LINEMEN'S HANDBOOK

LINES TESTING AND INSTRUMENTS

ISSUED TO .....
.....

ISSUED BY: General Manager
Engineering Department

Issue 2, 1981.

This handbook has been prepared to assist Lines and Technical staff engaged in the external plant fault location and service restoration work, as well as other activities associated with the use of instruments.

It is not intended as a training manual but provides a ready reference for the instruments currently on issue and their use.

Although the testing procedures outlined in this handbook are applicable throughout the Department, there may be minor variations in some areas to meet the local conditions. For further information, refer to the A.P.O. Engineering Instructions, State Engineering Instructions and the Linemens Handbooks, "Cable Jointing No. 1" and "Cable Jointing No. 2".

C Taylor

A/g First Assistant Director-General
(Engineering Works)

INDEX

INDEX

INDEX

INDEX

CABLE PAIR IDENTIFICATION SET TYPE GP -

DESCRIPTION AND TECHNICAL DETAILS

(See Section KF for USE OF CABLE PAIR IDENTIFICATION SET TYPE GP)

(See Section T for CABLE PAIR IDENTIFICATION SET TYPE GP -
PRINCIPLES OF HIGH IMPEDANCE TONE SEARCH)

Issue 1, 1981

CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION

GENERAL

The Cable Pair Identification Set (See Fig 1), type GP, utilises the principle of high impedance tone search in achieving its primary function of identifying a specific cable pair in a random jointed cable with minimum interference to working circuits. Damage to the insulation of the wires at the search end is minimised as it is unnecessary to make metallic contact to positively identify a pair.

The set can send and receive simultaneously for identification purposes and can therefore be used as a single unit where required or it can be used in conjunction with a number of other sets.

In addition to the identification function the set has a built-in loudspeaking intercom system.

DESCRIPTION

This portable set is housed in a moulded plastic case with a detachable lid. A carrying handle and a shoulder strap are provided. The shoulder strap also doubles as a means of securing the set in a convenient position when used at MDFs and manholes.

Provision is made for the storage of accessories in the main body of the instrument when they are not in use.

An abbreviated set of instructions is contained in the detachable lid.

THE GP SET IS A VALUABLE INSTRUMENT. ALWAYS HANDLE THE SET WITH CARE AND CAREFULLY POSITION THIS SET WHERE DAMAGE WILL BE AVOIDED.

Issue 1, 1981

FIG 1 GP SET AND ACCESSORIES

The operators controls appear on the front panel and are placed in groups relating to functions of the set.

DO NOT MAKE ALTERATIONS TO WORKING PAIRS OTHER THAN THOSE SHOWN ON TRANSFER ADVICE WITHOUT OBTAINING PRIOR APPROVAL.

CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION

There are three main functions of the set (See Fig 2). These are:

1. INTERCOM
2. RECEIVER
3. SENDER

Additional functions and facilities are described under MISCELLANEOUS.

INTERCOM

A loudspeaking intercommunication facility is built into the set which enables any number of sets to be connected across a common speak circuit to provide intercommunication to several locations.

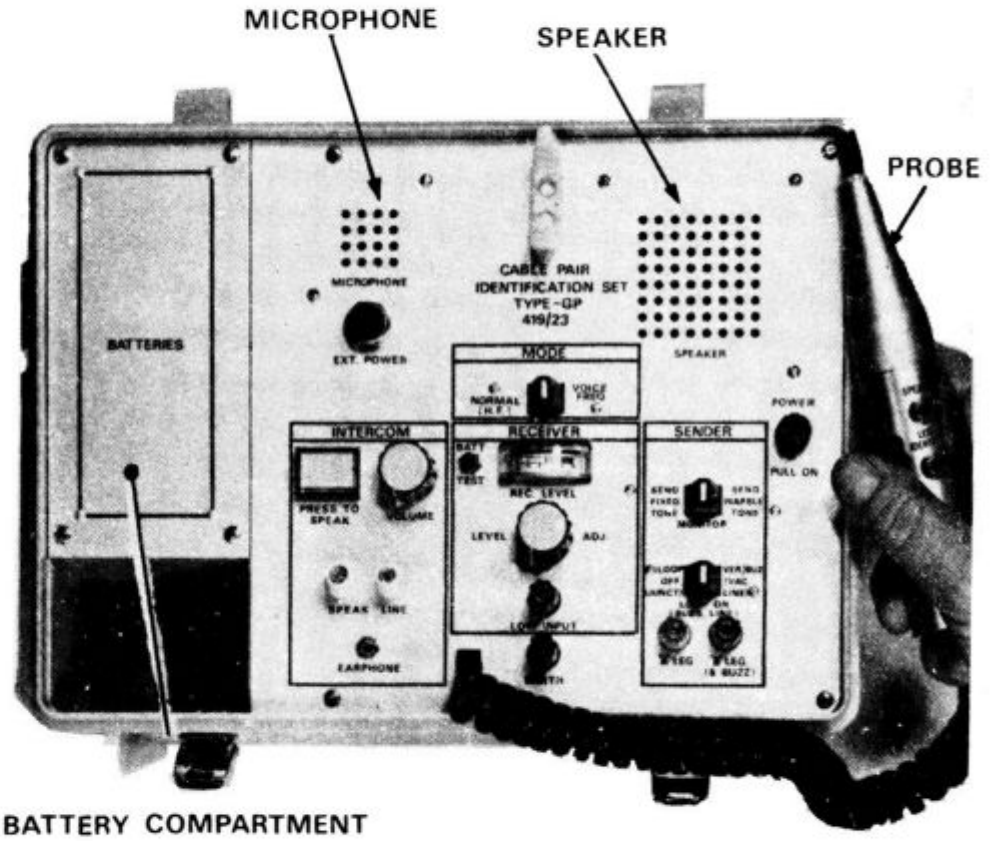


FIG 2 OPERATORS CONTROLS

INTERCOM (Cont)

The microphone and speaker are built in. An earphone is provided which can be used in lieu of the internal speaker. The unit is normally in the receive mode (able to receive transmission). Operation of a switch on the set or on the probe will enable the unit to transmit speech. It is essential that the speak pair is a vacant, non-faulty (balanced) pair, as it is also used for other control purposes.

The volume control adjusts the incoming speech level, transmitted speech level is not adjustable.

RECEIVER

The set has facilities to use either of two methods for detecting signals. They are the high impedance (balanced) method, which utilises a hand held probe (see below) to explore the electric field associated with the identification signal and the low impedance (unbalanced) method which requires metallic contact with the wires under test at the search end (similar to "A" set technique).

Hand Held Probe

The hand held probe is similar in appearance and operation to the early model "F" set probe, but has the following differences. It is permanently attached to the set via a flexible lead. A press to speak button and leg identification control button and indicator (LED) are mounted on the probe. When identifying in the high frequency mode, the signal detected by the probe is converted to a tone that can be heard. When identifying in the voice frequency mode with the probe or the low impedance input facility, the signal is amplified to a level that can be heard. It is not necessary to prick the insulation using the high impedance probe.

CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION

Leg Identification

A feature of the high impedance mode of operation is that it is possible to identify the "a" and "b" legs of a pair by operating the leg identify press-button on the probe. This will cause the signal to decrease on the "b" leg. Operating the Leg ID Button on one of any number of sets which have their speak terminals connected to the same speak line, will cause the level of tone sent on the "b" leg to decrease on all sets connected. Operation of the leg identify button on the probe causes a signal to be transmitted over the speak line to the remote GP Sets which causes the tone to be removed from the "B" terminal of the sender section of all Sets connected.

SENDER

The GP set can transmit identification signals in two frequency bands, "NORMAL (HF)" and "VOICE FREQ." The "NORMAL (HF)" mode of operation is used to transmit signals at a higher frequency (HF) than normal speech. The high frequency (HF) signal is normally inaudible on a telephone circuit. The "VOICE FREQ." mode of operation is used to transmit signals in the same frequency range as normal speech.

High Frequency Range

The "NORMAL (HF)" range is used to identify telephone circuits in a non-interferring mode. The "NORMAL (HF)" mode of operation has the advantage of better signal to noise ratio than the "VOICE FREQ." technique.

CARE MUST BE TAKEN TO AVOID INTERRUPTION TO IN USE CUSTOMER SERVICES, ALWAYS CHECK THE LINE BEFORE APPLYING ANY SIGNAL THAT MAY INTERFERE WITH THE SERVICE.

SENDER (Cont)

Voice Frequency Range

The "VOICE FREQ." range is used for identifying through loading coils and with other types of identification sets eg, F set. This frequency band will cause interference to, in-use-telephone circuits, in a similar manner to the F set. If the identification signal is transmitted on a single wire or the A set is used to transmit the signal, the "LOW INPUT" (low impedance input) must be used for detection.

NOTE:

. The probe will detect signals in the "NORMAL (HF)" range or the "VOICE FREQ." range.
. The low impedance input is used to identify single wires or unbalanced circuits and can only be used in the "VOICE FREQ," range.

In either the "NORMAL (HF)" range or the "VOICE FREQ." range, the GP Set is able to transmit identification signals in a fixed ("SEND FIXED TONE") or a swept range ("SEND WARBLE TONE") of frequencies. The fixed frequency aids leg identification on long circuits, especially when the meter is being used to measure the change in levels on each wire. The swept frequency (or "SEND WARBLE TONE") is preferred by most operators as it appears to be quite distinctive when searching, especially in situations where the surrounding noise level is high.

Mode Switch

When using the GP set to send and receive tone, operation of the mode switch automatically adjusts the sender and receiver of the set to the same frequency band. See page No. DF-11 TONE SENDER CHARACTERISTICS, for frequency and signal levels.

SENDER (Cont)

The Loop Key

A loop key is incorporated in the sender to enable the exchange lines to be brought to the balanced condition where needed. (See page KF-11, Selection of Output Conditions).

Monitor Key

The key which controls the fixed or swept frequency transmission has a position which allows the circuit on which the signal is to be transmitted to be monitored before application of the identification signal.

Leg Identification

As described in the section dealing with the probe, the output of the sender may be turned off at the "b" leg by operation of the switch on the probe to enable leg identification.

MISCELLANEOUS

Buzzer

A buzzer is included in the set and can be used in conjunction with the sender ("SEND FIXED TONE" or "SEND WARBLE TONE") or independently as a separate buzzer for checking the continuity of single wires. When used with the sender it acts as a check that the correct pair has been found by emitting a buzz at all sets when the far ends of the identified pair are shorted together. As a single wire buzzer it operates when a circuit is made from the "b" leg terminal to ground.

NOTE: The volume of the buzz tone is controlled by the "Intercom" "Volume" control.

MISCELLANEOUS (Cont)

Meter

The meter on the front panel serves as a visual indicator of received signals. Transmitted signals from the intercom also give an indication on the meter. In addition the condition of the battery is displayed when the battery test button is pressed.

Power

The Power switch is a pull on/push off switch located on the front panel and is automatically switched off when the lid is closed.

The set operates off inbuilt batteries (2 x 6 volt lantern cells, S2/28 Eveready Type 409). An external battery jack is provided and power for the set can be supplied from external batteries when required. It may be necessary to remove the internal batteries when using external supplies (refer page KF24 part iii).

Instructions

Operator instructions are included in the lid.

Battery Test

Providing the power is switched on, the condition of the batteries will be indicated on the meter when the battery test button is pressed.

CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION

MISCELLANEOUS (Cont)

Accessories

Included with the set are the following:

1 Sender lead

1 Speak lead

1 Earth lead

1 Earphone piece

1 50mm Tip

NOTE: A special external battery lead is available as an option and must be ordered as a separate item.

The Serial and item numbers of all accessories are listed along with the technical details, (See Page No. DF-11 to 14).

THE SKILLED WORKMAN

- SELECTS THE RIGHT TOOL FOR THE JOB
- MAKES SURE IT IS IN GOOD CONDITION
- USES IT CORRECTLY
- PUTS IT AWAY SAFELY

CABLE PAIR IDENTIFICATION SET TYPE GP - TECHNICAL DETAILS

1. TONE SENDER CHARACTERISTICS

MODE	FREQ RANGE* (kHz)	REP RATE (Hz)	O/P (NO LOAD)	O/P (300 OHMS NIR LOAD)
High freq swept	14 -17 ± 10%	2.7 ± 0.2	2.25V + 20% - 10%	0.9V + 20% - 10%
High freq single	14 ± 0.1	-	2.25V + 20% - 10%	0.9V + 20% - 10%
Voice freq swept	1.2 -1.5 ± 10%	2.7 ± 0.2	2.45V + 20% - 10%	0.9V + 20% - 10%
Voice freq single	1.2 ± 0.1	-	2.45V + 20% - 10%	0.9V + 20% - 10%

* Waveshape is essentially sawtooth at point of generation and the output contains considerable harmonics.

Output balance with respect to earth : 34 dB (under 300 ohms load)

Output impedance (modulus) : High frequency, 450 ohms ± 20% @ 15 kHz
Voice frequency 530 ohms ± 20% @ 1 kHz

DC looping resistance : 1.0 k ohms ± 10%

Leg identification conditions, attenuation of signal at B terminal : High frequency not less than 40 dB
Voice frequency not less than 14 dB

CABLE PAIR IDENTIFICATION SET TYPE GP - TECHNICAL DETAILS

2. TONE RECEIVER (PROBE)

Input impedance	:	Greater than 5 M ohms for frequencies below 20 kHz
Freq. response	:	High frequency peak 14.5 kHz and 16.5 kHz ± 5% Voice frequency peak 1.4 kHz ± 10%
Local OSC	:	15.5 kHz ± 0.1 kHz
Gain	:	47 dB ± 4 dB
Max output	:	1.0V (8 ohms load)

3. LOW INPUT

Input impedance	:	3.3 µF ± 10%
Freq. response	:	Max. 0.9 kHz ± 0.1 kHz
Gain	:	Better than 38 dB.

4. BUZZER (CONTINUITY TESTER)

Freq.	:	400 Hz ± 20%
Level at Intercom line	:	-27 dBm ± 4 dB
Operating range	:	0 - 3000 ohms.

5. INTERCOM

Sending:	Output impedance	:	Not greater than 600 ohms @ 1 kHz
	Freq. response	:	Within 3 dB in the range 0.6-2 kHz
	Gain	:	56 dB
	Max Output	:	1.5V with 600 ohms load.
Receiving:	Input impedance	:	Not greater than 600 ohms @ 1 kHz
	Freq. response	:	Within 3 dB in the range 0.6 - 3 kHz
	Gain	:	32 dB
	Max output	:	1.0V $^{+25\%}_{-10\%}$ (8 ohms load).

6. MONITOR

Input impedance	:	950 ohms - 10% at 1 kHz
Gain	:	20 dB
Freq. response	:	Within 3 dB 0.4 - 2 kHz
Max. output	:	1.0V (8 ohms load)

7. POWER SUPPLY

Internal: 2 x 6V Lantern Cells. Serial 2/28. (Eveready Type 409)

External: 2 x 12 Volt lead/acid accumulator or equivalent.

CABLE PAIR IDENTIFICATION SET TYPE GP - TECHNICAL DETAILS

8. ACCESSORIES AND SPARES

Sender lead x 1	Serial 419/50
Speak lead x 1	419/51
Earth lead x 1	419/52
External battery lead x 1	419/53
Earphone piece (complete) x 1	419/44
Probe tip (50 mm) x 1	419/26
Probe tip (15 mm) x 1	419/27
Probe (complete with tip and lead) x 1	419/24
Pricker, Assembly	419/6
Lead, Pricker	419/18
Carrying strap	N/S
G.P. Set (Complete)	419/23

9. OVERALL DIMENSIONS (Includes Hinges, Handles and Latches)

Size: Length 320 mm, Width 260 mm, Height 200 mm.

Weight: 5.55 Kilograms.

INTERCOM SETS

DESCRIPTION

This Section will be issued at a later stage. The cable pair identification sets type GP (see section DF) and type A (see section DA), have intercom facilities that connect across a common speak circuit.

USE OF AMPOS EQUIPMENT -

TONE/SEARCH FAULT LOCATION AND CABLE TRACING

(See Section CC for
AMPOS FAULT LOCATOR AND CABLE AND METALLIC PIPE TRACER - DESCRIPTION)

PLAN RECORDS, MARKERS AND OTHER SURFACE INDICATIONS PROVIDE A VALUABLE KEY TO THE PRESENCE OF UNDERGROUND PLANT, BUT CANNOT BE RELIED ON TO ACCURATELY SHOW THEIR CORRECT LOCATION. HOWEVER, IF THE OPERATOR HAS RECIEVED ADEQUATE TRAINING IN THE USE OF HIS EQUIPMENT, IT IS POSSIBLE TO LOCATE UNDERGROUND PLANT AND THAT USED BY OTHER AUTHORITIES WITH SUFFICIENT ACCURACY FOR MOST PURPOSES.

Issue 2, 1981.

USE OF AMPOS EQUIPMENT

LOCATING CONDUCTOR TO EARTH FAULT IN BURIED PLASTIC CABLE

When a signal is applied to an earthed conductor by the Ampos OSCILLATOR, current flowing to earth through the fault sets up a potential gradient in the surrounding soil. The fault is located with the Ampos AMPLIFIER by sampling the voltage gradient along the route until the point of maximum tone intensity is located. This will be directly over the fault.

Testing Procedure

(i) Before using the Ampos equipment, localise and isolate the fault to the shortest section of cable possible, preferably less than 500 metres.

(ii) Connect the OSCILLATOR terminal marked "O" to an earth spike driven into the ground at least 2 metres away from the route of the cable under test otherwise the voltage gradient in the soil will mask the effect of any nearby fault.

(iii) Select a conductor showing the worst earth condition and connect it to one of the three terminals (3V, 10V or 50V) on the OSCILLATOR. The choice of the terminal will depend upon the severity of the fault, depth of cable and power hum level. Generally, the highest voltage selected will produce the strongest signal at the fault, but it may also increase crosstalk interference to working circuits. Several faulty conductors may be bunched to provide a higher leakage path to earth at the fault.

LOCATING CONDUCTOR TO EARTH FAULT IN BURIED PLASTIC CABLE (Continued)

(iv) Turn the switch in the OSCILLATOR to CONT (continuous tone). If it is subsequently found that electrical interference obscures the test signal, turn the switch to INT (interrupted tone).

(v) Switch the AMPLIFIER on and rotate the volume control to maximum level. Connect the SOIL PROBE to the red terminal of the AMPLIFIER. Hold the AMPLIFIER with a finger contacting the metal stud on the case and test the equipment by probing the ground in the vicinity of the OSCILLATOR earth spike. A loud tone should be heard. The equipment is now ready for use.

NOTE: When using modified Ampos equipment, with the lead provided, connect the soil probe to the "HI FILTER" input of the receiver. The metal stud of the Amplifier is replaced by a metal section fitted on the probe. The equipment can be tested by touching this metal section and probing the ground.

(vi) Search for fault by walking about 1 metre to one side of the cable route and probe the ground directly over the line of the cable. Keep a finger on the metal stud/section as this completes the circuit to enable the instrument to detect the potential difference between the SOIL PROBE and the operator's feet. Little or no tone will be heard until the region of the fault is reached, where the intensity of the tone will rise and be the highest directly over the fault (see Fig. 1).

(vii) To pin-point the fault, stick the SOIL PROBE into the ground approximately 1.5 metres from the line of the cable in the region where the intensity of the tone is the highest and explore the ground with:

(a) A short bare metal probe, such as a 15 centimetre screwdriver with an uninsulated handle, held in the free hand, but maintain the finger/hand in contact with the metal stud/section of the AMPLIFIER.

USE OF AMPOS EQUIPMENT

LOCATING CONDUCTOR TO EARTH FAULT IN BURIED PLASTIC CABLE (Continued)

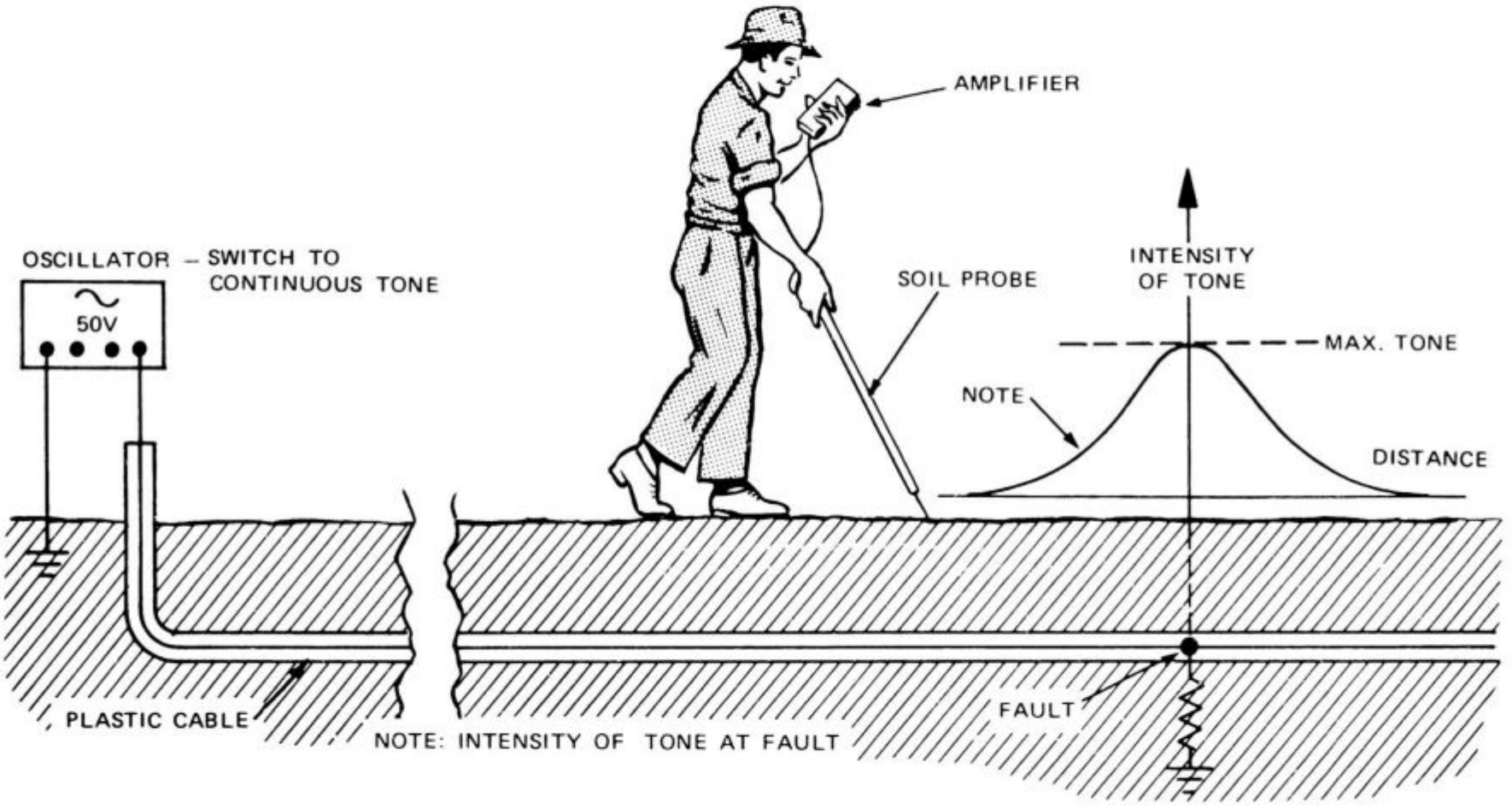


FIG. 1. LOCATING AN EARTH FAULT IN BURIED PLASTIC CABLE WITH SOIL PROBE.

LOCATING CONDUCTOR TO EARTH FAULT IN BURIED PLASTIC CABLE (Continued)

(b) A short metal probe with an insulated handle, such as a 15 centimetre screwdriver connected by a lead from the metallic part of the screwdriver to the black terminal of the AMPLIFIER to increase the input. Do not allow the hand or fingers to touch the metal stud of the AMPLIFIER while using this method of pin-pointing the fault.

NOTE: When using modified Ampos equipment, the lead is connected between the metallic section fitted on the Ampos Probe and the metallic section of the short metal probe. Do not allow the hand or fingers to touch the metallic section of the probe when pin-pointing the fault.

(viii) Good results in pin-pointing the fault may be obtained by the use of an "A Frame" (see Fig. 2), the output of which is connected to red and black terminals of the AMPLIFIER or in the modified Ampos equipment, to the "HI FILTER" input of the receiver. Do not allow the hand or fingers to touch the metal stud/section of the AMPLIFIER when using an "A Frame". The "A Frame" is not supplied with the equipment but may be constructed locally if required.

TRACING METAL SHEATHED CABLE, PLASTIC SHEATHED CABLE OR METALLIC PIPE

(i) Connect the OSCILLATOR output between the sheath of a lead covered cable or metallic pipe and an earth spike driven into the ground approximately 6 metres away from the route of the structure (see Fig. 3(a)).

FOR PLASTIC INSULATED CABLE connect the OSCILLATOR between the earth spike and a conductor which must be earthed at the far end for satisfactory results.

(ii) Turn the switch in the OSCILLATOR to CONT (continuous tone). If it is subsequently found that electrical interference obscures the test signal, turn the switch to INT (interrupted tone).

LOCATING CONDUCTOR TO EARTH FAULT IN BURIED PLASTIC CABLE (Continued)

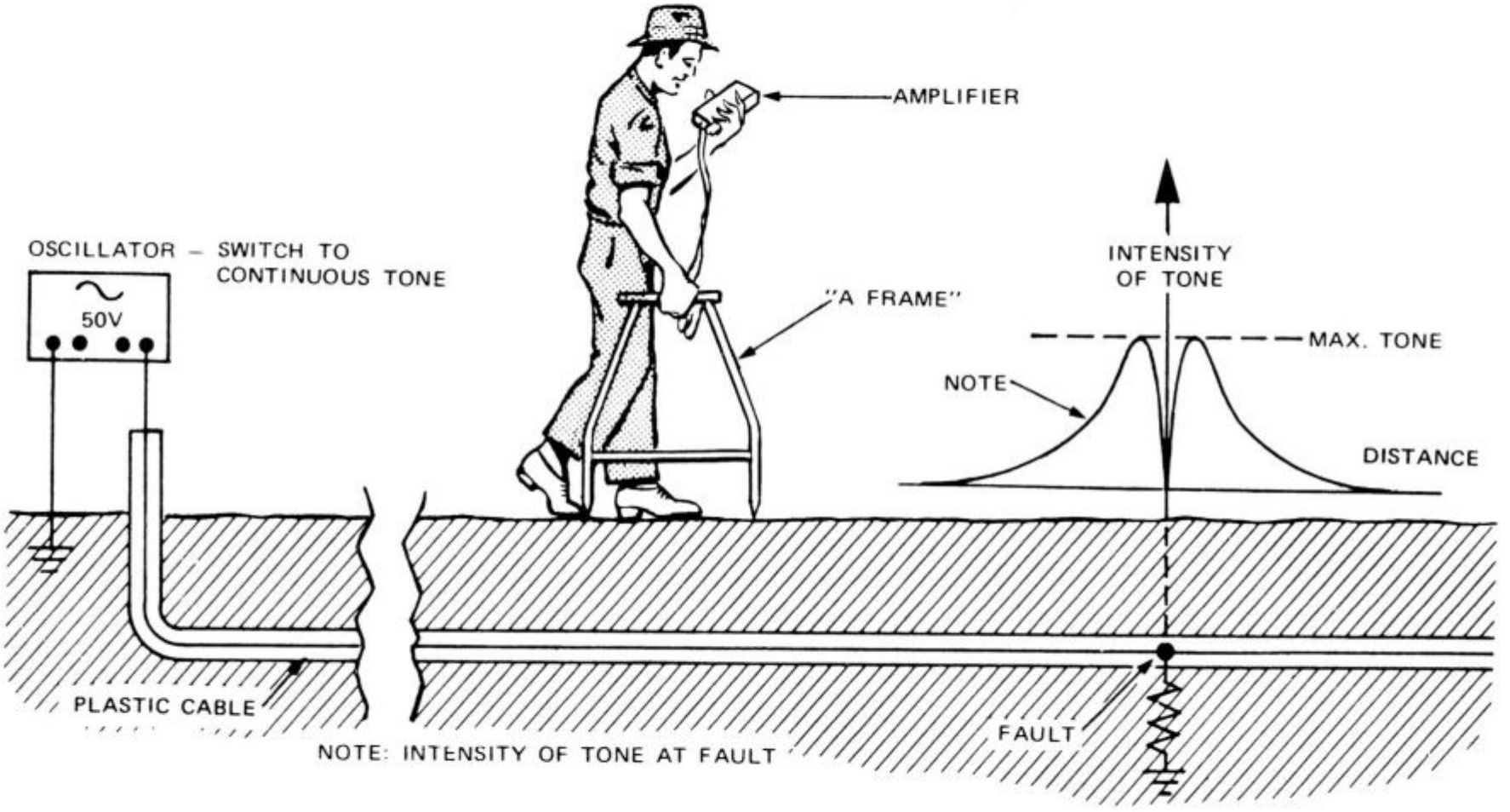


FIG. 2. LOCATING AN EARTH FAULT IN BURIED PLASTIC CABLE WITH "A FRAME".

TRACING METAL SHEATHED CABLE, PLASTIC SHEATHED CABLE OR METALLIC PIPE (Continued)

(iii) Connect the MAGNETIC COIL PROBE to the AMPLIFIER input terminals by means of the red and black leads.

NOTE: When using modified Ampos equipment, with the lead supplied, connect the "MAGNETIC COIL PROBE" to the receiver "LO-FILTER" input.

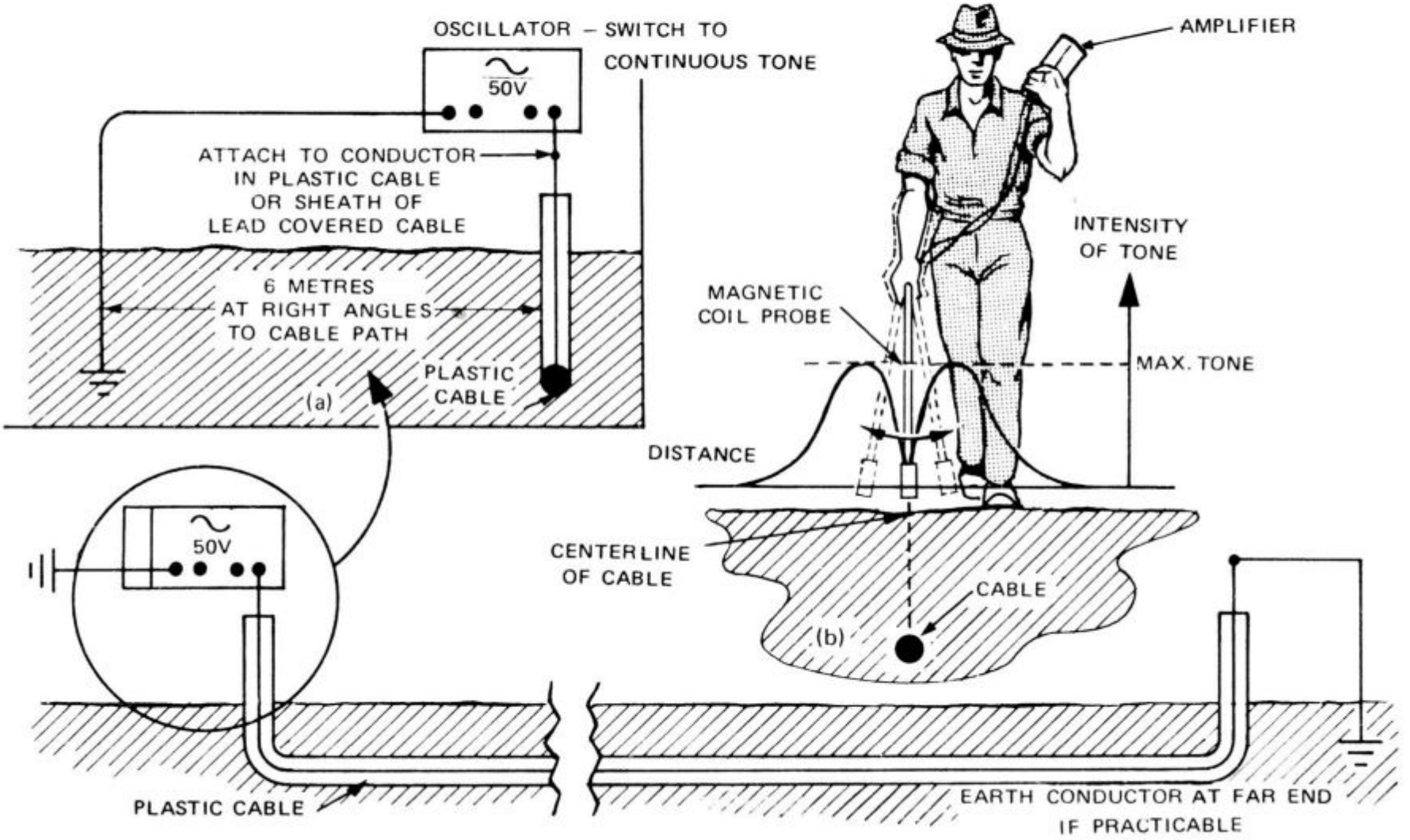
(iv) With the MAGNETIC COIL PROBE held near the cable or pipe rotate the volume control until tone is heard. The equipment is now ready for use.

(v) Trace the centreline of the cable or pipe with the MAGNETIC COIL PROBE held vertically. Minimum tone will be heard when the MAGNETIC COIL PROBE is directly over the centreline of the structure. As the MAGNETIC COIL PROBE is moved away the tone intensity will rise to a maximum a few centimetres away from the centreline of the structure and then diminish as the distance increases (see Fig. 3(b)).

NOTE: Do not allow the hand or fingers to touch the metal stud/section of the AMPLFIER during the tracing operation.

(vi) Where pin-point centreing is required, progress down the length of the cable or metallic pipe marking the centreline of the structure with chalk or pegs.

TRACING METAL SHEATHED CABLE, PLASTIC SHEATHED CABLE OR METALLIC PIPE (Continued)



Issue 2, 1975. FIG. 3. TRACING PATH OF PLASTIC CABLE WITH MAGNETIC COIL PROBE.

USE OF AMPOS EQUIPMENT

TRACING METAL SHEATHED CABLE, PLASTIC SHEATHED CABLE OR METALLIC PIPE (Continued)

(vii) When tracing long cables or metallic pipes situations may arise where, due to excessive distance between the OSCILLATOR and the AMPLIFIER, the tone in the vicinity of the structure may fade. In such cases transfer the OSCILLATOR and the earth spike closer to the amplifier.

MEASURING DEPTH OF CABLE OR METALLIC PIPE

(i) Connect and test the OSCILLATOR and the AMPLIFIER as outlined in paragraphs (i), (ii), (iii) and (iv) on pages JA-5 and JA-7.

(ii) Locate and mark the centreline of the cable or metallic pipe.

(iii) Incline the MAGNETIC COIL PROBE at an angle of 45^{o} to the ground (a 45^{o} angle is obtained when $d_1 = d_2$, see Fig. 4).

(iv) Walk slowly away from the centreline at right angles (crosswise), keeping the MAGNETIC COIL PROBE at 45^{o} to the ground, until a NULL point (minimum intensity of tone) is reached.

(v) The depth of the structure (X) equals the horizontal distance between the centreline and the bottom tip of the MAGNETIC COIL PROBE (see Fig. 4).

MEASURING DEPTH OF CABLE OR METALLIC PIPE (Continued)

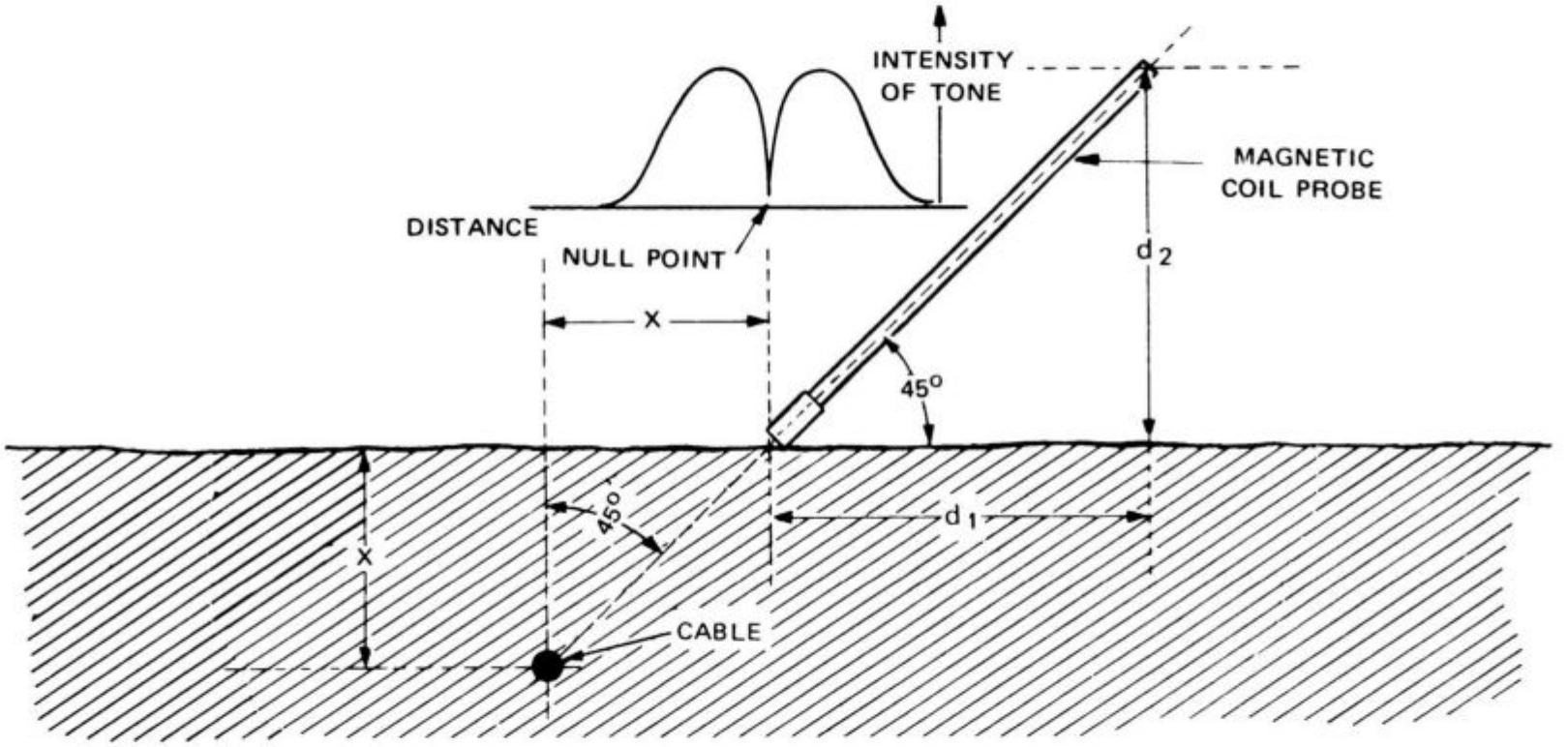


FIG. 4. MEASURING CABLE DEPTH WITH MAGNETIC COIL PROBE.

LOCATING CONDUCTOR TO CONDUCTOR FAULT

In many cases conductor to conductor faults are associated with conductor to earth faults, particularly in plastic cables. In these cases the fault is located with the Ampos AMPLIFIER and SOIL PROBE or "A Frame" by sampling the voltage gradient along the cable route until the point of maximum tone intensity is located (see Figs. 1 and 2).

Where conductor to conductor fault is not associated with earth fault(s) very little signal is radiated from the shorted conductors before the S/C is reached making it difficult to notice the reduction of tone intensity which is taking place as the fault is passed. Faults up to 5000 ohms in cable buried up to 60 centimetres deep may be located using the MAGNETIC COIL PROBE.

Testing Procedure

(i) Isolate faulty conductors at a box or pillar and connect one conductor to the 50 volt red terminal of the OSCILLATOR and the other conductor to the black terminal.

(ii) Turn the switch in the OSCILLATOR to CONT (continuous tone). If it is subsequently found that electrical interference obscures the test signal, turn the switch to INT (interrupted tone).

(iii) Connect the MAGNETIC COIL PROBE to the terminals/LO FILTER terminal of the AMPLIFIER.

(iv) Switch the AMPLIFIER on and rotate the volume control to maximum level. The equipment is now ready for use.

(v) Walk carefully along the cable route holding the MAGNETIC COIL PROBE close to the ground.

(vi) If the cable is not too deep (less than 600mm) and if there is sufficient current passing through the conductors tone will be heard, decreasing at the fault (see Fig. 5).

LOCATING CONDUCTOR TO CONDUCTOR FAULT (Continued)

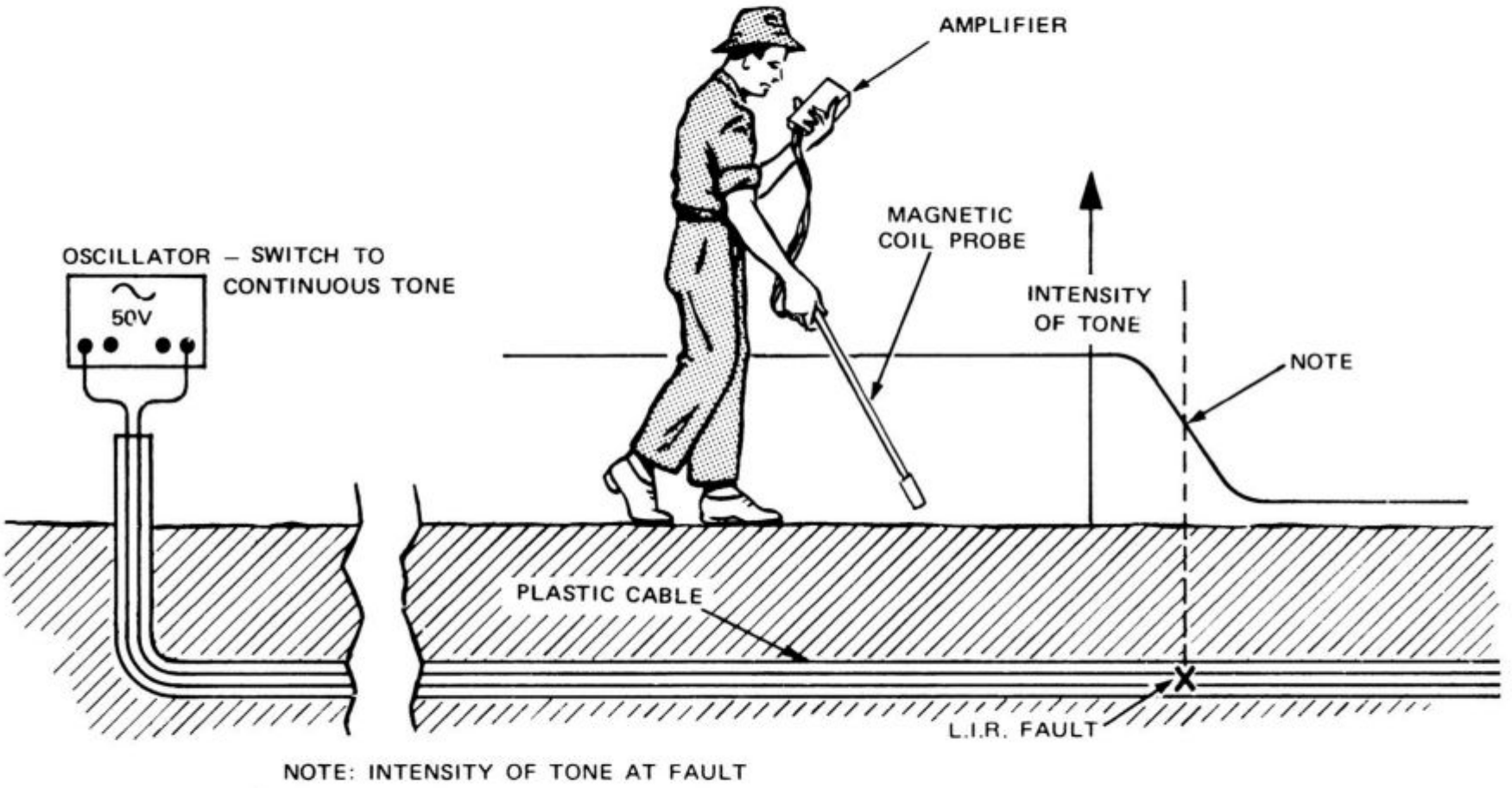
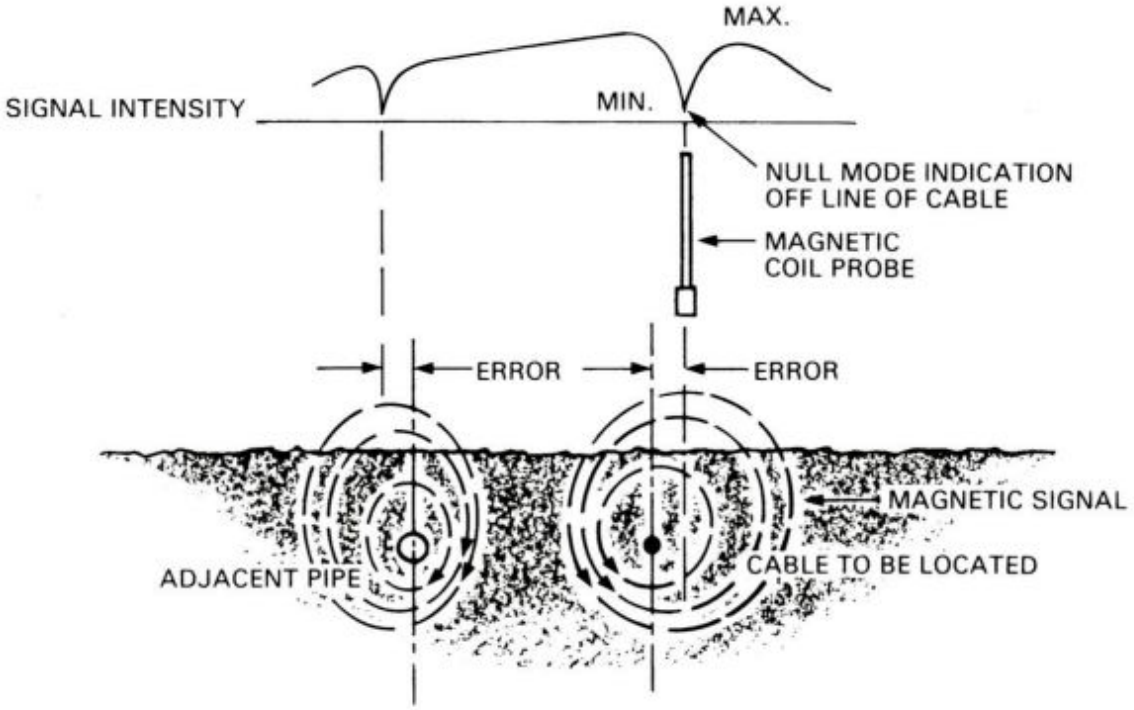


FIG. 5. LOCATING CONDUCTOR TO CONDUCTOR FAULT IN PLASTIC CABLE WITH MAGNETIC COIL PROBE.

PROBLEMS WHEN LOCATING

Locating and depthing of underground plant is frequently complicated by the presence of other buried services. Any nearby conductive structure in contact with the earth will pick up a portion of the signal current and itself radiate a magnetic signal similar to that being located. This also distorts the magnetic signal of plant being identified and produces a peak (tone) or null location displaced from the correct cable alignment.



RETURN CURRENT IN ADJACENT STRUCTURE DISTORTS MAGNETIC FIELD AND CAUSES ERROR IN NULL LOCATION

The size of such error resulting from a single interfering structure and the number of nulls and peaks occurring depends on a number of factors, the most important being:

(i) The depth of the cable or pipe.

(ii) The distance between cable and pipe.

(iii) Their resistance to ground.

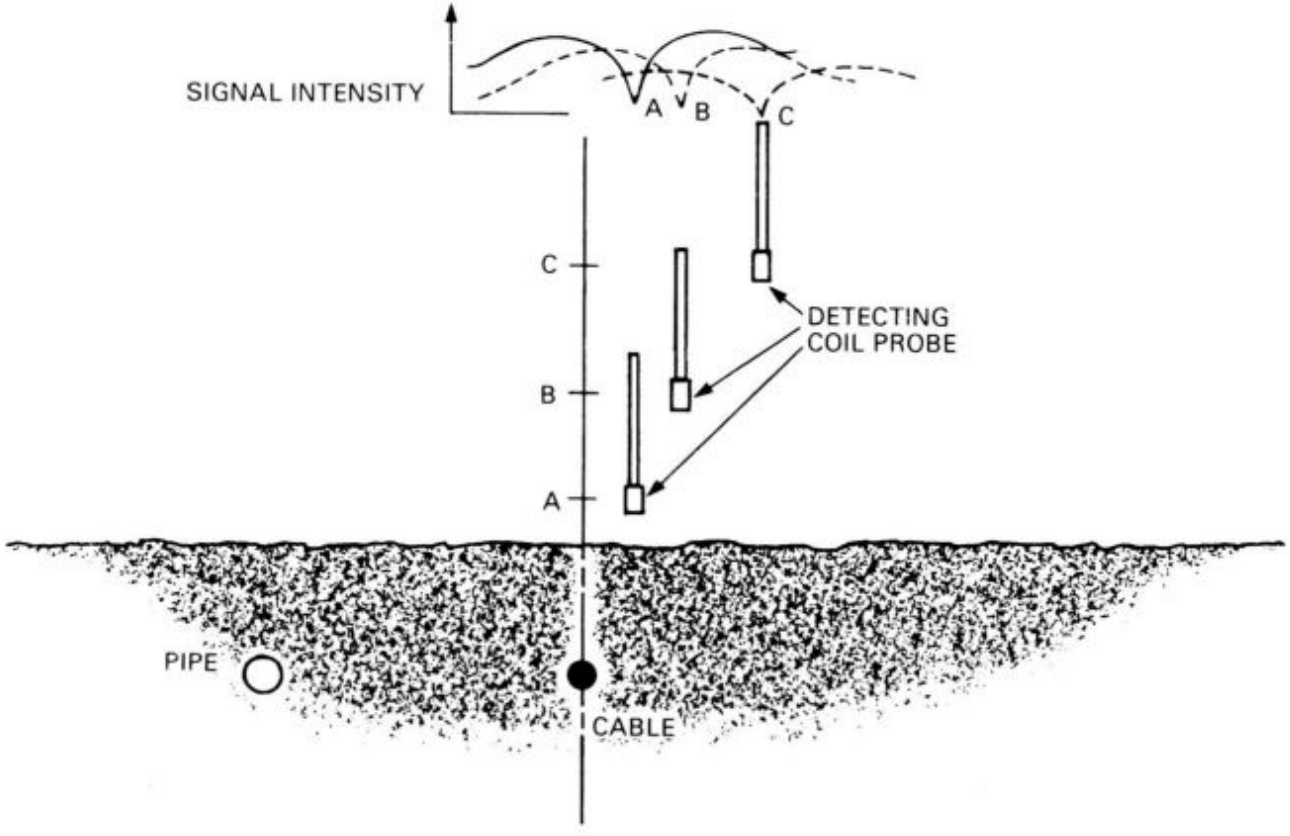
(iv) The earth resistivity.

(v) The location of the transmitter earth stake relative to the water pipe (if conductively coupled).

Distortion of the magnetic signal may also produce a significant error in the measurement of depth when using the 45° NULL method (See page JA-9). The error may be as great as 80% or even worse and will depend on which side of the route the measurement is made.

HOW TO GET BEST RESULTS WHEN LOCATING

When interference from an adjacent structure occurs, the error produced will increase with the depth of the structure. Since the error is related to the vertical distance between the service being located and the Magnetic Coil Probe, care should be exercised to ensure that the detecting probe is operated as close to the ground as possible.



VARIATION IN ERROR WITH CHANGE IN AMPLIFIER HEIGHT

MINIMISATION OF ERRORS

To prove the accuracy of location and depth measurement adopt the same procedure described in Section L page No. 27. "Minimisation of Errors".

LOCATING POWER CABLES

If the premises has a light dimmer installation, arrange for it to be turned on and adjusted until the lights are just glowing. The receiver and probe of the Ampos can then be used to locate the cable (when using modified Ampos equipment use the receiver High Impedance No Filter input).

If no light dimmer is installed and the MEN system is used as the power supply, it is possible to use the Ampos Oscillator to transmit a signal from the power earth terminal (See Section L-28 "Locating Power Cables") but the cable cannot be traced as far from the transmitter as with the Fisher M-Scope or Detectron.

USE OF PULSE ECHO TESTER ON COAXIAL AND PAIR CABLES

This Section will be issued at a later stage.

USE OF TYPE GP SETS - IDENTIFICATION OF WORKING RANDOM JOINTED CABLES

(See Section DF for CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION AND TECHNICAL DETAILS)

(See Section T for CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLES OF HIGH IMPEDANCE TONE SEARCH)

KF-2

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

GENERAL

The Cable Pair Identification Set, Type GP, is a compact portable unit for rapidly and accurately identifying cable pairs in large size random jointed cables.

When working on unloaded cable pairs, identification of subscribers circuits can proceed without causing interference or interruption to telephone conversations. This is achieved by using an identification signal in the range of 14 kHz to 17 kHz which is outside the response of the normal telephone.

A signal in the range of 1.2 kHz to 1.5 kHz is also provided for situations where the high frequency signal is unsuitable such as:

(a) Loaded cable identification.
(b) Operation with other type sets ie, the "A" or "F" set.

The VOICE FREQ. signal cannot be used on working telephone circuits without causing severe interference to normal voice frequency transmission.

When identification of special circuits is necessary eg, datel lines, telex lines, tie lines, carrier circuits, alarms etc, it is important that interference to working circuits is kept to a minimum. When using the high impedance identification technique "NORMAL (HF)" it is important that the circuit under test is balanced. This can be done by using the LOOP ON key located on the front panel layout (See Fig. 1).

SET CHECK PROCEDURES

It is essential that the GP set be operating correctly before being used on a job. Considerable time can be wasted in searching for faults which may appear to be caused by unbalances on the cable pair but are really due to a malfunction of the set or defective leads. A quick check procedure has been established and this will be discussed first.

Issue 1, 1981.

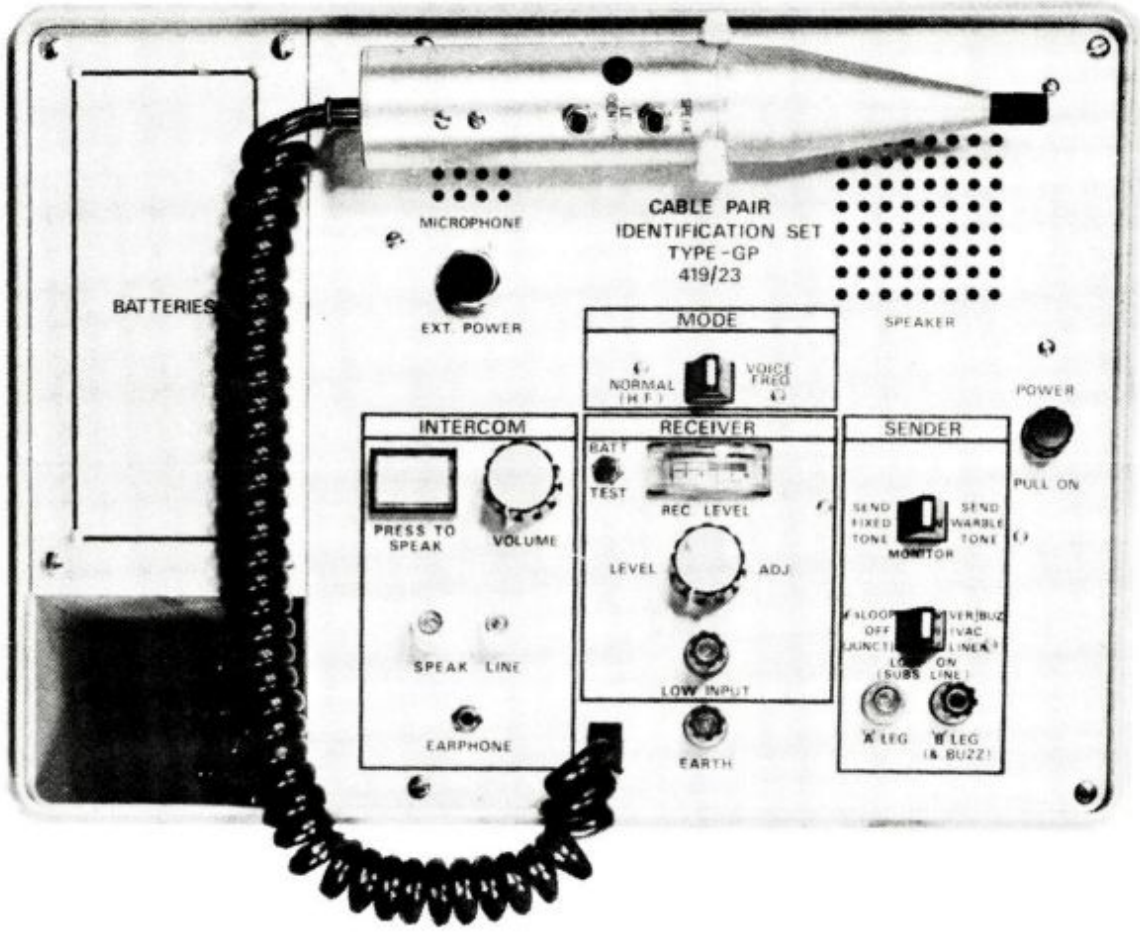


FIG 1 FRONT PANEL LAYOUT

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

SET CHECK PROCEDURES (Cont) (See control panel layout page KF-3)

(a) Remove lid and switch set on.

(b) Switch the monitor Key to "SEND FIXED TONE". Operate the "PRESS TO SPEAK" and "BATT. TEST" switches. The meter should read in the "battery OK" section, if not, check battery connections and/or replace both batteries.

(c) Operate controls as follows:

- SENDER Keys - "SEND FIXED TONE" and "LOOP OFF" position
- MODE Key - "NORMAL (HF)"
- RECEIVER Level control to mid position.

(d) Place tip of probe near the "A" and "B" leg terminals, tone should be heard, varying in volume as the distance between the probe tip and terminals is changed.

(e) Test for a null by placing tip of probe midway between the "A" and "B" leg terminals. If a null is not located approximately midway between the terminals, the set should not be used for sending purposes.

(f) If the null is present check the "LEG IDENTIFY" function by placing the probe tip on the outside of "B" leg terminal and operating the "LEG IDENTIFY" button. The light (LED) on the probe should operate and the tone at the "B" leg terminal should decrease sharply - tone at "A" leg should not alter in level.

NOTE: Sometimes a small increase in level will occur on the "A" leg when the "LEG IDENTIFY" button is operated. This is acceptable.

(g) Repeat tests (c) to (f) with mode key in "VOICE FREQ" position.

SET CHECK PROCEDURES (Cont)

(h) Check operation of warble tone by leaving the "MODE" key in "VOICE FREQ" and placing the sender key in the "SEND WARBLE TONE" position. Hold the probe tip near the "A" and "B" leg terminals - a distinctive warble tone should be heard.

(i) Adjust the intercom "VOLUME" control to halfway, operate the "VERIFY/BUZZ" key on the sender and place a short circuit across "A" and "B" leg terminals. A buzz should be heard.

(j) All leads can now be checked by plugging into the sender terminals ("A" and "B"). Short the ends of the leads together and check for the buzz. It is good practice to manipulate the leads during this test to detect possible open circuits.

(k) To check the intercom receive function, connect a test lead from the sender terminals ("A" and "B" leg) to the intercom "SPEAK LINE" terminals. Operate the mode key to "VOICE FREQ" and the sender key to "SEND WARBLE TONE"- the warble tone should be heard and the level of signal should be controlled by the "VOLUME" control.

(l) To check the intercom transmit function operate the "PRESS TO SPEAK" switch on the set and tap the front panel near the microphone - the "REC LEVEL" meter needle should respond to the tapping. Repeat procedure using "SPEAK" button on probe.

NOTE: Where the operator experiences difficulty in identifying pairs during field use, he can verify the operation of the GP set and its leads by completing the check procedure above.

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

INTERCOM

The intercom system provides for loudspeaking intercommunication between a number of test locations. The GP sets are connected in parallel across a spare cable pair. Connection is made by using the lead supplied and connecting to the "SPEAK LINE" terminals.

It is important that the line chosen for the intercom is a vacant, non-faulty (balanced) pair, as the intercom line is used as a control circuit for the leg identify function on all sets connected to that line.

The set is normally in the receive mode (able to receive transmission) and the level of the received speech can be adjusted by the "VOLUME" control. The internal speaker is switched out of service when the earphone piece is plugged into the "EARPHONE" jack. To transmit speech operate either the "PRESS TO SPEAK" button or the probe "SPEAK" button, and direct speech towards the front panel microphone.

The level of transmitted speech is not adjustable.

ESTABLISHING INTERCOM PAIR

To eliminate time wastage in establishing a speaking circuit in random jointed cable, using the GP set (See Fig 2 page KF-8), adopt the following procedure using an unloaded cable pair:

At the A end of the test Section (Sending End)

(i) Connect the earth lead to the cable sheath, or secure to a good earth.
(ii) Select a vacant fault free pair to be used as the intercom pair.

ESTABLISHING INTERCOM PAIR (Cont)

(iii) Connect the "SPEAK LINE" terminals to the selected pair.

(iv) Connect the "SENDER" terminals to the selected pair.

(v) Adjust the controls of the GP set as follows:

- Pull "POWER" switch ON.
- Set "MODE" key to "NORMAL (HF)"
- Set sender keys to "SEND WARBLE TONE"
- Set INTERCOM "VOLUME" control to approximately halfway.

At the B end of the Test Section (Receiving End)

(i) Connect the earth lead to the cable sheath, or secure to a good earth.

(ii) Adjust the controls of the GP set as follows:

- Pull "POWER" switch ON
- Set "MODE" key to NORMAL (HF)
- Set "RECEIVER" "LEVEL ADJ" control to approximately halfway.

(iii) Using the PROBE locate the speak pair. (See Fig. 2).

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

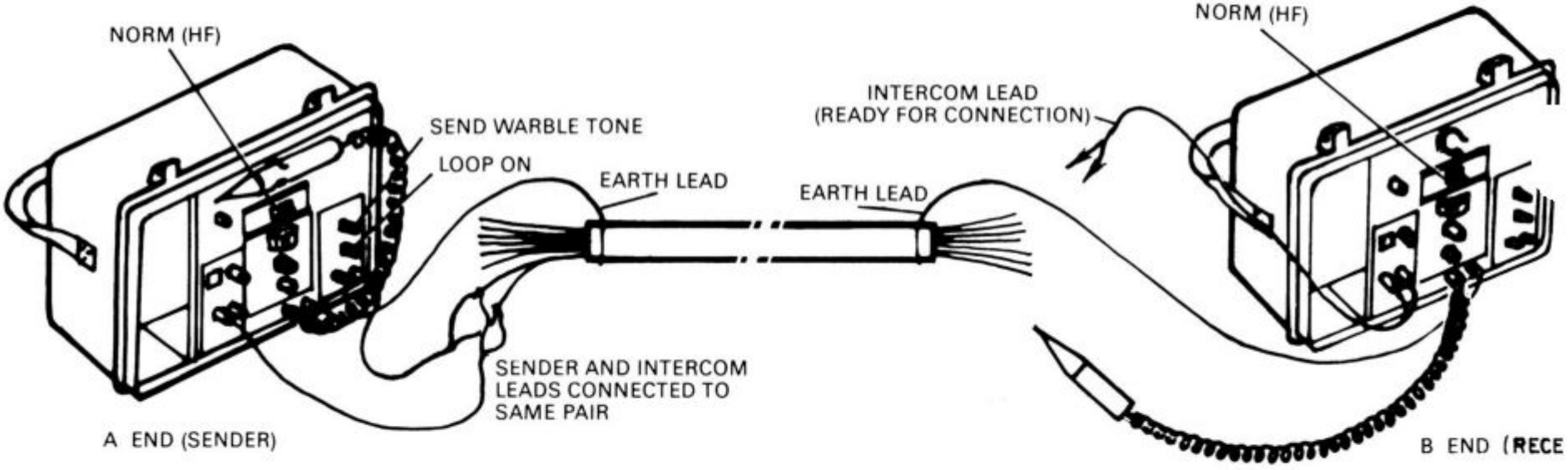


FIG 2 LOCATING SPEAK PAIR

ESTABLISHING INTERCOM PAIR (Cont)

(a) When the pair is located, use the speak lead to connect the pair to the "SPEAK LINE" terminals.

(b) Adjust the Intercom "VOLUME" control to halfway and operate the "PRESS TO SPEAK" switch and talk to A end. Release the "PRESS TO SPEAK" switch and wait for the A end to acknowledge.

NOTE: If "PRESS TO SPEAK" is held operated you will not be able to hear the person at the A end.

(c) The A end should acknowledge the call from B end by operating "PRESS TO SPEAK" switch and talking.

(d) Restore the sender key to "MONITOR" position and remove the sender lead from the speak pair.

SENDING IDENTIFICATION SIGNAL

Selection of Frequency Band:

Two frequency bands are available and these are selected by the operation of the "MODE" key situated on the Front panel layout (See Fig 3). The "NORMAL (HF)" position is used on unloaded cable pairs and this tone can be connected to working, and in use, telephone services without causing interference to the transmission.

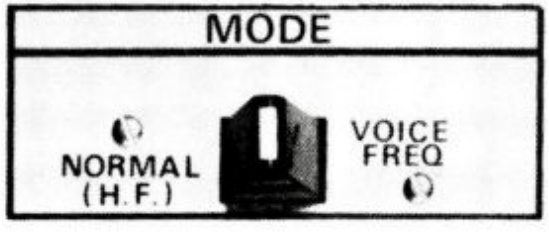


FIG 3 MODE KEY LOCATION

Selection of Frequency Band (Cont)

NOTE: With the key either upright or moved to the left, the set is in the "NORMAL (HF)" mode. Only when the key is moved to the right is the set in the Voice Frequency "VOICE FREQ" mode.

The "VOICE FREQ" position transmits signals in the voice frequency range and is intended for use on loaded circuits or on long unloaded lines where attenuation of the high frequency signal is excessive. In this mode the signal should not be applied to circuits whilst a conversation is in progress as interference to speech transmission will occur. Use of the GP set in either mode or with the "LOOP ON (SUBS LINE)" key operated may cause interference to Special Services such as alarm pairs, telex, datel and carrier circuits. To minimise interference to these services contact the telephone exchange to determine suitable arrangements for the identification of all special circuits.

Selection of Tone

In both "NORMAL (HF)" and "VOICE FREQ" modes the tone may be either a "WARBLE" (swept) tone or a "FIXED" (single) tone. Generally the selection of one tone or the other is a matter of individual likes or dislikes of the receiving or searching officer. However, under certain conditions, especially for leg identification, it is beneficial to use the single tone. Where there is difficulty in detecting the difference in levels on the two wires due to high ambient noise or for a long circuit where the signal is highly attenuated, it is recommended that the "FIXED" tone be used. Tone is selected using the sender key. (See Fig. 4).

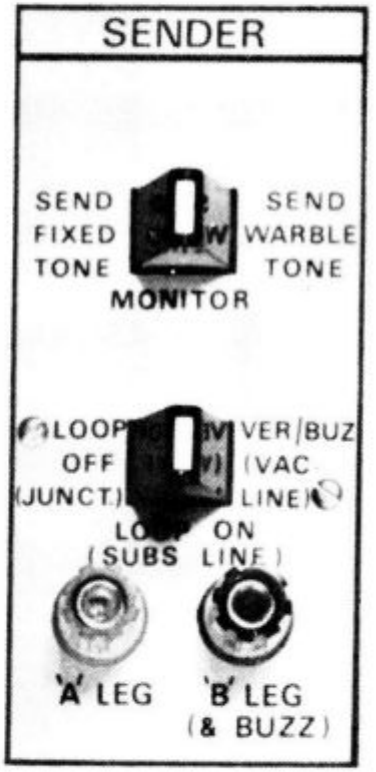


FIG 4 TONE AND LOOP KEY LOCATION

Selection of Output Conditions

Unless the sender is connected to a balanced cable pair, difficulty may be experienced in correctly identifying the pair due to tone spread through the cable. For normal telephone services which are not in use, the circuit must be brought to a balanced condition. This is achieved by operating the loop key to "LOOP ON (SUBS LINE)" which applies a dc loop of 1000 ohms across the circuit causing the exchange equipment to bring the circuit into balance. (See illustration page KF-10 for location of "LOOP ON (SUBS LINES)" position).

Junction circuits are normally in the balanced mode. The "LOOP OFF (JUNCTIONS)" position should be used when identifying junction circuits as it removes the dc loop and lessens the shunt effect of the sender across the circuit. It is also best to the use this position when identifying normal telephone circuits which are in use at the time. On vacant lines either condition may be used.

Another facility available for use on vacant lines is utilised by operating the "VERIFY/BUZZ (VAC LINE)" key. The buzzer will operate on all sets (provided they are all connected to the same speak line), when a loop (s/c) is applied to the cable pair which is connected to the sender terminals. This facility is useful when identifying vacant cable pairs that are rotational jointed or for verification testing of vacant tagged pairs in random jointed cables. All operators hearing the buzz tone may automatically transfer to the next pair without any further instruction from the controlling operator.

NOTE: The buzzer will also operate if the "B" LEG (& BUZZ)" terminal is connected to earth.

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

How to connect tone to a Pair

To connect the sending system of the GP set to a pair of wires, adopt the following procedure:

(i) Select the red and black accessory leads supplied with the GP set.

(ii) Plug the adaptor ends of the lead into the jacks marked "A" leg and "B" leg ensuring that the red leg adaptor is placed into the red jack ("A" leg) and the black lead adaptor is placed into the black jack ("B" leg).

(iii) Connect the other ends of the lead to the selected pair ensuring the red lead goes to the "A" leg and black lead goes to the "B" leg of the pair.

(iv) With the sender key in the "MONITOR" position listen for conversation on the line. If conversation is in progress ensure set is in "NORMAL (HF)" mode and then send tone by switching to "SEND WARBLE TONE" or "SEND FIXED TONE". If there is no conversation in progress loop the line by operating the loop key to "LOOP ON (SUBS LINE)" to bring the line into a working balanced condition. This procedure will minimise interference to operation of the customers line.

RECEIVING IDENTIFICATION SIGNALS

Electrostatic (High Impedance):

The search probe is used to explore the electric field created by the identification signal. It is unnecessary to make metallic contact with the pair carrying the signal to positively identify both legs of the pair.

Selection of Frequency Range

Operation of the "MODE" key will select the range of frequencies "NORMAL (HF)" or "VOICE FREQ" for the sender, it also selects the same frequency range for receiving. This occurs automatically where the sending and receiving is being carried out by the same set. Where more than one set is being used to send or receive it is essential that the "MODE" key on all sets is in the same position, i.e. all sets on "NORMAL (HF)" or "VOICE FREQ".

Receive Level

The level of received tone is adjusted by the "REC LEVEL" control (See Fig 5) and should be such that the operator can distinguish the difference in levels between the "a" and "b" wires under leg identification conditions. If the level is too high this can become difficult. In addition the continued high level output from the speaker shortens the life of the internal batteries.

Generally the internal speaker will be used by the operator to interpret the signals picked up by the probe, however, two other facilities are available for use under difficult conditions i.e., use of an earphone or use of the meter.

Earphone Jack

Under conditions of high ambient noise, or where the normal output from the inbuilt speaker may cause a disturbance to others, the "EARPHONE JACK" can be used (See Fig 5).

The internal speaker is disconnected when the earphone is plugged in and all received signals (intercom, identification and monitor), will be heard through the earphone.

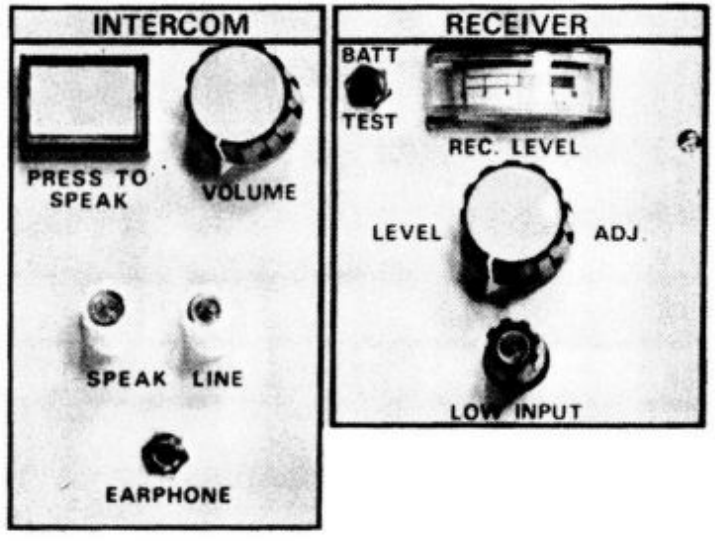


FIG 5 RECEIVE LEVEL CONTROL METER AND EARPHONE JACK LOCATION

BE CONSTANTLY ON GUARD AGAINST AN ACCIDENT AND DO NOT COMMENCE A JOB UNTIL YOU ARE SURE THAT YOU CAN WORK IN SAFETY.

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

Receive Level Meter

The "REC LEVEL" meter will indicate levels of all signals received by the GP set, i.e. intercom, probe signals and signals from the low impedance input ("LOW INPUT"). The "REC LEVEL" meter will also indicate signal levels transmitted through the intercom. Under conditions where identification signal suffers excessive attenuation the meter can be used to assist leg identification by enabling smaller changes in signal level to be distinguished.

Identifying with the Probe

The probe should be held so that the thumb can be used to operate either the "LEG IDENTIFY" or "SPEAK" buttons without interrupting the search procedure.

To locate a pair in an unterminated cable, hold as many of the pairs as practicable in one hand, spreading the pairs slightly.

Run the tip of the probe across the wires (See Fig 6) until identification signal is detected.

FIG. 6 LOCATING A PAIR IN UNTERMINATED CABLE

DO NOT TREAD ON CABLES WHEN ENTERING OR LEAVING MANHOLES.

Searching for Pair

"Home in" on the pair by moving the probe in the vicinity of where the tone appeares to be loudest. Experience has shown that once an approximate location is noted it is best to divide the group of pairs (See Fig 7), by doing this the search can be very quickly narrowed down to a few conductors and the wanted pair easily located.

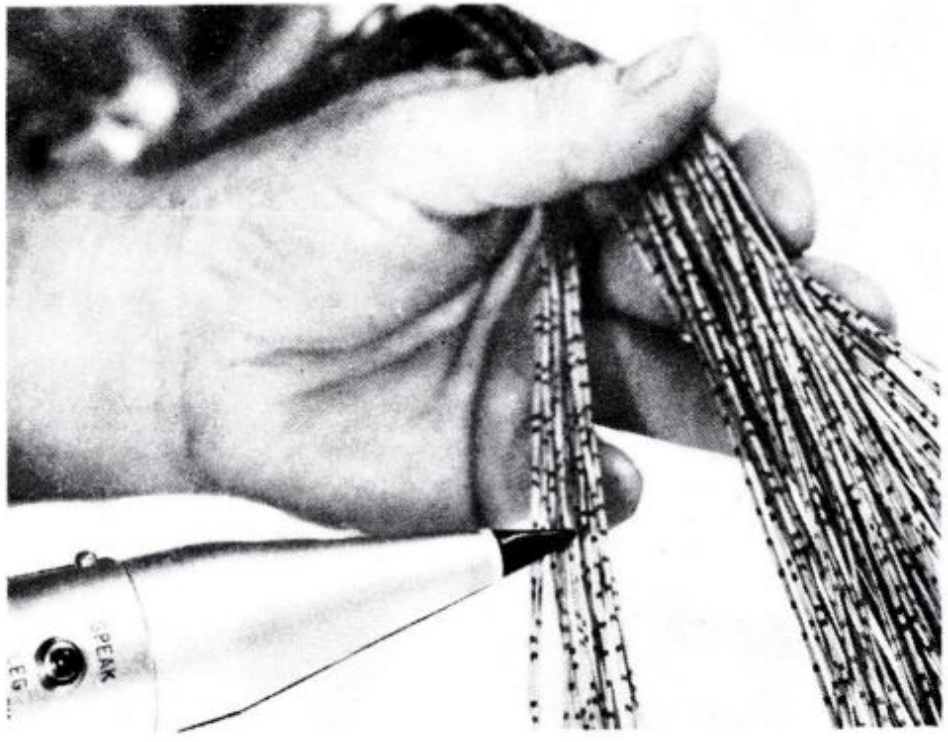


FIG 7 DIVIDING THE GROUP OF PAIRS

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

Isolating the Pair

The pair with the loudest signal should be easily isolated (unless some fault condition exists). It is essential that this selection be confirmed by checking that a NULL i.e. minimum signal exists when the probe tip is located midway between the two wires of the pair (See Fig 8). The tip of the probe can be used to spread the wires apart, 20 mm or so should be sufficient. Then move the probe tip back and forwards near the centre ensuring the null is present.

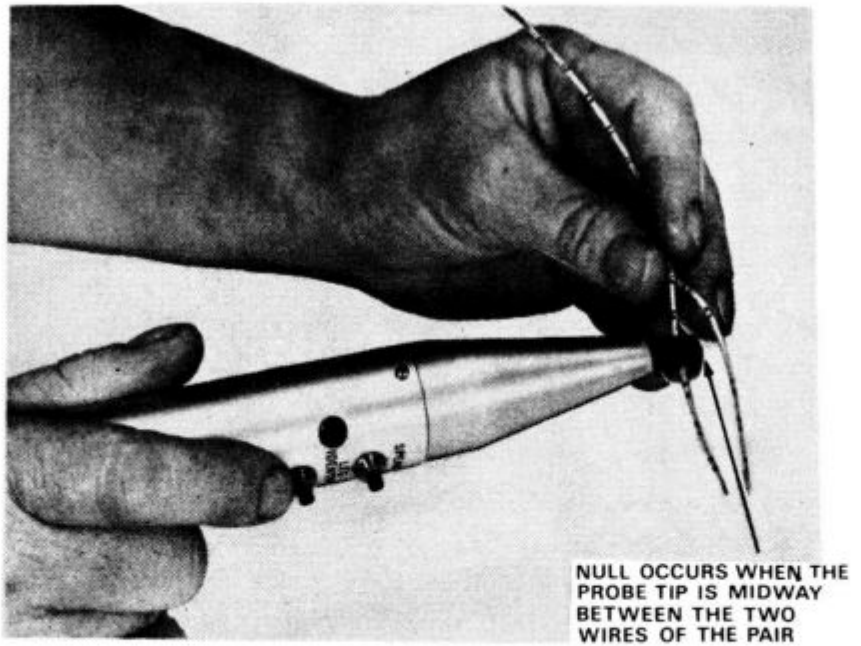


FIG 8 CHECKING THE NULL

The presence of the NULL ensures that the identification is correct.

NOTE: Unless the NULL is detected you cannot be sure that you have the correct two wires.

Lack of a NULL indicates that:

(a) The circuit connected to the pair is unbalanced. (Operation of the "LOOP ON (SUBS LINE)" key may bring the circuit into a balanced condition) or

(b) The test leads are faulty or

(c) The GP set is faulty or

(d) The pair is faulty.

Leg Identification

Connection of leads.

The set can only identify which wire is connected to the "A LEG" or "B LEG (& BUZZ)" sender terminal.

The sender terminals and sender lead are colour coded i.e. red for "A" LEG and black for "B" LEG, and it is important that the leads are connected in the correct manner, especially when leg identification is required.

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

The "LEG IDENTIFY" button on the probe controls the leg identify function. Operation of the "LEG IDENTIFY" button causes a control signal to be transmitted via the speak lines. This control signal removes the identification signal from the B leg terminal of the sender of all GP sets which are connected to that speak line. The return path for the control signal is via earth, therefore it is important that all sets have their earth terminal connected to a good common earth e.g., cable sheath, or a spare wire in the cable.

Once a NULL has been detected (See Page No. KF.16) it is a simple matter to identify the "a" and "b" legs of the pair. Hold the probe against the outside of each wire and operate the "LEG IDENTIFY" Button. Listen for a change in tone level as the button is pressed. The b leg will be the wire on which there is a decrease in tone level as the "LEG IDENTIFY" Button is pressed. The meter on this set can be used to observe changes in signal level where the change in signal level is small.

Probe Light

The light on the probe glows when the "LEG IDENTIFY" button is depressed - it will glow on the probes of all sets which are connected to the common speak line. The purpose of this light is to indicate to operators that the leg identify function is operating and that all sets which are sending will have the tone disconnected from the "B LEG" terminal. Searching must cease at the other test points as tone will spread to other pairs in the cable which will create difficulty in correctly locating pairs.

BEFORE SEALING JOINTS IN MOISTURE BARRIER CABLES, MAKE SURE THE ALUMINIUM SCREEN IS ELECTRICALLY CONTINUOUS AND THE CONTINUITY WIRES SECURE.

It is important to realise that the "LEG IDENTIFY" button should only be operated after the pair has been located and positively identified i.e. after the null has been detected.

The only exception to this is where unit identification is required. Operation of the "LEG IDENTIFY" (See Fig 9) button will cause tone spread to all pairs in the cable but the tone will be louder in the unit containing the pair connected to the send terminals. To check that the correct unit has been located release the "LEG IDENTIFY" button and proceed to locate and verify the pair carrying the identification tone.

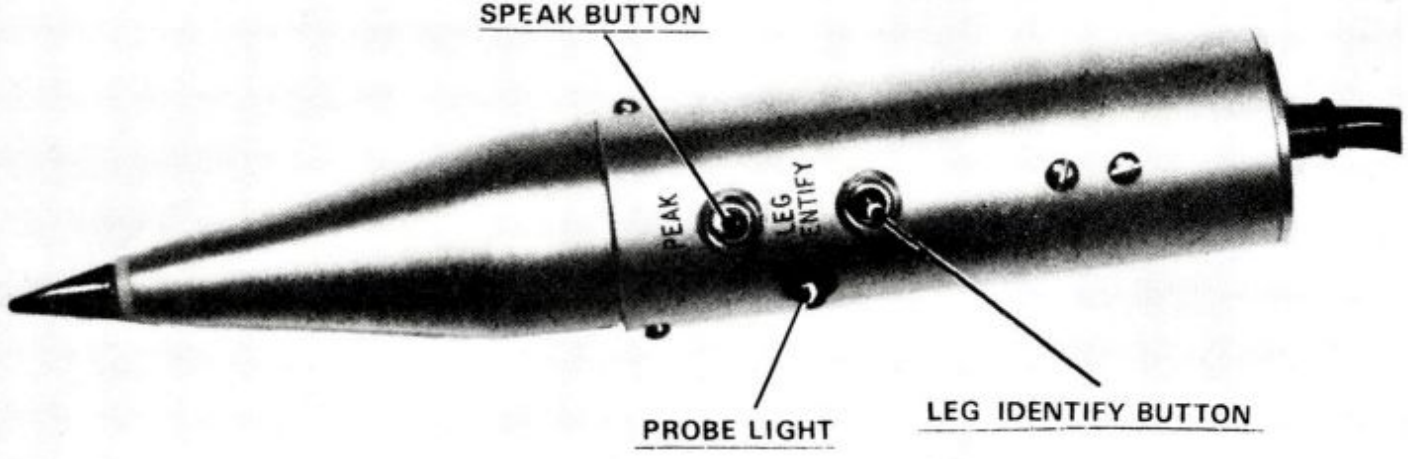


FIG 9 LEG IDENTIFY BUTTON LOCATION

KF-20

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

IDENTIFYING AT A JOINT

A different approach is required when searching for a pair at a through joint, especially when there is very little slack and the cable size (number of pairs) is large. When this occurs it is advantageous to use a larger tip (S419/26).

Both the probe tip and the other hand are used to search out the wanted pair. This is achieved by initially placing the probe tip deeply into the cable pairs and then repeating this action until the wanted tone is detected. The unwanted pairs are moved away with the hand while the probe tip is held against the group containing the tone.

The probe tip is again used to explore the group of pairs containing the wanted pair and the process of moving the unwanted pairs away is repeated. This is continued until the required pair is isolated.

It is essential to check for a NULL to ensure that the correct pair has been selected. This is achieved by separating the wires of the pair (near the joint is the best spot) and proceeding as before for a cable end identification. The leg identification is also carried out as before.

BEWARE OF LEAD POISIONING - AFTER HANDLING LEAD OR LEAD COVERED CABLE, WASH YOUR HANDS AND FACE THOROUGHLY WITH SOAP AND WATER BEFORE EATING OR SMOKING.

IDENTIFYING AT A TERMINATION

When identifying at a cabinet, pillar or MDF it is necessary to ensure that the earth used is in fact commoned to the earth at the far end.

When searching with the probe at terminations care should be taken to avoid knocking the probe tip against the tags as this will cause the insulated coating to be worn away from the probe tip. If this does happen metallic contact will be made to the circuits under test resulting in some disturbance to the circuits. In addition excessive noise will be generated in the receiving GP set.

Leg identification is then carried out as before, by placing the tip of the probe on the outside of the tags and comparing the signal levels.

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

LOW IMPEDANCE INPUT ("LOW INPUT")

The "LOW INPUT" jack (See Fig 11) facilitates the identification of single conductors and unbalanced circuits. When the set is used in this mode it is necessary to make metallic contact with the wire carrying the identification signal.

The identification signal can be sent from a GP set ("VOICE FREQ" mode only), or other audio signal generator, i.e. "F" set or "A" set.

The "MODE" key of the receiving GP set must also be in the "VOICE FREQ" position. The "REC LEVEL" control is used to adjust the level of the received tone. A "pricker" (similar to that used with the "A" set), is connected to the "LOW INPUT" jack to provide contact with the wires under test.

When metallic contact is made with the correct wire the identification signal will be heard. Where identification signal is heard on several wires, the wires with the loudest tone will be the correct wires.

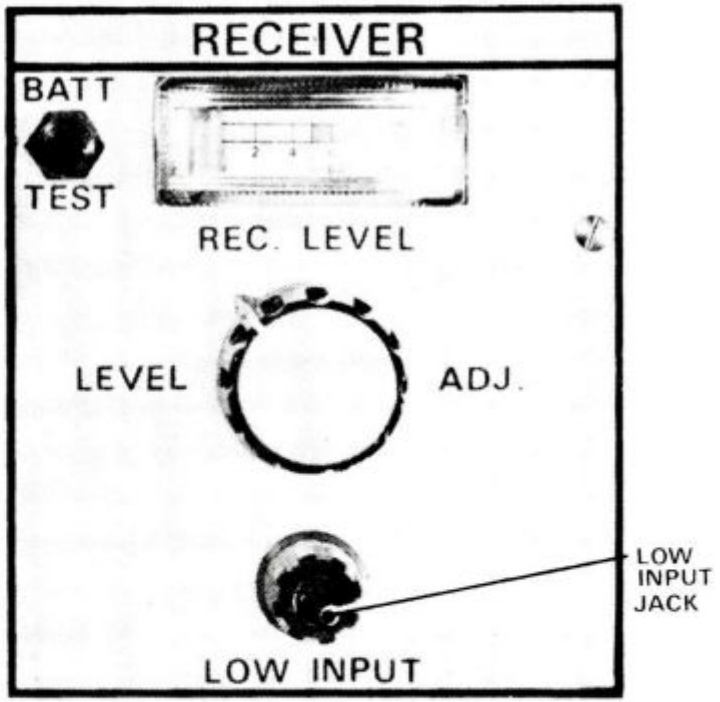


FIG 11 LOW INPUT JACK LOCATION

INTERNAL POWER SUPPLY

Use only two 6V Lantern Cell Battaries S2/28 (Eveready type 409). Alkaline batteries are not suitable unless special precautions are taken to avoid damage to the set when using external batteries.

Fitting Batteries

To fit new six volt heavy duty batteries, the following procedure should be adopted:

(i) Using the correct size screw-driver, unscrew the four screws holding the battery cover.
(ii) Carefully lift the cover approximately 40 mm. (This will allow enough slack insulated wire to enable the cover to be turned over on to its reverse side and rest on the front panel of the GP set.)
(iii) Turn the cover over, taking care not to damage the insulated wire or to loosen the four pin plug from its socket.
(iv) Remove old batteries and insert two new batteries (S2/28).
(v) Reverse the procedure described in para (i) to (iii).

EXTERNAL POWER SUPPLY

Where the GP set will be used continuously on large cable works, two external 12 volt car batteries can be used as the power supply source. This will avoide the need to frequently change batteries in the set. When connecting the external batteries, the following procedure should be adopted:

(i) Remove the dust cap from the socket marked "EXT POWER" on the front panel of the GP set, and insert the plug connected to one end of the battery lead (S419/53).

EXTERNAL POWER SUPPLY (Cont)

NOTE: To avoid the possibility of damage to the lead, it is important to insert the battery lead plug into the "EXT POWER" socket before connecting the four coloured clips to the battery.
Use only External Battery Lead (S419/53). Other battery leads may have an incorrect type jack attached, which may cause shorting within the socket. This can cause the lead to heat up and catch fire.

(ii) Connect the four coloured clips of the battery lead S419/53 to the battery terminals of two 12 volt batteries, being careful that the coloured clips are connected exactly as shown in Fig. 10.

(iii) If the GP set does not function normally or the battery test (page KF-4 part b) indicates a need for battery replacement remove the two internal 6 volt batteries from the GP set by using the procedure described in page No. KF-20 part (i) to (v) Fitting Batteries.

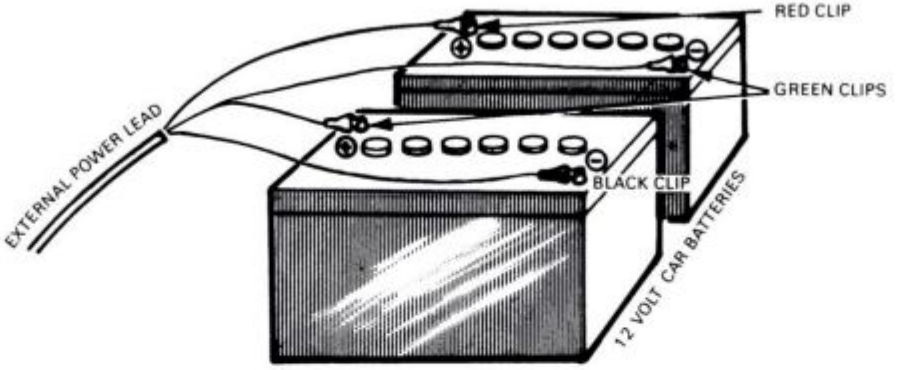


FIG. 10. CONNECTION OF EXTERNAL BATTERIES

After work has been completed, reverse the procedure described in the above paragraphs (ii) and (iii). The two six volt batteries can then be replaced (See Fitting Batteries page No KF-20 para (i) to (v)).

GENERAL

The methods described are intended as a guide for an operator using the tone search technique for the first time. Experience has shown that operators very quickly develop their own technique which usually varies little from the methods described, but does enable them to identify quickly and comfortably.

The most important point, however, which must not be neglected for the sake of extra speed is the verification of the pair by checking for a NULL.

APPLICATION OF GP SET

Figs 12 - 14 show typical applications of the GP set in various situations:

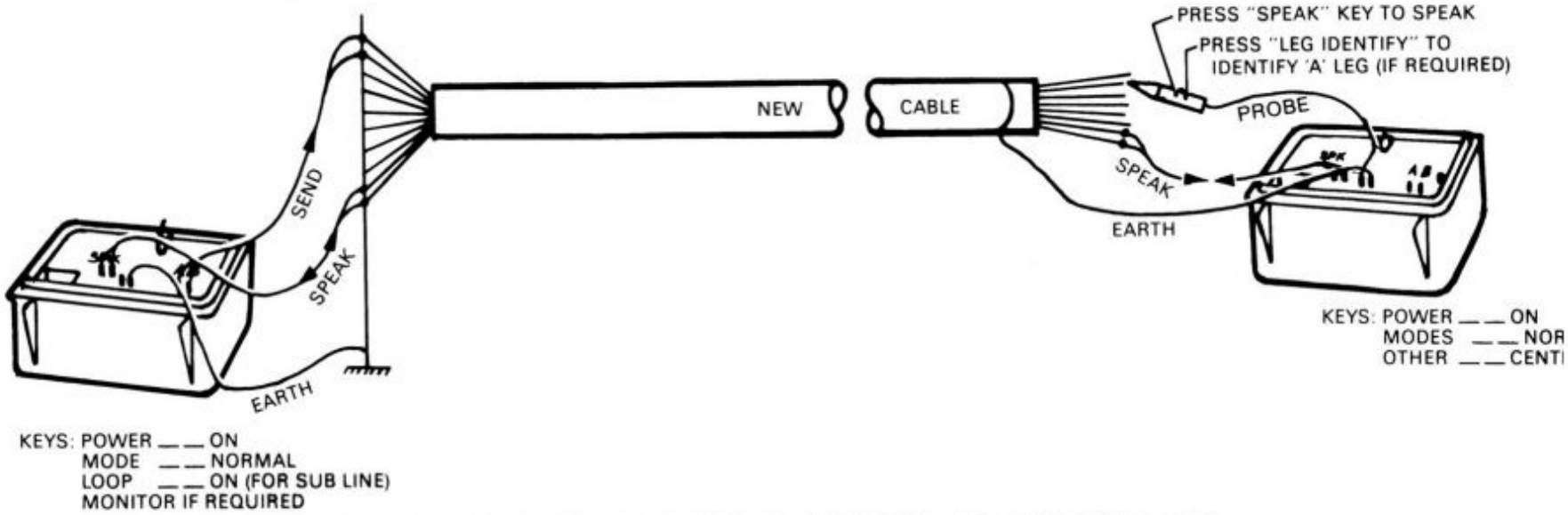


FIG 12 IDENTIFYING CABLE PAIRS TERMINATED AT EXCHANGE MDF

USE OF CABLE PAIR IDENTIFICATION SET TYPE GP

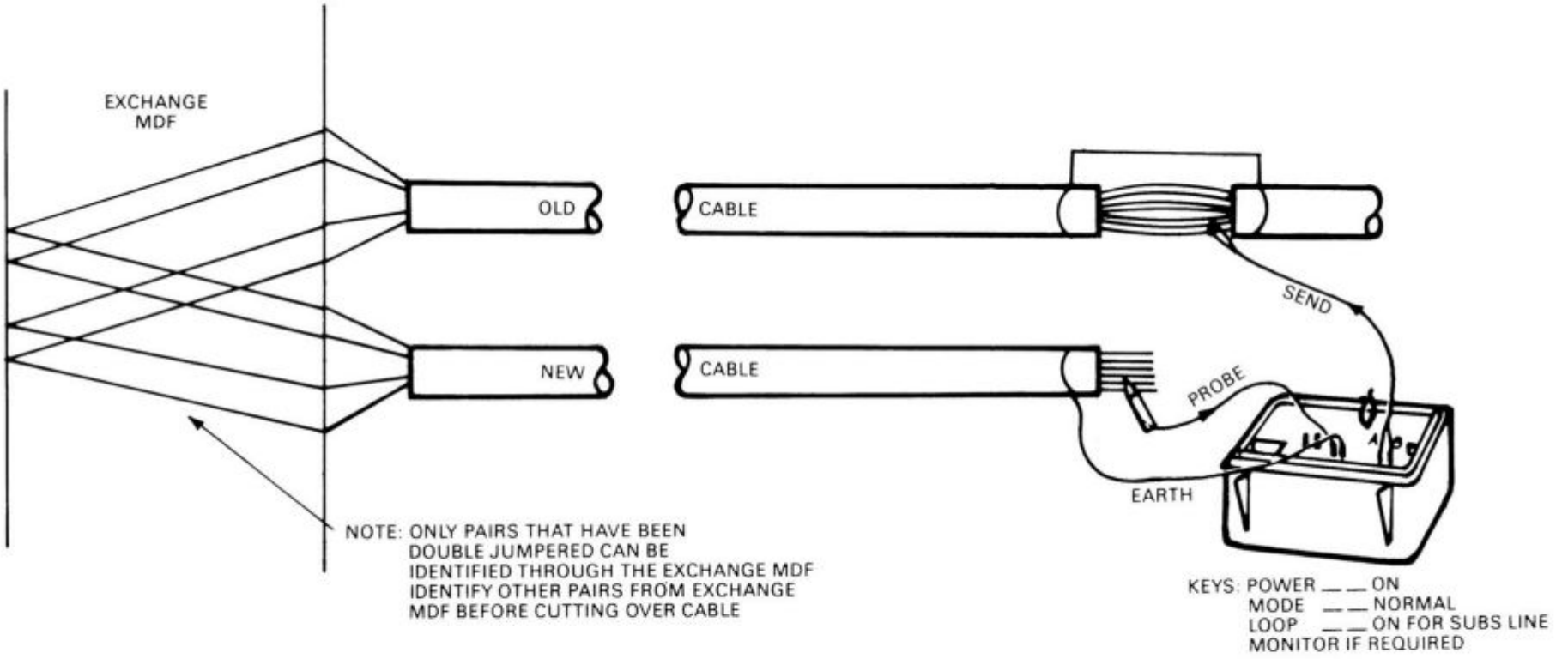


FIG 13 IDENTIFYING CABLE PAIRS DOUBLE JUMPERED AT EXCHANGE

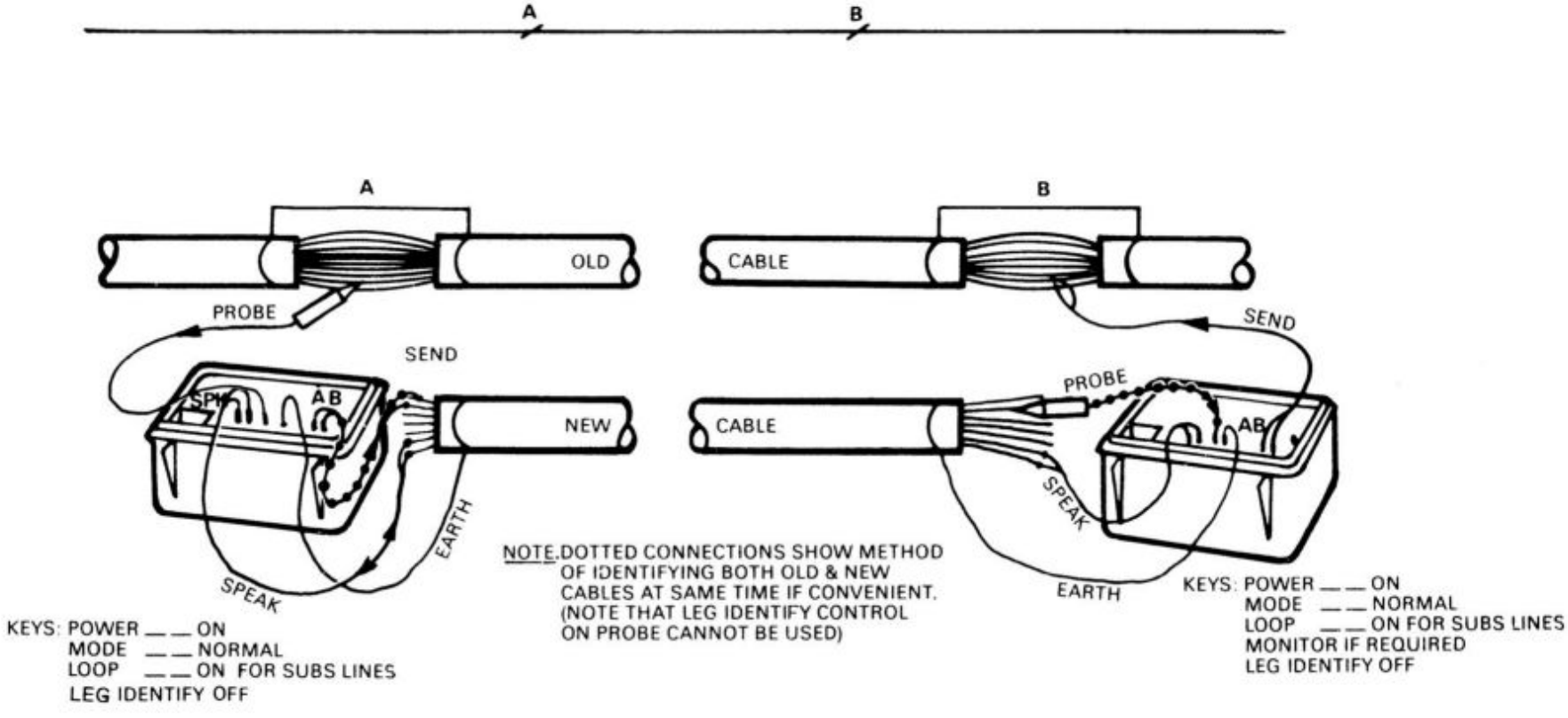


FIG 14 IDENTIFYING CABLE PAIRS AT EACH END OF A CABLE SECTION

PROBLEMS WHEN IDENTIFYING

Most of the problems encountered in identifying cable pairs can be resolved by carefully checking through the procedures being used, the type of circuits being identified and the set.

The following Tables 1 to 4 (pages KF-28 to 31) will assist in identifying and where possible rectifying any difficulties with identification.

Type of Problem	Causes	Test Procedure	Corrective Action
NO TONE	1. Set not switched on. Batteries flat.	Operate "BATT TEST" button meter must register in green section.	Switch set on. Replace batteries
	2. Sending set in "MONITOR" position.	Check position of sender key on sending set.	Send "FIXED", or "WARBLE TONE" by operating sender key.
	3. Sets in different modes.	Check position of "MODE" keys on all sets in use.	Switch all sets to same mode.
	4. Leads not connected or connected to wrong cable.	Check leads are properly connected to correct cable.	Connect leads correctly
	5. Normal (HF) mode used on loaded cable.	Is cable loaded?	Operate "MODE" key to "VOICE FREQ" position.
	6. Set faulty.	Use set check procedure.	Return set for repair and obtain replacement set.

TABLE 1. PROBLEMS WHEN IDENTIFYING

Type of Problems	Causes	Test Procedure	Corrective Action
TONE SPREAD (Tone on many pairs -no null) Leg Identify light on	1. One set switched off and still connected to speak pair.	Check with other operators.	Turn on set or disconnect set from speak pair.
	2. "LEG IDENTIFY" button operated on one set.	Check with other operators.	Release "LEG IDENTIFY" button on all sets.
	3. Speak pair faulty or in use	Test with LTS No. 1 or connect speak pair to one set only. "LEG IDENTIFY" light should not operate when speak pair is connected.	Choose another vacant fault free pair in the cable to use for speak pair.
	4. Set faulty.	Use set check procedure.	Return set for repair and obtain replacement set.

TABLE 2. PROBLEMS WHEN IDENTIFYING

Type of Problem	Causes	Test Procedure	Corrective Action
TONE SPREAD (Tone on many pairs- no null) Leg identify light not on	1. One side of sending lead O/C or not connected.	Check connections. Check leads using set check procedure.	Connect leads correctly. Repair or replace faulty leads.
	2. Faulty Pair Low IR Grounds S/C O/C Split pair	Test line with Lines Test Set No. 1 at sending end. Send on another pair and check no tone spread.	Leave faulty pairs until remainder of unit jointed, then identify single wires using "LOW INPUT". ("LOW INPUT" can be used at any stage but it may be difficult to find the correct conductor in the unit).
	3. Unbalance due to equipment connected to the line	Normal telephone line- operate- "LOOP ON" key to balance line, tone spread should cease.	Operate "LOOP ON" key to balance line.
		Special circuit-check with exchange	If the circuit can be interrupted ask exchange to remove links, or use "LOW INPUT" to identify individual wires.
	4. Set faulty	Use set check procedure.	Return set for repair and obtain replacement set.

TABLE 3. PROBLEMS WHEN IDENTIFYING

Type of Problem	Causes	Test Procedure	Corrective Action
CANNOT LEG IDENTIFY	1. Faulty Earth.	Check earth connections at each set.	Use pair in cable to provide good earth between sets.
	2. Faulty speak pair (O/C)	Connect one side of speak pair to earth terminal on set. "LEG IDENTIFY" should operate.	Select vacant fault free pair for speak pair.
	3. Identification set too far from sending end	-	Use Voice Frequency Mode or identify over shorter distance or use "LOW INPUT" to identify each wire.
	4. Faulty Set.	Use set check procedure	Return set for repair and obtain replacement set.

TABLE 4. PROBLEMS WHEN LOCATING

NOTE: "LOW INPUT" must be used in "VOICE FREQ" mode only. This will cause interference with other pairs in the cable and with the circuit being identified.

USE OF CABLE AND METALLIC PIPE LOCATORS AND TRACERS

(See Section FB for CABLE AND METALLIC PIPE LOCATORS AND TRACERS - DESCRIPTION)

PLAN RECORDS, MARKERS AND OTHER SURFACE INDICATIONS PROVIDE A VALUABLE KEY TO THE PRESENCE OF UNDERGROUND PLANT, BUT CANNOT BE RELIED ON TO ACCURATELY SHOW THEIR CORRECT LOCATION. HOWEVER, IF THE OPERATOR HAS RECEIVED ADEQUATE TRAINING IN THE USE OF HIS EQUIPMENT, IT IS POSSIBLE TO LOCATE UNDERGROUND PLANT AND THAT USED BY OTHER AUTHORITIES WITH SUFFICIENT ACCURACY FOR MOST PURPOSES.

Issue 2, 1981.

USE OF CABLE AND METALLIC PIPE LOCATORS AND TRACERS

WHERE APPROXIMATE POSITION OF CABLE OR PIPE IS NOT KNOWN

To locate a cable or a metallic pipe in situations where approximate position of the structure is not known use is made of High Frequency Instruments, such as FISHER M-SCOPE (Serial 140/92), in "ON HANDLE" mode of operation.

ASSEMBLYING AND PREPARING FISHER M-SCOPE FOR "ON HANDLE" MODE OF OPERATION

(i) Place the OSCILLATOR on the ground or on an elevated surface and connect the handle to the OSCILLATOR as shown in Fig. 1.

(ii) With the OSCILLATOR resting on the ground, attach the AMPLIFIER to the handle as shown in Fig. 2. The aluminium knob is to be fastened tightly and the black knob - only finger tight.

(iii) Pull out the SPEAKER PULL OUT switch in the AMPLIFIER, or plug in headphones in noisy locations, thus turning the AMPLIFIER on.

PARTICULARLY BEWARE OF TRAFFIC WHILE WEARING HEADPHONES.

(iv) Turn POWER switch in the AMPLIFIER to BATTERY TEST position. If the METER registers below "OK" indicating mark - replace the battery.

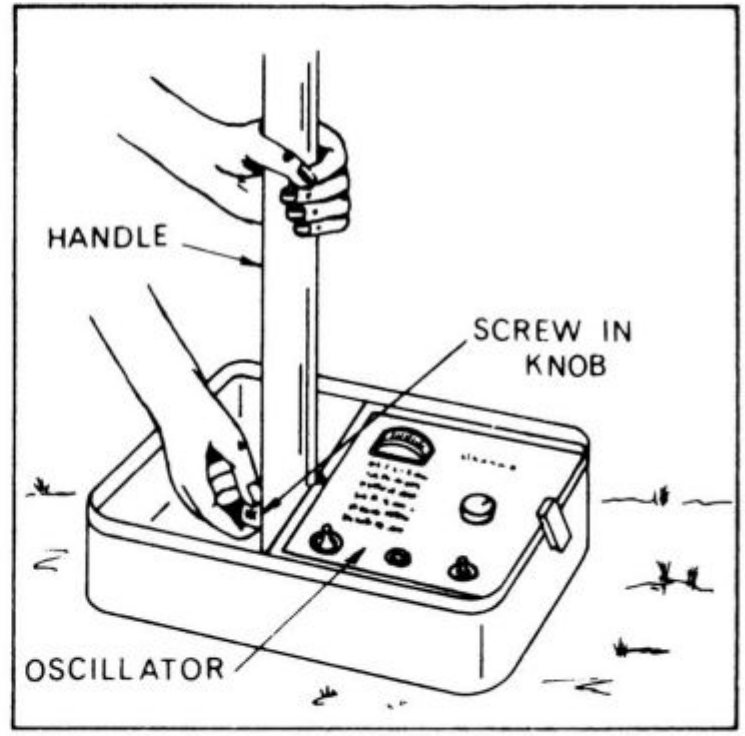
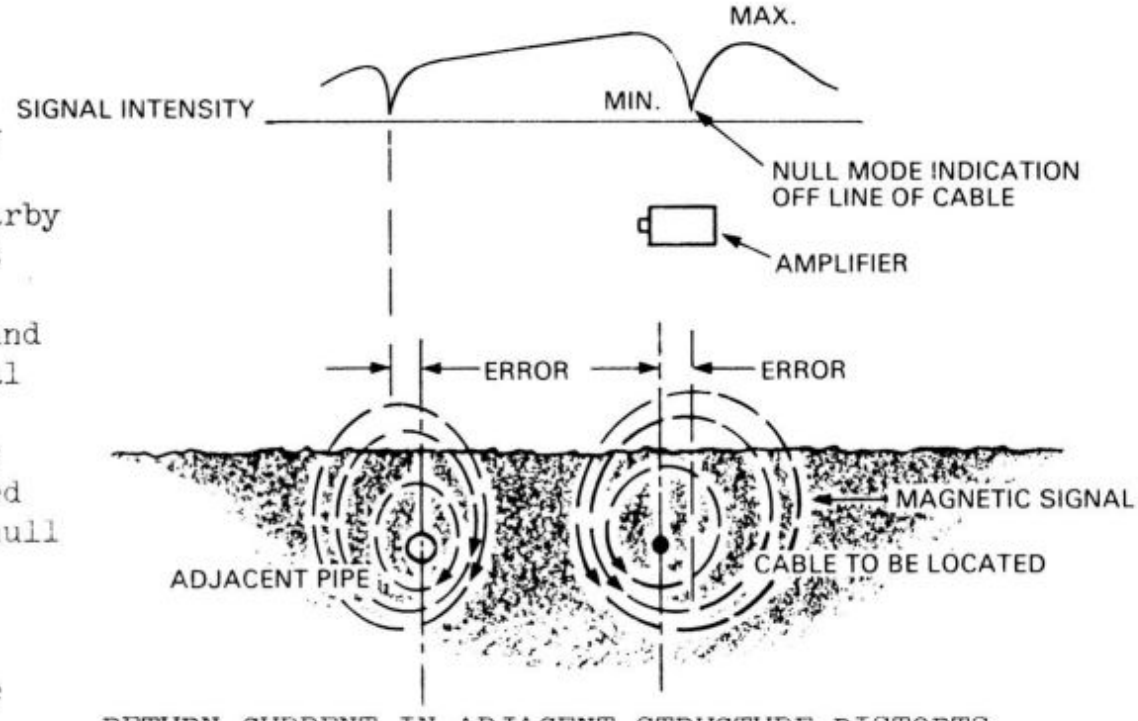


FIG. 1. CONNECTING HANDLE TO THE OSCILLATOR.

PROBLEMS WHEN LOCATING

Locating and depthing of underground plant is frequently complicated by the presence of other buried services. Any nearby conductive structure in contact with the earth will pick up a portion of the signal current and itself radiate a magnetic signal similar to that being located. This also distorts the magnetic signal of plant being identified and produces a peak (tone) or null location displaced from the correct cable alignment.

NOTE: The error due to interference will not be as pronounced when the amplifier is operated vertically to obtain a peak mode.



RETURN CURRENT IN ADJACENT STRUCTURE DISTORTS MAGNETIC FIELD AND CAUSES ERROR IN NULL LOCATION

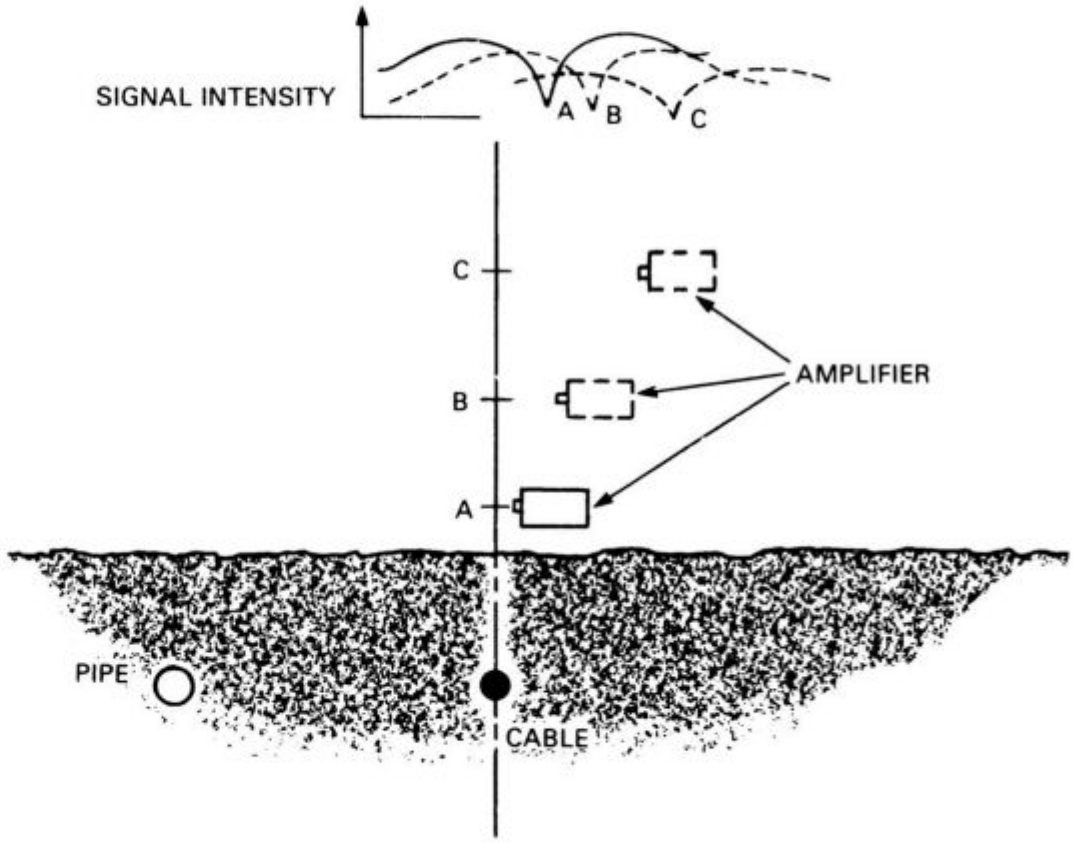
The size of such error resulting from a single interfering structure and the number of nulls and peaks occurring depends on a number of factors, the most important being:

(i) The depth of the cable or pipe.
(ii) The distance between cable and pipe.
(iii) Their resistance to ground.
(iv) The earth resistivity.
(v) The location of the transmitter earth stake relative to the water pipe (if conductively coupled).

Distortion of the magnetic signal may also produce a significant error in the measurement of depth when using the 45° NULL method (See page L-22). The error may be as great as 80% or even worse and will depend on which side of the route the measurement is made.

HOW TO GET BEST RESULTS WHEN LOCATING

When interference from an adjacent structure occurs, the error produced will increase with the depth of the structure. Since the error is related to the vertical distance between the service being located and the amplifier, care should be exercised to ensure that the amplifier is operated as close to the ground as possible.



VARIATION IN ERROR WITH CHANGE IN AMPLIFIER HEIGHT

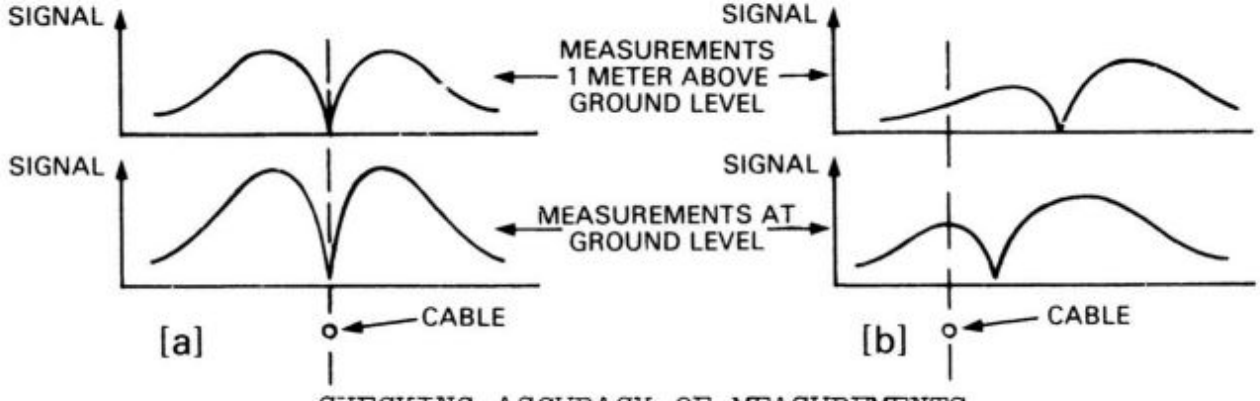
MINIMISATION OF ERRORS

To prove the accuracy of location and depth measurements adopt the following procedure:

1. Checking Location and Depth Accuracy.

The presence of errors in the route or depth locations may be detected by the following tests:

(i) Perform two null location measurements at the same point in the route, preferably one at ground level and the other one metre higher. If the two agree, the measurement in most cases will be fairly accurate. See Fig. (a).



CHECKING ACCURACY OF MEASUREMENTS

(ii) If the locations indicated by the two nulls do not agree it will usually be found that the true location of the cable will be offset as shown in Fig. (b).

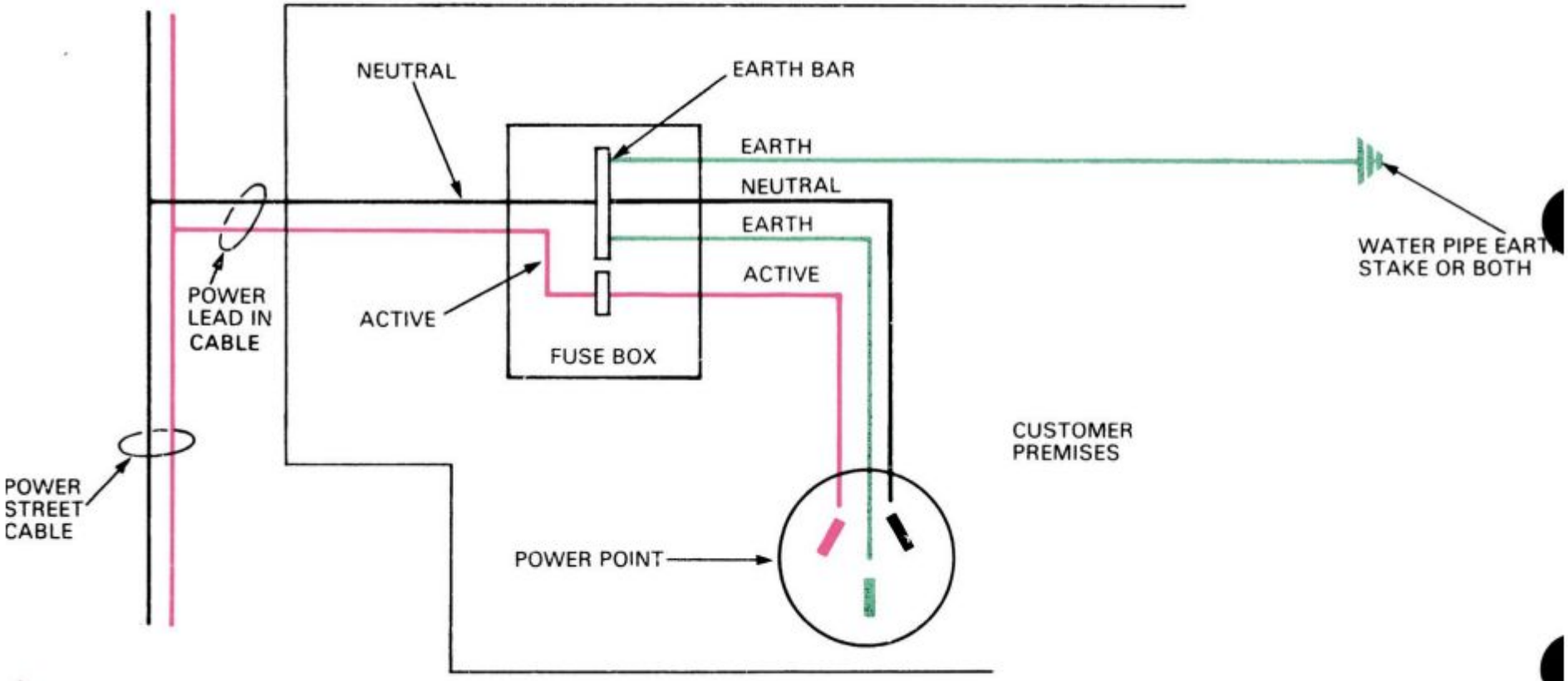
2. Depthing Errors

To reduce the error in a depthing measurement when errors are known to be present perform two depthing measurements (one either side of the route) and average the two results.

NOTE: The exact alignment and/or depth of a structure must always be verified by 'pot-holding'.

LOCATING POWER CABLES

One of the more common types of underground power systems installed in the metropolitan area is the Multiple Earth Neutral (MEN) system. In the MEN system the neutral conductor is connected to the earth bar at the customer premises. The earth may have been provided by either connecting to the water pipe or by connecting to an earth stake or both.



TYPICAL MEN SYSTEM LAYOUT

When trying to locate power cables connected to the MEN system, signal current may flow in the waterpipe. This current will cause effects as described on page L-25 and particular care should be taken to ensure that:

(i) The power cable is being traced, not the water pipe.

(ii) The exact location of the power cable is determined. This must be done by pot-holing at various intervals along the power cable route.

Where difficulty exists in placing the transmitter at a suitable location eg. service pillar, pit, street light etc, and the MEN system is being used, it is possible to transmit the signal from the power earth terminal ie. earth stake or water pipe providing the power earth is connected to it. When transmitting the signal from the water pipe, careful interpretation of results is necessary as the signal would be similar in both structures.

NOTE: Under no circumstances should conductive connection be made inside the fuse box or in any terminating box used by the power authority.

Locations which conductive connection (see page L-15) can be made to the power authorities plant to transmit the signal are as follows:

(i) Metallic Riser Pipes. eg. on poles that connect underground power cables to aerial feed power lines.

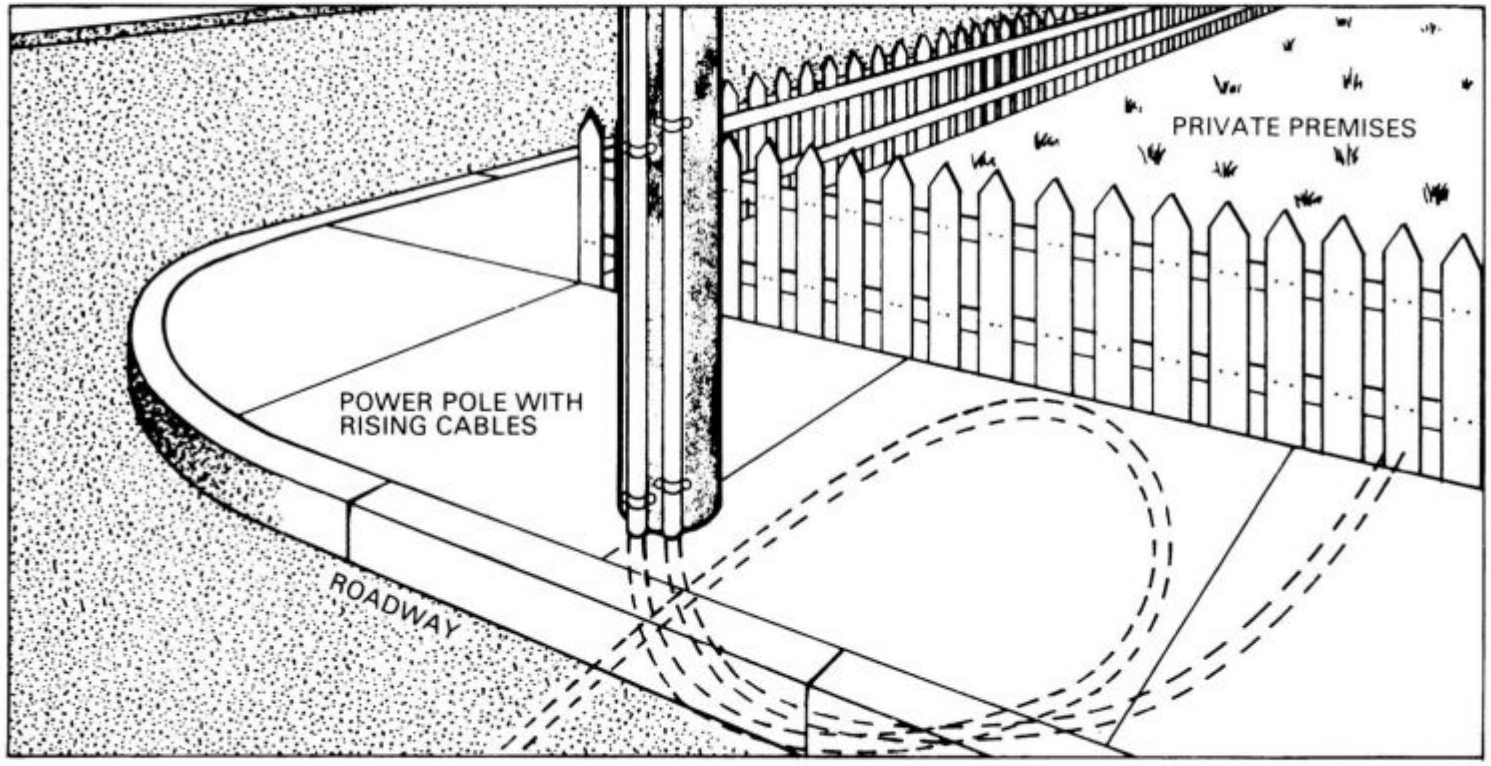
(ii) Metallic Covers. Used by power authorities eg. at pillars and transformers.

(iii) Power Earth Terminals. (as above).

(iv) Metallic Fuse Boxes. Where the earth neutral is connected to the frame.

TRACING POWER CABLES FROM TERMINAL POLES

Underground power cables leaving power termination poles sometimes deviate away from the trench alignment and may even be looped around the pole. The example below shows an underground power cable crossing a street and entering private premises. The bending radius is large hence the loop at the pole base in the cable which crosses the road.



POWER POLE WITH UNDERGROUND POWER FEED

If you are required to locate a power cable close to the terminal pole:

(i) Place the Oscillator over the cable close to the pole.

(ii) Locate the cable at a distance approximately 12 m from the pole (this should give a minimum of 9 m distance between Oscillator and Amplifier when locating cable close to pole).

(iii) Place the Oscillator at the position where the cable was located.

(iv) Locate the power cable close to the terminal pole.

NOTE: For the locator to perform satisfactory the distance between Oscillator and Amplifier should be no less than 9 metres.

METHOD TO USE FOR BEST RESULTS

Generally when locating underground structures ie Telecom Cables, Power Cables, Water Pipes etc the conductive (direct connection) method is preferred (See page L-15) however in most instances the inductive (direct connection not practicable) method (See page L-7) can be used for good results.

USE OF INTERCOM SETS

This Section will be issued at a later stage. The cable pair identification sets type GP (see section DF) and type A (see section DA), have intercom facilities that connect across a common speak circuit.

CABLE PAIR IDENTIFICATION SET TYPE GP -

PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

(See Section DF for CABLE PAIR IDENTIFICATION SET TYPE GP - DESCRIPTION AND TECHNICAL DETAILS)

(See Section KF for USE OF TYPE GP SETS - IDENTIFICATION OF WORKING RANDOM JOINTED CABLES)

CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

PRINCIPLE OF TONE SEARCH

The GP Set probe is specially designed to detect the electric field around a conductor (or conductors) carrying an AC signal without the need to make contact with the conductor. The signal detected by the probe is very small and must be amplified before it is powerful enough to produce sound from a loud speaker or earphone. The stronger the electric field detected by the probe the louder the sound produced by the GP Set. This type of detector is called a "High Impedance" detector.

Fig 1 represents the electric field around a conductor carrying an identification signal. The electric field is stronger closer to the conductor.

When searching for a Cable Pair with the GP set, the operator can "home-in" on the conductors carrying the identification signal because as the probe is moved closer to the pair the electric field strength increases and the sound produced by the GP Set gets louder.

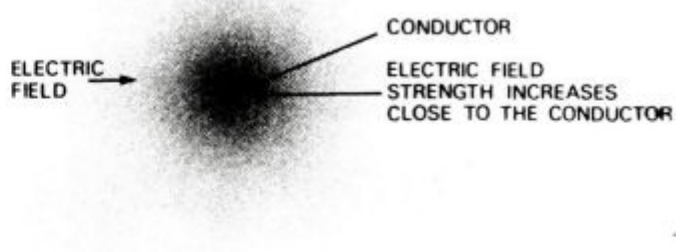


FIG. 1. ELECTRIC FIELD AROUND A CONDUCTOR CARRYING AN IDENTIFICATION SIGNAL
(Note: The field is much stronger closer to the wire.)

PRINCIPLE OF TONE SEARCH (Cont)

With the GP Set identification signals are normally sent on both conductors of a cable pair. Each of these conductors has its own electric field. See Fig. 2.

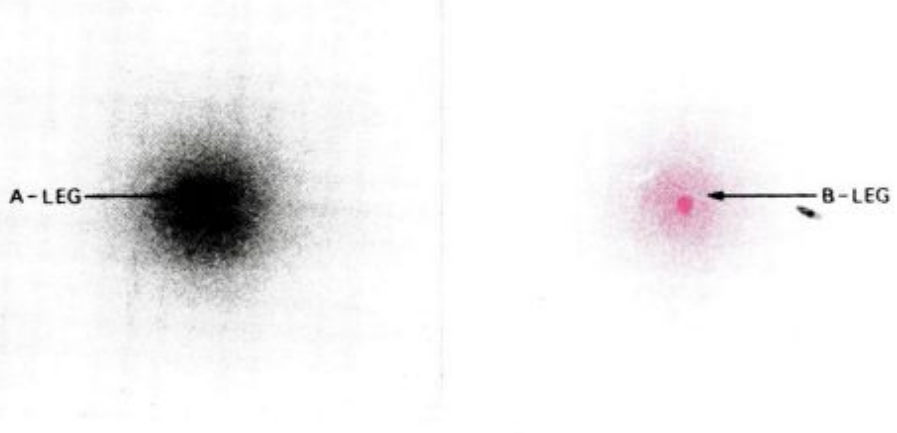


FIG. 2. ELECTRIC FIELDS AROUND EACH CONDUCTOR OF A CABLE PAIR WITH WIRES WELL SEPARATED

Transverse Signal

The signal which is sent on the A wire is the same tone as that on the B wire but is 180° out of phase (or one is positive and the other negative). This is called a transverse signal. The GP set cannot tell the difference between these two signals and the sound produced by the GP set will appear the same no matter whether the A wire or B wire is approached with the probe.

CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

PRINCIPLE OF TONE SEARCH (Cont)

When the two conductors of the pair are close together, the electric fields from each wire partially cancel each other. At any point where the electrical field from each wire is the same strength they cancel each other out completely. This will normally occur midway between the two wires carrying the identification signal. When the GP set probe is placed at this point, there will be no electric field to detect and hence no tone will be heard from the speaker (ie, a NULL is found midway between the wires.) Fig. 3 shows the resultant electric field around the pair of wires when they are close together.

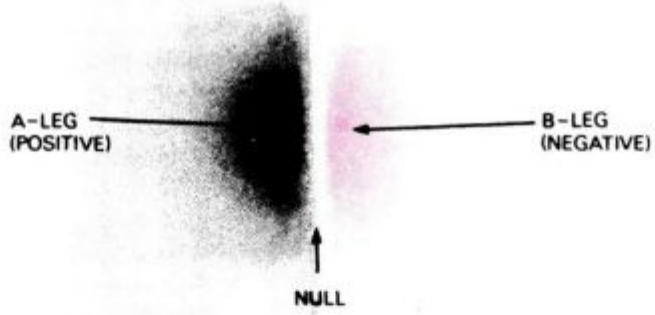


FIG 3. ELECTRIC FIELD AROUND A PAIR OF WIRES

Locating the Correct Pair

This cancelling of the fields will normally only occur when a balanced cable pair is connected to a GP set with a well balanced output.

This "NULL" is the means by which the correct pair of wires can be selected even when there may be some tone spread to other pairs in the cable.

PRINCIPLE OF TONE SEARCH (Cont)

The method for sending the identification signals with the GP set (in the transverse mode) is different to the method by which identification signals were sent with the "A" type identification sets. "A" sets send the same signal on both wires. This method of sending the signal is called the longitudinal mode. Figs. 4 and 5 show the differences in the way we connect the tone sender to the cable pair in the GP set and the "A" set.

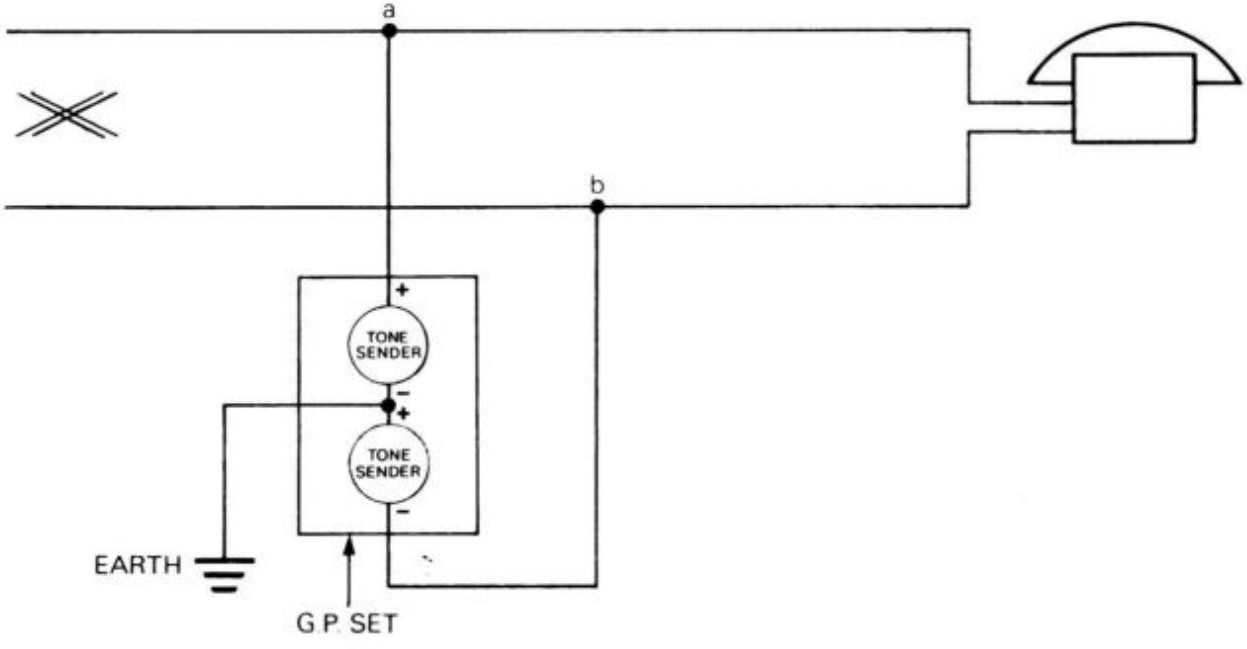


FIG. 4. GP SET SENDS IN "TRANSVERSE" MODE

CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

PRINCIPLE OF TONE SEARCH (Cont)

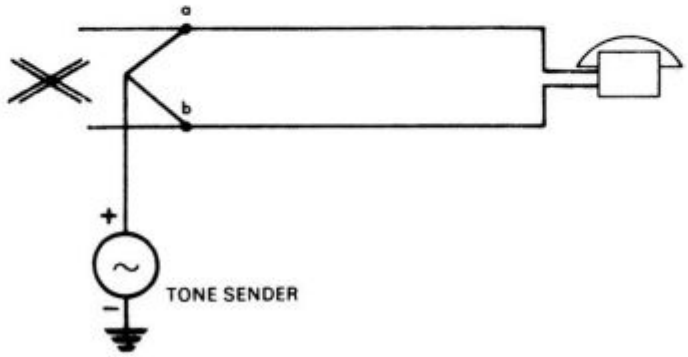


FIG. 5. A-SET SENDS IN "LONGITUDINAL" MODE

The GP set, does not use the "longitudinal" mode for sending tone because this induces tone into other pairs in the cable. The probe of the GP set is much more sensitive than the pricker of the "A" set (because it amplifies the signal) and consequently it is very difficult to determine the difference in tone level on the correct pair from the tone level on other pairs. There is no null between the wires when tone is sent longitudinally because the signals on each wire are the same and therefore do not cancel.

Sending tone in the transverse mode causes much less tone spread to other cable pairs in the cable (especially where cable pairs are well balanced). When the tone has been detected on two wires these can be confirmed as the correct pair by the "NULL" between them. Although the fields cancel to give a null midway between there is still sufficient uncancelled field around the wires to enable us to search through the cable and quickly isolate the wanted pair from the others.

PRINCIPLE OF TONE SEARCH (Cont)

To reduce tone spread from a pair to a minimum, the signal on each wire must be of the same strength and 180° out of phase. When this occurs the tone is said to be "balanced". Unbalance can be caused by fault on the cable pair, unbalanced output from the GP set sender or unbalance in the equipment connected to a cable pair. If there is good balance in all these factors then there will be little spread of tone to other pairs and the NULL will be midway between the two wires. A small amount of unbalance will cause some tone to be spread to other pairs and the NULL will be closer to one wire than the other. A large degree of unbalance will cause tone spread through the cable and the NULL will not be present.

Balancing the Pair

A cable pair without equipment connected (vacant pair) is normally balanced. However when exchange equipment is connected to the line, this can create an unbalanced condition. When a normal telephone service is in use the exchange equipment is electrically balanced and does not interfere with the balance of the line. When a normal telephone service is not in use (receiver on the hook) the equipment is unbalanced and this in turn unbalances the line. NB pairs cannot be identified properly unless balanced. To balance the telephone line when the service is not in use, the GP set is equipped with a "LOOP ON (SUBS LINE)" Key. When operated, this key loops the line and brings it to a balanced condition in the same way as if the service was in use.

MOST OF THE PROBLEMS ENCOUNTERED WHEN IDENTIFYING CABLE PAIRS CAN BE RESOLVED BY CHECKING THROUGH THE PROCEDURES BEING USED, THE TYPE OF CIRCUITS BEING IDENTIFIED AND THE SET (SEE PAGE KF-28).

CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

PRINCIPLE OF TONE SEARCH (Cont)

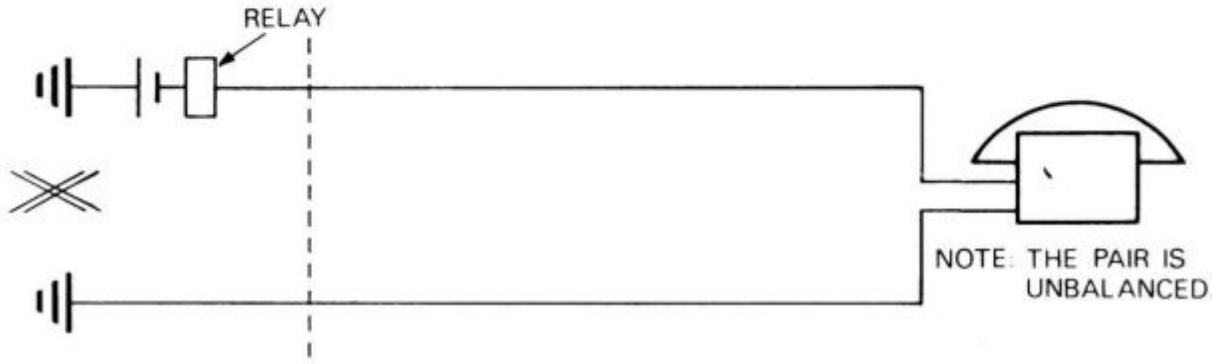


FIG. 6. TELEPHONE CIRCUIT IN IDLE (ON HOOK) CONDITION

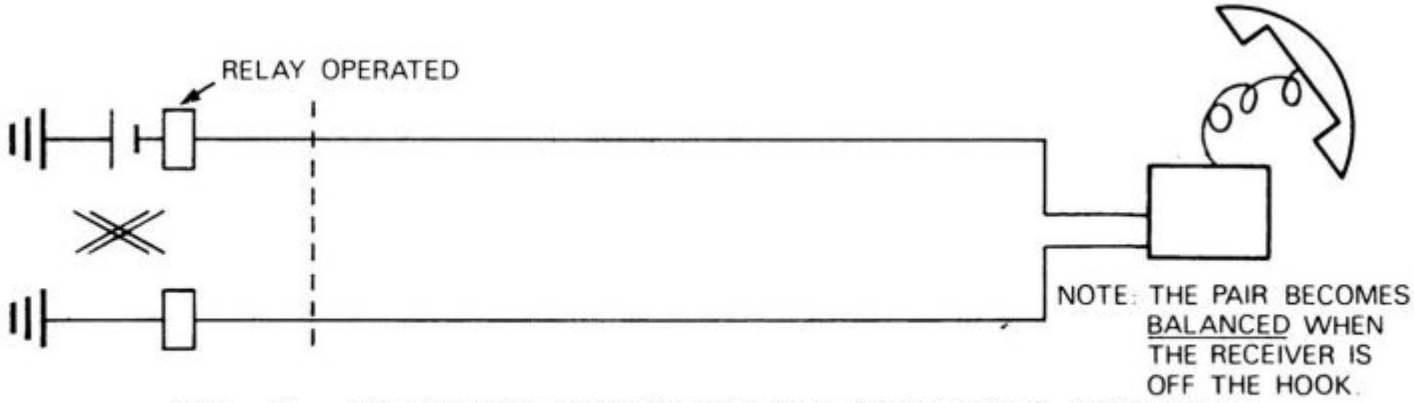


FIG. 7. TELEPHONE CIRCUIT IN USE (OFF HOOK) CONDITION

PRINCIPLE OF TONE SEARCH (Cont)

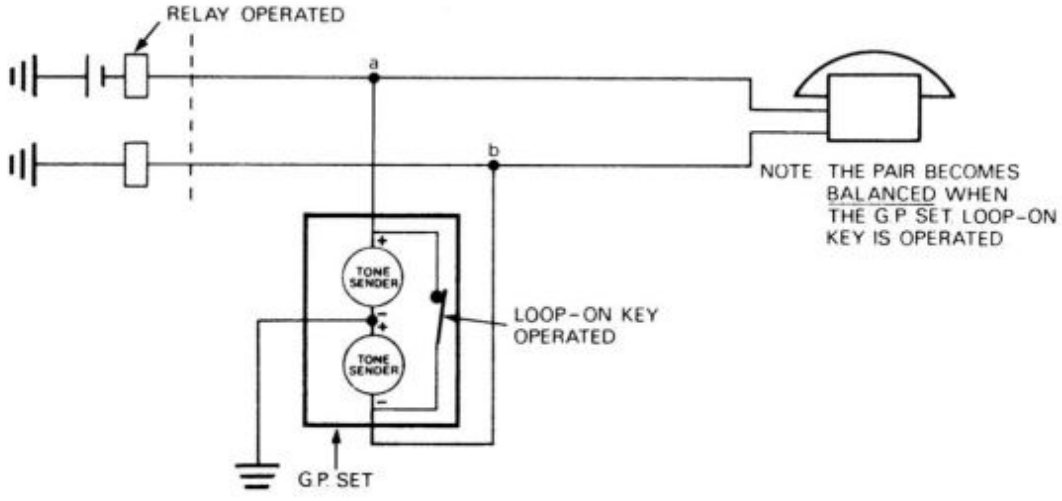


FIG. 8. TELEPHONE BECOMES IN USE WITH LOOP ON SWITCH IN ON POSITION

Unbalanced Cable Pairs

In some instances circuits cannot be balanced. When this occurs the high impedance probe cannot be used successfully to identify the pair because of tone spread and no NULL. In these cases looping the line will not bring the line into a balanced condition to enable use of the high impedance probe. The pair can still be identified using the low impedance input ("LOW INPUT") to the GP set which will enable the operator to differentiate between wires on which tone is sent and on those on which tone is induced. Single wires can also be identified using this technique.

CABLE PAIR IDENTIFICATION SET TYPE GP - PRINCIPLE OF HIGH IMPEDANCE TONE SEARCH

PRINCIPLE OF TONE SEARCH (Cont)

Using the Low Impedance Probe

The low impedance input is not as sensitive as the probe and metallic contact must be made with the conductor (see page KF-22 LOW IMPEDANCE INPUT) to determine whether there is tone on the wire. A better connection to the wire means we are able to detect whether the tone is connected directly to the wire or coupled into the wire from other wires in the cable. The tone level will be louder when the pricker is attached to the correct wire ie. the one with tone connected (the use of the GP set with low impedance input for unbalanced circuits is similar to the use of the "A" set).

Care must be taken when using the low impedance input close to the exchange. All telephones which are not in use have their "a" legs connected together at the exchange. If tone is applied at the exchange the tone level on all "A" legs will be the same.

The low impedance input in the GP Set can only be used in the VF mode and will interfere with VF circuits.

Leg Identification

Leg Identification is achieved in the GP Set by turning the tone off on the "b" leg. The speak pair is used as the control circuit for turning the tone off.

When the tone is turned off on the 'b' leg there is no cancelling effect with the tone on the "a" leg and hence there will be tone spread through the cable including the "b" leg. The amount of tone spread will depend on the length of cable. Leg identification may be difficult over long cable lengths because of the amount of tone spread to the "b" leg. (Note: The low input could be used if leg identification is difficult with the high impedance probe.)

LINEMANS HANDBOOK : LINES TESTING AND INSTRUMENTS

Use of Cable Pair Identification Set GP

For notation by jointers and supervising staff; and filing in Handbook.

The VF mode of sending tone must not be used on working circuits a the send level may give rise to a dangerous sound pressure level from the earpiece in the ear of an operator or customer on the circuit.

A modification is proposed to reduce the send level to a safe figu and details of the arrangements will be forwarded later.

INSTRUCTION HANDBOOK TOOLS AND OTHER AIDS
EXTERNAL PLANT CONSTRUCTION SAFETY NOTE 8/81 SE LA 16/4/3

SAFETY CHECKS OF LINEMAN'S POLE BELT 534/47

INTRODUCTION

Some instances of a sticking safety latch on the snaphook of pole belts have been experienced. The condition represents a risk to any user should the snaphook latch remain in the open position, and allow accidental uncoupling of the snaphook and pole belt 'D' ring during use.

Although regular checks on the belts are carried out by the Senior Lines Officer, (Refer Instruction H.B. Tools and Other Aids P. H7, H8) it is the responsibility of the Lines staff to check their own belt for defects. The recommended practice described below will enable staff to confirm correct operations of their belt snaphook and thereby minimise the risk of snaphook failure.

DESCRIPTION OF THE RECOMMENDED PRACTICE

The accumulation of dust and debris, accidental side impact or the use of non-standard 'D' ring couplings can cause the spring loaded safety catch on the snaphook to 'stick' in the open position.

H8(S)

Inspect the snaphook at least daily or after any possibility of dust entering the snaphook or after sustaining a side impact. The inspection will be made by operating the safety latch several times to ensure a positive and free return of the latch to the closed position.

Any tendency for the latch to remain open must be regarded as dangerous. Remove any particles or grit between the moving faces, and ensure sufficient clearance exists between the hook sides and the latch faces. Under no circumstances must any oil, grease or liquid lubricants be applied, however a small amount of graphite powder can be used, when necessary.

If a sticky latch cannot be corrected by the above method then the belt shall be removed from service and returned by S417 to Main Store. Each belt should have the owners name and location on a label securely attached to the belt. Supply Branch should retain the defective belt until informed regarding further action - or modification is likely.