

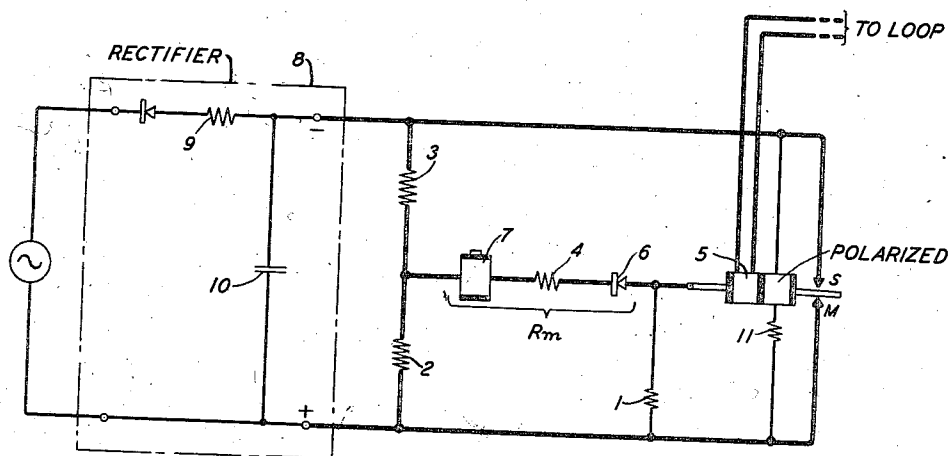
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ELIMINATION OF BIAS IN TELETYPEWRITER RECEIVING MAGNET

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ELIMINATION OF BIAS IN TELETYPE-
WRITER RECEIVING MAGNETS

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This invention relates to telegraph systems and more particularly to improved reception of telegraph signals by eliminating the biasing effect of armature travel time of a telegraph receiving relay on a teletypewriter receiving magnet with which the relay cooperates in a teletypewriter receiving circuit.

An object of this invention is the improvement of telegraph circuits.

A more particular object of this invention is the elimination of the bias caused in a teletypewriter receiving magnet circuit by the armature travel time of a telegraph receiving relay which controls the operation of the magnet.

Another object of the invention is the elimination of the adverse biasing effect caused by certain transients generated by the operation of the receiving relay.

A feature of this invention is a teletypewriter receiving circuit including a teletypewriter receiving magnet controlled by a polar type telegraph receiving relay, in which the values of the electrical constants of the various apparatus units are chosen, in accordance with formulae described herein, so as to prevent the release of the teletypewriter receiving magnet during the interval while the armature of the telegraph receiving relay, which controls the operation of the magnet, is traveling from its marking to its spacing contact and so as to prevent the operation of the teletypewriter receiving magnet during the interval while said armature is traveling in the opposite direction, in order that the armature travel time in each direction may in effect be added to the preceding signal pulse, thus eliminating the biasing effect of the armature travel time.

A further feature of this invention is a rectifier connected in series between the winding of the receiving magnet and the armature of the polar type telegraph receiving relay to prevent the flow of current of a particular polarity through the winding of the magnet while the winding is connected through the armature and a contact of the receiving relay to battery of a particular polarity.

A further feature of this invention is a teletypewriter receiving circuit in which the values of the electrical constants of the various apparatus units are chosen, in accordance with formulae described herein, so as to maintain the value of the current in the winding of the teletypewriter receiving magnet lower than the operate value and higher than the release value of the magnet during the travel time of the

armature of the receiving relay in each direction, so that the magnet cannot release while the armature of the receiving relay is traveling from its marking to its spacing contact, thus adding the mark to space armature travel time to the marking interval of the receiving magnet and so that the magnet cannot operate while the armature of the receiving relay is traveling from its spacing to its marking contact, thus adding the space to mark armature travel time to the spacing interval of the receiving magnet, thus tending to equalize the marking and spacing interval of the receiving magnet.

These and other features will become apparent from the following description when read with reference to the associated drawing which shows the teletypewriter receiving circuit of this invention.

Refer now to the drawing which shows a teletypewriter receiving circuit in which a telegraph receiving relay controls the operation of a teletypewriter receiving magnet. It is desirable that no marking and spacing bias be introduced by the receiving circuit. In circuits of the general character of the figure, which do not include this invention, there is an inherent bias due to the time required for the armature of the polar receiving relay to travel between contacts. In general, in such circuits, current flows through the winding of the receiving magnet while the armature of the receiving relay is in engagement with one of its pair of contacts. While the armature of the receiving relay is traveling in each direction, and while it is in engagement with the other contact, current will not flow through the magnet of the receiving relay. As a result of this, the interval during which the receiving magnet is energized is shorter than the interval during which the magnet is deenergized by an interval equal to the sum of the times required for the armature to travel in each direction.

In order to equalize the intervals during which the receiving magnet of the figure is energized and deenergized, for marking and spacing impulses, the circuit per the figure is arranged, by a proper choice of values for the various resistances, so that the current flowing through the winding of the receiving magnet is maintained at a value intermediate the operate and release current values for the magnet when the armature of the relay is in engagement with neither contact.

In the following description steady state current conditions will first be described. The effect

of transient current conditions will be described thereafter.

When the armature of the receiving magnet 5 is in engagement with its bottom or marking contact, sufficient current flows through the winding of receiving magnet 7 to operate the magnet. While the armature of relay 5 is traveling from its bottom or marking contact to its top or spacing contact, the value of the current in the winding of receiving magnet 7 drops slightly, but not low enough to permit magnet 7 to release. The effect of this is to add the travel time of the armature of polar relay 5 to the marking interval. When the armature of polar relay 5 engages with its top or spacing contact the value of the current in the winding of receiving magnet 7 immediately drops to zero and magnet 7 releases. The magnet remains released while the armature of polar relay 5 is in engagement with its top or spacing contact. When the armature of polar relay 5 leaves its top or spacing contact and during the interval while the armature is traveling to its bottom or marking contact, the value of the current in the winding of magnet 7 rises to the same value as obtained during the travel of the armature of polar relay 5 in the opposite direction. This value is above the release value but less than the operate value for magnet 7, so that the magnet does not operate during this interval. When the armature of polar relay 5 again engages its marking contact the magnet current builds up almost instantaneously to its full operate value. The effect of this is to add the interval required for the armature to travel from its top or spacing contact to its bottom or marking contact to the spacing interval. The times required for the travel of the armature in each direction may be assumed to be equal. The effect of this, therefore, is to equalize the marking and spacing interval, thus eliminating the biasing effect ordinarily caused by the travel time of the armature of the receiving relay.

The operation of the circuit will now be described, and then the formulae which enable one to assign constants to the various resistance units in the circuit, so that the results described above may be achieved, will be presented.

The circuit per the figure is connected to a telegraph loop circuit which is shown extending through the left-hand winding of polar receiving relay 5. Power is supplied to the teletypewriter receiving circuit from a primary source of alternating current at the extreme left of the figure through power supply rectifier 8. The circuit is arranged so that the current drains for the marking and spacing conditions are equal so as to prevent undesirable transients resulting from supply voltage changes due to unequal drains. A circuit may be traced from the positive terminal of the rectifier through resistance 11 and the right-hand winding of polar receiving relay 5 to the negative terminal of the rectifier. The effect of current through the right-hand winding of polar relay 5 tends to maintain the armature of polar receiving relay 5 in engagement with its top or spacing contact. When current flows in the loop through the left-hand winding of polar receiving relay 5, its effect preponderates over the effect of the current flowing through the right-hand winding of polar receiving relay 5 and the armature of polar receiving relay 5 is maintained in engagement with its bottom or marking contact. When the armature of polar receiving relay 5 is in engagement with its bottom

or marking contact, the path through resistance 1 is shunted by the path through the marking contact and armature of polar receiving relay 5. Under these circumstances the circuit through the copper-oxide rectifier 6, resistance 4 and the winding of the teletypewriter receiving magnet 7 is connected in parallel with resistance 2 and a circuit may be traced from the positive terminal of the power supply rectifier 8 through these parallel branches and through resistance 3 to the negative terminal of the power supply rectifier 8. Copper-oxide rectifier 6 is connected in such a manner that it presents a low resistance to current of this polarity and a substantial current flows through the receiving magnet 7 for the marking condition.

When the armature of polar receiving relay 5 is in engagement with its top or spacing contact, full negative potential from the negative terminal of power supply rectifier 8 is connected directly to the right-hand terminal of copper-oxide rectifier 6. As is well known, it is characteristic of copper-oxide rectifiers, such as 6, that they present a very low resistance to current of a particular polarity and a very high resistance to current of the opposite polarity. When negative battery is connected to the right-hand terminal of copper-oxide rectifier 6, the rectifier presents a very high resistance. It will be assumed that its resistance is infinite for this condition so that no current will flow through receiving magnet 7 while the armature of polar receiving relay 5 is in engagement with its top or spacing contact.

When the armature of polar receiving relay 5 leaves its bottom or marking contact to travel to its spacing contact a circuit may be traced from the positive terminal of power supply rectifier 8 to a parallel circuit comprising two branches. The first of these branches extends through resistance 2. The second of these branches extends through resistance 1, copper-oxide rectifier 6, resistance 4 and winding of receiving magnet 7. The branches join and the circuit is extended through resistance 3 to the negative terminal of power supply rectifier 8. When the armature of polar receiving relay 5 is traveling from its top or spacing contact to its bottom or marking contact, the circuit through the winding of receiving magnet 7 is the same as for the armature travel in the opposite direction described above. The current which passes through the winding of receiving magnet 7 will, therefore, be the same for each direction of travel of the armature of polar receiving relay 5.

The manner in which the values of the various resistances in the circuit may be chosen so that the value of the current flowing through the winding of receiving magnet 7 during the armature travel time of polar receiving relay 5 in either direction will remain at a value intermediate the operate and release values of receiving magnet 7 is explained in the following.

Given:

- (1) Current through the receiving magnet 7 for the marking condition= I .
- (2) Current through the receiving magnet for the spacing condition= O .
- (3) Current through the receiving magnet 7 for the travel condition of relay 5 in either direction $=nI$, where $0 < n < 1$.
- (4) Total drain of rectifier 8 is the same for the marking and spacing condition of relay 5.
- (5) Total drain on the rectifier $8=I_r$.
- (6) The ratio of the total drain on the recti-

fier to the current through the receiving magnet during marking or

$$\frac{I_T}{I} = P$$

(7) The ratio of the current through the receiving magnet during travel time to that flowing in the marking condition = n .

(8) Forward resistance of rectifier 6 + resistance 4 + resistance of receiving magnet 7 = R_m .

(9) Backward resistance of rectifier 6 = ∞ .

Even though the total drain on the rectifier is not the same during travel time as during the marking and spacing conditions, it will be assumed that the output voltage of the rectifier is maintained substantially constant by the filter condenser 10 of rectifier 8.

Total rectifier drain in the marking condition

$$I_{TM} = \frac{E(R_2 + R_M)}{R_2 R_3 + R_M(R_2 + R_3)} \quad (1)$$

Total rectifier drain in the spacing condition

$$I_{TS} = \frac{E(R_1 + R_2 + R_3)}{R(R_2 + R_3)} \quad (2)$$

Magnet current in the marking condition

$$I = \frac{ER_2}{R_2 R_3 + R_M(R_2 + R_3)} \quad (3)$$

Magnet current during travel time

$$nI = \frac{ER_2}{R_2 R_3 + (R_2 + R_3)(R_1 + R_M)} \quad (4)$$

Since $I_{TM} = I_{TS} = I_T$, from (1) and (2),

$$R_1 = \frac{R_2 + R_3}{R_2^2} [R_2 R_3 + R_M(R_2 + R_3)] \quad (5)$$

From (3) and (4)

$$R_1 = \frac{1-n}{n} \left[R_M + \frac{R_2 R_3}{R_2 + R_3} \right] \quad (6)$$

From (1) and (3)

$$R_2 = R_M \frac{I}{I_T - I} \quad (7)$$

Substituting (7) in (1)

$$R_3 = \frac{E - IR_M}{I_T} \quad (8)$$

From (5), (7) and (8)

$$R_1 = \frac{E^2}{I^2 R_M} - \frac{E^2}{I I_T R_M} + \frac{E}{I_T} \quad (9)$$

and substituting (7), (8) and (9) in (6)

$$n = \frac{1}{1 + \left(\frac{E}{I R_M} - \frac{E}{I_T R_M} + \frac{I}{I_T} \right)^2} \quad (10)$$

Given n , it can be substituted in Equation 10 and I_T can be found. Then R_1 can be found from Equation 9, R_2 from (7) and R_3 from (8).

The manner in which rectifier 6 affects transients developed by the magnet will now be described. There are four conditions.

The first transient to be considered will be the transient developed as the armature of relay 5 separates from its bottom or marking contact. For this condition, full marking current, which has been flowing through the winding of receiving magnet 7, is interrupted. A transient is developed. The current resulting will be in the same direction as the marking current which was theretofore flowing. This transient current will therefore be passed by rectifier 6. The effect of this current will be in a direction to maintain magnet 7 operated, tending to prolong the marking interval. The value of the current de-

clines from full marking value and approaches the steady state current value for the armature travel condition as a limit which, as noted before, is greater than the release value for the magnet. Since the entire marking to spacing travel time is in effect added, as has been shown to the marking interval, this transient has no significant effect.

The second transient is that developed on the engagement of the armature of relay 5 with the spacing contact. The effect of the magnetic inductance is to tend to maintain the flow of current in the same direction in which it has been flowing for the marking condition. Due to the fact that the potential across the circuit, including the magnet 7 and rectifier 6, has been reversed and the effect of the reversed potential predominates over the transient voltage, the transient current is almost immediately reduced to zero. The second transient, therefore, is also without significant effect.

Due to the fact that the armature (not shown) of magnet 7 is in its attracted position, when the second transient is generated, the reluctance of its magnetic path is low and the inductance of the magnet is high. If the circuits were not arranged in accordance with this invention to suppress this transient, a serious delay in the release of the magnet armature would result.

During the interval while the armature of relay 5 is in engagement with its spacing contact, no current flows through the magnet winding, as described above.

A third transient is generated when the armature of relay 5 breaks from its spacing contact. For this condition, the polarity applied across the circuit which includes the magnet 7 and the rectifier 6 is in a direction such that rectifier 6 again presents its low impedance. But the inductance of magnet 7 opposes the build-up of current to its value for the steady state armature travel condition. Notwithstanding that the build-up is opposed, the third transient has no significant effect on marking or spacing intervals, as the current does not build up to a value greater than the value for the steady state armature travel condition, which, as has been shown is less than the operate current value for magnet 7.

A fourth transient is generated when the armature of relay 5 engages its marking contact. For this condition, the build-up of the current to its full operate value is opposed by the inductance of the magnet. This tends to delay the operation of the magnet. Due to the fact, however, that the magnet armature (not shown) is in its unattracted position for this condition, the reluctance of the magnet's magnetic path is high and the inductance of the magnet is low, so that the operate current build-up, while slightly delayed, is sufficiently fast so as not to seriously delay the operation of the magnet.

The net result of the effect of all of these transients, therefore, is to make the spacing interval very slightly longer than the marking interval, due to the effect of the fourth transient. But the bias introduced by the effect of the transients is considerably smaller than the bias heretofore introduced by transients in the presently known receiving circuits, while the bias introduced by armature travel time has been eliminated.

In addition, therefore, to eliminate the biasing effect of relay travel time, the invention herein eliminates the biasing effect of three of the four transients caused by the making and breaking

of the receiving relay armature with its marking and spacing contacts. Among the three adverse transient effects which have been eliminated, as described above, is the one caused by the breaking of the armature of the receiving relay from its marking contact. This adverse transient effect has heretofore been the most serious encountered in telegraph receiving magnets controlled by receiving relays.

What is claimed is:

1. In a telegraph system, a local telegraph station, a telegraph receiving circuit at said station, a telegraph receiving magnet and a telegraph receiving relay both in said circuit at said station, means in said circuit for supplying current to a winding on said magnet through an armature and a cooperating contact both on said relay and means for maintaining the magnitude of the current through said winding intermediate the operate and release current values for said magnet while said armature travels to and from said contact, to eliminate the biasing effect of the travel time of said armature.
2. In a telegraph system, a local telegraph station, a telegraph receiving circuit at said station, a telegraph receiving relay and a telegraph receiving magnet both in said circuit at said station, an armature and a pair of opposed contacts on said relay, means for controlling the operation of said magnet in response to the operation of said relay, a source of local power connected to said magnet under control of said relay, means in said circuit for supplying current from said source sufficient to operate said magnet when said armature is in engagement with one of said contacts, means for preventing the supplying of any appreciable current to said magnet while said armature is in engagement with the other of said contacts and means for supplying current of a value intermediate the operate and release current values of said magnet while said armature is traveling in each direction between said contacts.
3. In a telegraph circuit, a source of electromotive force, a positive and a negative terminal on said source, a first and a second resistance connected in series directly across said terminals, a circuit connected in shunt around said first resistance extending in the order named through a third resistance, a rectifier and the winding of a magnet of a telegraph receiver, a telegraph receiving relay having an armature and a pair of opposing contacts, means for operating said armature to engage said contacts alternately, a conductor connecting the fixed end of said armature to the junction between said third resistance and said rectifier, a conductor connecting one of said contacts to said positive terminal and another conductor connecting the other of said contacts to said negative terminal.
4. A telegraph receiving magnet having a winding connected through a resistance network to a source of electromotive force, a telegraph receiving relay having an armature and a cooperat-

ing contact controlling the connection of said source to said magnet and means comprising a rectifier connected directly in series with said winding for maintaining the magnitude of the current in said winding at a value intermediate the operating and releasing current values of said magnet while said armature travels toward and away from said contact.

5. In a telegraph receiving circuit, a telegraph receiving magnet, a winding thereon, a resistance network, a telegraph receiving relay, an armature on said relay conditioned to engage a pair of opposed contacts also on said relay, a rectifier connected in series between said winding and said armature, means for supplying current of one polarity to said winding through said rectifier, when said armature is in engagement with one of said contacts, of a magnitude sufficient to operate said magnet, means for reducing the magnitude of the current supplied to said magnet through said rectifier when said armature is in engagement with the other of said contacts so as to release said magnet and means comprising the proper proportioning of the resistances in said network for maintaining the current in said winding at a value intermediate the operate and release current values of said magnet while said armature travels in each direction between said contacts.

6. In a telegraph circuit, a polar telegraph receiving relay, an armature thereon, a telegraph receiving magnet, a winding on said magnet, a rectifier connected in series with said winding and said armature and means in said circuit for eliminating the biasing effect of the transient voltage generated when current flowing through said winding is interrupted.

7. In a telegraph circuit, a telegraph receiving magnet, a winding thereon, a telegraph receiving relay, an armature on said relay conditioned to engage alternately a pair of opposed contacts on said relay, battery of opposite polarity connected to each of said contacts for controlling the polarity of voltage impressed on said magnet and a rectifier connected in series with said winding and said armature to suppress the flow of current of a particular polarity through said winding.

8. A teletypewriter receiving magnet, a telegraph receiving relay, an armature on said relay, means for interconnecting said magnet and said armature for controlling the energization and deenergization of said magnet and means, comprising a rectifier in said control means, tending to eliminate the effect of bias in the periods of energization and deenergization of said magnet due to the travel time of said armature.

9. A teletypewriter receiving magnet, a switch controlling the energization and deenergization of said magnet and means comprising a rectifier for eliminating the effect on the duration of the periods of such energization and deenergization caused by the travel time of said switch.

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