POST OFFICE ENGINEERING DEPARTMENT

DIAGRAM NOTES

relating to

DIAGRAM AT 4750

SPECIFICATION

Tester AT 4750. Relay Timing Tester

1. GENERAL

This diagram shows the circuit of a tester designed to check the time in milliseconds of the operate and release lags of relays up to a maximum time limit of 1000 milliseconds.

The tester provides for timing the lags of single or double coil relays in 24, 40, 50 and 60 volt exchanges with the relay connected:-

(a) to battery

(b) to earth

(c) as a loop

(d) as a double coil relay having one winding connected to battery and the other to earth.

The test can be made on either a make or a break contact returning:-

(e) a battery

(f) an earth

(g) a loop

2. FACILITY SCHEDULE

Provision is made for:-

(1) Applying to the relay to be tested, under key control, battery, earth, loop or battery and earth.

(2) Timing to a make or break contact action returning battery, earth or loop to the tester.

(3) Indication from a meter and timing scale the duration in milliseconds of the lag of the relay under test.

(4) Selecting the suitable timing range by means of a key.

(5) Changing conditions in the tester by means of a key to suit the particular exchange voltage to which the tester is working.

(6) Adjusting the zero setting of the scale.

3. CIRCUIT DESCRIPTION

Outline

For measurement of relay lags the circuit uses a condenser with a known charging circuit time constant, and a galvanometer connected to a potential equal to that attained by the condenser after this time. In this way the device is rendered independent of voltage variations.

The condenser is charged during the lag being measured, and if the lag is not equal to the time constant, the condenser potential will not equal that of

the galvanometer, and this will be detected when the galvanometer is connected to the condenser.

It is arranged that the time constant is greater than the lag being measured, and therefore the condenser potential will be less than that of the galvanometer. Although the deflection is a measure of the different potentials, it is not possible to read the meter due to the transient nature of the resultant current. By arranging for an additional charge to be applied to the condenser (under control of a potentiometer) a null deflection can be obtained. The magnitude of the charge will be dependent upon the duration of the lag being measured, i.e., the greater the lag the less the additional charge required. Since the charging time constant and voltage are fixed, the amount of additional charge is related to time and the potentiometer is scaled accordingly.

For the convenience of these notes this "timing" circuit can be regarded as being composed of a condenser (QA) connected in turn to three distinct elements, namely:-

(a) the scaled potentiometer (ZL) which provides the additional charge. In practice this voltage is applied first and can be regarded as the "pre-charge" circuit.

(b) the battery connected chain of resistors which, under control of KFM and KTM, form the charging circuit to determine the fixed time constant.

(c) the galvanometer and associated potentiometer, forming a "voltage checking" circuit.

Before commencing tests the circuit is checked for zero, to ensure potential equality between the 'pre-charge' and "voltage check" potentiometers.

When making tests, the scale is set to an anticipated time and the appropriate range key is operated. Condenser QA is therefore partially charged.

Operation of the Test Key (KT) applies the condenser to the charging circuit under control of contact A1. An increased voltage is applied to the condenser for the duration of the lag being measured and the condenser is then transferred to the 'voltage check' circuit again under control of contact A1.

If the sum of the two charges equal the galvanometer potential no deflection will result, and the time being measured corresponds with the scale reading. A deflection of the galvanometer needle indicates that increase or decrease of the time scale is required. This re-adjustment is made and the cycle repeated until no deflection is given.

Detail

Preparation for testing.

The zero reading of the timing scale should be checked before commencing a test as follows. The tester battery plug is inserted into a battery jack and the voltage key set to correspond to the voltage being used. (The 50 volt position is used for 60 volt supplies).

KTV1 & 2) Short circuit part or all of the resistances connected in series
or) with the high speed relays to prevent overloading at the higher
KFV1 & 2) voltages.

The "check zero" key (KZ) is operated.

Key KZ operated

KZ1 Disconnects the condenser charging circuits and prepares for direct application of the condenser to the galvanometer under the control of C1.
KZ2 is spare.

The "Test" key (KT) is now operated.

Key KT operated

KT1 operates relays B & C
KT2 is spare.

Relay B operating

B1 has no function in this test. (See "Release lag using a make contact")

Relay C operating

C1 disconnects the condenser from the pre-charging circuit, and connects it to the voltage checking circuit.

If a deflection of the galvanometer results the "Test" key is restored, the "Adjust Zero" potentiometer is varied and the test repeated until no deflection of the galvanometer is obtained.

KZ and KT should be restored, the tester is now ready for use.

If a null deflection cannot be obtained over the range of the "Adjust Zero" potentiometer the tester is faulty and should be returned for repair. (See design details).

Relay Timing Tests

When making a timing test the following sequence should be followed:-

(1) Connect the relay coil to the tester by means of the appropriate clips. (Terminal A must be used for low resistance relays. See design details). Operate key KPB or KNB according to the relay coil connections.

(2) Connect the relay contact to the tester and operate the appropriate "contact" key.

(3) Set the scale pointer to the anticipated lag with the appropriate range key operated.

(4) Operate key KR or KO according to whether an operate or release lag is to be measured.

(5) Operate the "Cords Connect" key.

(6) Operate the "Test" key.

Relay Coil Connections

Battery connected coil.

The coil is connected to terminals A or B and key KPB operated.

Key KPB operated

KPB1 disconnects terminal C and extends earth to B1 to prepare for operation of the relay under test.
KPB2 is spare.

Earth or Loop Connected Coil.

The coil is connected to terminal A or B (and C for a loop connected coil) and key KNB operated.

Key KNB operated

KNB1 extends battery to terminal A or B via contact B1 to prepare for the operation of the relay under test.
KNB2 extends earth to terminal C to complete the circuit for a loop connected relay.

In the case of a double coil relay with one coil connected to earth and the other to battery, the coils are connected to terminals B and C. A loop is extended from the tester via B1 contact with KND and KPB normal.

Relay Contact Connections

Battery Connected Contact.

The relay contact is connected to terminal D and key ~~KPB~~ KPD operated.

Key KPD operated

KPD1 disconnects the earth from terminal E (see design details).
KPD2 disconnects the resistor battery from relay A and connects resistance earth to prepare for its operation when the relay contact applies battery to terminal D.

Earth Connected Contact

The contact is connected to terminal D and key KND operated.

Key KND operated

KND1 disconnects terminal E (See design details).
KND2 spare.

Loop Connected Contact

The contact is connected to terminals D and E. With keys KND and KPD normal the tester extends earth to terminal E to operate relay A when the contact under test closes.

Timing Range Keys

The scale normally covers a range of 0-500 milliseconds. Operation of keys KFM or KTM alters this to 0-50 milliseconds or 0-1000 milliseconds respectively.

Key KFM operated

KFM1 short circuits part of the charging resistance to reduce the time constant to 50 milliseconds.
KFM2 applies a correction to the galvanometer potential (See design details).

Key KTM operated

KTM1 removes a short circuit from part of the charging resistance, increasing the time constant to 1000 milliseconds.
KTM2 is spare.

Operate or Release Lag Measurements

The circuit requirements for measuring operate lag are opposite to those required for release lag since the former time commences on completion of the circuit of the relay under test and the latter commences on disconnexion of the relay under test. It is necessary to select the appropriate condition by contacts of the "Operate Lag" (KO) key, or the "Release Lag" (KR) key. For measuring operate lag, key KO is operated.

Key KO operated

KO1 extends the voltage check circuit to the contact selection keys KM1 and KB1.
KO2 extends the charging circuit to the contact selection keys KM2 and KB2.
KO3 prepares for the connexion of the make contact of B1 to the coil under test.
KO4 spare.

For measuring release lag, key KR is operated.

Key KR operated.

KR1 extends the charging circuit to the contact selection keys KM1, and KB1.

KR2 extends the voltage check circuit to the contact selection keys KM2 and KB2.
KR3 prepares for the connexion of the break contact of B1 to the coil under test
KR4 see design details.

Make or Break Contact Measurements.

The circuit requirements for measuring the lag of a make are opposite to those required for a break contact, since closing of the make contacts terminates the measurement as against the opening of the break contact. It is necessary to select the appropriate condition by means of the "Make Contact" (KM) key or "Break Contact" (KB) keys. For timing to a make contact key KM is operated.

Key KM operated.

KM1 applies the timing condenser, under control of the make contact to A1 to the charging circuit or voltage checking circuit dependent upon the lag being measured, viz., release (KR key) or operate (KO key).
KM2 applies the timing condenser, under control of the break contact of A1 to the charging circuit or voltage checking circuits dependent upon the lag being measured to operate (KO key) or release (KR key).

For timing to a break contact key KB is operated.

Key KB operated

KB1 applies the timing condenser under control of the break contact of A1 to the charging circuit, or voltage checking circuit dependent upon the lag being measured, viz., operate lag (KO key) or release lag (KR key).

The selection of operate or release lag to a make or break contact as described above determines the manner in which contact A1 is connected to the charging and voltage checking circuits by a simple reversal of the A contact make and break springs. This is because relay A is always directly connected to the contact under test.

Release lag using a make contact.

For the purpose of these notes it will be assumed that a release lag of a make contact is being measured, in which case keys KR and KM are operated as previously described, thus the make spring of A1 is connected to the charging circuit via KM1 and KR1 and the break spring to the voltage checking circuit via KM2 and KR2.

The "Cords Connect" key (KC) is operated.

Key KC operated

KC1) extend the A or B and C wires to the relay under test, completing
KC2) the operate circuit for the relay via KR3 and B1.
KC3) extend the D and E wires to the make contact of the relay under test,
KC4) thus preparing for the operation of relay A under control of the make contact.
KC5 extends the start relays B and C to the test wires to provide for external control of the start condition if required.
KC6 prepares to short circuit resistor YD to provide a "correction factor" to the 50 m/S scale. (See design details).

Operation of the relay under test completes the circuit for relay A.

Relay A operating

A1 prepares for application of the timing condenser to the charging circuit.

The Timing potentiometer has been set to an anticipated release time, for example, the relay under test may have a timing range of 100 - 150 m/S, the scale should therefore be set to 100 m/S and condenser QA will be pre-charged to a potential corresponding to this setting.

Check of the release lag is now made by operation of key KT.

Key KT operated

KT1 operates relays B and C.
KT2 spare.

Relay B operating

B1 disconnects the coil of the relay under test.

Relay C operating

C1 disconnects the timing condenser from the pre-charging circuit and applies it to the charging circuit via contact A1.

During the slow release of the relay under test, relay A remains operated and maintains the timing condenser applied to the charging circuit. At the end of the slow release period relay A releases.

Relay A releasing

A1 disconnects the timing condenser from the charging circuit and connects it to the voltage checking circuit via KM2 and KR2.

If the voltage of the timing condenser is different from that of the voltage checking circuit a momentary surge current will flow through the meter. The direction of this current will depend upon the relative voltages and the meter will indicate whether increase or decrease of the timing scale is required. The voltage of the timing condenser will be the sum of the pre-charging voltage and the charging voltage. If this summation equals the original checking voltage then no deflection occurs. The potentiometer is calibrated in terms of time, and scaled to indicate the duration of the lag.

The actual time of the contact under test can be found by re-adjusting the timing scale (as indicated by the meter) and repeating the operation of the test key.

Assuming the meter indicates that "increase" is required, then key KT is released and the scale potentiometer set to 150 m/S for the example cited.

Key KT released.

KT releases relays B and C.

Relay B releasing.

B1 operates the relay under test.

Relay C releasing.

C1 disconnects the timing condenser from contact A1 and applies it to the pre-charging circuit.

The condenser is charged to a voltage corresponding to the 150 m/S setting, and the test is repeated as previously described, when the meter should indicate that "decrease" is required if the relay under test lies between the timing limits of 100 - 150 m/S.

Release lag using a break contact

The operation in this case is similar to that described under Release Lag using a make contact except that key KR is operated as previously described, and not the key KM.

The effect of this is to reverse the functions of A1 break contact with that of A1 make contact because relay A will operate on release of the relay under test.

Operate lag using a make contact.

In this case key KM is operated as previously described, together with key KO.

Key KO operated

KO1) Reverse the functions of A1 contact as previously described.
KO2)
KO3 prepares for the operation of the relay under test.
KO4 spare.

Operate lag using a break contact

For this test keys KO and KB are operated as previously described.

4. DESIGN DETAILS

Terminal A is provided for testing low resistance relays (e.g. 4 ohm C relays). A 50 ohm resistance is connected in series with the relay coil to prevent excessive current flowing.

Key contacts not previously described.

KPD1) When testing to an earth or battery connected contact the clip connected
KND1) to terminal E is not used, and to prevent damage due to the clip coming into contact with adjacent apparatus the earth is removed.
KR4) The high speed relays can introduce a slight error due to the transit
KFM4) time of their contacts (approx. 1 millisecond). This error can only
KC6) occur when measuring a release lag due to the winding of the relay under test being disconnected as soon as the B1 break opens while the charging circuit is not connected to the condenser until C1 make contact closes. This small error which could only be detected on small lags has been corrected on the 50 millisecond scale by decreasing the reference voltage (i.e. short circuiting resistor YD) when measuring release lags.
KO3 Ensures that the make contact of B1 is disconnected when measuring a release lag.
KR3 Ensures the disconnection of B1 break contact when measuring an operate lag.
KC1) Ensures that the test clips are disconnected from the tester whilst they
KC2) are being connected to the relay under test, thus damage due to accidental
KC3) contact with other components is avoided.
KC5 Extends the test relays to a terminal so that the start of the test may be controlled from an external source if desired.

Initial Calibration

The initial calibration of the tester is made from known time values which are selected to correspond with the upper limits of the three timing ranges, viz., not less than 40 m/S, 400 m/S and 900 m/S.

The sequence of calibration is as follows:-

The tester is connected in the normal way to a voltage supply, and Key KFM operated. The resistor chain YA, YB, YF, YP, ZN is adjusted to a total of 12,500 ± 10 ohms.

(a) 50 m/S Calibration

The known source of approximately 50 m/S is connected to the tester in an appropriate manner. The timing scale is set to correspond with this time and tests are made so that null deflection is obtained by adjustment of potentiometer YW. The potentiometer is now locked in this position.

(b) 500 m/S Calibration

The source is now changed to approximately 500 m/S, Key KFM restored, and the timing scale set to correspond with this time. Tests are made so that null deflection is obtained by short-circuiting the resistor chain YA, YB, YV, YZ, ZE and ZJ as required. (These resistors permit change in steps of 100 ohms.)

(c) 1000 m/S Calibration

Key KFM is operated and the procedure is similar to (b) except that in

this case resistors YK, YQ, YU, YY, ZC and ZH are short-circuited as required, and the timing scale set to correspond to the source of approximately 1000 m/S.

(d) Setting Zero

The timing scale is set to zero and Key KZ operated. With the "Adjust Zero" potentiometer in a mid position, resistors YT and/or ZA are S/C to give minimum deflection when the test key is operated. This ensures maximum range of adjustment being given by the adjust zero potentiometer.

It will be seen from the foregoing that calibration must be made from an accurately known source of time, and therefore no attempt should be made to calibrate the tester in the field, beyond the adjustment of the "adjust zero" potentiometer. If the tester develops a fault, check that the cords etc., are in order. For any other defects local repair should not be attempted since change of components necessitates re-calibration.

5. HISTORY

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END OF DIAGRAM NOTES