TOLL SYSTEMS
SIGNALING
SIGNALING TEST SET NO. 2B
FOR TESTING SIGNALING CIRCUITS
HAVING SENDING M LEAD
AND RECEIVING E LEAD

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Option "E" provided for when the (B) jack is mounted in a 252A jack mounting otherwise provide Option "F".

1. PURPOSE OF CIRCUIT

1.1 This circuit provides a source of controlled pulses or supervisory signals suitable for application toward "Line" or "Drop" on "E" or "M" signaling leads; and a means of measuring percent break of continuous received pulses or observing received supervisory signals.

2. WORKING LIMITS

2.1 This circuit is designed to function with signaling circuits which (1) require a ground on an "M" lead from the drop equipment as an On-Hook signal, and -48 volt regulated signaling battery thru a 13-A lamp as an Off-Hook signal; and (2) supply toward the drop equipment on an "E" lead, a ground as an Off-Hook signal and -48 volt regulated signaling battery thru a 13-A lamp or an open circuit as an On-Hook signal.

3. FUNCTIONS

3.1 Provision is made for typical cord lamp supervision in this test set on "E" and "M" signaling leads with or without continuity between line and drop equipment.

3.2 On-Hook, Off-Hook or controlled dc pulses may be applied on an "M" lead to a line signaling circuit or on an "E" lead to the associated drop equipment without signaling lead continuity thru the test set between line and drop equipment.

3.3 The percent break of continuous pulses received on an "E" lead from a line signaling circuit, or an "M" lead from the associated drop equipment, may be measured by means of a percent break meter without signaling lead continuity thru the test set between line and drop equipment.

3.4 Adjustment of pulse speed and percent break is provided for continuous pulsing, and of percent break only on dial controlled trains or pulses.

3.5 Flashing supervisory signals may be produced under control of a connection to the office interrupter ground.

3.6 Single or repeated On-Hook and Off-Hook signals of variable length maby be produced and compared with certain timed functions of a connected V.F. signaling circuit.

3.7 A scale switch is provided for converting the pulse speed indicator to a 0-20 or 0-200 volt voltmeter or 0-20 ma. milliammeter for voltage measurements.

4. CONNECTING CIRCUITS

When this circuit is listed on a keysheet, connecting information thereon is to be followed.

4.1 1600 or 2000 Cycle Signaling Circuit - SD-55954-01.

4.2 Miscellaneous Test Jack Circuit - SD-56137-01.

4.3 Circuit Patching Bay Jack Circuit - SD-68327-01.

4.4 Patching Jack Circuits - SD-64724-01, SD-62741-01, SD-55337-01.

DESCRIPTION OF OPERATION

5. GENERAL

This pulsing source is essentially an electronic interrupter consisting of two multivibrators (V1) and (V2) and a mercury contact relay (P). One multivibrator (V1) controls the repetition rate, or as hereinafter referred to, the pulsing speed. It may be arranged for continuous pulsing or as a single cycle multivibrator controlled by a dial which is provided for the purpose. In either case it triggers a second multivibrator (V2) which determines the relative operated and released time of the relay (P).

Both pulsing speed and percent break of the outgoing pulses are independently adjustable on continuous pulsing. When under dial control, only percent break is adjustable.

Two meters are provided; one for setting outgoing pulse speed, the other for measuring sent or received percent break of continuously pulsing signals.

6. EXTERNAL CONNECTIONS

6.1 Power Leads

Connection to the office 22-26 volt filament battery and 45-50 and 125-135 volt signaling batteries (V option) or to the office 45-50 and 125-135 volts signaling batteries thru battery supply filters (W option) is obtained by patching two low resistance cords to the power supply jacks for No. 2 type signaling test sets. Where a 45-50 volt filtered battery supply is used, the 24 volt filament supply to the test set is obtained from this source.

The (P) relay mercury contacts may momentarily bridge battery and ground thru the (LP1) lamp. This lamp by itself gives adequate steady state excess current protection. The (R33) resistor and (L1) inductor are provided to decrease the rate of build up of this current sufficiently to prevent appreciably adding to office battery noise.

6.2 Signaling Leads

Two sets of jacks designated (TST 1) and (TST 2) are provided for obtaining access to the "E" and "M" leads of signaling systems using this type of supervision. Either pair of jacks may be used as required by the corresponding jack arrangement at a particular test location. Thus, at V.F. signaling equipment bays, the (E) and (M) jacks of group (TST 1) would be patched to corresponding (E) and (M) jacks in the signaling bay jack field. The line signaling equipment may then be controlled by the test set thru the tip springs of these jacks and the drop equipment thru the sleeves of these jacks. This test set may also be used at patch jack boards or at other test locations where the "E" and "M" leads appear on the tip and ring springs respectively of Line and Drop jacks designated LINE and DROP or DSL and DSD respectively. In such cases the line signaling equipment "E" and "M", leads may be controlled by the test set thru tip and ring springs respectively of the (L) jack and the drop equipment "E" and "M" leads thru the tip and ring springs respectively of the (D) jack.

In all "E" and "M" lead signaling circuits the drop equipment furnishes on the "M" lead to the line signaling equipment or to this test set a ground as an On-Hook signal or -48 volt battery thru a 13A lamp as an Off-Hook signal. Ordinarily the line signaling equipment or this test set furnishes on the "E" lead to the drop equipment an open circuit as an On-Hook signal or a ground as an Off-Hook signal. In some instances it is expected that the On-Hook signal to the drop equipment may require -48 volt battery thru a 13A lamp. The (BG OG) key when in the (OG) position, provides for the open circuit-ground requirement and when operated to (BG) provides for the battery-ground requirements.

7. SUPERVISORY SIGNALS

7.1 Monitoring

Typical cord lamp supervision is provided by the (L) and (D) lamps on the "E" and "M" leads respectively, and when all keys are normal continuity of these leads is also provided thru the test set between line and drop equipment. Either lamp lighted indicates an On-Hook condition and when subsequently extinguished indicates that the connected equipment is transmitting an Off-Hook signal. Prior to connection between the test set and equipment "E" and "M" leads both lamps are lighted on internal circuits as an indication of lamp circuit continuity. Either lamp will also follow alternations between Off-Hook and On-Hook signals produced by flashing supervisory signals or dial pulsing.

7.2 Continuous Supervisory Signals

Control of "E" and "M" lead signals is provided in the test set by means of the (TWD L) and (TWD D) keys. On-Hook or Off-Hook signals may be applied independently toward line or drop on the tip of the (M) jack or sleeve of the (E) jack respectively. When either of these keys is operated off normal the associated signaling lead continuity between line and drop equipment is removed. This is done in such a manner that, lamp supervision on the "M" lead from the drop equipment is retained in the (D) lamp, and lamp supervision on the "E" lead from the line equipment is retained in the (L) lamp.

Operation of the (TWD D) key to On-Hook substitutes, for the line signal being received at the test set, an open circuit or -48 volt battery thru the (LP2) lamp and (BG OG) key to the sleeve of the (E) jack. Operation to Off-Hook substitutes a ground on the sleeve of the (E) jack thru normally made contacts of the (PLS) pulsing key.

Operation of the (TWD L) key to On-Hook substitutes, for the drop signal being received at the test set, a ground on the tip of the (M) jack. Operation to Off-Hook substitutes -48 volt battery thru the (LP2) lamp and thru normally made contacts of the (PLS) pulsing key to the tip of the (M) jack.

In the On-Hook position both the (TWD D) and (TWD L) keys supersede the (PLS) key control over the signaling leads. In the Off-Hook or normal positions the (PLS) key supersedes these keys in the control of the signaling leads. This combination of keys and division of superseding control, facilitates the transmission from Off-Hook to dialing or pulsing in either direction and at the same time maintaining either On-Hook or Off-Hook in the opposite direction.

7.3 Interrupted Supervisory Signals

Typical reorder, all trunks busy or subscriber busy signals ordinarily are Off-Hook signals interrupted at 60 IPM or 120 IPM. These may be produced in the test set and applied to either line or drop equipment under control of the (PLS) key. The operation of the (PLS) key to LINE connects the armature of the (P) relay to the tip of the (M) jack and when operated to DROP connects the sleeve of the (E) jack to the armature of the (P) relay. It also connects the proper potentials to the contacts of the (P) relay so that in the operated position of this relay an Off-Hook signal is applied in the direction indicated by the position of the (PLS) key. When the (P) jack of the test set is patched to the 60 or 120 IPM supply jack in the V.F. signaling bays, the (P) relay will operate and release on interrupted ground supplied to this jack from the office interrupter.

Typical dial pulse signals consist of an Off-Hook signal with momentary return to On-Hook. These may be produced in the test set and applied to either line or drop equipment under control of the (PLS) key with the (P) jack vacant. Under this condition the (P) relay is controlled by an electronic interrupter thru a normally closed contact on the (P) jack. With the (CONT PLS) key normal the pulsing signal is continuously interrupted at a rate and for intervals dependent on the setting of the (ADJ PPS) and (ADJ % BK) controls.

Two indicating instruments are provided as a means of setting rate of pulsing and duration of the On-Hook interval in terms of percent break. A multiscale microammeter is so arranged that it will read pulsing rate in pulses per second (pps) on the 0-20 scale with the (SCALE SEL) switch in the PPS position irrespective of the position of the (PLS) key. Percent break is read on a milliammeter provided with a black 0-100 scale and an inverse red 100-0 scale. This instrument is under control of the (MEAS % BK) key, which when normal completes the connection to the contacts of the (P) relay thru the (PLS) key when the latter is in a nonoperated position. The deflection then indicates the percent break (i.e. percent On-Hook) which will be applied toward the indicated equipment when the (PLS) key is operated. These instruments and the associated electronic interrupter are described in greater detail below.

Trains of dial pulse signals with a controlled percent break may be originated within the test set under the control of an accurately adjusted 9.9 to 10.1 pps dial. With conditions set up as for continuously pulsing signals operation of the (CONT PLS) key to (DIAL PLS) holds the electronic interrupter in the Off-Hook condition under control of the dial. Operation of the dial will thereafter produce a number of momentary Off-Hook signals corresponding to the digit dialed. The duration of the applied dial pulses is adjustable in terms of percent break by adjusting the (ADJ % BK) control to obtain the desired value on the (PERCENT BREAK) meter with the electronic interrupter running continuously during this adjustment at a speed of 10 pps.

A single timed pulse of On-Hook signal or a train of timed pulses of any number up to 10 may be produced in a manner similar to that employed for setting up dial pulse signals. These times may range from approximately 5 to 300 milliseconds. The same range of duration of On-Hook signal is of course also available on a continuously interrupted basis. These duration limits are based upon the range of speed and percent break available; which are respectively 2.5 to 17 pps and 10 to 75 percent break. The duration of the pulse may be related to speed and percent break as shown below.

$$\text{Duration in mil sec.} = \frac{1000}{\text{pps rdg}} \times \frac{\%\text{BRK rdg}}{100}$$

A desired duration of pulse may be set up at any convenient speed and then repeated at a slower rate merely by reducing the rate of pulsing. On the other hand repetition rate for a given duration can be increased only to the point at which the given duration represents a 75 percent break. Beyond this value there may be insufficient time for the electronic interrupter to recycle. Failure to recycle will result in unstable pulse length and pulse skipping and may occur only when percent break exceeds 80.

In addition to the (ADJ % BK) potentiometer an (ADJ % BK) switch is provided as a means of extending the range of adjustment. Ordinarily at 10 pps the (S) or (M) positions are used for the relatively short or medium pulse durations used. The (L) position is useful in obtaining longer pulse durations.

8. ELECTRONIC INTERRUPTER

The interrupter comprises two miltivibrators; one for control of repetition rate, the other for control of pulse duration.

8.1 Repetition Rate Multivibrator

In this multivibrator elements 6 and 8 are normally conducting. When extinguished by a drop in voltage impressed on grids (7) by the (C7) condenser it will remain so for a fixed time interval determined by (R11) and (C7). This time is of the order of .015 seconds and is dependent to some extent on the particular tube in use. During the extinction time of 8 and 6, elements 4 and 2 are conducting. When (C7) has discharged sufficiently element 7 will reach a potential which causes elements 6 and 8 to fire again, and in so doing extinguish elements 4 and 2 thru the coupling provided by the (C6) condenser. Elements 4 and 2 now remain extinguished until grid (3) returns to firing potential for grid (3). This half of the multivibrator has a variable extinguished time by virtue of an adjustable grid (3) bias potential. Thus the recycling time of the multivibrator may be varied by a ratio of approximately 6:1 under control of the PPS ADJ potentiometer. The minimum pulsing speed will be approximately 3 pps and the maximum about 20 pps.

The (V3) vacuum tube and the series resistor (R26) serves to minimize voltage variations and surges which might interfere with uniform pulsing speed.

Measurement of pulsing speed is obtained by a specially dampled multiscale microammeter and a scale switch SCAL SEL. With this switch in the PPS position the microammeter damping is increased by the capacitive and resistive shunts C3-C5 and R7. The average deflection of the meter is now dependent upon the rate of .015 second square wave pulses it receives from the plate current of element 4 (V1). Since this average is also dependent upon the energy in each individual pulse as determined by the current amplitude and pulse width it will vary slightly for different (407-A) vacuum tubes or for a particular tube as it ages. For this reason a calibration control CAL PPS is provided so that for any known rate of pulsing speed the meter deflection can be initially, and as the need arises, set to read exactly at that speed. Other points on the scale will then be accurate to within ± 1% between 9 and 11 and within ± 2% beyond these speeds.

The actual pulsing rate may be checked conveniently by comparison to commercial 60 cycle power frequency or any other low frequency standard with the aid of a Dumont 208-B oscilloscope orits equivalent. This is provided for by the (SYNC) jack and its associated open ended cord. The sleeve of this jack provides a ground for the oscilloscope. The tip and ring leads when connected to the vertical amplifier input and 3 volt 60 cycle test frequency of the oscilloscope provide a suitable ratio of multivibrator synchonizing pulse and commercial power frequency for frequency comparison. If the oscilloscope horizontal sweep rate is synchronized to 1/6 of the 60 cycle power frequency a single stationary synchronizing pulse superimposed upon the single line 6 cycle trace indicates that the test set pulsing rate is 10 pps. The CAL PPS potentiometer is then adjusted to produce a 10 pps deflection. Similarly other points on the scale may be calibrated by employing other ratios of multivibrator synchronizing pulses to sweep speeds which are even submultiples of a standard reference frequency. Ordinarily power line frequency is accurate to ± 0.1 cycle per second. For general use the test set pulsing speed is calibrated at 10 pps.

The multivibrator synchronizing pulse is derived by differentiating the abrupt voltage changes which occur at element 6 of (V1). The (C8), (R14), (R15) and (VR2) varistor are provided for this purpose. This pulse actually consists of two voltage spikes, one positive and the other negative, separated by approximately .015 seconds. They also have a high ratio of amplitude to duration. A suitable positive triggering pulse for the percent break multivibrator (V2) is obtained by the combination of (R14), (R15) and (VR2). These serve to attenuate the negative portion of the synchronizing pulse with respect to the positive portion of the pulse and thus produces a suitably shaped pulse for triggering the single cycle multivibrator (V2).

When the (CONT PLS) key is operated to the (DIAL PLS) position pulsing will cease until triggered by the (5LB) dial. The dial pulses are shaped by a differentiating circuit so that (V1) will be triggered once for each dial contact break. (V1) in going thru its single cycle then triggers (V2) as during continuous pulsing.

8.2 Pulse Duration Multivibrator

In this multivibrator plate current thru the 6 and 8 elements produces a voltage drop in the cathode bias resistor (R17) which holds elements 2 and 4 nonconducting. Each time a positive triggering pulse arrives at grid (3) elements 2 and 4 become conducting and produce a sudden voltage drop in the plate resistor (R16). This drop in voltage is transferred to grid (7) by the capacitive coupling controlled by the switch (ADJ % BK). Its effect is to hold elements 6 and

8 nonconducting momentarily dependent on the switch setting and the position of the (ADJ % BK) potentiometer. Thus the ratio of conducting to nonconducting time of elements 6 and 8 is variable by means of a coarse adjustment of capacitance and a fine adjustment of grid bias potential. It is desirable, in the use of these two controls, to use the minimum value of capacitance (S switch position) which will permit adjustment to the desired percent break.

Percent break output of this test set is the ratio of the (P) relay back contact (4-5) closure to front contact (1-2) closure to its armature (3). This in turn is determined by the ratio of conduction to nonconduction of the multivibrator V2 as determined by the coarse and fine (ADJ % BK) controls. An included percent break meter reads the percent break of the (P) relay contacts to within ± 1% on its black scale when key (PLS) and (MEAS % BK) are normal. Thus any percent break can be readily set up, and when the (PLS) key is subsequently reoperated to (LINE) or (DROP) an On-Hook signal bearing that percent ratio to the pulse cycle will be sent out at a rate determined by the pulse speed control.

9. PERCENT BREAK MEASUREMENT

Continuous pulses received from either line or drop equipment may be measured with the percent break meter provided. The (MEAS % BK) key operated to either (LINE) or (DROP) substitutes the meter for the normally connected (D) or (L) lamp and breaks the continuity between line and drop equipment. Dial pulses cannot be measured since 10 pulses, the maximum which a dial can produce are insufficient for the percent break meter to come to a steady average reading. On continuous pulses received from the drop on an "M" lead percent break is read on the black scale. Pulsing signals received from the line on an "E" lead are read on the red scale. In other words, whichever scale has its zero under the meter pointer during an Off-Hook signal will read percent break when that signal is replaced by continuous pulsing from the same direction of signaling.

The percent break meter itself is fundamentally a percent make type since current flows thru the meter upon circuit closures. It is so designed that it will read percent break equally well upon alternations between ground and open circuit or between ground and the same local battery that is used to supply the test set. The only calibration necessary for this meter is to check that the pointer positions are in line with the ends of the scale for zero current and full scale current. The former is the usual mechanical meter pointer adjustment. The latter is a full scale current adjustment by means of the (CAL % BK) potentiometer.

10. MISCELLANEOUS

10.1 A multiscale microammeter with a medium amount of damping has been furnished as a means of indicating pulsing rate in pulses per second. Its use as a general purpose 0-20 ma. milliammeter and 0-20 volt or 0-200 volt 5000ω/volt voltmeter preclude providing sufficient inherent damping in the meter movement for satisfactory pulse rate readings. Sufficient damping is therefore obtained in the (PPS) position of the scale switch by adding capacitances (C3) to (C5) inclusive.

10.2 The (RR) jack is provided to permit use of the 20 or 200 volt voltmeter as an indicator for a release time adjustment of a relay designated (RR) in the V.F. signaling circuit SD-55954-01.

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DEPT. 2241-NS-EGS-AP