

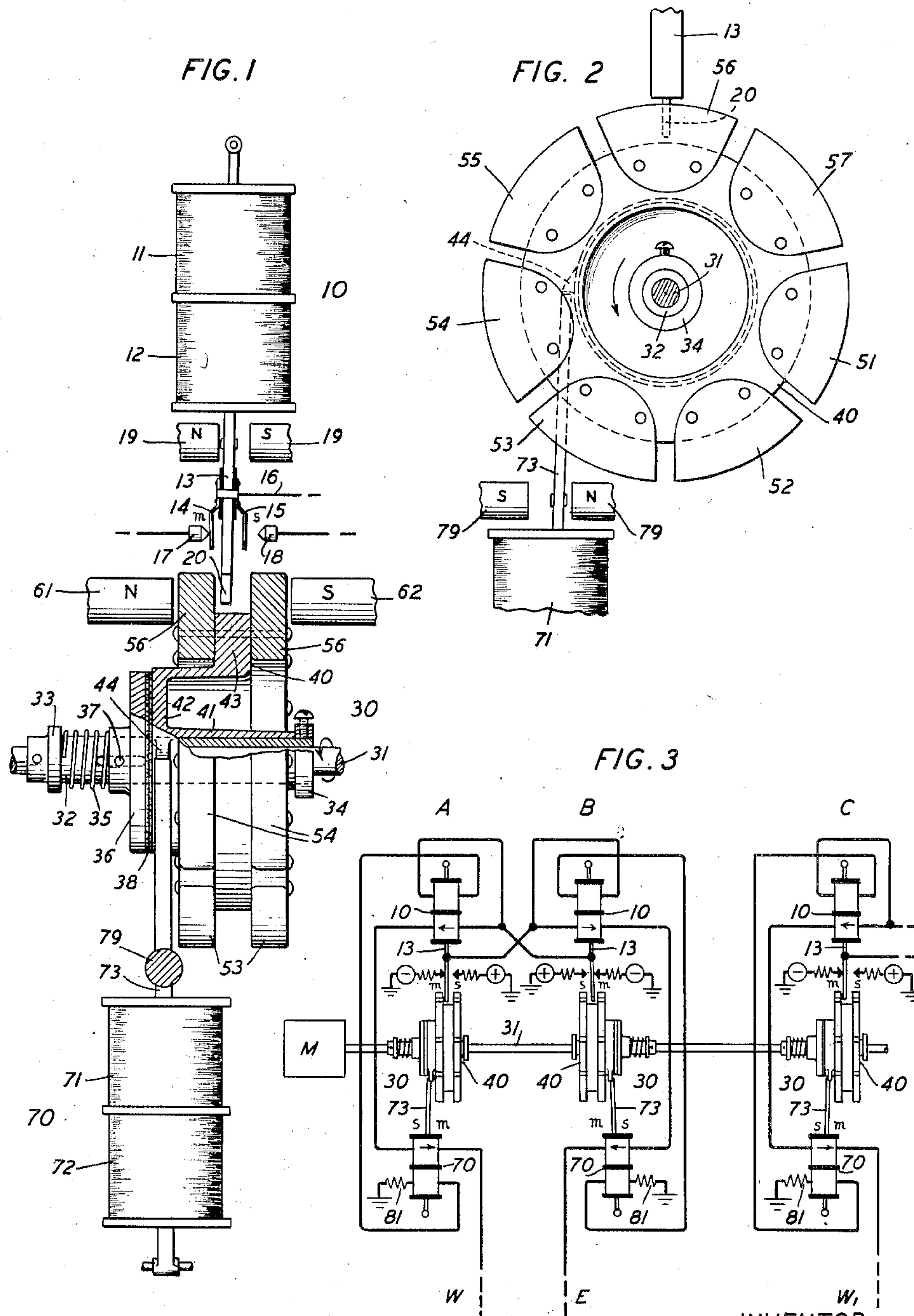
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REGENERATIVE REPEATER

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REGENERATIVE REPEATER

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This invention relates to regenerative signal repeaters and more particularly to telegraph repeating devices of the mechanical regenerative type.

6 An object of the invention is to provide an impulse repeater capable of retransmitting signals of a desired wave shape and frequency in response to received signals which may have become more or less distorted from the desired wave shape in the transmission over a line.

10 Another object of the invention is to provide a mechanical repeater of simple construction and operation.

15 Still another object is to provide a regenerative repeater which will occupy small space and which will require little attention for maintenance.

20 Telegraph repeaters are used in lines of high attenuation, where they are inserted between adjacent sections of the line so that signals, which may have become greatly distorted in the transmission over one line section, may be restored for retransmission over the next line section and finally be received by the recording instruments at the end of the line for reproduction of the message with full fidelity. With the ordinary relay repeater the signals are only corrected for attenuation and are retransmitted with most of the distortion of the received signals. The regenerative repeater, besides correcting attenuation regenerates the signals to have the same wave shape as the originally transmitted signal or such wave shape as would be most suitable for the line section retransmitted into.

25 The regenerative telegraph repeater most commonly used includes receiving and retransmitting rotary distributors of the segment and wiper type, which require considerable attention for maintenance and are comparatively expensive, besides occupying large space in the station. However, in recent years telegraph practices have arisen which involve extensive networks and long subscribers' loops where less expensive repeaters would be desirable.

30 In accordance with the invention, a mechanical regenerative signal repeating device is provided which has the receiving and retransmitting elements incorporated in a single relay structure; the retransmitting arm of the relay is controlled by a timing device which magnetically locks the arm during the comparatively long periods between the moments of largest signal amplitude, leaving the arm free only

transmitted signals.

35 In accordance with a more specific feature of the invention the timing device comprises two revolving parallel rings each formed by a series of magnetized segments separated by air-gaps, the gaps in one ring being aligned with those of the other ring; and a magnetic element attached to the retransmitting arm of the relay and placed so as to oscillate in the space between the two rings. During rotation of the rings the element is subjected in either of its extreme positions to the magnetic pull of a segment strong enough to prevent operation of the retransmitting arm by received impulses, except during the periodical passing of an air-gap, at which time the oscillating element is released for resetting of the armature. By proper orientation of the timing device, the resetting of the armature is made concurrent with the largest amplitude of each received impulse, thereby insuring against errors in retransmission due to distortion of the received signals.

40 In accordance with another specific feature of the invention, the revolving segments are magnetized in pairs and only for the time during which they pass the oscillating member, the magnetizing force being supplied by a pair of stationary opposed pole-pieces aligned with the oscillating element of the retransmitting arm and between which the revolving segments are being passed; the segmented rings of the timing device are driven by a motor in synchronism with the incoming signals and, in the case of start-stop telegraph repeaters, the device, which is driven through a friction coupling, is held from rotation by a latch which will be released by the first impulse of a code series to permit the rings to make one revolution for each code series. The timing device, particularly for operation in start-stop telegraph systems, is designed so that the rotating element is simplified and made as light in weight as possible in order that it may pick up speed quickly when released.

45 The invention is readily adapted to signal codes composed of various numbers of impulses as well as to codes employing both start and stop impulses or only a start impulse in addition to the code impulses. The repeater, in accordance with the invention, is adaptable for insertion in standard repeater switchboard equipments; due to their small dimensions several repeaters may be mounted on a single bay of the switchboard and driven by a common motor. Since no wiping contacts are used diffi-

culties, such as have been due to vibration of the wipers on rotary distributors, are obviated, thus permitting high speed of operation.

The invention will now be described in detail in connection with the accompanying drawing in which:

Figure 1 is a general view showing a preferred form of a magnetic regenerative repeater constructed in accordance with the invention, certain parts of the rotating member being broken away to show details of the construction;

Fig. 2 is a side view of the rotating member; and

Fig. 3 is a circuit diagram showing the incorporation of the device shown in Figs. 1 and 2 in a simple two-way or half-duplex repeater circuit and also showing schematically the common motor drive for a plurality of such devices.

Referring now particularly to Figs. 1 and 2, the repeating device proper may be in the form of a standard, polarized telegraph relay 10, comprising the operating windings 11 and 12, the armature 13 carrying a set of contact springs 14 and 15 having a common connection 16 and being adapted to contact with stationary contacts 17 and 18 in marking and spacing positions, respectively, and the pole pieces 19 forming part of the usual polarizing structure for relays of this type, the rest of the structure not being shown in the drawing since any well known arrangement may be used.

The relay 10 is associated with the timing device 30, which is mounted on a shaft 31 common to a plurality of such timing devices. The timing device 30 comprises a sleeve 32 which serves as a mounting for the individual devices and is fixed on the shaft 31 in any desirable way; it includes shoulders 33 and 34. Between these shoulders are mounted a spring 35, backed by the shoulder 33 and exerting a pressure on a disc 36 which forms one side of a friction clutch and is positively driven with the sleeve 32 by means of a pin and slot arrangement 37 which will permit a slight axial movement of the disc 36. The pressure of disc 36 acts upon one or more friction shims 38, which may be of any suitable material, such as felt or cork, for the purpose of driving the timing element 40 when the latter is released and yet permit slippage without undue power loss, when the timing element is held stationary, as is well known in the art. The timing element 40 comprises a sleeve portion 41 running on the sleeve 32 and a friction surface 42 receiving the pressure of the friction clutch and a mounting rim 43. The timing element 40 furthermore comprises a plurality of pairs of magnetic segments 51 to 57 which are mounted on opposite sides of the rim 43, the segments of each pair being axially aligned with each other and being separated by air-gaps in the circumferential direction from the adjacent pairs of segments; rim 43 may be, and in this preferred form is, of non-magnetic material and the segments 51 to 57 are of a magnetizable material having high permeability and also having high resistivity to eddy currents.

The relay 10 is placed with respect to the timing device 30 in such a manner that a rigid extension 20, of magnetizable material and attached to or forming an integral part of the armature 13, may play from one side to the other in the groove formed between the two rings of magnetic segments without the segments interfering with the contacting of the armature con-

tacts 14 and 15 with the stationary contacts 17 and 18, respectively; furthermore, the relation is such that the extension 20 will be aligned with the pair of magnetic segments 56, when the timing device is held in its stop position. For the purpose of magnetizing the magnetic segments a stationary magnetic structure, not shown in the drawing except for its pole pieces 61 and 62, is arranged so that these pole pieces are in alignment with the extension 20 and permit the timing element to rotate and pass the pairs of segments between them for the successive magnetization of the pairs of segments.

In its preferred form the magnetic repeater is adapted for use in start-stop telegraph systems, and particularly in teletypewriter systems, for which purpose it is necessary that the timing element be held temporarily in normal or stop position. For this function a start magnet 70 is provided which has two operating windings 71 and 72, a polarizing structure of which only the pole-pieces 79 are shown, and an armature 73 which operates to marking and spacing positions, similar to the structure and operation of relay 10. In the marking position, the end of the armature 73 engages the stop 44 and thus holds the timing element 40 in the stop position.

In the operation of the magnetic repeater, current impulses will be passing through the windings 11 and 12 of the relay 10 to operate the armature 13 to marking or spacing in accordance with the alternate characters of the impulses; the impulses may thus be repeated by the circuit changes taking place between contacts 17 and 18 and the conductor 16. If it were not for the timing device, the relay would operate to merely repeat impulses so that the outgoing impulses would retain the characteristics of the incoming impulses and thus would be subjected to the same distortions as the incoming impulses. By means of the timing device this disadvantage is obviated, as will appear from the following description.

The shaft 31, which is motor driven at a constant speed, drives the sleeve 32 and the friction disc 36. The timing element 40 thus is always subjected to a driving force through the clutch, but is in its present position prevented from rotating with the clutch by the engagement of armature 73 with the stop 44. The start magnet 70 is made responsive to the received impulses either by having its windings included directly in the impulse circuit together with the windings of relay 10 or by being controlled by an auxiliary relay included in the impulse circuit, in any convenient manner, such as is well known in the art. Thus, while a marking impulse is being received the armature 73 will be in the path of the stop 44, as is the case shown in the drawing. While a spacing impulse is being received the armature is removed from the stop by the magnet 70 and the timing element 40 will rotate with the friction clutch and cause the segment pairs 51 and 57 to pass in succession between the pole-pieces 61 and 62 with a uniform frequency.

When the timing element is in its stop position, the segment pair 56 will be in alignment with the extension 20 of the relay armature 13, as already stated; consequently, the reluctance of the gap between the pole-pieces 61 and 62 will be comparatively low and the flux will be of high intensity at the point where the extension 20 is located; the extension furthermore

will be situated relatively close to one of the segments 56. The force exerted on the magnetic extension 20 by the magnetic flux between the pole-pieces 61 and 62 is under these circumstances sufficient to prevent the armature 13 from moving from one position to the other under the influence of an impulse through the windings 11 and 12. Similar conditions will exist during the periods in which other magnetic segments are passing by the extension 20 upon release of the timing element 40. However, when an air-gap between adjacent pairs of segments passes the extension 20, the magnetic flux in the gap between the pole-pieces 61 and 62 is so greatly reduced and the extension will be so distant from the segments that the armature 13 will be free for an instant to change its position in response to a received impulse. Since it is desirable that the armature change its position at about the time at which the peak of each impulse occurs in the windings 11 and 12, that is, at about the center of each impulse, it is necessary that the timing element 40 be driven at a speed such that the air-gaps will be passing the armature extension in synchronism with the incoming signals; and the starting of the timing element 40 by the release or start magnet 70 must be timed by proper orientation or other means so that the first air-gap, that between segments 56 and 57, will pass by the extension 20 simultaneously with the arrival of the center of the initial or start impulse; the succeeding air-gaps, as a consequence, will pass the armature extension simultaneously with the arrival of the peaks of succeeding impulses through the operating windings 11 and 12.

It will thus be seen that the armature 13 is free to respond to received impulses only during the short periods within which a pair of air-gaps are passing by the armature extension 20, whereas the armature is prevented from responding during the comparatively long intervals in which a pair of magnetic segments intervene between the armature extension 20 and the pole-pieces 61 and 62; and that, therefore, the armature will be rendered responsive each time to only that portion of an incoming signal at which no distortion need be expected, and that at all other times it will be prevented from responding, no matter what impulses may fortuitously or regularly pass through the windings 11 and 12. The consequences are that the armature will operate at definite intervals and thus produce marking or spacing signals of a definite predetermined length.

At the end of a complete rotation the stop 44 will encounter the armature 73 and the timing device 30 will come to a stop; the operation then may be repeated for the next series of impulses composing the next character to be transmitted.

Referring now to the circuit diagram shown in Fig. 3, a pair of repeating devices A and B of the general type shown in Figs. 1 and 2 are shown connected into a simple two-way or half-duplex repeater circuit, and as having their timing devices 30 mounted on the common shaft 31. The relay devices 10 have their alternate contacts connected to marking and spacing potentials, respectively. Other pairs of repeating devices may be similarly connected into repeater circuits and may have their timing devices mounted on the same shaft 31. The repeater C may be assumed to be one of such a pair of devices adjacent to the pair A and B. The

shaft 31 may be driven in any desirable way by a motor M.

It will be assumed that the repeaters shown in Fig. 3 are used in a telegraph system of the start-stop type using a 7-unit code, such as is used in the teletypewriter systems. The repeater A—B is connected between line section W and line section E, either or both of which, however, may be a subscriber's loop circuit; these lines or loops are normally closed to a source of current at the distant station. With the repeater A—B in the condition shown in Fig. 3, that is, with the timing devices 30 held in their stop position by the stop magnets 70 and with the armatures 13 of the relays 10 in normal or marking position, a minus potential is applied from the marking contact of device A through the lower winding of the relay 10 of the device B, the upper winding of start magnet 70 and over the line circuit E to a source of positive potential at the distant station; a current, which may be conveniently made approximately 60 milliamperes, flows through this circuit.

For the purpose of explanation, it will be assumed that an electron flow from left to right through any relay winding, as it appears in the drawing, urges the relay armature from left to right and vice versa. Thus, the direction of the electron flow through the windings in the circuit just described will normally be as indicated by the arrows, with the result that the armatures 13 and 73 of the device B will be held in their marking position.

Still assuming the circuit to be in the condition shown in Fig. 3, the minus potential from the marking contact of device A is also applied through the upper winding of the relay 10 of device B and the lower winding of stop magnet 70 and impedance 81 to ground; this biasing current is conveniently made 30 milliamperes and has such a direction that the force of the biasing windings on the armatures 13 and 73 is opposed to that of the operating windings; the resulting force will thus be urging the armatures to their marking position with a strength corresponding to a 30 milliampere current through the operating windings of relay 10 and start magnet 70 in the direction of the arrows. When during transmission from the distant station on the line section E, the line current changes from marking to spacing, that is, when the line current is reduced from sixty milliamperes to zero by a reversal of the potential at the distant station, the current through the biasing windings of relay 10 and start magnet 70 will act with the force of 30 milliamperes to operate the armatures into their spacing position. It will thus be seen that the device B is responsive to signals arriving over the line section E, and, similarly, that the device A is responsive to signals arriving over the line section W.

When on the other hand signals are received over the line section W to operate the device A in the manner just described for the device B, causing the armature 13 of device A to operate to spacing, a positive potential will be applied through the operating windings of relay 10 and start magnet 70 of device B to the line section E, causing the current in this line circuit to be reduced to zero; at the same time the plus potential from the spacing contact of device A will be applied to the biasing windings of relay 10 and start magnet 70 of device B, causing the biasing current to become reversed and to force the armatures 13 and 73 to remain in their

marking positions. Thus, the operation of the device A will have no effect upon the device B, and, similarly, the operation of the device B will have no effect upon the device A.

5 Assuming now that a start impulse, often termed the seventh impulse, arrives over line E, which will be due to the change of the normal plus potential to a minus potential at the distant
10 end of line E, the current through the operating windings of device B will be reduced to zero and the biasing windings will tend to move the armatures 13 and 73 to their spacing positions. The start magnet will operate and permit
15 the timing element 40 of device B to rotate; the armature 13 being locked in its marking position by the magnetic pull on its extension 20 by the segment pair 56, which at this time is aligned with the armature, can not operate
20 until the timing element 40 has rotated sufficiently to bring the gaps between segments 56 and 57 in alignment therewith. When at such time the armature 13 operates to spacing it will cause a spacing potential to be applied to the
25 line W, and, since the armature 13 immediately upon its operation will be locked in its new position and will be held there during the comparatively long period in which the segment pair 57 is passing, the spacing signal retransmitted
30 over line W will be maintained undisturbed by any currents or impulses through the operating windings.

At some time, during the passing of the segment pair 57 by the armature 13, the first character impulse of the code series arrives over
35 line E and exerts a force on the armature 13 to which the armature will respond only at the instant the air gaps between segment pairs 57 and 51 come in alignment with the armature. The subsequent passing of the segment pair 51
40 by the armature will again cause the locking thereof until the air gaps between segment pairs 51 and 52 come in alignment with the armature, thereby insuring the complete, undistorted retransmission of the first character impulse over
45 the line W for the time during which the segment pair 51 passes by the armature.

Similar operations take place during the passing of segment pairs 52, 53, 54 and 55 in response
50 to the second, third, fourth and fifth character impulses; the start magnet armature 73 follows the operations of the relay armature 13 during the transmission of the character impulses without affecting the operation of the device. At
55 the time when the sixth or stop impulse arrives the segment pair 55 will be passing by the armature 13 which will be retransmitting the fifth impulse. The stop impulse is a marking impulse which will operate armature 73 to marking
60 position, and, when the air gaps between segment pairs 55 and 56 come in alignment therewith, the armature 13 will also operate to marking in response to the stop signal; armature 13 will again be locked and will retransmit the stop
65 signal over the line W, whereas the armature 73 will be in the path of the stop 44 and thus cause the timing element 40 to stop in normal position, where it will be held until released by the start magnet in response to the start impulse of the
70 next signal series.

The angular relation of segment 56 with respect to the extension 20 of the armature 13 depends upon the speed of operation of the start magnet armature, as well as upon the quickness
75 of picking up speed of the timing element 40

and may be varied by orientation, as is well known in the art, so that the different air gaps will be in alignment with the armature extension just at the time of arrival of the peaks of the
80 corresponding impulses.

In this manner impulses which have become greatly distorted, except at some point near their center, may arrive over the line E and operate the relay 10 of device B under the control of the
85 magnetic timing device 30 to repeat signals into the line W which will have a strength determined by the current sources at the spacing and marking contacts of the device B and the lengths of which will be uniform.

Signals arriving over the line W may be regenerated by the device A and retransmitted into the line E in the same manner as just described for the reverse direction of transmission, without affecting the device B.

The invention may be embodied in structures and systems which in their details of design and operation depart from the preferred form used here for an illustration, without departing from the spirit of the invention as set forth in the
90 appended claims.

The manner in which the revolving segment pairs of the timing device are magnetized is capable of considerable variation, as will be fully understood by one skilled in this art. Thus, a permanent magnet and an electromagnet for
95 this purpose will be practically equivalent. The segments may be magnetized one pair at a time or may all be magnetized continuously by means of a separate, magnetized structure or by magnetizing windings placed about the timing device
100 and rotating therewith or remaining stationary.

For quick operation of the retransmitting armature the material of the armature extension 20, which is subjected to sudden variations in the locking flux produced by the timing device,
105 should be of high permeability to insure quick locking due to high flux intensity, and should be of low coercivity to insure quick release due to low retentive force. Permalloy is a suitable magnetic material for this purpose.

The start magnet may be operated in the same impulse circuit as the retransmitting relay, as in the preferred form described above; or it may be operated by an auxiliary relay included in the impulse circuit, in which case the start
125 magnet would not need to be of the polarized type.

The portions of the impulse circuit designated as lines W and E in the description of the preferred form of the invention may be line sections
130 between adjacent repeater stations of a long line or they may be subscribers' loops; or they may connect to repeating equipment such as is used in carrier systems for segregation of the transmission channels, the signals of the tele-
135 graph channel thus being subject to regeneration by the repeater provided in accordance with the invention.

What is claimed is:

1. A signal repeating relay comprising an armature with transmitting contacts, a receiving winding for operation of said armature, instrumentalities including a magnetic circuit of alternate high and low reluctance paths for producing a periodically varying magnetic flux for alternately locking said armature in an operated position and releasing said armature for operation by said winding in unison with received signals.

2. In a telegraph repeater a transmitting con- 150

tact, a contacting member therefor having a magnetic portion, electromagnetic operating means for said member responsive to received impulses, a magnetic timing device having a magnetic circuit of reluctance which varies periodically in synchronism with received impulses for producing alternate high and low magnetic fluxes for intermittently attracting said magnetic portion to lock said contacting member in an operated position against operation by said winding between successive periods of high amplitude of received impulses.

3. A telegraph relay having a receiving winding and an armature with a transmitting contact, a rotating member having a series of magnetized polar configurations for producing high and low intensity magnetic fields for locking said armature in an operated position and for momentarily releasing said armature for operation by said receiving winding.

4. In a telegraph repeater, a relay having a receiving winding and an armature responsive to current impulses in said winding for operation of retransmitting contacts, and a rotating disc of magnetized segments for intermittently locking said armature in an operated position by magnetic force synchronously with the received impulses.

5. A repeating telegraph relay comprising a receiving winding, a two-position armature with retransmitting contacts responsive to signal impulses in said winding, an extension on said armature of magnetic material, a rotatable distributor element having a plurality of circumferentially arranged segments of magnetic material adapted to be passed successively by said extension to lock said armature in operated position between operations by said winding and means for magnetizing said segments.

6. A start-stop signal repeater comprising an armature with transmitting contacts having a portion of magnetic material, a receiving winding for operation of said armature in response to a start-stop series of signals, a normally stopped rotatable distributor element having a plurality of pairs of spaced magnetized segments adapted to pass successively in pairs adjacent to said portion during rotation to exert a magnetic locking action on said armature in both of its operated positions, said segments being sufficiently spaced apart in the direction of rotation to momentarily unlock magnetically said armature for operation by said winding, and means responsive to a start signal for starting said distributor.

7. A start-stop telegraph repeater comprising electromagnetic operating means for reception of impulses of a start-stop telegraph code including an armature with retransmitting contacts responsive to each received impulse, a stop latch for starting said repeater in response to the first impulse of a code series, an extension of said armature of high permeability and low coercivity material, and a motor driven distributor stopped from rotation by said latch and comprising a plurality of magnetized pole pieces arranged circumferentially in spaced relation to

pass during a revolution of said distributor in pairs on both sides of said extension to exert a varying force thereon in both positions of said armature, said force, for short moments coincident with the times of greatest strength of the received impulses, being small enough to permit the operation of said armature and said force, for intermediate longer periods, being strong enough to hold said armature against an impulse reversal in said operating means to insure a long uninterrupted closure of the retransmitting contacts for each received impulse.

8. A start-stop telegraph repeater which comprises a magnetic distributor, a motor driven shaft, a friction clutch between said shaft and said distributor, a stop latch for said distributor, a two-position contact closing arm for retransmission of signal impulses and electromagnetic means for operation of said stop latch to release said distributor in response to a starting pulse and for operating said arm into both positions in accordance with an impulse series, said distributor comprising a pair of rotatable parallel rings, spaced apart and each composed of a series of segments of magnetic material separated by air-gaps which are aligned with corresponding air-gaps in the other ring, a magnetizing system having a pair of stationary pole-pieces adjacent said pair of rings for magnetizing successive segments in both rings during rotation, and an armature fixedly mounted in the space between said rings in alignment with said pole-pieces and attached to said arm for oscillation therewith from proximity to one ring to proximity to the other, said armature being of a magnetic material having high permeability and low coercivity.

9. In a two-way start-stop telegraph repeater, a west equipment and an east equipment, each comprising a double winding receiving relay having an oscillating armature with retransmitting contacts responsive to impulses of a start-stop code through the windings of said relay, a magnetic distributor with a friction drive for rotation in isochronism with received impulses, a double winding start magnet having a stop latch for release of said distributor in response to the start impulse of a start-stop code, and operating and biasing circuits from the line through the windings of said relay and said magnet, said circuits being connected to the armature of the other equipment, said distributor comprising a magnetizing system having a pair of stationary opposed pole-pieces, a magnetizable low coercivity element attached for oscillation with said armature between said pole-pieces in response to a received impulse and a rotating system of magnetizable segments arranged in parallel pairs to intervene simultaneously in both air-gaps between said element and said pole-pieces to produce a strong flux for locking said element in either operated position during reversals of received impulse, said segments being spaced circumferentially sufficiently to permit operation of said armature once for each signal of a series.

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