Oct. 25, 1938. H. C. WILLIAMS 2,134,068

START-STOP PRINTING TELEGRAPH SYSTEM

Filed Feb. 23, 1933 2 Sheets-Sheet 1

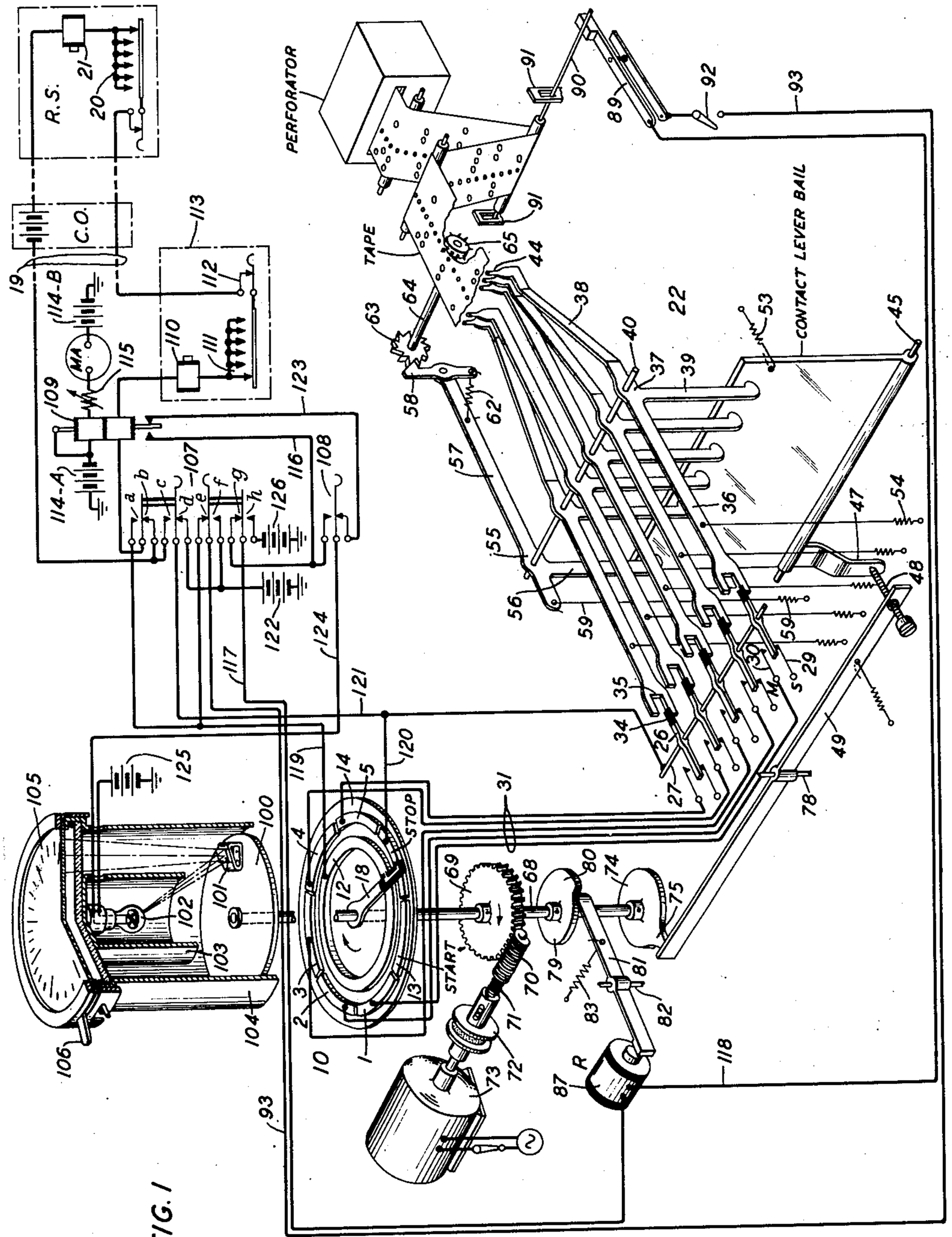


FIG. 1

INVENTOR
H. C. WILLIAMS
BY
William R. Ballard
ATTORNEY

Oct. 25, 1938. H. C. WILLIAMS 2,134,068

START-STOP PRINTING TELEGRAPH SYSTEM

Filed Feb. 23, 1933 2 Sheets-Sheet 2

FIG. 2

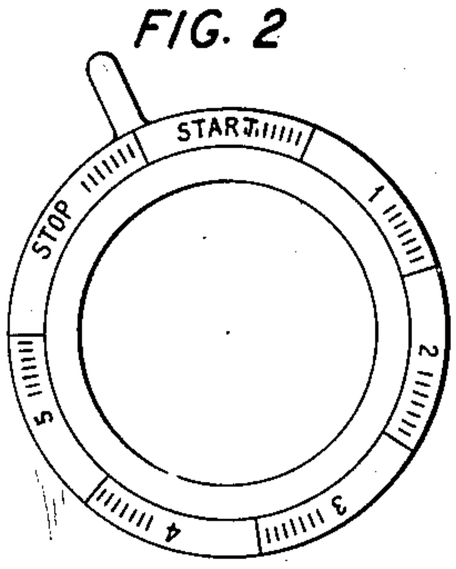


FIG. 3

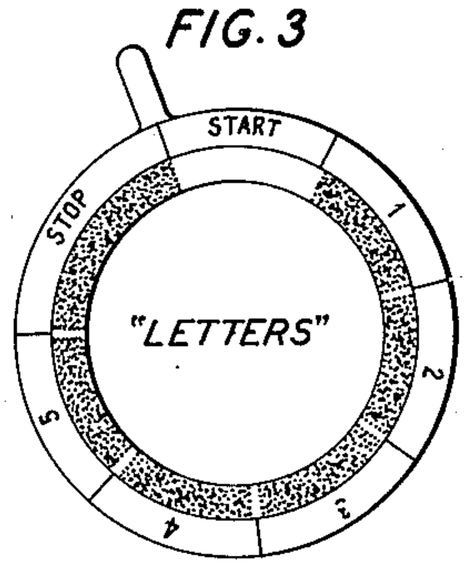


FIG. 4

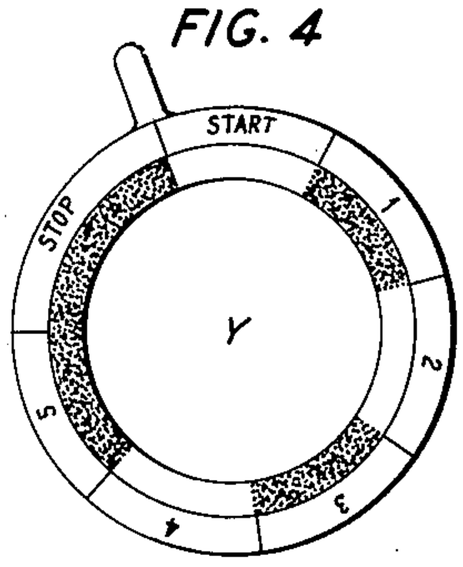


FIG. 5

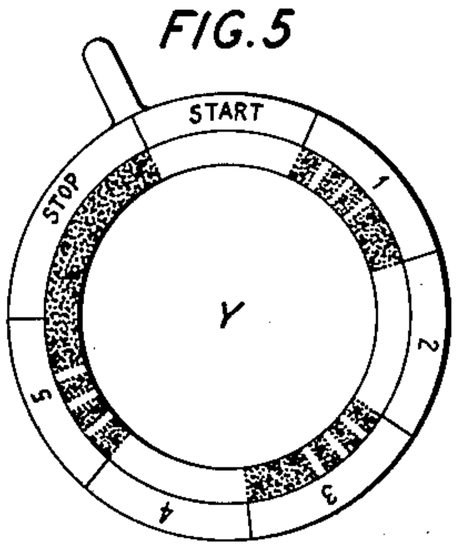


FIG. 6

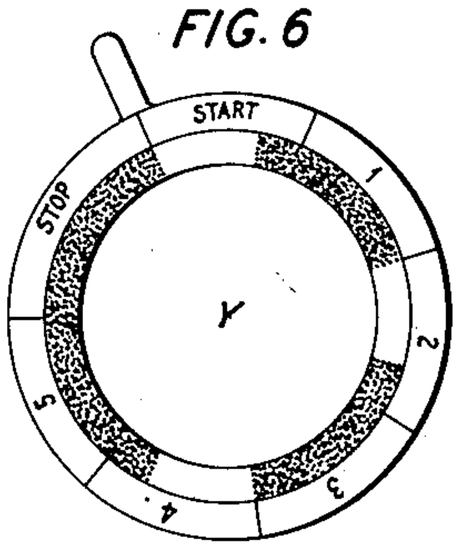


FIG. 7

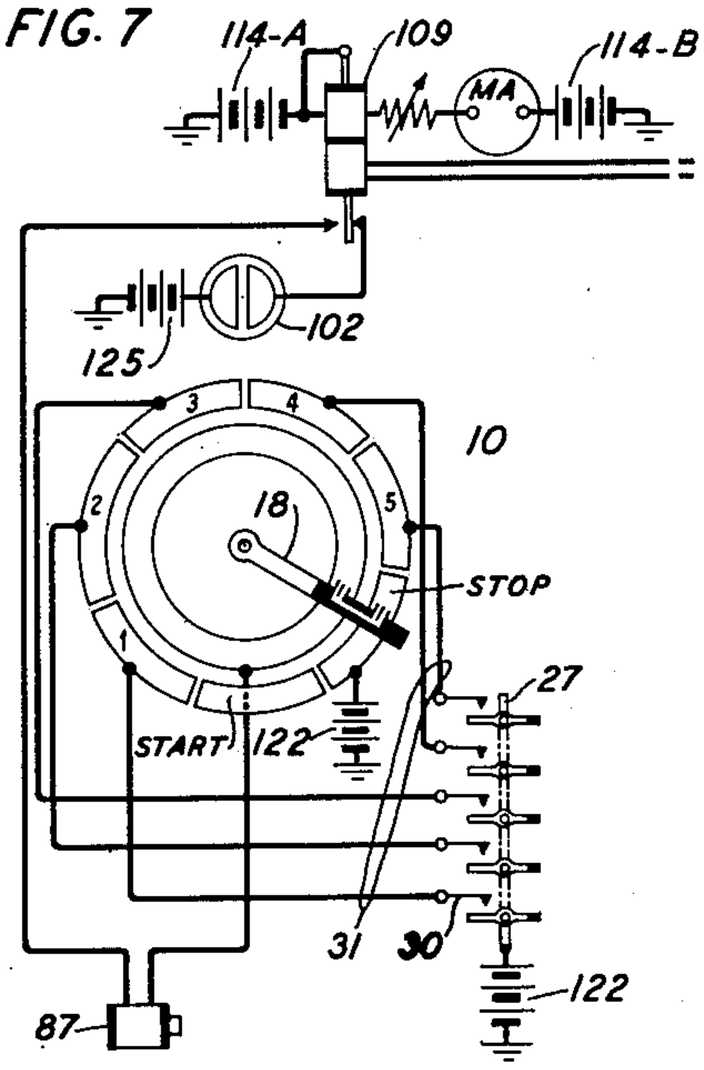
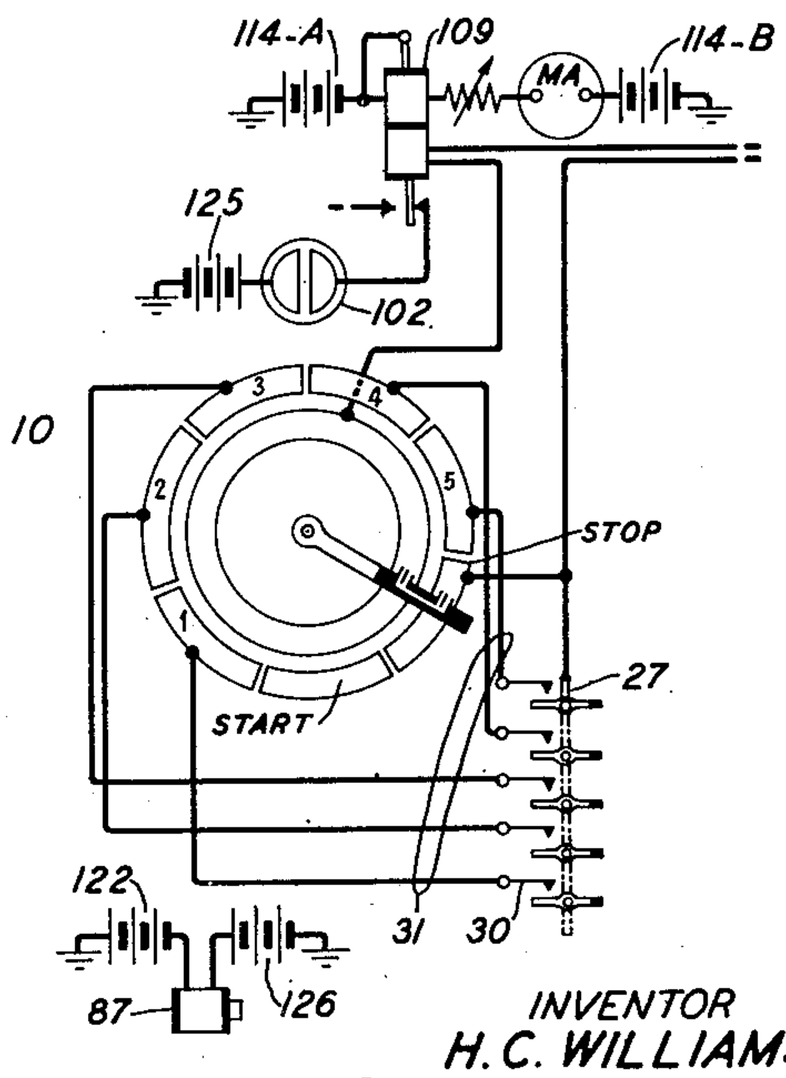


FIG. 8



INVENTOR
H. C. WILLIAMS
BY
William R. Ballard
ATTORNEY

Patented Oct. 25, 1938 2,134,068

UNITED STATES PATENT OFFICE

2,134,068

START-STOP PRINTING TELEGRAPH SYSTEM

Hollie Cyrus Williams, Cleveland, Ohio, assignor to American Telephone and Telegraph Company, a corporation of New York

Application February 23, 1938, Serial No. 192,124

16 Claims. (Cl. 178—69)

The invention relates to distortion indicating devices employed in printing telegraph systems.

The object of the invention is to produce a non-recording type of oscillograph for indicating distortion, which is simple, portable and relatively inexpensive.

A more specific object is to analyze telegraphic transmission to a somewhat finer degree than is ordinarily possible using only a monitoring teletypewriter.

Heretofore in distortion indicating and measuring devices adapted for use in teletypewriter systems flashes appeared at recurring intervals corresponding to the intervals of incoming signaling pulse transitions. If the incoming signal pulses were undistorted the flashes appeared at predetermined points on a rotating disc, but if distortion was present these flashes appeared to be rotating clockwise or counter-clockwise, depending upon whether the signaling pulses were longer or shorter than the standard unit length.

Another system heretofore employed is that in which a beam of light is permitted to fall upon a rotating mirror for the duration of the signal to be recorded. The mirror causes the reflected beam to travel across a surface, such as a photographic plate which may be continuously moved, so that the surface signals will appear on the developed plate as parallel lines forming a column. If imperfect signals are transmitted variations from the perfect unit, due to line or apparatus effects, will be indicated by lengthened or shortened lines in the column.

The present invention comprises arrangements which are more convenient, compact and effective to give similar or better results and more particularly to produce more finely graduated and easily read indications than these and other known types of prior art devices.

According to the present invention there is provided a non-recording oscillograph which shows the length and relative location of teletypewriter signal pulses. The invention resides in a portable set for measuring distortion of start-stop teletypewriter signals. The set comprises a rotatable disc fixedly mounted on a start-stop distributor shaft and positioned directly above the distributor face, an annular graduated scale adjustably arranged above and around the periphery of the disc, a small mirror mounted at a point near the periphery of the disc and set at an angle with the horizontal plane, and a neon lamp positioned in the center of a pair of concentric cylinders which are fixedly arranged directly above the rotatable disc to shield the mirror from outside light. The mirror reflects the light from the lamp up through the annular space between the concentric cylinders to an observer. The graduated scale is divided into segments corresponding to the start-stop and code selecting units of a teletypewriter signal and may be shifted by means of a projection so that the start segment will coincide with the start impulse of a transmitted or received teletypewriter signal. The light reflected by the mirror appears on the graduated scale as a thin arc of light and represents the duration of a transmitted or a received signal impulse and the duration of each arc may be compared with the length of its corresponding segment on the graduated scale to determine whether or not there is any distortion present in the signal impulse.

A feature of the invention is that no calibration is necessary other than a check of the distributor speed and an observation of the signals sent by the distributor itself.

Another feature is that it can be used on working circuits and will give the same result with keyboard or automatic sending.

Another feature is that it can be used to measure transmitted signals as well as received signals.

Another feature is that it will measure the distortion of individual impulses, combinations of impulses or average distortion depending upon the nature of the signals being transmitted.

Another feature is that the distortion is directly observable and the reading can be taken in degrees, in time, or in per cent of a normal signal with an accuracy about ± 2 per cent.

Another feature is that the speed of distributors in working circuits can be checked from the central office and comparisons of the speeds of the distributors at opposite ends of a circuit can be made without interfering with service.

Another feature is that it can be used to check the adjustment of relays and will indicate bias, chatter and armature travel time.

Another feature is that it will accurately check the correctness of teletypewriter sending contact adjustments.

Another feature is that it will measure the effect of line relay bias on teletypewriter orientation range and indirectly give an indication of the wave shape of the line current at the point where the measurement is taken.

A more complete understanding of the invention will be had by referring to the accompanying drawings in which:

Fig. 1 shows a schematic circuit arrangement

of the invention whereby the invention is used in conjunction with a high speed transmitter-distributor for indicating distortion in either transmitted or received start-stop signals;

Fig. 2 shows the annular graduated scale divided into segments corresponding to the start, the stop, and the code selecting units of a teletypewriter signal;

Fig. 3 shows the graduated scale of Fig. 2 with reflected arcs of light of the "letters" signal without distortion;

Fig. 4 shows the annular graduated scale of Fig. 2 with reflected arcs of light corresponding to signal "Y" without distortion;

Fig. 5 represents the annular graduated scale of Fig. 2 with the reflected arcs of light corresponding to signal "Y" without distortion, but showing chatter of the line relay armature;

Fig. 6 shows the annular graduated scale of Fig. 2 with the reflected arcs of light corresponding to signal "Y" with 30 per cent marking bias; and

Figs. 7 and 8 show two conditions, in simplified form, of the circuit arrangement of Fig. 1. Fig. 7 shows the circuit arrangement of Fig. 1 conditioned for receiving and Fig. 8 shows the same circuit arrangement conditioned for sending.

Referring to Fig. 1 there is shown a teletypewriter system arranged for automatic sending, wherein is employed a high speed transmitter-distributor. Such a system is disclosed in U. S. Patent 2,055,567 granted to E. F. Watson on September 29, 1936. A description of the transmitter-distributor arranged for automatic sending will now be given. Although it forms no part of the present invention it serves to show a system whereto the present invention may be satisfactorily adapted.

A transmitter-distributor 10 comprises an inner solid commutator ring 12 and an outer commutator ring 13, both of which are suitably attached to the upper surface of an insulating disc 14. The outer commutator ring is divided into seven insulated segments which include the five segments corresponding to the five units of a code, a "stop" segment, and a "start" segment. A distributor brush 18 wiping on the stop segment closes a line circuit 19 connecting therewith a teletypewriter station RS preferably through a central office CO. The RS station is provided with the usual sending contacts 20 and receiving printer magnet 21. It will be understood that while a central office CO may be used for interconnecting the local distributor and the remote station RS, the invention is not necessarily limited thereto and may be readily applied to a private wire, or direct wire system wherein a central office is not employed.

A tape transmitter assembly 22 preferably arranged for "make-break operation" is provided with five contact tongues 26 pivotally mounted on a shaft 27 which is connected by a lead 121 to one side of line 19 through an operated contact on switch 107. Each of the five tongues is adapted to be rotated so that one end thereof engages either a spacing contact 29 or a marking contact 30, the latter being connected by leads 31 with the segments of the outer ring 13 corresponding to the five units of a code. It will be observed from the drawings that when a tongue 26 engages its marking contact 30, the line is connected with the corresponding segment of the commutator ring 13. The spacing contacts 29 are always in the opened condition. The opposite end of the tongue 26 is provided with a tip 34 of suitable electrical insulating material which is adapted to engage a bifurcated end portion 35 of a horizontal prong 36 of a three-prong contact lever 37 that is formed with a second prong 38, substantially a horizontal extension of prong 36, and a third prong 39 extending transversely in a downward direction from approximately the junction point between prongs 36 and 38. The junction point provides a pivotal point for rotating the contact lever 37 on a shaft 40. The free end of each of prongs 38 is formed into the shape of a pin 44 for projecting vertically upward into the perforations of the tape. The distances between the tape pins 44 are arranged to be identical with the distances between perforations produced in the tape by the perforator. Mounted directly to the right of the lower portion of prong 39 is a contact lever bail pivotally mounted on shaft 45 and provided on the lower left end thereof with a projection 47 normally engaging an adjustable pin 48 extending through the right-hand end of an operating lever 49 mounted on a vertical pivot 78. The contact lever bail is normally urged in a clockwise direction by spring 53. When the contact lever bail is actuated by the operating lever to the left in a manner to be described hereinafter, the prongs 39 are moved in a clockwise direction thereby rotating lever 37 about the shaft 40 to withdraw the pins 44 beneath the surface of the tape and at the same time to cause the prongs 36 to be moved upwardly to actuate the tongues into engagement with their spacing contacts 29. It will be seen from the drawings that the prongs 36 are normally biased in a downward direction by spring 54 against actuation by the contact lever bail.

Also pivoted on shaft 40 to the extreme left of the contact lever 37 is a feed lever 55 formed with a transverse prong 56 extending vertically downward for engagement with the contact lever bail, and a horizontal prong 57 provided on its free end with a pivotal feed pawl 58. The feed lever 55 is normally drawn in a counter-clockwise direction by spring 59. The pawl is normally urged by spring 62 into engagement with a ratchet wheel 63 fixedly carried on one end of shaft 64 which is provided on its opposite end with a feed wheel 65 arranged with suitable teeth for projection into the spaced perforations provided longitudinally in the central portion of the tape to effect the advancement thereof.

The position of the feed pawl with respect to the ratchet is determined so that a downward movement of prong 57 under actuation of the contact lever bail does not permit the feed pawl to engage the ratchet to advance the tape until the five tape pins 44 have been drawn below the tape surface by a leftward movement of the contact lever bail as previously explained. In this manner it is made certain that the tape is not advanced before the withdrawal of the pins 44 therefrom to obviate a tearing of the tape.

In setting up combinations in the transmitter for transmission by the distributor, the contact lever bail is normally biased to the right by spring 53 out of engagement with prong 39. This allows spring 54 attached to prong 36 to cause a counter-clockwise rotation of the contact lever 37 to move the pin 44 upwardly into engagement with the under-surface of the tape. In this position the first one of pins 44 will be accommodated by appropriate code perforations in the tape, and accordingly, will be projected thereinto. Any additional movement of a particular contact lever 37 occasioned by the projection of its pin 44 into its

tape perforation will cause prong 36 of that lever to move downwardly a corresponding amount thereby rotating the contact tongue 26 from the spacing contact 29 into engagement with marking contact 30. Obviously, the absence of perforations in the tape will block the pins 44 to prevent any additional movement of levers 37, and hence, the contact tongue 26 associated with a blocked lever 37 will be retained on spacing contact 29. It will be readily understood, therefore, that when there is a perforation in the tape to accommodate the pin 44, the corresponding contact tongue will move into engagement with its marking contact 30 thereby connecting one side of the line to the segment of commutator 13 with which that contact is associated to transmit a marking impulse over the line. When a pin 44 is blocked, due to the absence of a tape perforation, the contact tongue corresponding thereto remains on its spacing contact 29, and the segment of the commutator 13 associated with the latter will cause a spacing, or no-current, impulse to be transmitted over the line.

Brush 18 comprising metallic portions for wiping over the commutator rings 12 and 13, respectively, is mounted on one end of a main drive shaft 68 having a gear wheel 69 fixed thereon in mesh with a worm 70 carried on shaft 71 which is connected through a friction clutch 72 to motor 73 employed to drive the main shaft 68. On the lowermost portion of shaft 68 is fastened a tape feed operating cam 74 provided with a raised cam portion 75 which engages the left end of operating lever 49 pivoted at 78 to actuate the contact lever bail. The raised cam portion is predeterminedly fixed on the main drive shaft with respect to the brush in a manner so that when the brush commences to wipe over the stop segment of the outer commutator ring 13 after each revolution, lever 49, which heretofore was riding on the lower portion of cam 74, begins now to engage the raised cam portion 75 with the result that the contact lever bail is started in its movement to the left on pivot 45. The continuation of the latter movement pushes prong 39 in a clockwise direction thereby causing prong 36 to disengage from the marking contact 30 any tongues that may have been in engagement therewith and to move them into touch with the spacing contacts 29. As previously seen, contact lever bail also actuates the feed lever 55 and, in addition, effects the withdrawal of pins 44 from the tape perforations before the tape is advanced. With this kept in mind, it will be understood as the raised cam portion 75 commences to engage the lever 49, prong 57 of lever 55 begins to move downward to cause the pawl mounted thereon to start the rotation of the ratchet. When the lever 49 reaches the highest point of the cam portion 75, the ratchet is moved an angular distance to an amount equivalent to the distance between adjacent teeth of the ratchet. Accordingly, the tape is advanced to set up the code unit combination for the next character to be transmitted.

In the normal operation of the transmitter distributor, it occurs frequently that there is a difference between the rate at which the character units are transmitted and that at which the tape is fed from the perforator. Since the tape is fed directly from the perforator to the transmitter, it will be evident that, if for any reason the perforator operation is interrupted, the transmitter will use up all of the slack in the tape and thereafter proceed to damage the feed holes used with the feed wheel 55 for advancing the tape, unless a provision is made to stop the transmitter distributor automatically. For the purpose, therefore, of taking care of the difference between the rates of operation of the transmitter distributor and the perforator, there is fixedly mounted on the main drive shaft intermediate the gear wheel 69 and the tape speed operating cam 74 a stop cam 79 formed with a peripheral shoulder 80. Associated with the stop cam is a stop arm 81 pivoted at 82 and normally having one end held in engagement with the periphery of the stop cam by spring 83. The opposite end of the stop arm is operatively associated with magnet 87 which is employed to rotate the stop arm about its pivot to move the former out of engagement with the stop cam periphery. Battery is connected through the winding of the magnet as will be hereinafter described to an electrical contact 89, which is opened and closed under control of an automatic stop lever 90 projecting between transmitter and perforator so that the tape passes thereunder and supported in vertical slots in upright members 91, 91. The contact 89 is also connected through a manually operated switch 92.

After motor 73 has been started by closing the switch in its power supply circuit, the manual switch 92 is closed to complete an energization circuit for the magnet 87. The magnet operates to disengage the stop arm from the stop cam to permit the rotation of the main drive shaft. So long as the perforator continues to operate, the tape being fed therefrom will have sufficient slack to allow the stop lever 90 to rest on the upper member of contact 89, thereby retaining the latter in the closed condition. In the event that the perforator operation is interrupted, the tape will be pulled taut to raise the stop lever 90 out of engagement with contact 89, thereby enabling the upper spring member of the contact to disengage from the lower member to interrupt the circuit through the magnet. The stop arm 81 actuated by spring 83 then moves into contact with the stop cam periphery and eventually engages the shoulder 80 to stop the distributor brush by holding the main drive shaft from rotation. In this event, it will be evident that the transmitter is also stopped since it is also driven from the main shaft. It will be understood that the distributor brush will only be stopped on the "stop" segment of the commutator 13 due to the fact that the shoulder 80 of stop cam 78 is predeterminedly positioned with respect to the distributor brush to effect this result.

Referring now to the present invention itself, a disc 100 of dull black color is fixedly mounted on the transmitter-distributor shaft 68, as shown, so that it rotates with the brush arm 18. Disc 100 carries a small mirror 101 set at an angle so as to reflect a beam of light from neon lamp 102 up through the annular space between a pair of concentric cylinders 103 and 104. The inner cylinder 103 supports at its upper end the neon lamp and both cylinders being of an opaque material shield the mirror from any outside light. Supported by the outer cylinder is an annular scale 105 divided into graduated segments which respectively represent the start, the stop and the five code unit selecting pulses of a start-stop teletypewriter signal. The scale may be shifted by means of a projection 106 so that the start segment of the scale may be rotated into coincidence with the start impulse of the transmitted or received teletypewriter signal as indicated by a particular segment in the arcs of light

traced on the scale by the mirror as it rotates around the distributor axis.

The invention will be described first as being connected in the receiving circuit, and secondly, as being connected in the transmitting circuit. The transmission circuit is shown in the upper right-hand corner of Fig. 1 and by means of keys 107 and 108 the circuit may be conditioned for receiving or transmitting as desired. When keys 107 and 108 are in normal position the circuit is conditioned for receiving as shown in the simplified schematic form in Fig. 7 and when key 107 is operated and key 108 is normal, the circuit is conditioned for sending as shown in the simplified schematic form in Fig. 8.

Assume that the invention is conditioned for receiving, that is, keys 107 and 108 are in the positions shown and that the conductors of circuit 19 shown in Fig. 1 are connected in a loop extending over contact *b*, closed, of key 107, through the lower winding of high speed polar receiving relay 109, through the winding of printer magnet 110 and the transmitting contacts 111 and stop key 112 of teletypewriter 113, back to the central office CO. The line current is furnished from an outside source, preferably at office CO. A local current is furnished from sources 114—A and 114—B to bias relay 109 through the upper winding of the relay, the desired adjustment of the biasing current being obtained through the use of variable resistance 115. In using the set, that is, the invention, as a measuring instrument for received signals, the code selecting contacts of the distributor are held open by the insertion of an unpunched tape at transmitter 22. Under this condition the distributor brush arm 18 and mirror 101 will remain stationary and the neon lamp 102 will flow until an open, or spacing impulse is received from the line, or transmission circuit 19.

When an open, or spacing, signal impulse is received line relay 109 is operated to its left-hand position by the biasing current flowing through its upper winding, the line circuit which extends through the lower winding being opened by the start segment at the distant office CO or distant station RS. Relay 109 in operating to its left-hand position closes a circuit extending from grounded negative battery 114—A, armature and left contact of relay 109, conductor 116, closed contact *g* of switch 107, conductor 117, through the winding of start magnet 87, conductor 118, closed contact 89, switch 92 in a closed position, conductor 93, closed contact *e* of switch 107, conductor 119, feed ring 12, brush arm 18 on stop segment, conductors 120 and 121, closed contact *d* of switch 107, to grounded positive battery 122. Magnet 87 operates and releases armature 81 from engagement with cam 79. The first impulse of the incoming start-stop signal is always spacing and, therefore, the start magnet 87 momentarily operates to permit the distributor 10 and mirror 101 to rotate through one revolution only. As soon as the outside brush on brush arm 18 leaves the end of the stop segment, distributor magnet 87 will be released if it had not been previously released due to the opening of the operating circuit at the left-hand contact of relay 109 by a marking signal impulse. By this means synchronism is obtained between the received signal impulse and the position of mirror 101. At a given instant after the beginning of the start impulse the mirror, therefore, will have the same position relative to the [illegible] for any signal code combination being received. The five selecting impulses of a received signal code combination may be marking or spacing depending on the signal received. Each of the five segments Nos. 1 to 5 of the distributor 10 will be engaged by the outside brush of brush arm 18 during its corresponding interval of the five in which the five selecting impulses are received.

When a closed, or marking, signal impulse is received, line relay 109 operates to its right-hand position by the line current flowing through the lower winding, the line circuit now being closed. The closing of the right-hand contact of relay 109 closes the normally operated circuit extending from grounded negative battery 114—A, armature and right-hand contact of the relay, conductor 123, lower closed contact of key 108, conductor 124, through neon lamp 102 to grounded positive battery 125 and the lamp again glows during the signal impulse interval or intervals that the armature of relay 109 is in engagement with its right-hand contact. During the rotation of brush arm 18 neon lamp 102 will glow or be extinguished while the armature of line relay 109 is in engagement with one of its contacts according to the marking or spacing condition of a current in the line circuit at the time. With key 108 in its normal position lamp 102 will glow during the marking interval and be extinguished during the spacing interval. The operation of key 108 merely reverses the effects of marking and spacing signal impulses. The effect of the rotating mirror 101 and the light flashes produced by the received signal impulses is to reflect on the graduated scale, or screen, 105 arcs of light corresponding in length to the duration of the teletypewriter signal impulses. With key 108 in normal position, the received teletypewriter signals will have the following effects: The stop impulse will produce an arc of light, the start impulse will produce no arc of light, and the five selecting impulses of the code signal will or will not produce an arc of light according to whether the impulses of the received combination are marking or spacing.

Assume that the invention is conditioned for sending, that, key 107 is in its operated position and key 108 is in its normal position, distributor 10 and the line, or lower, winding of relay 109 are in series and tape sending is employed. The quality of transmitted signals can be observed the same as for receiving. This arrangement enables the use of the invention as a means of detecting unsatisfactory impedance conditions at the sending end of the line or loop. With hand sending as by keyboard direct to the distributor, however, unless sending is at the maximum speed, the lag of mirror 101 in starting causes an apparent shortening of the start impulse. This effect is not detrimental to the measurement of the other teletypewriter signal impulses and the effect can be overcome without changing the basic principle. This condition resulting from direct keyboard sending and its means of compensation are well known in the art.

The line circuit when key 107 is in its operated condition for sending from the local office may be traced over the upper conductor of line circuit 19, contact *c*, closed, of switch 107, conductors 121 and 120, stop segment and feed ring 12 of distributor 10, conductor 119, contact *a*, closed, of switch 107, to the line, or lower, winding of relay 109, and through the winding of printer magnet 110, transmitting contact 111 and stop key 112 of the local operated teletypewriter 113,

to the lower conductor of circuit 19. During the sending time start magnet 87 for distributor 10 is continually energized by a circuit traceable from grounded negative battery 126, contact *h*, closed, of switch 107, conductor 117, through the winding of magnet 87, conductor 118, contact 89 and switch 92 in closed positions, conductor 93, contact *f*, closed, of switch 107, to grounded positive battery 122. Consequently, distributor 10 and mirror 101 are continuously rotating during the sending interval. The punched perforation in each transverse row in the tape closes a corresponding marking contact 30 to form a combination of five marking and spacing impulses which, in turn, correspond to the letter or character that is to be transmitted. The five closed or open contacts 30 and 29 accordingly transmit "current" or "no-current" impulses from the source of signals at the distant office, over the upper conductor of line circuit 19, contact *c*, closed, of switch 107, conductor 121, pivotal shaft 27, to closed contacts 30 or open contact 29. At the closed contacts 30, the circuit is extended over paths extending over conductors 31, respectively connected to the closed contacts 30 and then over their corresponding selecting segments Nos. 1 to 5 of outside ring 13 of distributor 10, through the brushes of brush arm 18 to feed ring 12, conductor 119, contact *a*, closed, of switch 107, through the line, or lower winding of relay 109 to lower conductor of line circuit 19 as hereinbefore traced. The start and stop impulses of each transmitted signal combination are automatically inserted by the start and the stop segments, respectively, of distributor 10, the start impulse being an open interval and the stop being a closed interval, the closed stop impulse being transmitted over substantially the same circuit as that of the selecting impulses except that conductors 31 are shunted by conductor 120. With key 107 in its operated position the transmitted teletypewriter signals will have the same effects with respect to arcs of light caused by the operation of relay 109 as described above for the received teletypewriter signals.

Fig. 2 is a typical graduated scale which in Fig. 1 is designated 105. This scale is suitably adapted for use as shown, but it may also be used as an annular ring located around the periphery of disc 100. The scale in either position provides a satisfactory medium for indicating trouble in transmission.

Fig. 3 is a scale of Fig. 2 showing arcs of light for each of the five selecting impulse intervals and the stop interval, the start interval, as in all cases, being clear; that is, no arc of light is produced during the start interval. This combination of intervals represents the "letters" character.

Fig. 4 is also the scale of Fig. 2 showing arcs of light for the first, third and fifth selecting intervals and also for the stop interval, there being no arc of light produced during the second and fourth selecting intervals, or during the start interval. This combination represents "Y" signals. It will be noted that the beginning and ending of each arc of light coincides with the limit of the segment indicating that the signal transmitted or received is undistorted.

Fig. 5 is substantially the same as Fig. 4 except that it indicates chattering of the armature of receiving relay 109 and this undesirable condition may be overcome by inserting as shunt paths across the relay armature and contacts spark killers, as is well known in the art. It may indicate an unsatisfactory adjustment of relay 109 with respect to bias current or the positioning of adjustable contacts relative to the armature of the relay.

Fig. 6 is also the scale of Fig. 2 showing the arcs of light representing the "Y" signal, but it will be noted that these arcs of light extend beyond the limits of the corresponding segments by about 30 per cent indicating that there is present in the transmitted or the received signal approximately 30 per cent distortion.

Figs. 7 and 8 show the circuit arrangement of Fig. 1 in simplified form. The parts shown in Figs. 7 and 8 are designated by the same reference characters as designate corresponding parts in Fig. 1. Figs. 7 and 8, respectively, represent a skeletonized arrangement to show the circuit arrangement of Fig. 1 when it is, first, in a condition for receiving, and secondly, in a condition for sending. Only the fundamental circuits are shown.

The arrangement disclosed can be used to obtain an accurate check on the adjustment of teletypewriter sending contacts and will give a good indication of the transmission conditions of a working telegraph circuit. Variations of speed between the sending and the receiving distributor are indicated by a gradual shift of the arcs of light corresponding to the successive elements of the code in a clockwise or counter-clockwise direction, depending on which distributor is the fastest. After a shift corresponding to about one-half unit, or segment, on the scale, the position will be corrected automatically. To obtain specific information as to the effect of different types of distortion which may be present simultaneously, it is preferable to send a succession of signals, such as "R's", "Y's" or some other letter suitably adapted for use in testing. By changing the bias of receiving, or line, relay 109 while receiving neutral signals over a circuit and noting the effect on the length and position of the arcs of light, it is possible to learn something of the wave shape and hence of the measures necessary to correct distortion introduced by the line circuit.

What is claimed is:

1. A testing device for observing as an arc of illumination the time occupied by the armature of a relay in a given position comprising an electromagnetic relay having an armature, a source for producing a beam of radiation, means for energizing said source only when said armature is in said given position, a mirror set in a plane oblique to said beam of radiation, means for rotating said mirror at a predetermined speed of rotation about an axis extending through the center of said source, and a graduated scale for indicating the duration of said arcs of illumination.

2. A distortion measuring set comprising a relay, a source of electric impulses adapted to operate said relay, a source of light, an armature for said relay for causing said source of light to be intermittently energized, a mirror arranged in response to said electric impulses flowing from said source to rotate about an axis extending through the center of said source of light and to reflect the light at an angle, driving means for rotating said mirror to cause the reflected light to describe an arc, and a graduated scale in the path of said arc.

3. A distortion measuring set according to claim 2 wherein said source of electric impulses comprises other means for transmitting at least cer-

tain of electric impulses at a definite frequency and for operating said driving means at a predetermined angular velocity with respect to said frequency.

4. A distortion indicating device for a printing telegraph system of the start-stop type comprising a source of start-stop signals, a transmission circuit for transmitting signal pulses from said source, means responsive to the pulses from said source, a source of light, and a start-stop rotatable means controlled by said responsive means, a mirror arranged to rotate in synchronism with said start-stop rotatable means, a stationary screen subdivided into graduated segments corresponding in number to a group of pulses received from said source of start-stop signal pulses, and means whereby said mirror, in rotating, reflects on said screen an arc of light from said light source in synchronism with the pulses from said source of start-stop signals, each of said arcs produced on said screen being of such a length as to be equivalent to the duration of its corresponding pulse from said start-stop signaling source.

5. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 4, wherein the source of start-stop signals comprises means for transmitting neutral signals.

6. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 4, wherein said last-mentioned means comprises a disc arranged to rotate in synchronism with said start-stop rotatable means, two concentric cylindrical devices fixedly mounted above said disc and so arranged with respect to each other that the inner cylindrical device and the outer cylindrical device provide an annular space therebetween whereby said mirror fixedly mounted on said disc reflects the light from said light source as arcs having a duration corresponding to the length of the corresponding segments on said graduated screen.

7. A distortion indicating device for a printing telegraph system of the start-stop type comprising a transmission circuit, sources of start-stop signaling pulses of different types respectively connected to opposite ends of said circuit, means in said circuit responsive to the signal pulses of either of said sources, a source of light responsive to said means, a rotatable device arranged to operate in synchronism with said sources of start-stop signaling pulses, a reflecting surface fixed at a point near the periphery of said rotatable device, manually operated means included in said responsive means for causing said light source to light when the signals are of one type and to be extinguished when the signal pulses are of the other type, a stationary screen divided into graduated segments corresponding in length to the duration of the respective standard units of a group of start-stop signaling pulses received from said sources, for receiving arcs of light reflected from said surface when the signaling pulses are of said one type only.

8. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 7, wherein said manually operated means comprise a multicontact switch arranged when operated in one position to adapt said device for indicating distortion in incoming signal pulses received over said transmission circuit and when operated in another position to adapt said device for indicating distortion in outgoing signal impulses transmitted over said transmission circuit.

9. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 7, wherein said manually operated means comprise another multicontact switch arranged when operated in one position to cause said light source to light when the signal impulses are of one type and to be extinguished when the signal impulses are of another type, and when operated in the other position to reverse the operation of the light source in response to the signal pulses of different types.

10. A distortion indicating device for a printing telegraph system of the start-stop type comprising a transmission circuit, a source of start-stop signal pulses connected to said circuit, means in said circuit responsive to the signals from said source, a source of light arranged to light when said means is in one condition and to be extinguished when said means is in another condition, a rotatable means controlled by said responsive means, a mirror on said start-stop rotatable device for reflecting light from said source, an orientable screen for receiving said reflected light in a series of arcs of light respectively corresponding in length to the duration of the condition of the transmitting circuit in said one condition.

11. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 10, wherein said screen comprises segments corresponding in number to the pulses of each group of start-stop signals received from said signal source, and means for orienting said segments so that the reflected arcs of light on said screen coincide with the duration of undistorted current pulses of the start-stop signals received from said signal source.

12. A distortion measuring set comprising a source of incoming start-stop signals, relay means responsive to the signals from said source, a source of light responsive to said relay means only, a start-stop member rotatable in synchronism with the signals from said source, an orientable scale encircling the periphery of said start-stop member and graduated into segments corresponding to the time intervals of the current impulses of a signal incoming from said source, and an element arranged near the periphery of said start-stop member for reflecting light from said source to the observer whereby the duration of light reflected by said element may be compared with the duration of its corresponding segment to determine any difference from the standard duration of the current impulses of an incoming signal combination.

13. A distortion measuring set comprising a source of incoming start-stop signals constituted of a combination of spacing and marking current impulses, relay means responsive to the signals from said source, an inertialess source of light responsive to said relay means only, switching means for causing said inertialess source to operate at each change-over from a spacing to marking, or marking to spacing current impulses of the signals incoming from said source, a start-stop member rotatable in synchronism with the signals from said source, an orientable scale encircling the periphery of said start-stop member and graduated into segments corresponding in length to the time intervals of the current impulses of a signal incoming from said source, an element arranged near the periphery of said start-stop member for reflecting the operation of

said inertialess source to the observer whereby the duration of the operation of said inertialess source reflected by said element may be compared with the length of the corresponding segment to determine any difference from the standard duration of the current impulses of an incoming signal combination.

14. A distortion indicating device for a printing telegraph system of the start-stop type comprising a distant station, a source of start-stop signals at said station, a receiving circuit for receiving signal pulses from said source, means responsive to the pulses from said source, a source of light, and a start-stop rotatable means controlled by said responsive means, a mirror arranged to rotate in synchronism with said start-stop rotatable means, a stationary screen subdivided into graduated segments corresponding in number to a group of pulses received from said source of start-stop signal pulses, and means whereby said mirror, in rotating, reflects on said screen an arc of light from said light source in synchronism with the pulses from said source of start-stop signals, each of said arcs produced on said screen being of such a length as to be equivalent to the duration of its corresponding pulse from said start-stop signaling source.

15. A distortion indicating device for a printing telegraph system of the start-stop type according to claim 14, wherein said device comprises means for indicating distortion in polar signals received from said source.

16. In a distortion indicating device for a printing telegraph system of the start-stop type according to claim 14, wherein said device comprises means for indicating distortion in neutral signals received from said source.

HOLLIE C. WILLIAMS.