet for controlling the rotation of said member, a storing relay, an armature and contact for said storing relay, a normally deenergized circuit comprising a source of potential, the armature and contact of said line relay and a plurality of parallel paths, one extending through the first of said ring sets and the winding of said electromagnet, and the other of said paths extending through the second of said ring sets and a winding of said storing relay, said other of said paths providing means for alternately energizing and deenergizing said circuit during rotation of said device, and a normally energized circuit comprising a source of potential, the armature and contact of said storing relay, the second of said ring sets and a winding of said line relay, said normally energized circuit having a plurality of paths over which it may be alternately deenergized and energized during rotation of said device.

6. A start-stop receiving system for receiving combinations of start, code and stop impulses, in which unit impulses following a start impulse are not received in effective amplitude, comprising a line circuit, a local circuit, a line relay having line circuit windings and a local circuit winding, said relay being ineffective in response to incoming code impulses of unit length but effective in response to incoming code impulses of two or more unit lengths, a start-stop rotary distributor and a storing relay connected in said local circuit and a printer controlled by said storing relay, said distributor being arranged to rotate through one revolution in response to the start impulse and to provide through its rotation, for said line relay and said storing relay to alternately control the operation of each other during intervals when unit length impulses are being received.

7. A system in accordance with claim 6 wherein sources of potential of opposite polarities are respectively connected to the contacts of said storing relay whereby interpolated unit length impulses in consecutive sequence are caused to be of alternately opposite polarities.

GEORGE A. LOCKE.