90C1 LOOP REPEATER

CONTENTS

1. GENERAL

1.01 This section gives the principles of operation and a description of the circuit and the equipment of the 90C1 loop repeater developed for use in No. 2 and No. 9B service board offices and for use in testboard offices. Operating limits are also included in this section. The 90C1 repeater is a polar-relay repeater.

1.02 In No. 2 and No. 9B service board offices, this repeater is for use on station loops exceeding the range of the 96A1 electronic loop repeater and for emergency use on circuits to telegraph company offices. A block schematic of station loop operation in a service board office is shown in Fig. 1.

1.03 In testboard offices, the 90C1 repeater may be used with line or loop facilities in concentration groups arranged to provide multi-way electronic regeneration with the 143A2 regenerative repeater. With line facilities, it will be associated with balanced loop line repeaters and on loop facilities the usage will be the same as in service board offices; namely, on loops exceeding the range of the electronic loop repeater. A block schematic for testboard office operation with a line repeater is shown in the upper part of Fig. 2 and operation on a station loop in the lower part of Fig. 2.

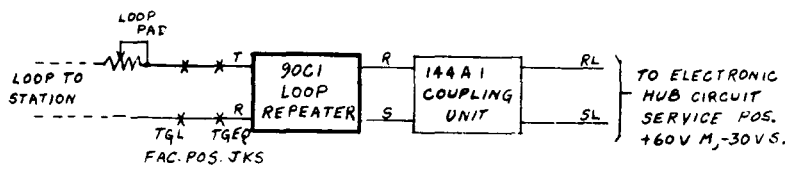

Fig. 1 - Block Schematic of Loop Operation in a No. 9B or No. 2 Service Board Office

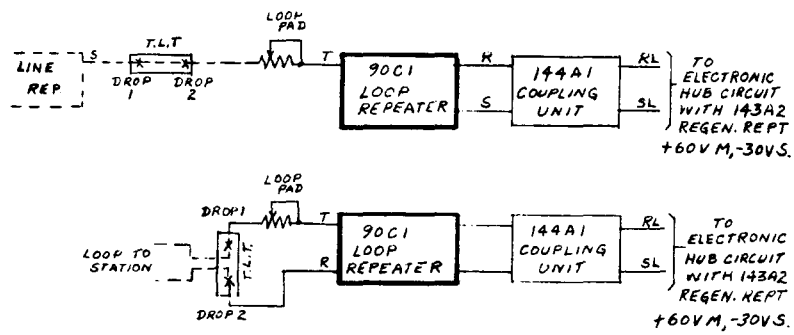

Fig. 2 - Block Schematic of Line and Loop Operation in a Testboard Office for Electronic Regeneration

1.04 One side of the 90C1 repeater is arranged for operation with the legs side of a 144A1 coupling unit. The other side of the repeater is arranged for half-duplex balanced loop operation or for one-wire differential duplex operation or two-wire polar operation. The differential duplex and polar options are for telegraph company circuits which may be operated full duplex.

1.05 A loop pad external to the repeater is required for adjusting the loop current. Under certain loop conditions wave shaping networks are required external to the repeater as described in detail later in this section.

1.06 A multi-contact switch is supplied as part of the equipment to arrange the repeater circuit for the different forms of services; no terminal strapping is required.

2. PRINCIPLES OF OPERATION

2.01 For transmission purposes, the 90C1 repeater consists of two 255A polar relays, a sending relay and a receiving relay. The sending relay transmits signals to a station or locally to the loop side of a line repeater in the same office and receives signals from an associated coupling unit. The receiving relay receives signals from a station or a line repeater in the same office and transmits to the associated coupling unit.

2.02 Reception from the coupling unit is on a polar basis with 7.5 mils for marking and 7.5 mils for spacing. Transmission to the coupling unit is positive 130V for marking and negative 130V for spacing.

2.03 Station loops are conventional metallic return 62.5 mil half-duplex neutral balanced loop circuits with negative 130V for marking and positive 130V for spacing. Transmission to the station is "effective polar" and transmission from the station is "open-and-close." The positive 130V on the return side of the station loop is supplied through the repeater to permit flexibility in the selection of the service options.

2.04 Operation with a line repeater in a test-board office for electronic regeneration is equivalent to connecting the loops of two balanced loop repeaters for through operation. In these cases, the 90C1 repeater is arranged for positive +130V for marking and negative -130V for spacing.

2.05 One-wire operation to a commercial telegraph company office is differential duplex operation with no current for marking (or a very small current) and about 60 mils more for spacing than for marking. The 90C1 repeater furnishes negative 130V for marking and positive 130V for spacing.

2.06 Two-wire telegraph company operation is polar to ground in both directions with negative 130V for marking and positive 130V for spacing at both offices. Reception at the 90C1 is approximately 15 mils for mark and for space and approximately 30 mils for mark and for space is transmitted to the telegraph company repeater.

3. DESCRIPTION OF CIRCUIT OPERATION

(A) Station Loop Operation

3.01 The circuit arrangement of the repeater for operation to a station is shown in Fig. 3. The selector switch OPN is operated to the position designated STA.

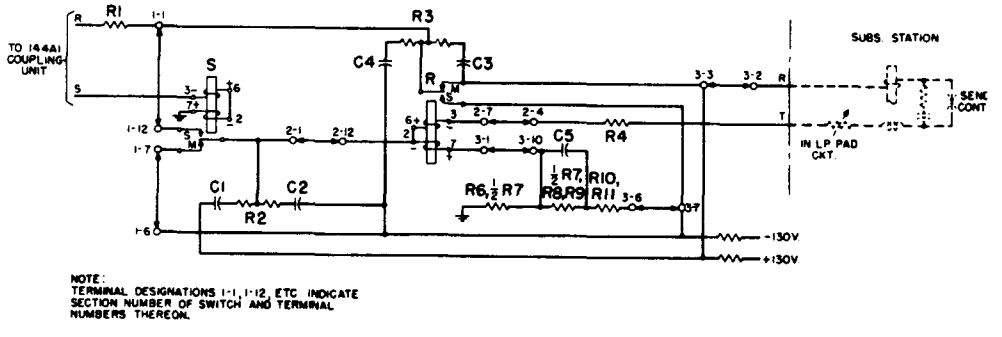

Fig. 3 - Station Loop Operation

3.02 Signals from the hub via the 144A1 coupling unit operate relay S with 7.5 mils for mark and 7.5 mils for space. The armature of relay S applies negative 130 volts to the tip side of the loop for marking and positive 130 volts for spacing, resulting in a mark and space loop current of 62.5 mils and zero, respectively.

3.03 When relay S transmits a space, transient currents due to loop capacitance flow through the 6-3 winding of relay R in a spacing direction and this tends to produce "kick-off" of relay R. This kick-off is prevented largely by a steady state marking current of about 100 mils flowing through the 2-7 winding of relay R to the loop balancing network consisting of resistors R6 to R11 and capacitor C5. Transient currents through capacitor C5 are also a marking influence through winding 2-7. On the longest loops, the loop pad will be adjusted to a very small resistance or removed entirely. Under such conditions, loop wave shaping network is connected in series in the tip side of the loop to assist the 2-7 bias winding in the prevention of kick-off. The use of this loop wave shaper permits a maximum loop length of 34 miles of 19 gauge cable and without this wave shaper the maximum loop length is 30 miles of 19 gauge cable. This wave shaping network also called a loop noise suppressor consists of a 307L coil in series in the tip side of the loop and a 1/4 MF capacitor in series with 1000 ohms connected to ground.

3.04 When relay S operates to mark, the transient currents through winding 6-3 of relay R flowing to the loop capacitance is marking and the transient currents through capacitor C5 is a spacing influence. Hence, on short loops which have low capacitance, kick-off of relay R is prevented by use of a wave shaping condenser connected from the tip side of the loop to ground so that the marking influence of winding 6-3 of relay R is greater than the spacing influence of the 2-7 winding of the same relay. This wave shaping condenser will be required especially on a short loop to a pulling magnet teletypewriter or to a manual Morse loop with two or three sounders.

3.05 Transmission from the station actuates receiving relay R and the 62.5 mil current which flows when the loop is closed, is a marking influence for winding 3-6 of relay R. When the station sends a space the current in the 6-3 winding of relay R becomes zero and the spacing current of about 31 mils in the 2-7 winding operates it to space. The armature of relay R transmits to the coupling unit through resistor R1 (250 ohms). The R relay sends to the coupling unit approximately 27 mils for mark and 31 mils for space. While the station is transmitting relay S is held marking by the coupling unit. On long loops, inductive wave shaping is required at the station to compensate for the marking effect of loop capacitance when the station is transmitting.

3.06 The 90C1 repeater includes a break feature for station loop operation. This feature provides a fast break and a rapid indication of simultaneous sending when used with electronic hub circuits and associated equipments. By referring to Fig. 3 it will be seen that the spacing contact of relay S is connected to the armature of relay R. Therefore, when the break key in the station teletypewriter is depressed the 62.5 mil marking loop current is removed from the 6-3 winding of relay R on the initial incoming mark to relay S and the R relay then operates to its spacing contact through the influence of negative battery connected to winding 2-7. With relay R on space its 2-7 winding will be connected to negative whether the S relay is marking or spacing. Hence, the R relay is held spacing during transmission from the coupling unit and it transmits a space in response to operation of the station break key immediately following the first incoming mark from the hub circuit.

(B) Operation with Line Repeaters

3.07 The 90C1 repeater is arranged for local operation with a differential loop (balanced loop) line repeater for electronic regeneration in testboard offices under certain service conditions. A schematic of the 90C1 repeater arranged for operation with a differential loop repeater is shown in Fig. 4. The selector switch OPN is operated to the position designated TBR.

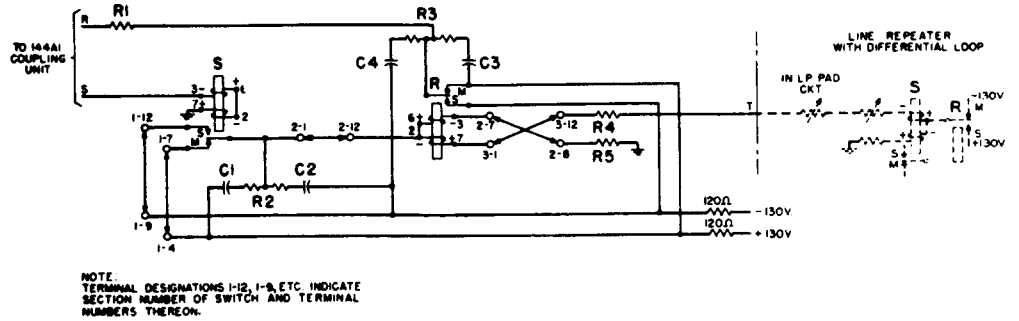

Fig. 4 - Operation with a Differential Loop Line Repeater

3.08 The break relay in the line repeater should be removed in order to take advantage of the double-space by-pass feature of the coupling unit connected to the 90C1 loop repeater. Removal of the break relay permits simultaneous spaces in both directions between the loop repeater and the line repeater even though the repeaters are arranged for half duplex. This is possible because the R relay of the loop repeater is not responsive to signals from its associated S relay and also the S relay of the line repeater is not responsive to signals from its associated R relay.

3.09 The circuit arrangement of the 90C1 loop repeater in this case is equivalent to a line repeater operating "loop reversed" and "loop battery reversed" and since the loop repeater furnishes positive 130V for mark and the line repeater must furnish negative 130V for mark. The purpose of "poling" the 90C1 repeater in this manner is so that it will be connected to Drop 2 jacks of a TLT circuit and the line repeaters will remain normally connected to the Drop 1 jacks thereby permitting flexibility in the office as regards patching line repeaters.

3.10 Signals from the hub via the 144A1 unit operate the loop repeater S relay which applies negative 130V for space to the line winding of the S relay in the line repeater and the current falls to zero since the bias winding of the S relay is poled to operate it to space when the line winding current is zero.

3.11 Transmission from the line repeater likewise reduces the local circuit current to zero and the bias winding of the R relay in the 90C1 repeater operates it to space. The R relay transmits to the coupling unit.

(C) Emergency Operation with Telegraph Company Repeaters

3.12 The 90C1 loop repeater may be arranged for emergency use with telegraph company repeaters in No. 2 and No. 9B service board offices. Two forms of circuits are provided for; one is differential duplex and the other is two-path polar. A schematic of a differential duplex circuit which is a one-wire circuit is shown in Fig. 5. For this circuit arrangement the selector switch OPN is operated to the position designated T1W.

3.13 The loop repeater and the telegraph company repeater are arranged to supply negative 130 volts for mark and positive 130 volts for space. The marking line current is approximately zero. Under certain conditions, there may be a small "over-ride" current due to differences in potentials in the two offices. When either repeater sends, the spacing line current is approximately 62.5 mils.

3.14 The loop pad associated with the 90C1 repeater provides means for obtaining an approximate duplex balance. This pad and the adjustable series line resistance at the telegraph company repeater should be adjusted so that there is an algebraic difference of 62.5 mils in the mark and space line currents when sending from the loop repeater.

3.15 Full-duplex transmission on one-wire will have severe limitations and should be used for full-duplex service only when a loop is not available for two-path polar operation.

3.16 The circuit arrangement of the 90C1 repeater for two-path polar operation to a telegraph company repeater is shown in Fig. 6. The OPN switch should be operated to the position designated T2W.

3.17 The loop repeater and the telegraph company repeater are arranged for negative 130 volts for mark and positive 130 volts for space. The sending line and the receiving line are each equipped with a loop pad. Transmission to the telegraph company office is about 30 mils mark and space and reception at the 90C1 repeater is about 15 mils mark and space. Except for cross fire and ground potential effects, the two-path polar circuit should furnish good full-duplex service.

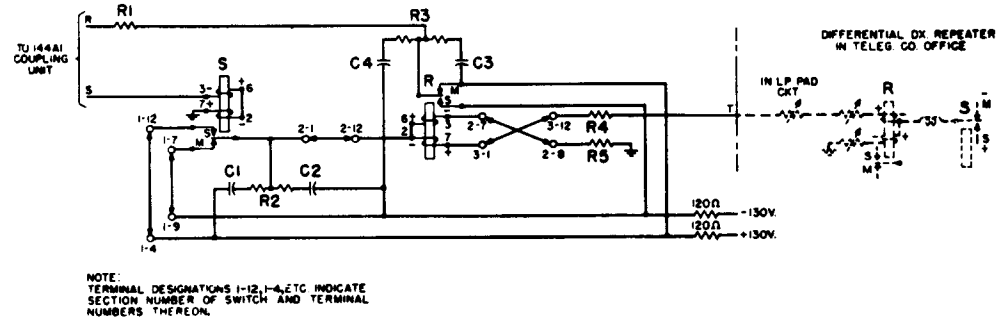

Fig. 5 - Differential Duplex Operation for a One-Wire Circuit to Telegraph Company Repeater

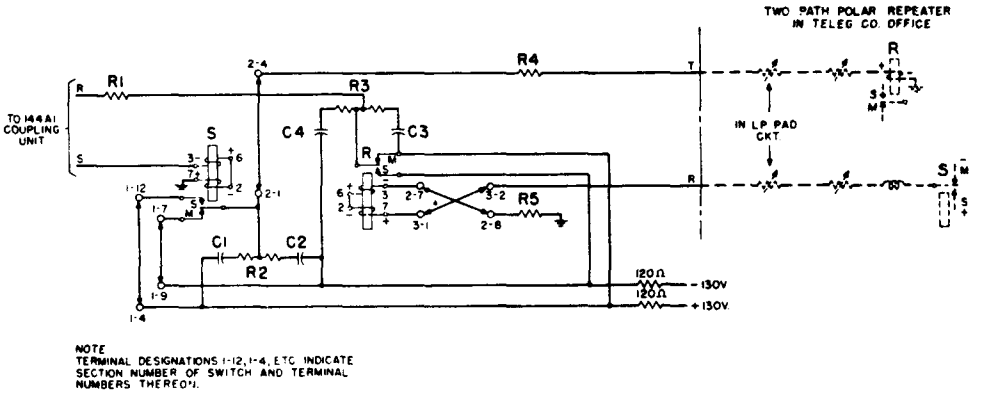

Fig. 6 - Two-Path Polar Operation with a Telegraph Company Repeater

4. OPERATING LIMITS

4.01 The following operating limits apply to station loop operation.

(1) Total resistance external to the repeater between the "T" and "R" leads for normal loop current of .0625 ampere is approximately 3450 ohms.

(2) Minimum resistance in the "T" lead between the repeater and the cable loop to avoid kick-off when loop noise killer is not used is approximately 400 ohms. This permits a maximum of about 30 miles of 19 gauge cable with 85 ohms per mile in the loop, allowing 470 ohms for one relay winding and loading at the station.

(3) No resistance is required in the "T" lead between the repeater and the cable loop to avoid kick-off when the loop noise killer is employed. This permits a maximum of about 34 miles of 19 gauge cable at 85 ohms per mile in the loop, allowing 470 ohms for one relay winding and loading at the station and 45 ohms for the noise killer.

(4) The maximum inductance in series with a resistance loop not equipped with the capacitative anti-kick-off network in order to avoid kick-off is approximately 2 henries. Ordinarily the anti-kick-off network will not be needed for loops to relay or holding magnet equipped teletypewriters, but it may be required in loops containing pulling magnets or sounders and little or no cable.

4.02 The following operating limit applies to operation with a differential loop line repeater.

(1) Total resistance external to the "T" lead of the repeater including the termination in the line repeater is approximately 3560 ohms.

4.03 The following operating limits apply to differential duplex operation to a telegraph company repeater.

(1) Total resistance external to the "T" lead of the repeater is approximately 3560 ohms.

(2) Maximum length of single conductor of 19 gauge cable in series with the "T" lead to limit to 10 per cent the distortion in received 60-speed teletypewriter signals due to duplex unbalance is about 20 miles.

4.04 The following operating limits apply to two-path polar operation to a telegraph company repeater.

(1) Total resistance external to the repeater between the "T" lead and ground for normal sending line current of .030 ampere is approximately 4000 ohms.

(2) The line facilities may be of any type and length normally suitable for use with standard two-path polar

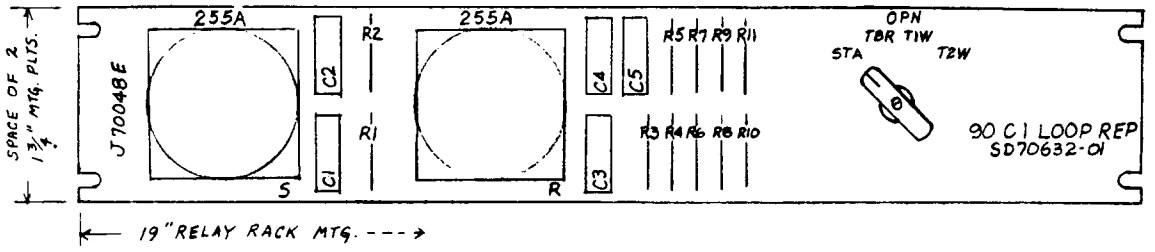

Fig. 7 - Equipment Layout

systems, subject to usual restrictions regarding cross fire and ground potential.

5. DESCRIPTION OF EQUIPMENT

5.01 The equipment for the 90C1 loop repeater is a single circuit shop wired unit occupying a rack space of two 1-3/4" plates on a 19" relay rack. A layout of the equipment on the front of the unit is shown in Fig. 7. The 255A polar relays are supplied only when ordered by the customer.

6. REFERENCE INFORMATION

6.01 The following is the specification and the drawings for the 90C1 loop repeater and the loop pad and wave shaping condensers and networks which may be associated with the repeater.

90C1 Loop Repeater

Equipment Specification	J70048E
Circuit	SD-70632-01
Equipment Unit	ED-71020-01

Loop Pad and Wave Shaping Condensers and Networks

Circuit	SD-70563-01
Relay Rack Mounting	ED-70987-01