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SIGNAL DISTORTION INDICATING AND MEASURING
DEVICE FOR PRINTING TELEGRAPH SYSTEMS
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FIG. 1

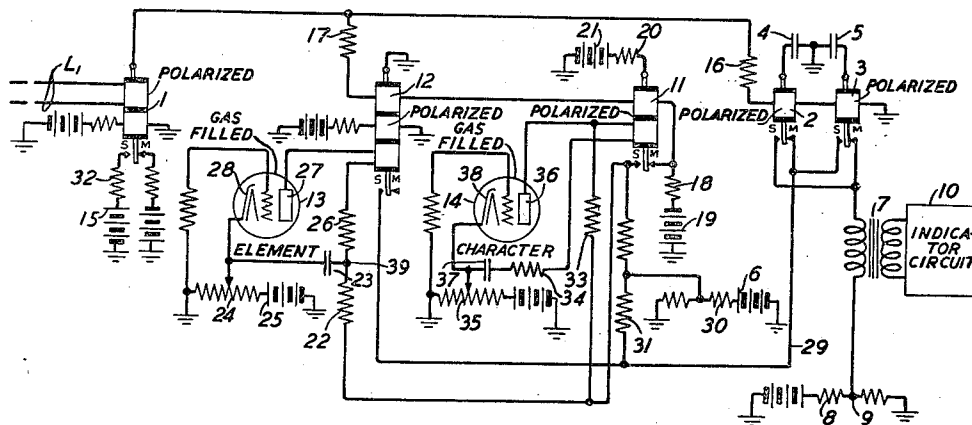
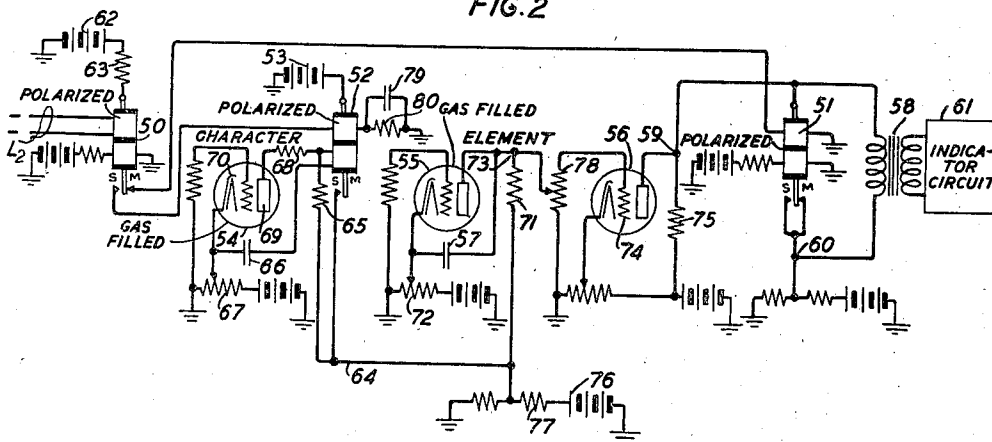


FIG. 2



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SIGNAL DISTORTION INDICATING AND
MEASURING DEVICE FOR PRINTING
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Application September 30, 1936, Serial No. 103,337

6 Claims. (Cl. 178—69)

This invention relates to telegraph apparatus and more particularly to apparatus for indicating and measuring signal distortion in a teletypewriter start-stop telegraph system.

5 An object of the invention is to obtain a visible indication of the extent of the distortion at either end of each signal impulse of a combination. More specifically stated, this object is to obtain the maximum displacement of either end
10 of each received impulse and thereby determine the quality of the telegraph transmission over a circuit.

An important feature of the present invention is that there is provided for a start-stop printing telegraph system a distortion measuring circuit wherein all rotating machinery for timing is eliminated.

15 According to the present invention, the timing apparatus of the distortion indicator comprises relays connected in a cascade arrangement between a transmission circuit and an indicating device. Two arrangements are shown.

In the first arrangement there are five polar relays, two gas-filled tubes, a transformer and a peak voltmeter. This arrangement employs the use of reference condensers such as disclosed in a copending application of F. A. Cowan, Serial No. 29,569, filed July 2, 1935. The first, or line, relay is normally held in its marking position under the influence of the normal current in the transmission circuit. The other relays are arranged in pairs, each pair being controlled by the line relay over one of two parallel paths. The first pair of relays controls the alternate charging and alternate discharging of the two reference condensers and the second pair of relays are respectively controlled by two gas-filled tubes, after the operation of the tube has been started by one of the relays. In response to a combination of signal impulses of the start-stop type received from the transmission circuit, the line relay is operated by the first, or spacing, impulse to its space position, then to either its mark or space position depending on the character of the corresponding impulse of the next succeeding five impulses and finally to the mark position in response to the last, or mark, impulse of the combination. One of the gas-filled tubes operates once during the character interval, that is, during an interval of time which it takes the complete combination of start-stop signal impulses to be received, and the other tube operates once during an interval which it takes the unit, or dot, length impulse to be received. The second pair
55 of relays repeats the operation of the line relay.

The second pair, after being operated to their spacing positions by the line relay in response to the first impulse of the received signal combination, is controlled independently of the line relay until the stop, or last, impulse of the combination is received. The first relay of the second pair is held to its spacing position during the interval of time it takes to receive the five selecting impulses of a signal combination, or in other words, during the time it takes to store on a condenser connected in shunt to the plate and cathode of the first gas-filled tube a charge of sufficient magnitude to operate the tube. The second relay of the second pair is operated under the influence of the second gas-filled tube in the middle of each unit, or dot, length impulse of the five selecting impulses of a signal combination and the starting impulses. The relays of the first pair follow the incoming signals and the second relay of the second pair is so timed that when the reference condenser connected to the charging circuit will be discharged to ground through the armature of the second relay of the second pair in the middle of each signal element. When distortionless signals are received the charge on the condensers at the time of a transition from marking to spacing, or spacing to marking, is the same as a reference value of voltage. When distorted signals are received, the charge on the condenser at the time of transition from marking to spacing, or spacing to marking, is proportionately more or less than the above-mentioned reference voltage depending on whether the transition occurs early or late. This difference in potential between the voltage on the condenser and the reference voltage causes the condenser to be either charged or discharged through the primary winding of the transformer connected to the peak voltmeter. The peak voltmeter in response to the voltage so impressed on the transformer indicates the amount of distortion present in the incoming signal impulses.

In the second arrangement there are three polar relays respectively referred to herein as the line, the start, and the recorder relays. The transmission circuits or loops over which are received the signals to be measured for distortion is connected to the primary winding of the line relay. The line relay in this arrangement also is normally held to its mark position under the influence of the normal current in the transmission circuit. Likewise, each of the other two relays is normally held in its mark position, the second relay normally being controlled independently of the line relay and the third relay normally be-
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ing controlled by the line relay. Two gas-filled tubes are provided and respectively operate like those described above in the first arrangement, that is, one tube operating once during the character interval and the other operating once during an interval which it takes the unit, or dot, length impulse to be received. The third, or recorder, relay follows the operation of the line relay and thereby moves its armature between two associated interconnected contacts which are connected in series with the primary winding of a transformer. The secondary winding of the transformer is connected to a peak voltmeter. Connected in the plate circuit of the second gas-filled tube is the grid of an amplifier vacuum tube, the plate battery for which is the current supply of varying potential. Inasmuch as the second gas-filled tube is arranged to operate at the frequency of undistorted selecting impulses of a received signal combination and these undistorted impulses are impressed on the grid of the amplifier tube, the output of the amplifier tube is compared with the operation of the third relay over the circuit including the primary winding of the transformer. The primary winding of the transformer is normally short-circuited by the contacts of the recorder relay. When the armature of the recorder relay is not on either contact, the primary winding of the transformer is connected between a fixed source of potential and a variable potential. The variable potential has a straight line variation with respect to time from a small value to a larger value. The value of the fixed potential is midway between these two values.

When undistorted signals are received the recorder relay operates at the moment when the potentials are equal. When distorted signals are received the two potentials are not equal when the recorder relay operates. The difference between the two potentials is proportional to the amount of distortion. This difference is applied to the primary winding of the transformer while the armature of the recorder relay is traveling from either contact to the other and in turn is repeated by means of the transformer to the peak voltmeter whereon the amount of distortion present is indicated.

The objects and advantages of the invention will be better understood from the following description when read in connection with the accompanying drawing in which

Fig. 1 is an arrangement of the invention using two gas-filled ionic tubes to control, respectively, two relays, which in cooperation with two other relays and two reference condensers, effect the operation of a distortion indicating circuit; and

Fig. 2 is another arrangement of the invention using two gas-filled ionic tubes to control, respectively, a relay and an ionic output tube, which in cooperation with another relay, effect the operation of a distortion indicating circuit.

Referring now to the arrangement of Fig. 1, the upper winding of a line relay 1 is connected in series with the conductors of a line L1. Relay 1 responds to the line impulses and causes relays 2 and 3 to respond in unison. In association with relays 2 and 3 are condensers 4 and 5 respectively. Conden-
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sers 4 and 5 are connected, respectively, by the spacing contacts of relay 2 and the marking contacts of relay 3, through the left winding of transformer 7 to the potentiometer 8. The potential of potentiometer 8 at junction point 9 is so adjusted that it equals the potential of the charge that is accumulated on condensers 4 and 5, during one-half of a standard space or mark interval, that is, it is the voltage of the charge accumulated when there is no distortion. Under this condition there is no current flow through the left winding of transformer 7 and consequently no voltage is induced in the right winding and there is no actuation of the indicating circuit 10, which is conventionally represented by a box 10 and which may be of any suitable form designed to give a maximum indication. A peak voltmeter of the same general type shown in the aforementioned Cowan application may be used. When distortion is present, condensers 4 and 5 are either not charged fully during a space or mark period being measured or are overcharged during this period. Consequently, under this condition there will be a flow of current through the left winding of transformer 7, which is proportional to the difference between the voltage of the charged condenser and the voltage at the point 9 of potentiometer 8, and the indicating circuit 10 will respond accordingly.

When relay 1 responds to the initial spacing impulse, relay 11 also operates to its spacing contacts due to the reversal of current through its upper winding. Relay 11 in operating causes gas-filled tube 13 to discharge at the approximate center of every period of time equivalent to that of a perfect unit, or dot, length impulse and gas-filled tube 14 to discharge at the end of every time interval required to receive approximately five and one-half selecting impulses of a signal combination or character. Tube 13 in discharging at the center of the perfect dot length impulse aforesaid causes relay 12 to operate momentarily and discharge condenser 4 or 5, so that the condenser 4 or 5 may be ready to receive a new charge during the succeeding interval in accordance with the distortion present. Tube 14 in discharging at the end of the character impulses causes relay 11 to operate back to its marking contacts. The operation described is repeated when the spacing start impulse of the next character is received. A more complete understanding of the operation may be obtained from the following detailed description.

Let it be assumed that in response to an initial spacing start impulse received over line L1 the circuit through the upper winding of line relay 1 is opened. Relay 1, which is normally operated to its marking contacts, now operates to its spacing contacts in response to the effect of the current in its biasing or lower winding. A circuit is closed from battery 15, through resistance 32, spacing contacts of relay 1, resistance 16 and windings of relays 2 and 3 to ground. Relays 2 and 3 each operate to their spacing contacts. Another parallel circuit is closed through resistance 17, uppermost winding of relay 12, upper winding of relay 11, through resistance 18 to battery 19. The current through the uppermost winding of relay 12 now opposes the current in its middle winding, and tends to operate relay 12 to its spacing contacts, but the current in the middle winding predominates and relay 12 remains on its marking contacts until tube 13 discharges as will be hereinafter de-
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scribed. The current through the upper winding of relay 11 is now directed so that relay 11 operates to its spacing contacts and remains there until tube 14 discharges as hereinafter described.

When relay 11 operates to its spacing contacts it closes a circuit from battery 21 through resistance 20, spacing contacts of relay 11 through resistance 22, condenser 23 and potentiometer 24 to ground. After an interval, following the beginning of the initial spacing impulse and which is equivalent to half of a standard dot period and which is determined by the capacity of condenser 23, resistance 22, and the adjustment of potentiometer 24 condenser 23 is sufficiently charged so that the potential at point 39 causes tube 13 to ionize. Condenser 23 now discharges in a circuit including resistance 26, lowermost winding of relay 12, plate element 27 of tube 13 and cathode element 28. Current from battery 21 also now flows through resistance 22 into the circuit of tube 13, just traced, and through potentiometer 24 to ground. Relay 12 operates momentarily to its spacing contacts through its lowermost winding, the magnetic effect of which predominates over the effect of the current in the middle winding which tends to operate relay 12 to its marking contacts. Ground is thereby connected to conductor 29 and thence through spacing contacts of relay 3 to condenser 5, which is discharged. This first operation of relay 12 is adjusted to occur at the approximate middle of the initial, starting space impulse. When condenser 23 discharges, the potential of point 39 falls and permits tube 13 to deionize, the current in the lowermost winding of relay 12 is reduced to zero, and relay 12 reoperates to its marking contacts under the influence of the current in its middle winding, which now predominates over the current in its upper winding.

As soon as relay 12 reoperates to its marking contacts ground is removed from conductor 29 and condenser 5 immediately begins to charge in a circuit from battery 6, through resistance 30 and from battery 21 through resistance 20 and spacing contacts of relay 11, through resistance 31, over conductor 29, through spacing contacts of relay 3 and condenser 5 to ground. Assuming that the first impulse after the initial spacing impulse is a marking impulse, relays 2 and 3 reoperate to their marking contacts. If the marking impulse occurs exactly on time, that is, if there is no distortion, the potential of condenser 5 will equal that of the junction point 9, there will be no flow of current to or from condenser 5 through marking contacts of relay 3 and the left winding of transformer 7. Indicating circuit 10 will accordingly not respond. If the marking impulse occurs prematurely, that is, before the end of the standard period, then condenser 5 receives a charge below the standard amount and there will be a flow of current from point 9 through the left winding of transformer 7 into condenser 5, causing indicating circuit 10 to respond in accordance with the difference of potential between that of condenser 5 and point 9. If the marking impulse occurs late, that is, after the end of the standard period, then condenser 5 will be charged more than the standard amount and when connected to the transformer circuit there will be a flow of current from condenser 5 to point 9, the indicating circuit 10 recording as before the difference of potential, which is a measure of the distortion.

After the transition from the space to mark condition as assumed in the before given description, relay 2 in operating to its marking contacts, connects condenser 4 to conductor 29. Condenser 4 now begins to charge through the same circuit that was traced for condenser 5.

At the approximate center of the assumed marking impulse, relay 12 operates again in the manner before described and grounds conductor 29, removing the accumulated charge on condenser 4. When immediately after, relay 12 reoperates to its marking contacts condenser 4 begins to charge again until relays 2 and 3, reoperate to their spacing contacts, at the next transition from mark to space or until the middle of the next signal element. Assuming that the transition comes before the next operation of relay 12, and either before or after the end of the standard dot impulse condenser 4 is charged or discharges through the spacing contacts of relay 2 and the left winding of transformer 7, causing the actuation of the indicating circuit 10, as before described. This action continues until the transmission of all five character impulses is completed, when relay 11 reoperates to its marking contacts as will now be explained.

When relay 11 operated to its spacing contacts a circuit is closed from battery 21, through resistance 20, spacing contacts of relay 11, resistance 33, lower winding of relay 11, resistance 34, condenser 37 and potentiometer resistance 35 to ground. This current is directed so that relay 11 is held on its spacing contacts, and the values of resistances 33, 34 and 35 and condenser 37 are so determined that the time required to charge condenser 37 is equivalent to the time required for the transmission of approximately five and one-half character impulses. After condenser 37 becomes charged the potential applied to the plate element 36 is sufficient to cause tube 14 to ionize. Condenser 37 then discharges, in a circuit which includes resistance 34, lower winding of relay 11, anode element 36, tube 14 and cathode element 38. This current is so directed that relay 11 reoperates to its marking contacts and continues thereon, since the five character impulses have now been sent and the current through the upper winding of relay 11 now flows in the original direction which causes relay 11 to remain normally on its marking contacts. After condenser 37 has discharged and relay 11 has reoperated to its marking contacts the potential in the plate circuit of tube 14 is insufficient to maintain ionization and the current in the lower winding of relay 11 is reduced to zero.

From the above given description it is seen that in the arrangement of Fig. 1 indicating circuit 10 records the space or mark distortion, without differentiating between the two, that is, the indication displayed may refer to either a space or mark distortion.

Referring now to the arrangement of the invention shown by Fig. 2, line L2 is looped through the upper winding of line relay 50, which follows the line impulses and transmits these to the upper winding of relay 51, which responds in unison. When the spacing contacts of relay 50 are closed, relay 52 operates to its spacing contacts and thereby connects battery 53 to the plate circuit of the gas-filled tube 54, which after a time equivalent to approximately five and one-half character elements discharges and operates relay 52 to its marking contacts. Relay 52 also connects battery 53 to the plate circuit of gas-filled tube 55, causing condenser 57 to begin charging. Tube

55 is caused to ionize and discharge condenser 57 at the center of each perfect dot interval, during the period that relay 52 remains on its spacing contacts. The left or primary winding of transformer 58 is connected across two points 59 and 60, between which there is normally no current flow. At the end of each perfect dot interval condenser 57 is charged to a voltage, whereby the potential on the grid element of output ionic tube 56 is such that the current in the plate circuit of said tube causes the potential or point 59 to equal that of point 60. Accordingly if relay 51 transfers from mark to space or vice versa at the end of a perfect dot interval, which is equivalent to a condition of no distortion, then there will be no flow of current through the left winding of transformer 58, and indicating circuit 61 will accordingly not respond. When there is distortion, the transfer from mark to space, or vice versa, will occur either early or late, and under this condition the charge on condenser 57 will be either less or greater than the distortionless charge and the indicating circuit 61 will respond accordingly. A more complete understanding of this arrangement of the invention may be obtained from the following detailed description.

Let it be assumed that the circuit through the upper winding of line relay 50 is opened due to the initial start spacing impulse. Relay 50 then operates due to the biasing effect of its lower winding and opens the circuit through the upper winding of relay 51, which operates to its spacing contacts due to the biasing effect of its lower winding. It also closes a circuit from battery 62 through resistance 63, spacing contacts of relay 50, upper winding of character relay 52 and resistance 63 to ground. Relay 52 then operates to its spacing contacts. Condenser 79 is shunted across resistance 80 to accelerate the operation of relay 52. A charging current flows from battery 53 through spacing contacts of relay 52, over conductor 64 through resistance 65, lower winding of relay 52, through condenser 66 and adjustable resistance 67 to ground. This current is sufficient to hold relay 52 on its spacing contacts independently of the current through its upper winding. After an interval equivalent to approximately five and one-half standard dot impulses, condenser 66 becomes sufficiently charged to cause the ionization of gas-filled tube 54. Condenser 66 then discharges in a circuit traced from its right-hand terminal through lower winding of relay 52, resistance 68, plate element 69 of tube 54, and cathode element 70 to the left terminal of condenser 66. Resistance 65 and condenser 66 are so determined that the ionization of tube 54 occurs after approximately five and one-half standard dot intervals as before stated. The discharge current through the lower winding of relay 52 is so directed that relay 52 returns to its marking contacts, and is held there since the regular marking stop impulse is now effective.

A circuit is also closed from conductor 64 through resistance 71, condenser 57 and adjustable resistance 72 to ground. Condenser 57 now charges gradually raising the potential of point 73 which is equivalent to raising the potential of grid element 74 of output tube 56. This causes an increase of current in the plate circuit of tube 56, which increases the voltage drop in resistance 75 until there is no flow of current between points 60 and 59. This condition is obtained normally when relay 52 is not operated by adjusting with resistance 78, the flow of current from battery 76, through resistances 77 and 71.

The constants of the circuit are adjusted so that the zero flow current condition before described is obtained after condenser 57 has charged for one-half a standard dot period. Assuming no distortion, relay 51 operates at the end of each perfect element period, transferring from mark to space, or vice versa. Since, as before explained, there is no flow of current between points 59 and 60 there will be no flow through the left winding of transformer 58, when the armature of relay 51 transfers after a standard dot interval. Consequently there will be no voltage induced in the right winding of transformer 58, and consequently indicating circuit 61 will not respond. If, however, there is distortion present, relay 51 will operate either before or after the end of the standard dot period, and then there will be a flow of current through the left winding of transformer 58, proportional to the difference between the actual charge on condenser 57 and the standard charge obtained under a distortionless condition as before described. Indicating circuit 61, will accordingly, when properly calibrated indicate the per cent distortion.

What is claimed is:

1. A signal distortion indicator comprising a source of signaling impulses transmitted in combinations of the start-stop type, an electromagnetic relay responsive to the signaling impulses from said source, a plurality of other electromagnetic relays responsive to the first-mentioned relay, certain of said other electromagnetic relays being responsive to the first impulse only of a start-stop signal combination repeated by said first electromagnetic relay, a thermionic discharge device, a storing element for said thermionic discharge device controlled by said combination of signal impulses and arranged to operate said device once only while each of said combinations of signal impulses is being received, a second thermionic discharge device, a storing element for said second thermionic discharge device controlled by said combination of signaling impulses and arranged to operate said second device a number of times while each of said combinations is being received, circuit means for comparing the individual operating time intervals of said second device with the individual operating time intervals of certain others of said plurality of other electromagnetic relays, and registering means for indicating any difference in the compared corresponding operating time intervals.

2. A signal distortion indicator, according to claim 1, wherein each of said thermionic discharge devices and its associated storing element constitutes an oscillator, the oscillator comprising the second-mentioned thermionic discharge device being arranged to operate at a frequency at least five times that of the oscillator comprising the first-mentioned thermionic discharge device.

3. A signal distortion indicating and measuring device comprising a source of start-stop signaling impulses, a circuit over which signaling impulses from said source are received, an electromagnetic relay responsive to the signaling impulses from said source, a plurality of pairs of electromagnetic relays responsive to the first-mentioned relay, a pair of electron discharge devices and operating circuits therefor, storing elements of different time values respectively connected across said operating circuit and arranged to permit operation of said devices at intervals of different duration, other elements of equal time value responsive to one of said pairs of electromagnetic relays, a source of voltage for storing on

each of said other elements a voltage corresponding in value to alternate pulses received from said start-stop signaling impulse source, circuit means including a junction point of uniform voltage value arranged to compare the individual voltage values on each of said other elements with the uniform voltage value at said junction point, and an indicating device connected with said circuit means for measuring any difference between the individual values of voltages stored on said other elements and the uniform voltage at said junction point.

4. A signal distortion indicating and measuring device, according to claim 3, wherein an additional winding provided on each of the electromagnetic relays of one pair are respectively connected to the operating circuits of said electron discharge devices for permitting one of the relays of said one pair to operate every time a signaling impulse of dot length is being received from said first-mentioned circuit and for permitting the other of the relays of said pair to operate once during the time that the five selecting signaling impulses of a start-stop signaling combination is received from said first-mentioned circuit.

5. A signal distortion indicating and measuring device comprising a source of start-stop signaling impulses, a circuit over which signaling impulses from said source are received, a single electromagnetic relay responsive to the signaling impulses from said source, a plurality of other electromagnetic relays alternately responsive to said

single electromagnetic relay, a pair of oscillators arranged to produce currents of different frequencies, an amplifier comprising an output circuit and responsive to said pair of oscillators at different times, another circuit comprising an armature and contact of one of said electromagnetic relays, a path included in said other circuit and connected in shunt to said armature and contact, a source of voltage for substantially maintaining a potential of normal value across said path, electromagnetic means included in said shunt path for transmitting differences in voltages in the output of said amplifier from voltages of a fixed value, and indicating means connected to said electromagnetic means for measuring said differences in voltage.

6. A signal distortion indicating and measuring device, according to claim 5, wherein each of said oscillators comprises an output circuit and a storing element of distinctive value, a source of voltage common to said storing elements and said output circuit, one of said oscillators being capable under the control of its storing element of operating five times during the interval the five selecting signaling impulses of a signal combination are being received over the first-mentioned circuit and the other of said oscillators under control of its storing element being capable of operating once only during the time that the five signaling impulses of a signaling combination are being received over said first-mentioned circuit.

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