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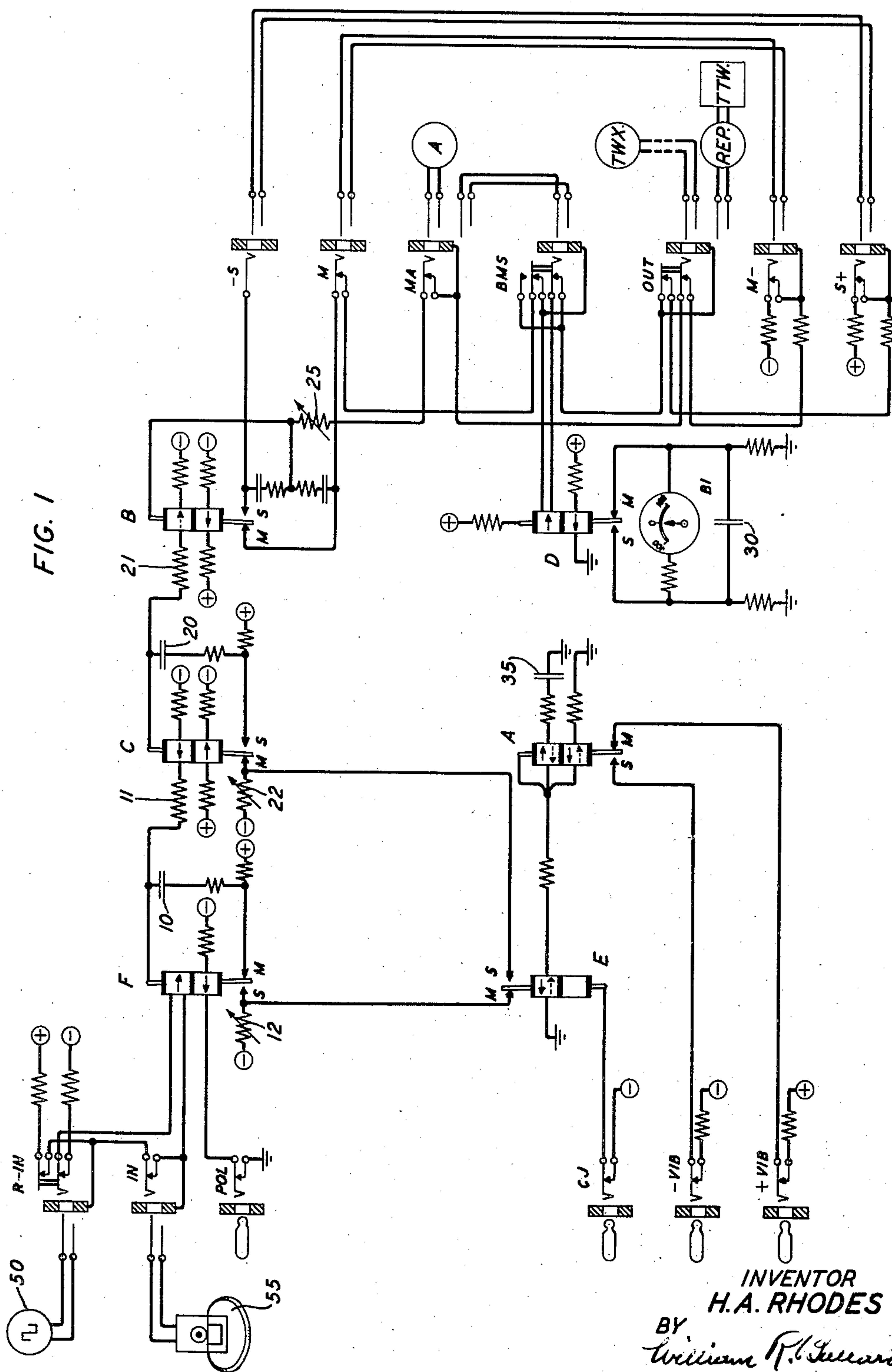
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2,140,680

TELEGRAPH TESTING SET

Filed Sept. 26, 1936

2 Sheets-Sheet 1



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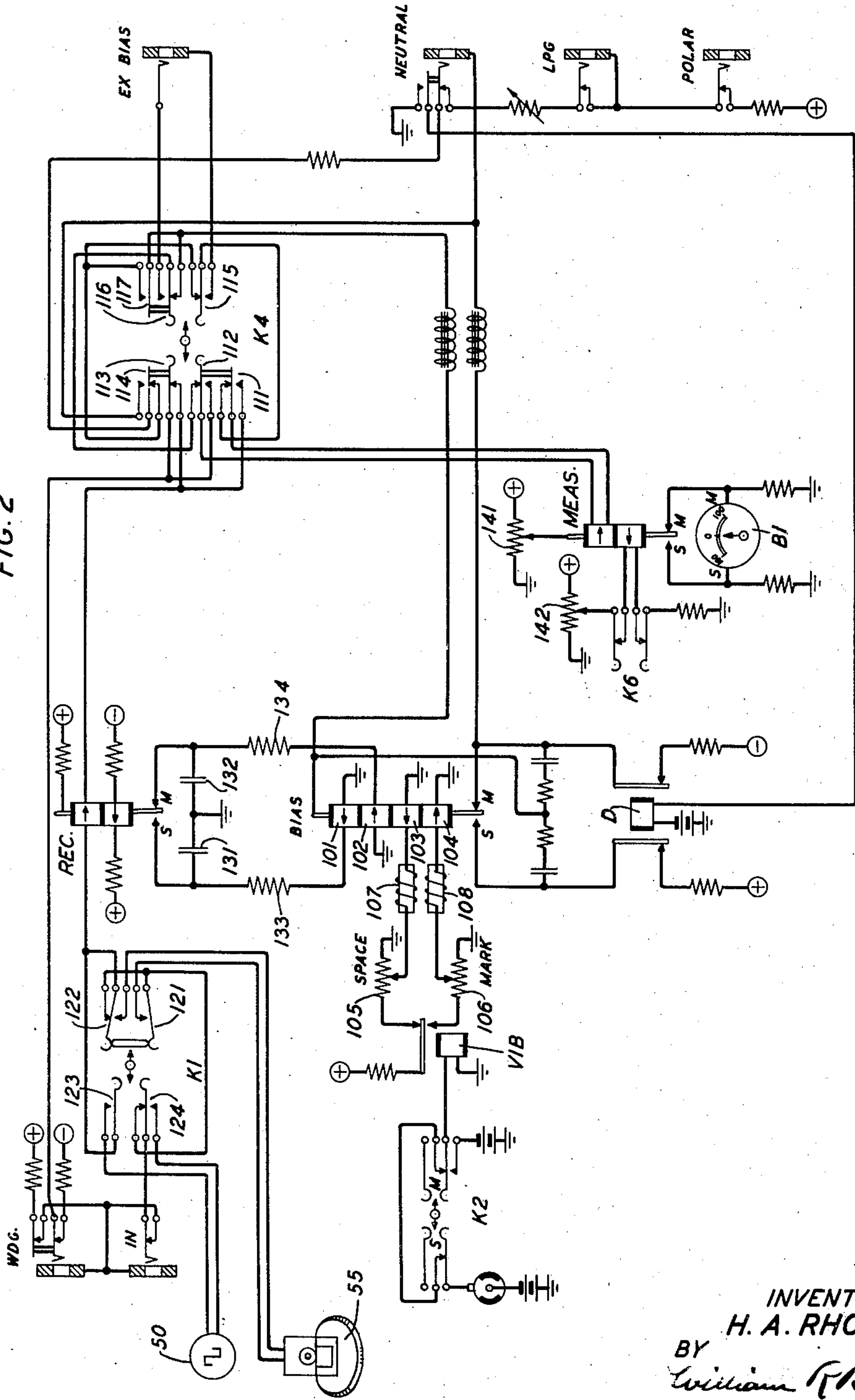
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FIG. 2



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TELEGRAPH TESTING SET

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6 Claims. (Cl. 178—69)

This invention relates to telegraph testing sets and particularly to testing sets arranged for introducing bias into the test message.

Among the objects of the invention are the provision of a bias introducing set for observation of telegraph circuits which will introduce known amounts of bias in both the marking and the spacing directions, which will be accurate and stable in its operations and which will be simple and quick to operate.

For the purpose of observing telegraphic equipment such as teletypewriter stations and regenerative repeaters, it has been found desirable to provide means for sending biased impulses or signals into such circuits and observe their behavior under various bias conditions. For this purpose, various suggestions have already been made. Thus the Patent 1,735,933 issued November 19, 1929, to Nyquist discloses a bias introducing system for producing bias in one direction at a time. In Patent 1,847,151 issued March 1, 1932, to Watson and Hunt, a bias producing set composed of a rotating distributor adjustable to produce either marking or spacing bias is disclosed. The Patent 1,900,992 issued March 14, 1933, to McCann shows the use of bias producing distributors, one for the marking bias and the other for the spacing bias.

In accordance with one feature of the invention, the marking and spacing impulses impressed upon the set are treated in identical manners so that the biasing effect will be accurate in both directions. Thus the impressed marking and spacing impulses are converted in the set to current impulses, as contrasted by no-current impulses, and the impulses of both kinds are similarly shaped to facilitate the introduction of bias over a wide range and to the same extent in both directions. The shaped impulses are then subjected to the biasing effect within the set and are finally reproduced in the output circuit, either as neutral or polar biased signals.

In accordance with another feature of the invention, the amount of bias introduced by the set can be varied by adjustment and can be observed in both directions, and the set after such adjustment may be connected to an external circuit and thus will reproduce in that circuit signals biased to a known extent.

In accordance with another feature of the invention, the known bias may be quickly switched in either direction, without changing the amount of bias, either at odd times by manual means or at regular intervals by automatic means without the need of changing connections.

The invention will now be described more in detail in connection with the accompanying drawings in which

Figure 1 shows one embodiment of the invention in which the marking and spacing bias is introduced at two different repeating stages within the set; and

Fig. 2 shows an alternative form of the invention in which the marking and spacing bias is introduced at the same repeating stage within the set.

It should be understood that various details of the systems shown in the drawings and their interrelation may be modified for special purposes without a departure from the general principles and functions of the invention.

Reference will now be made particularly to Fig. 1 of the drawings in which is shown a specific embodiment of the invention.

The circuit in Fig. 1 includes the signal repeating relays F, C and B, the vibrating relays A and E and the metering relay D.

The four relays F, C, B and D have permanently energized biasing windings for operating the respective armatures from marking to spacing. The upper winding of each of these relays is the operating winding and has twice the number of ampere turns of the biasing winding, thus being capable of overcoming the biasing winding and operating the armature from spacing to marking. On relay B, however, the biasing winding operates the armature to marking, and the operating winding is for operation to spacing.

Signals are impressed upon the input relay F for testing purposes and are in turn repeated to operate relay C, which in turn operates relay B for production of impulses in the output side of the set. For the purpose of biasing the output signals delay circuits are associated with the repeating relays for timing the operation of relay C with respect to the operation of relay F and of relay B with respect to the operation of relay C. Thus the delay circuit for producing a marking bias includes a condenser 10 connected between the marking contact and the armature of relay F, and a high resistance 11 in series with the operating winding of relay C, and also an adjustable resistance 12 connected from the spacing contact of relay F to negative source. For the introduction of spacing bias a similar delay circuit is provided, including condenser 20 and resistance 22 connected to armature and contacts of relay C and resistance 21 in series with the operating winding of relay B in the same manner

as just described for the delay circuit associated with relay F.

Assuming the circuit to be in the condition shown in the drawings, relay F will be held to marking by its operating winding, relay C will also be held to marking by its operating winding, whereas relay B is held to marking by its biasing winding, the operating winding of this relay being currentless. Next assuming that the circuit for the operating winding of relay F is opened as in the case of a spacing signal, relay F will operate to spacing. With the resistance 12 on zero, the condenser 10 will begin to charge by current through the operating winding of relay C during the travel time of relay F, thereby holding relay C against marking until relay F reaches its spacing position. At this moment the operating current of relay C quickly becomes zero and relay C operates to spacing; there is thus a definite, short time interval between the operations of relays F and C. Also assuming resistance 22 to be on zero, the condenser 20 will hold its charge after relay C leaves its marking contact and until it reaches its spacing contact, whereupon the condenser discharges and the operating winding of relay B receives full operating current, thereby overcoming the biasing winding of relay B and operating the relay to spacing a definite, short interval after the operation of relay C.

If now the operating circuit of relay F again be closed as in the case of a marking impulse, the armature will move from spacing to marking. Upon relay F reaching the marking position, condenser 10 will be discharged and relay C will receive full operating current and operate its armature to marking. When the armature of relay C leaves its spacing contact, condenser 20 charges through the operating winding of relay B, thereby delaying the operation to marking of relay B during the travel time of relay C; when relay C reaches its marking contact, the operating winding of relay B becomes currentless and the condenser 20 completes its charge over the marking contact of relay C. Relay B operates from spacing to marking.

Thus in changing from a marking to a spacing signal relay B operates after two definite intervals after the relay F, and in changing from a spacing to a marking impulse, relay B operates after two definite intervals after relay F, the sum of the two intervals in both cases being exactly the same, in which case the output signals will be true duplications of the input impulses. Thus, if the input impulses be unbiased the output impulses will be unbiased.

Assuming now that resistance 12 has been adjusted to include appreciable resistance in the circuit from the spacing contact of relay F to the negative source and that the operations just described are repeated, and also that the circuit to begin with is in the condition shown in the drawings, the impression of the spacing impulse on relay F will operate relay F to spacing; at the opening of the marking contact, condenser 10 will begin to charge through relay C as before and when relay F reaches the spacing contact, the condenser will continue to charge in part through the operating winding of relay C and in part through the resistance 12. The operation of relay C to spacing is thus further delayed by the presence of resistance 12 and to an extent depending upon the amount of resistance inserted by the adjustment of resistance 12. The operation of relay C causes the operation of relay B in exactly the same manner as described before.

Relay B thus is held for a longer time upon its marking contact than in the previous case. When now the relay F is returned to its marking contact by a marking impulse, the operation of relays C and B will take place in the same manner as described before. Thus, the marking impulse in the output circuit has been lengthened and the spacing impulse correspondingly shortened to an extent controlled by the adjustment of resistance 12.

Returning resistance 12 to its zero position and adjusting resistance 22 to the same value as the previous adjustment of resistance 12, the operation of relay C after the operation of relay F in response to a spacing impulse will take place as in the first case described above and relay B will be operated as described in that case. When a marking impulse is again received by relay F, relay C will return to marking as described in the first case above, whereas relay B will be held in spacing position for a longer time due to the continued charge of condenser 20 partly through the operating winding of relay B and partly through the resistance 22. Thus, the spacing impulse in the output circuit will be prolonged in accordance with the adjustment of resistance 22 and the marking impulse will be correspondingly shortened.

It will thus be seen that by this arrangement the currents in the operating windings of relays C and B are given a definite wave shape for normal operation of these relays by current impulses through their operating windings corresponding to both the marking and the spacing impulses in the input circuit, and that those current impulses may be further modified by introduction of resistances 12 and 22, respectively, to introduce marking and spacing bias, respectively, in the output signals. The operation of relays C and B to their spacing and marking positions, respectively, is accomplished by their biasing windings unaffected by the shaping and delaying networks.

For the purpose of impressing impulses upon relay F a jack R—IM is provided, by means of which a source of reversals 50 may be connected into the input circuit of relay F; in this case a dummy plug should be introduced in the jack POL to open the biasing circuit for relay F, thereby permitting relay F to operate continuously between marking and spacing in response to the polar signals. Another jack "in" is provided for impressing neutral signals, that is, open-and-close circuit conditions upon relay F, as by means of a 60-speed transmitter 55 automatically impressing test signals upon the operating winding of relay F.

The output circuit of the set is also provided with a number of jacks permitting various test conditions. Thus the jack MA permits the insertion of a milliammeter A in the output circuit for adjustment of the output current by means of resistance 25. The circuit to be tested can be included in the output circuit of relay B through the "out" jack, which operation at the same time disconnects the positive and negative sources from the output circuit, thus providing for neutral signals. In the case that polar signals are desired in the output circuit, the plus and minus sources are connected from jacks M— and S+ over patching cords and over jacks M and S to the marking and spacing contacts, respectively, of relay B.

A bias measuring circuit is also associated with the output circuit and comprises the relay

D and the bias indicator BI. Relay D is normally held on the marking contact by its upper operating winding which is included in the output circuit; with no current in the operating winding the biasing winding will operate the relay to spacing. The meter BI has a double scale with zero in the center and divisions for indicating marking bias in per cent on the right side of the scale and spacing bias on the left side of the scale. The meter is operated to the right when relay D is on the marking contact and to the left when the relay is on the spacing contact. Condenser 30 serves to dampen the movements of the meter needle. By means of the jack BMS the bias metering set can be disconnected from the output circuit of relay B and used for other purposes.

Provisions are made for at intervals changing the bias introducing set to produce signals alternately with marking bias and with spacing bias. This is obtained by an oscillating circuit comprising relays A and E. Relay A is a vibrating relay having its contacts normally connected to plus and minus sources. Thus, assuming that the relay has just arrived at its marking contact as shown in the drawings, the plus source is connected over the marking contact and to both windings of the relay. The current in the lower winding will now tend to operate the armature to spacing. However, the current in the upper winding during the charging period of condenser 35 will hold the armature against marking; when this current is sufficiently reduced, the lower winding will operate the relay to spacing. In this position of the relay minus source will be connected to both relay windings and when condenser 35 has been charged in the opposite direction, the armature will move back to marking. Simultaneous with these operations of relay A, relay E will be operated alternately to marking and spacing. The period of operation of the oscillating relays A and E may conveniently be fixed at about one cycle per second.

With relay E on marking as shown in the drawings, it will be noted that resistance 12 connected to the spacing contact of relay F is bridged. Similarly when relay E is on spacing contact, resistance 22 associated with relay C will be bridged. The effect of the operations of relay E thus is to alternately eliminate the biasing effects introduced by adjustments of resistances 12 and 22. This effect of relay E can be eliminated by inserting a dummy plug in the control jack CJ. Whenever it is desired to hold relay E in one position or the other, the vibrations of relay A may be stopped in either position of the relay by the insertion of a dummy plug in either of the jacks -VIB and +VIB.

In preparing the circuit shown in Fig. 1 for operation, the circuit will at first be put in condition as shown in the drawings. The source of reversals 50 is inserted in the jack R-IN. For the test about to be described the reversals have approximately the same dot frequency as the transmitter 55. Resistances 12 and 22 are adjusted to zero. Relay A is prevented from oscillating by insertion of a dummy plug and will be assumed to be at rest on its marking contact. With resistances 12 and 22 adjusted to zero, relays F, C, B and D will operate in unison with the reversals and the meter BI will be at rest on zero.

Resistance 22 is then adjusted until the meter shows, for example, 35 per cent spacing bias. By means of the dummy plug relays A and E are

now operated to rest on their spacing contacts and resistance 12 is adjusted until the meter shows 35 per cent marking bias. By this preliminary adjustment of the bias introducing set, the bias introduced in either direction by the operation of relays F, C and B will be known and can be set to as high as 100 per cent if desired.

The source of reversals 50 is now disconnected and a transmitter 55 adjusted to produce unbiased standard test signals is connected to jack "in" and the oscillating relays A and E are put in condition to continuously vibrate, for example, at the rate of one cycle per second, thereby changing the bias produced by the set from marking to spacing about once for every three characters without affecting the amount of bias.

Assuming that it is desired to test a distant teletypewriter station, the loop circuit from that station will be patched from the switchboard on which it appears to the "out" jack of the bias introducing set. The station will thus receive the standard test signals alternately with a 35 per cent marking bias and a 35 per cent spacing bias and by observing whether the test signals are correctly received by this station the attendant can judge the condition of the station equipment.

In case it should be desired to check the operation of a regenerative repeater, such as is frequently used in teletypewriter service, the input side of the repeater will be patched to the "out" jack on the set and the output side of the repeater will be patched directly to a monitoring teletypewriter which is known to be in satisfactory adjustment and the reception of the test signals is observed on the teletypewriter.

It should be noted that the condensers 10 and 20 have ample time to become fully discharged during the duration of a single impulse. For this reason no characteristic distortion will be introduced by this set even at very high speed of transmission, i. e., the amount of bias introduced at any transition from marking to spacing or from spacing to marking will be independent of the duration of the preceding impulse.

Referring now more particularly to Fig. 2 in the drawings which shows a bias introduction set in a modified form, this set comprises the repeating relays REC and BIAS. Relay REC has its upper operating winding included in the input circuit for operating its armature to marking. The lower or biasing winding of the relay is permanently energized to operate the armature to spacing when the operating winding is currentless. The relay BIAS has two upper operating windings connected to the marking and spacing contacts respectively of relay REC for operation of the armature of relay BIAS to marking and spacing respectively. The armature and contacts of relay BIAS are included in the output circuit of the set.

Signals are impressed upon the input relay REC for testing purposes and are in turn repeated to operate relay BIAS for production of impulses in the output side of the set. For the purpose of biasing the output signals, relay BIAS is provided with two lower biasing windings acting in opposite directions to aid or oppose one or the other of the operating windings to varying extents in accordance with the current strength in the biasing windings. Thus, bias winding 104 is connected through a retardation coil 108 to potentiometer 106 which in turn is connected to a source of positive potential over the armature in operated condition of relay VIB.

Similarly, bias winding 103 is connected through retardation coil 107 to potentiometer 105 which in turn is connected over the armature in retracted position of relay VIB to a source of positive potential.

It will first be assumed that the circuit is in condition as shown in the drawings, however, with potentiometers 105 and 106 adjusted to ground. Under these conditions, the operating winding of relay REC is energized to hold the armature to marking over a circuit which may be traced from negative potential, over tip contacts of jack WDG, normally closed contacts 113 of key K4, the operating winding of relay REC, alternate contacts 122 and normal contacts 124 of key K1, over tip contacts of jack IN and auxiliary contacts of jack WDG to positive source. With relay REC in marking position, the current flows in winding 102 of relay BIAS to hold the armature in marking position. Under the assumed conditions, windings 101, 103 and 104 will be currentless. The output circuit from relay BIAS may be traced as follows: from negative source over contacts of relay D, marking contacts of relay BIAS, normal contacts 116 and 112 of key K4, upper operating winding of relay MEAS, normal contacts 111, 115 and 114 of key K4, tip contacts of jacks "neutral", LPG, and "polar" to positive source. Thus under the present conditions, the output circuit is in marking position.

If now the input circuit through the operating winding of relay REC be opened as in the case of a spacing signal, relay REC will operate to spacing. Winding 102 of relay BIAS will now become deenergized and winding 101 will be energized and will operate the relay to spacing, thereby opening the output circuit at the marking contact and closing it to positive source over the spacing contact and contacts of relay D. When the input circuit again is closed relay REC and BIAS return to marking, thereby placing the output circuit in marking condition.

Condensers 131 and 132 and high resistances 133 and 134 are included in the operating circuit for windings 101 and 102 of relay BIAS for the purpose of shaping the operating current. These condensers are comparatively large, and besides acting as spark protection serve in combination with the high resistances to round the front of the operating impulses and to add a fairly long tail to the rear of the impulses, thereby permitting a bias of relay BIAS to the extent of 60 per cent in either direction. Thus when relay REC leaves its marking contact, condenser 132 will discharge slowly through winding 102. In the meantime, relay REC reaches its spacing contact and current begins to build up in winding 101. The result of these two currents will be a gradual reversal of the operating flux in relay BIAS for operating this relay to spacing. When relay REC returns to marking, these conditions are reversed. Thus with no current in windings 103 and 104, relay BIAS will follow relay REC after a definite short interval in both directions of operation.

It can readily be seen that by adjusting the resistances 105 and 106 and properly operating relay VIB, a biasing current may be established in either winding 103 or winding 104 which will affect the operating flux in relay BIAS to bias the operation of the relay either to marking or to spacing. The winding 103 is connected to aid the spacing winding 101 and thus will produce a spacing bias, whereas winding 104 aids the

marking winding 102 and will produce marking bias. The retardation coils 107 and 108 included in the circuit of the biasing windings 103 and 104 are for the purpose of preventing "kick-off" of relay BIAS. Thus in repeating signals through the set, both the marking and spacing impulses impressed upon the set will be repeated as current impulses which are subjected to shaping and are combined with biasing effects to be repeated as biased signals in the output circuit.

Relay VIB is connected over contacts of key K2 to a source of impulses for continually operating and releasing the relay. In this manner the positive source is connected alternately to potentiometer 105 and potentiometer 106, thereby alternately energizing the biasing windings 103 and 104 of relay BIAS. The rate of these alterations may conveniently be one or two cycles per second. By operation of key K2 to marking, relay VIB will be continuously operated and relay BIAS will be continuously biased to marking. By operation of key K2 to spacing, relay VIB will be continuously deenergized and relay BIAS will be continuously biased to spacing.

A bias measuring circuit is provided similar to that shown in Fig. 1 and comprises the relay MEAS and bias indicator BI. The upper operating winding of relay MEAS is included in the output circuit as already traced and serves to hold the relay to marking. The lower biasing winding is permanently energized to operate the relay to spacing when the operating winding is currentless. The current in the meter BI may be adjusted by means of potentiometer 141 and the current in the biasing winding by means of potentiometer 142.

For the purpose of impressing impulses upon the operating winding of relay REC, the key K1 may be operated to the left, thereby including a source of reversals 50 in the input circuit. The input circuit may now be traced as follows: from negative source over tip contacts of jacks WDG, normal contacts 113 of key K4, operating winding of relay REC, alternate contact 123 of key K1, source 50, alternate contact 124 of key K1, contacts of jacks IN and WDG to positive source. In this circuit, the receiving relay REC is operated in unison with the source 50. With the resistances 105 and 106 adjusted to ground, the BIAS relay will repeat the reversals in the output circuit which, as already traced above, includes the operating winding of relay MEAS. Any bias that may be present in the impulses from the source of reversals 50 may thus be noted on the bias indicator BI and should be taken into account in subsequently adjusting the set for a desired output bias.

For the purpose of checking the relay BIAS, an additional test may be made by switching key K4 to the left, thereby disconnecting the operating winding of relay MEAS from the output circuit and connecting it into the input circuit. The input circuit may now be traced as follows: from negative source over tip contacts of jack WDG, alternate contacts 112 of key K4, operating winding of relay MEAS, alternate contacts 111 of key K4, operating winding of relay REC, alternate contacts 123 of key K1, source of reversals 50, alternate contact 124 of key K1, contacts of jacks IN and WDG to positive source. With the circuit in this condition, the bias of the source of reversals may be determined independent of the operations of relay BIAS. From any disagreement

between these two readings, it may be determined whether relay BIAS requires adjustment.

Again turning key K4 to normal, the relay MEAS will be included in the output circuit and resistances 105 and 106 may each be adjusted to effect the desired bias with the key K2 operated to marking or spacing respectively. The amount of bias produced in the output circuit is read on the bias indicator BI and at this time any bias previously observed in the source of reversals 50 may be taken into account. Thus if a bias of 35 per cent be desired in both directions and it has been found that the source 50 has a 2 per cent marking bias, it will be necessary to adjust the mark potentiometer 106 to give a reading of 37 per cent marking on the bias indicator BI and to adjust the space potentiometer 105 to give a reading on the meter BI of 33 per cent spacing.

It should be understood that the source 50 used with the set shown in Fig. 2, though customarily termed a source of reversals, is in the nature of a circuit interrupter serially included in the operating circuit for relay REC to produce current and no-current impulses of substantially equal length and in continuous succession.

When the key K1 is operated to middle position, the source of reversals 50 will be disconnected from the input circuit and the source of standard test signals 55 will be substituted therefor. The input circuit may now be traced as follows: from negative source over tip contacts of jack WDG, normal contacts 113 of key K4, operating winding of relay REC, normal contacts 122 of key K1, through the source 55, over normal contacts 121 and 124 of key K1 and contacts of jacks IN and WDG to positive source. Standard telegraph signals are thus impressed upon the relay REC and will be repeated in the output circuit with a 35 per cent bias to marking or to spacing, depending upon the relay VIB.

The output circuit may be associated with any external circuit which it is desirable to observe under various bias conditions by connecting such external circuits by means of plugs into any of the jacks "neutral", LPG, or "polar". A circuit which requires polar signals should be connected through the jack "polar" and thus will receive plus and minus impulses from the spacing and marking contacts of relay BIAS over the tip contact of jack "polar" with a known desired bias. In this case the positive source is disconnected from the output circuit at the tip contact of jack "polar" and the whole system operates with ground return. Under these conditions, the key K6 should be operated to the right to open the circuit for the biasing winding of relay MEAS, the relay now being operated by polar impulses through its operating winding. If an external circuit for neutral signals is to be observed, it should be connected into the jack "neutral." By plugging into the jack "neutral", the auxiliary contact applies ground to relay D which operates and disconnects positive and negative potentials from the spacing and marking contacts of relay BIAS. The output circuit may now be traced as follows: from the marking contact M of relay BIAS, over the sleeve of jack "neutral", through the external circuit which includes an appropriate source of potential, over the tip contacts of jack "neutral", normal contacts 114, 115 and 111 of key K4, operating winding of relay MEAS, normal contacts 112 and 116 of key K4 to the armature of relay BIAS. As the relay BIAS closes and opens its marking contacts, current and no-current impulses are produced in the out-

put circuit and in the circuit under observation, with a known desired bias.

What is claimed is:

1. A telegraph signal reproducing system comprising receiving relay means for producing marking current impulses and spacing current impulses, circuit means for shaping substantially identically said marking and spacing impulses, transmitting relay means for producing from said shaped impulses signals with said marking and spacing elements combined, biasing resistance means for lengthening only the marking elements, biasing resistance means for lengthening only the spacing elements, and switching means for connecting alternately one or the other of said biasing means into operation for biasing said produced signals to marking or spacing.

2. A telegraph signal reproducing system comprising receiving relay means for producing marking current impulses and spacing current impulses in response to incoming telegraph signals, shaping circuit means connected for shaping substantially identically said marking and spacing current impulses, transmitting relay means responsive to the operations of said receiving relay means to retransmit said incoming signals, biasing circuit means for biasing the retransmitted signals a predetermined amount, and switching means for alternating the direction of the applied bias at intervals independently of the signaling speed.

3. A method of producing telegraph signals with a desired bias which comprises producing reversal impulses of signaling frequency alternately in marking and spacing directions, reproducing said impulses with current impulses for both the marking and spacing elements of said reversal impulses, impressing a distorting effect upon said marking and spacing impulses for biasing purpose, reproducing said reversals from said distorted impulses for retransmission, superimposing upon said distorted impulses biasing effects in the marking direction and in the spacing direction, adjusting to a desired value and observing said biasing effects, producing unbiased coded telegraph signals, reproducing said signals with current impulses for both the marking and spacing elements of said signals, impressing said distorting effect unchanged upon said reproduced signals, reproducing said telegraph signals from said latter distorted impulses for retransmission and superimposing upon said matter distorted impulses said adjusted biasing effects in the marking direction and in the spacing direction as desired.

4. A telegraph signal reproducing system comprising receiving relay means for producing marking current impulses and spacing current impulses in response to incoming telegraph signals, shaping circuit means connected for shaping substantially identically said marking and spacing current impulses, transmitting relay means responsive to the said shaped marking and spacing current impulses to retransmit said incoming signals, biasing circuit means for biasing said transmitting relay means a predetermined amount, and switching means for alternating the direction of the applied bias at intervals independently of the signaling speed.

5. A telegraph signal reproducing system comprising transmission relay means for producing marking current impulses in one circuit and spacing current impulses in another circuit in response to incoming telegraph signals and for reproducing from said current impulses the mark-

ing and spacing elements of said incoming telegraph signals, shaping circuit means connected to said one circuit for shaping said marking impulses for bias introduction and other circuit means connected to said other circuit for shaping said spacing impulses for bias introduction, circuit means connected to a winding of said relay means for varying the effective duration of said marking current impulses to bias the reproduced marking element and other circuit means connected to another winding of said relay means for varying the effective duration of said spacing current impulses to bias the reproduced spacing element.

6. A bias changing system for telegraph systems which comprises a plurality of relay means

for successive repeating of telegraph impulses, circuit means for shaping the marking elements and other circuit means for shaping the spacing elements of the telegraph impulses, said circuit means being permanently included in two separate circuits respectively intermediate successive ones of said relay means, marking bias circuit means and spacing bias circuit means, and switching means for connecting said bias circuit means into circuit relation with said two separate circuits, respectively, to each cooperate with a corresponding one of said shaping circuit means in changing the bias of said telegraph signals in either direction in the course of repeating by said relay means.

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