TOOLS AND TEST EQUIPMENT FOR TELEPHONE INSTRUMENT MAINTENANCE

CONTENTS

1 INTRODUCTION

1.1 The number and types of tools and items of test equipment supplied to either mobile or shop maintenance personnel will depend upon the extent of the work to be performed by each of these two groups. This sub-section is intended as a guide to the minimum tools and test equipment required to provide adequate facilities for the field repair and maintenance of telephone instruments.

1.2 The following sections detail the various items recommended for use by the maintenance staff of the categories noted above. The lists are split into groups showing how the requirements vary with the complexity of the work to be performed by each category. The listing of a specific manufacturer or type of any item is for illustrative purposes only and is not intended as a recommendation.

2 RECOMMENDED TOOLS

2.1 Table 2-1 lists the recommended tools for the replacement of faulty component parts of telephone instruments, at the subscriber's premises, without the use of a soldering instrument. In the event that maintenance on the subscriber's premises is restricted to changing the complete instrument, only the items marked with an asterisk (*) may be necessary.

2.2 The additional tools required to permit the normal field adjustments to be made on an installed telephone are listed in Table 2-2. The additional tools required for shop maintenance purposes are listed in Table 2-3.

2.3 Most telephone companies will extend these lists of tools depending upon their own preferences and requirements. In many cases the lists will be combined with those for line maintenance and also installation tools.

2.4 A small quantity of consumable supplies will be required in addition to the tools listed. These will include Rosin Core Solder, Electrical Tape, Lubricant, Cleaning Fluid, etc. It is recommended that a separate tool box is provided to carry the tools and supplies required for the maintenance of telephone instruments, when this involves more than changing of the complete instrument. Some small consumable items, such as lamps, fuses, terminal screws, etc., may be conveniently carried in the small compartments of this box.

Table 2-1 BASIC TOOLS REQUIRED

Item	Description	Size
1	Screwdriver, Instrument type	3" x 1/8"
2*	Screwdriver, Instrument type	6" x 3/16"
3*	Screwdriver, Cabinet type	8" x 1/4"
4*	Pliers, Long Nose Wiring type	6"
5*	Pliers, Sidecutting	5"
6	Pliers, Slip Joint or Pipe Grip	6"
7	Wrenches, Combination type	3/16" - 3/8"
8	Contact Cleaner or Burnisher	3/16" Blade
9	Dust or Cheese Cloth	as requ'd.

Table 2-2 TOOLS FOR ADJUSTMENTS

Item	Description	Size
1	Adjuster, Spring, Straight Tips	.020" Slots
2	Adjuster, Spring, Angled Tips	.020" Slots
3	Pliers, Flat Nose, Straight	5"
4	Tension Gauge (2 gram divisions)	0-50 grams
5	Tension Gauge (20 gram divisions)	0-500 grams
6	Tension Gauge (4 ozs. divisions)	0-5 lbs.
7	Thickness Gauges	.002" - .040"

Table 2-3 SHOP TOOLS

Item	Description	Size
1	Wrenches, Socket	3/16" - 3/8"
2	Wrench, Adjustable	4"
3	Soldering Pencil or Gun	30w - 65w
4	Drill, Hand or Power	1/4" Cap.
5	Twist Drills	1/16" - 1/4"
6	Small anvil or Steel Block	-
7	Hammer, Ball-Pein type	1/2 lb.
8	Punch, Riveting type	6"
9	Punch, Center	4"

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3 RECOMMENDED TEST EQUIPMENT

3.1 Table 3-1 lists the recommended basic test equipment required for the shop maintenance and repair of faulty telephone instruments. Two of these items, the continuity tester and the multi-range meter, will also be found useful for trouble shooting installation wiring in the subscriber's premises. Consideration should be given to the advantages of equipping the mobile maintenance crews with one or both of these items.

3.2 Correct shop adjustment of ringers requires the use of a ringer test set-up. Where more than the occasional ringer is adjusted it will be found that a ringer test set (see sub-section M1C-TST/RIN for details of an easily assembled unit) saves a considerable amount of time.

3.3 Refer to sub-section M1C-TST/DLS for details of dial test sets and dial testing.

3.4 Table 3.2 lists more comprehensive test equipment which is more likely to be of value to the larger operating companies requiring extensive test and adjustment facilities. For the smaller companies it is usually more economical to return some component parts to the factory, for repair. rather than invest in this type of equipment.

Table 3-1 BASIC TEST EQUIPMENT REQUIRED

Item	Description	Type
1	Continuity Tester	- Battery operated buzzer or test lamp.
2	Multi-range Meter	- Simpson model 260 or similar high resistance.
3	Ringer Test Set	- See Paragraph 3.2.
4	Dial Speed Tester	- See Paragraph 3.3 and
5	Dial Pulse Counter	- Sub-section
6	Pulse Ratio Tester	- M1C-TST/DLS.

Table 3-2 ADVANCED TEST EQUIPMENT

Item	Description	Type or Use
1	Ringer Magnetizing Set	- See Sub-section
2	Ringer Demagnetizing Set	- M2C-RIN/GEN.
3	Audio Generator	- General testing
4	AC Vacuum Tube Voltmeter	- and also used
5	Calibrated Attenuator	- with items 6 & 7.
6	Artificial Mouth	- Testing of
7	Artificial Ear	- transmitter and receiver units.
8	Impedance Bridge	- CRL type for general testing.
9	Wire Chief's Test Set	- General testing. Commercial item.

4 JIGS, FIXTURES AND ADAPTERS

4.1 The test and adjustment of some of the parts of telephone instruments is greatly facilitated by the use of test jigs, fixtures and adapters. Many of these items are very easily made up, as required, by the individual operating company - very few of them are available ready made commercially. The following paragraphs detail a number of the more useful and commonly needed items.

4.2 RINGER TEST JIG

For correct adjustment of ringer mechanisms it is essential that they are mounted on a proper, or simulated, telephone baseplate. The test jig is made from a discarded telephone baseplate with the bottom portion of a cradle switch bracket mounted in position to hold the ringer frame. This assembly must then be weighted to represent the total weight of a typical telephone instrument, it MUST NOT be mounted solidly to the work bench. Terminals may be fitted to enable the ringer leads to be connected easily and quickly.

4.3 DIAL TEST JIG

This item will be found to save appreciable time where a reasonable number of dials are tested and adjusted in the shop. It is simply a U-shaped bracket formed to hold the dial upside down so that adjustments may be made on the mechanism without the need to hold the dial in the hand. Any required digits can be dialed by feeling for the appropriate finger hole, or a mirror can be mounted under the dial face to enable the finger plate to be seen. Terminals may be fitted to the side of the bracket for connection of the dial leads, if necessary.

4.4 COIN CHUTE GAUGES

These are available commercially and consist of a set of metal disks in standard, undersize and oversize ranges representing 5¢, 10¢ and 25¢ coins. They are used to check the coin rejection settings of the paystation telephone mechanisms.

4.5 TEST ADAPTERS

The actual types of test adapters required by any maintenance shop will depend upon the type and volume of equipment to be tested and repaired. Some of the more commonly required adapters are detailed below:

a) Test Line from exchange - terminated on binding posts and extension telephone socket; with switches to connect ringer, convert to four wire circuit (500--(--)35- telephone), or other function as required.

b) Amphenol Socket - wired via switches to connect any desired circuit of a key type telephone to the test line.

c) Amphenol Plug wired out to terminal strip - this item may be plugged into the socket of item b) so that key telephones without plugs may be connected and tested. This arrangement is also useful for connecting other telephones requiring multi-conductor circuits - such as those for use with 3A speakerphone systems and two or three line instruments.

d) Artificial Line(s) - either switched into the test line circuit or wired in with test leads when required. This item is useful when testing ringers or dials for functioning over long loop circuits. (See also sub-section M1C-TST/DLS).

DIAL TESTING AND TEST SETS (ROTARY DIALS)

CONTENTS

1 INTRODUCTION

1.1 Correct testing of telephone instrument dials requires that at least two, and preferably three, electrical tests are made after the preliminary mechanical adjustments have been completed. These tests are for dial speed (number of impulses per second), pulse ratio (ratio of make, or break, period to total time of one pulse) and number of pulses when dial is fully wound up and released. The last of these tests is not essential; it is recommended, however, as cases have been reported where the dial has been incorrectly assembled and has delivered an incorrect number of pulses.

1.2 During the electrical tests, appropriate mechanical adjustments are made to correct any discrepancies in the measured parameters. The full method of adjustment is given in sub-section M2A-DLS/GEN and the specific data for each individual type of dial is given in the appropriate descriptive sub-section.

1.3 There are a number of instruments available, commercially, which are specifically made for the purpose of testing dials. The following sections detail various ways of making the required tests.

2 DIAL SPEED TESTING

2.1 The simpler forms of dial speed test set operate on the electromechanical principle. They consist of a spring, or synchronous motor, driven shaft which is normally prevented from rotating by a detent. The first dial break pulse is arranged to trip the detent and the shaft commences to turn. A second, normally disengaged, detent or clutch is arranged to stop the shaft when the dial pulses cease or the off-normal contacts open. The amount of rotation of the shaft is indicated by a pointer against a scale which is calibrated in fractions of a second. This form of tester must be calibrated for use with a specific type of dial. Once it is set it provides more than adequate accuracy for the adjustment of telephone instrument dials.

2.2 A more refined version of the type of tester described above also contains a pulse counter which is mechanically coupled to the speed tester. The speed tester drives off-scale if less than ten impulses are received. All the electromechanical types of dial speed tester are reset manually.

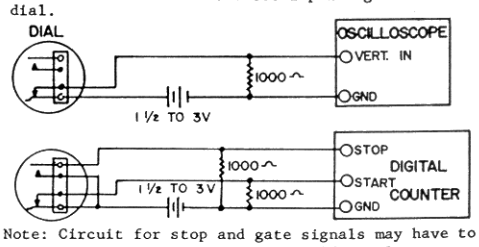
2.3 There are a number of all-electronic methods of dial speed testing; many of them have been used in the design of commercially available instruments. The remainder of this section describes a number of methods of making dial speed tests with various items of equipment. It should be noted that the speed of rotation of the dial is not constant during the return motion. This is due to the fact that a definite amount of time is taken for the mechanism to start from the rest position and reach the maximum speed allowed by the governor. The amount of speed variation during the pulsing period is only slight but it must be allowed for with some forms of measurement. Refer also to section 3.

2.4 OSCILLOSCOPE METHOD (see Fig. 2-1)

The instrument should have a medium to long persistance screen and the time base capable of providing a sweep of one second duration. Connect the impulse springs of the dial in series with a battery (1.1/2 to 3 Volts) and a 1,000 Ohm resistor. Then connect the oscilloscope vertical terminals across the resistor. Adjust the trigger control to cause the sweep to start at the beginning of the first break pulse. The number of pulses will be displayed on the trace and the dial speed should be adjusted so that the tenth pulse is completed just before completion of the horizontal sweep period; by an amount of 1/26 of the sweep time in the case of standard 10 IPS telephone dials (the last make period).

2.5 DIGITAL COUNTER METHOD (see Fig. 2-1)

If a digital counter is available this may be used to measure the dial speed. The set-up is very similar to that described for the oscilloscope in the previous paragraph. In this case, however, the dial off-normal springs must be wired in series with a second resistor and then to the stop or gate terminal of the counter. The counter is set to trigger on the first break pulse and stop when the gate signal is removed by the off-normal contacts. The time indicated is the total pulsing time of the dial.



Note: Circuit for stop and gate signals may have to be modified for some types of digital counter.

Fig. 2-1 OSCILLOSCOPE AND COUNTER CONNECTIONS

2.6 SIMPLE DIAL SPEED TESTER (see Fig. 2-2)

This easy to assemble arrangement provides more than adequate accuracy, using the 60 c/s power line frequency as a standard, for testing the speed of telephone dials. The final shaft of the motor is geared to make one revolution every two seconds and carries a pointer which may be set manually. Relay A operates when the dial is connected. Relay B operates as soon as the dial is rotated from the normal position and disconnects the operate circuit of relay A, which remains held over its own contact. Relay A releases at the start of the first break pulse and connects the power to the motor. The off-normal contacts open at the end of the dial rotation and release relay B, which disconnects the power from the motor. The amount of rotation of the pointer measures the speed of the dial when the digit '0' is dialled. A scale may be fitted to the unit so that dial speed may be read off directly.

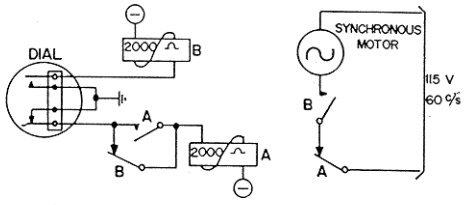


Fig. 2-2 SIMPLE DIAL SPEED TESTER

3 PULSE RATIO TESTING

3.1 Accurate measurement of the pulse ratio of a dial necessitates the use of reasonably complex test equipment. A number of pulse ratio test sets are available commercially, some of which measure the pulse ratio on a specific pulse in the train and some of which measure the average ratio over all the pulses in the train. At least one test set is available in which there are facilities for making measurements on any single pulse in the train.

3.2 A number of methods of making pulse ratio tests with standard items of test equipment are given below. As stated in section 2, the dial speed varies slightly during the pulsing period -- the first few pulses being longer than the remainder -- making compensation necessary with the more refined methods of measurement.

3.3 OSCILLOSCOPE METHOD

The connections for this test are the same as for the speed test (shown in Fig. 2-1). The time base is set to provide a recurrent sweep of one fifth of a second duration: the trigger control is then set to cause the sweep to reset at the start of the first pulse. Two complete pulses will occur during each sweep of the time base and this will repeat five times when the digit '0' is dialed. The consecutive traces will not be superimposed perfectly, due to the variation in dial speed (see para. 3.2), but it will be possible to measure the relative durations of the make and break periods of the average of alternate pulses. The accuracy to be expected depends upon the accuracy with which the oscilloscope scale can be read.

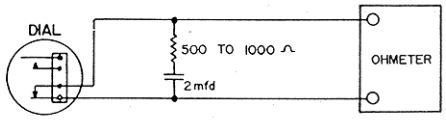
3.4 DIGITAL COUNTER METHOD

For this method the dial speed is measured as described in section 2.5. The connections are then changed so that the counter only functions when the pulse springs are open. The ratio of the second measurement to the first will be the break pulse ratio of the dial.

3.5 CAPACITOR-OHMETER METHOD

The equipment used for this method must first be calibrated with a known accurate dial. The set-up is shown in Fig. 3-1. With the accurate dial connected and the digit '0' dialled, it will be noted that the meter needle falls to the same low point each time the dial is operated. Once this point is established, the pulse ratio of any other dial may be checked. If the break pulse period of the unknown dial is too long then the meter needle will fall below the established reference point and if the break pulse period is too short then the needle will not fall to the reference point.

This method is capable of quite accurate comparisons. The meter scale could be marked with high and low limit points if calibration facilities are available. The actual percentage drop of the meter needle with respect to a given break pulse ratio depends upon the values of resistance and capacitance in the circuit and the damping of the meter movement. Hence it is not possible to pre-calibrate the meter.



NOTE: OHMETER POWER SUPPLY SHOULD BE 15 TO 80 VOLTS DC.

Fig. 3-1 CAPACITOR-OHMETER PULSE RATIO TESTER

4 PULSE COUNTING

4.1 It will occasionally be necessary to measure the number of pulses generated by a dial. This can be done simply by connecting it to any type of stepping switch, with a suitable spark suppression circuit across the pulsing contacts, and checking the action of the switch against the digit dialled.

4.2 The oscilloscope can be used as detailed in section 2.4, where the display shows each of the pulses in the train. The digital counter can also be used by setting the trigger so that one count is obtained at the start of each pulse, using the connections given in section 3.4.

RINGER TEST EQUIPMENT

CONTENTS

1 INTRODUCTION

1.1 In order to obtain maximum performance from ringer mechanisms it is essential that the proper test equipment is used. As with many other types of similar mechanisms, in which permanent magnets are used, the magnets are magnetized, adjusted to strength and stabilized after the mechanism is assembled. Disassembly of the magnetic components reduces the strength of the magnet and consequently affects the sensitivity of the ringers.

1.2 The equipment required to magnetize and adjust the strength of the permanent magnet is detailed in section 2. It is available from companies which specialize in magnetic equipment and is usually built to order.

1.3 The ringer test set described in section 3 is designed for simple assembly and to perform all the functions required for thorough testing of ringers.

2 MAGNETIZATION AND DEMAGNETIZATION

2.1 MAGNETIZING EQUIPMENT

This equipment consists of an adjustable DC power supply connected to a large solenoid with two pole pieces which are shaped to fit close to the ends of the magnet in the assembled ringer. Note that biased and frequency selective ringers require different shapes of pole pieces. In operation, the current through the solenoid is set so that when the magnet of an assembled ringer is placed between the pole pieces, and the current is switched on, the magnet is saturated.

2.2 DEMAGNETIZATION EQUIPMENT

This equipment is only required when biased type ringers are to be adjusted. It is similar to the magnetizing equipment described in the previous paragraph except that the solenoid is much smaller. The pole pieces are conveniently placed around the magnet of the assembled ringer while it is wired to to the test set (section 3) and in position in the test jig (sub-section M1C-TEQ). In operation, the current through the solenoid is adjusted to provide the required amount of demagnetization of the ringer magnet and obtain optimum performance.

2.3 OPERATIONAL PROCEDURE

The method of applying the magnetizing and demagnetizing equipment to the adjustment of the strength of the ringer magnets is detailed in sub-section M2C-RIN/GEN.

3 RINGER TEST SET

3.1 SPECIFICATIONS

The test set provides the following features:

a) Selection of any one of up to five externally generated ringing frequencies.
b) Adjustable series resistance from 0 to 80,000 ∿.
c) Four values of ringer series capacitor.
d) Optional load, representing five frequency selective ringers (one of each frequency in the series) in parallel.
e) Meter to read voltage across ringer under test.
f) Facilities to bias gas tube type ringers.
g) Facilities to check the ringer under test for dial pulse rejection.

The test set is completely self-contained except for the connections to the externally generated ringing supplies.

3.2 CONSTRUCTIONAL DATA

The test set may be assembled either as a case or panel mounted unit. The circuitry may be varied to suit individual needs - such as omitting the gas tube biasing arrangements, if they are not required, or substituting a single push button for the five ringing supply buttons when only biased type ringers are to be serviced.

All the component parts are either standard telephone equipment items or are readily available from radio/electronic supply houses.

Calibration of the test set is not required. The meter provides the necessary standard for test purposes. Terminals may be provided and an external meter used, if desired.

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Table 3-1 RINGER TEST SET - PARTS LIST

Item	Description	Qty
1	Push Button, Single Pole, Double Throw	5
2	Push Button, Single Pole, Normally Open	1
3	Key or Switch, Single Pole, Two Way, Center Off, Normally Closed	6
4	Key or Switch, Two Pole, Two Way, Center Off, Transfer Contacts	1
5	Key or Switch, Two Pole, Double Throw, Transfer Contacts	1
6	Key or Switch, Single Pole, Single Throw, Normally Closed	
7	Key or Switch, Single Pole, Two Way	1
8	Resistor, 22 Ohms, 1/2 Watt, 5%	2
9	Resistor, 1,000 Ohms, 40 Watt, 5%	1
10	Resistor, 2,000 Ohms, 20 Watt, 5%	1
11	Resistor, 3,000 Ohms, 20 Watt, 5%	1
12	Resistor, 6,000 Ohms, 10 Watt, 5%	2
13	Resistor, 9,000 Ohms, 5 Watt, 5%	1
14	Resistor, 18,000 Ohms, 5 Watt, 5%	1
15	Resistor, 27,000 Ohms, 2 Watt, 5%	1
16	Resistor, 54,000 Ohms, 1 Watt, 5%	1
17	Resistor, 750,000 Ohms, 1/2 Watt, 1%	1
18	Capacitor, 4 mfd, 300 Volt, 10%	1
19	Capacitor, 0.1 mfd, 400 Volt, 10%	1
20	Capacitor, 0.25 mfd, 400 Volt, 10%	1
21	Capacitor, 0.35 mfd, 400 Volt, 10%	1
22	Capacitor, 0.47 mfd, 400 Volt, 10%	1
23	Capacitor, 1.5 mfd, 400 Volt, 10%	1
24	Meter, 0-50 VAC, 5,000 Ohms/Volt	1
25	Terminals	9
26	Battery, 45 Volt 'B' type	1
27	Dial, Standard Telephone Type	1
28	Dial Mount	1
29	Relay, Standard Impulsing Type, 200 Ohm, Dual Coils	1
30	Case or Panel, c/w battery bracket	1
31	Battery Connector	1
32	Wire, Hardware, etc.	as req.

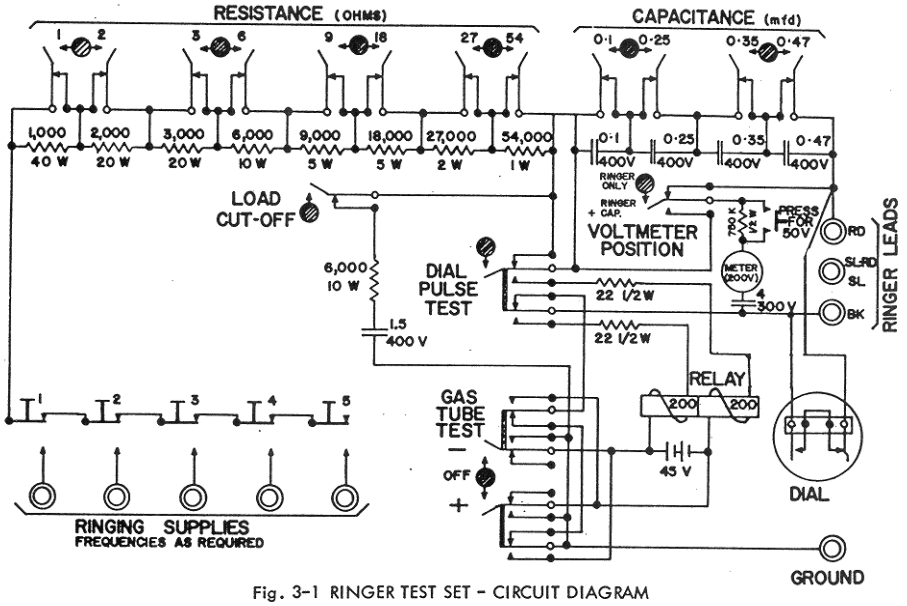

Fig. 3-1 RINGER TEST SET - CIRCUIT DIAGRAM

3.3 OPERATIONAL DATA

The complete method of testing ringer units is detailed in sub-section M2C-RIN/GEN. A brief explanation of the circuit features of the test set follows.

The ringing source selected by one of the push buttons is connected through the variable resistance to the ringer under test; through the selected capacitor, if required. The load network, which may be switched out as necessary, is shunted across the ringer and capacitor.

The meter may be switched to measure the voltage across the ringer coil only or across the ringer and capacitor, in series, as specified in the test data for the particular ringer under test.

The normal meter sensitivity is 200 volts FSD. This may be increased to 50 volts FSD by pressing the meter button, permitting more accurate readings for small deflections.

Negative or positive bias may be selected for the gas tube type ringer tests. The bias battery is connected in series with the ringer.

The battery connection for the dial pulse rejection tests is made through the dial off-normal contacts. This prevents accidental discharge of the battery in the event that the dial key is left in the test position.