TELETYPEWRITER LOOPS

WAVE SHAPING — LOOP LENGTH LIMITS — NOISE INFLUENCE

CONTENTS

1. GENERAL

1.01 This section shows the arrangements that are provided for use at central offices and at teletypwriter stations to modify the wave shape of 40, 60 and 75 speed signals in the teletypewriter loops in order to improve transmission. Both private line and TWX service are covered. The various arrangements show the central office networks, station wave shaping equipment, resistance distribution between the central office and the station and loop length limits. The general features of the application of wave shaping arrangements are shown in this section.

1.02 This section replaces Issue 1 and the related Addendum and is reissued primarily for the following reasons:

1 - To cover the 69A1 and 69B1 TTY switchboards.
2 - To cover the No. 1 Telegraph Service Board and the 101A and 102A Line Concentrating Units.
3 - To change the station wave shaping figures to show the inductance of the wave shaping set in the side of the line opposite to that containing the TTY relay or magnet to reduce the noise induction caused by the station.
4 - To give loop length limits.
5 - To extend the use of the section to cover 40 and 75 speed service.

2. DESCRIPTION OF CENTRAL OFFICE "KICK-OFF" AND WAVE SHAPING ARRANGEMENTS

2.01 Private Line Service: To improve transmission from the central office to the station, arrangements are provided to insert resistance, inductance or a network consisting of resistance, capacity and inductance connected in parallel, in the side of the loop connected to the repeater. The circuit arrangement is shown on SD-70122-01 and is connected either to a loop jack of the TLT or in the side of the loop between the repeater and loop. In the case of differential loop repeaters "kick-off" of the relays in the differential loop circuit can be prevented, in general, by inserting resistance, which forms a part of the repeater. When long loops are encountered and the proper loop current cannot be obtained with the required minimum resistance in the repeater, a network which is of low resistance is inserted instead. In the case of 12A1 and 12A2 repeaters, the condition which involves wave shaping is, in general, satisfied by using resistance which is in the repeater for controlling loop current. When long

© American Telephone and Telegraph Company, 1941
Printed in U.S.A.

loops are encountered and the proper loop current cannot be obtained with the required minimum resistance in the repeater, one or two 307E or 207E retardation coils, which are of lower resistance than the required minimum resistance, are inserted in the loop, externally to the repeater. This coil is the same as that provided in the network used above for differential loop repeaters. The network is so arranged that by the changing of straps, the coil may be used independently if desired.

2.02 TWX Service: To improve transmission from the central office to the station, arrangements are provided to insert a network, consisting of resistance, capacity and inductance connected in parallel, in the repeater side of the loop at the central office. "Kick-off" of the relay in the cord circuit repeater can be prevented, in general, by the strapping of resistances provided in the TWX subscriber line circuit. When long subscriber lines are encountered and the proper current cannot be obtained with the required minimum resistance in the subscriber line circuit, the network which is of low resistance is inserted in the subscriber line circuit. Two networks, differing only in the capacity element, are provided depending on the type of switchboard.

3. DESCRIPTION OF WAVE SHAPING SETS

3.01 The 150B1, 150C1, 150D1 and 150E1 wave shaping sets consist primarily of series inductance (307E or 207E retardation coil) which is provided for signal shaping purposes. In addition the 150B1 and 150C1 sets have a resistance and condenser protection equipment for teletypewriter not provided with spark protection equipment. The 150B1 and 150D1 sets have one inductance coil. The 150C1 and 150E1 sets have two inductance coils in series. The 150B1 or 150D1 set is used for the shorter loops and the 150C1 or 150E1 set for the longer loops. For the longest loops, the inductance of 3 or 4 coils may be needed in certain cases. Two wave shaping sets may be used, in these cases, to provide the necessary inductance.

3.02 The 150F1 wave shaping set consists of a pad which simulates 2 miles of No. 19 gauge loop cable. This set is used at the station to prevent "kick-off" of the central office repeater relays when the loop contains more than one holding magnet teletypewriter without a line relay and is less than 2 miles long.

3.03 The inductance of the 307E or 207E coil, used in the wave shaping sets, differs from coil to coil and also varies with different currents and wave shapes. The winding of this coil is provided with taps which are wired to screw terminals in the wave shaping set. Various combinations of terminal connections may be used to obtain inductance values in steps of about one henry, up to the maximum inductance of the two coils in series. The wiring of the wave shaping sets required to obtain these inductance values is shown in the line termination plans in the P series of Bell System Practices. The various combinations will have about the same effect on telegraph signal wave shape in 60 mil or 20 mil loops as the amount of inductance shown in the following tables, assuming that this inductance was made up of coils having a high degree of stability. These tables also give the approximate d-c resistance of the combination and list the line termination plans, which may be used to secure any desired value of inductance.

TABLE 1

150B1 or 150D1 Wave Shaping Sets

Line Termination Plan (LT) For Wave Shaping Set		Approximate Equivalent Inductance of Stable Coil in Henries		Approximate D-C Resistance In Ohms	*Coil Terminals
150B1	150D1	60 Mil Loop	20 Mil Loop		
1.04A or 1.06A	1.08A	0.7	0.8	56	1-2
1.04B or 1.06B	1.08B	2.0	2.0	111	2-3
1.04C or 1.06C	1.08C	3.0	3.0	142	2-4
1.04D or 1.06D	1.08D	3.5	4.0	161	2-5
1.04E or 1.06E	1.08E	4.5	5.5	167	1-3
1.04F or 1.06F	1.08F	5.5	7.0	198	1-4
1.04G or 1.06G	1.08G	6.0	8.0	217	1-5

* These coil terminals do not correspond to the wave shaping set terminals. For purposes of making connections, reference should be made to the LT plans in the P series of Bell System Practices.

TABLE 2

150C1 or 150E1 Wave Shaping Sets

Line Termination Plan (LT) For Wave Shaping Set		Approximate Equivalent Inductance of Stable Coil In Henries		Approximate D-C Resistance in Ohms	*Coil Terminals	
150C1	150E1	60 Mil Loop	20 Mil Loop		(A) Coil	(B) Coil
1.05A or 1.07A	1.09A	5.5	7.0	198	1-4	Not used
1.05B or 1.07B	1.09B	6.5	7.5	278	2-3	1-3
1.05C or 1.07C	1.09C	6.0	8.0	217	1-5	Not used
1.05D or 1.07D	1.09D	7.5	8.5	309	2-4	1-3
1.05E or 1.07E	1.09E	8.0	9.5	328	2-5	1-3
1.05F or 1.07F	1.09F	9.0	10.5	328	2-3	1-5
1.05G or 1.07G	1.09G	10.0	11.5	359	2-4	1-5
1.05H or 1.07H	1.09H	10.5	12.5	378	2-5	1-5
1.05J or 1.07J	1.09J	11.5	14.0	384	1-3	1-5
1.05K or 1.07K	1.09K	12.0	14.5	396	1-4	1-4
1.05L or 1.07L	1.09L	13.0	16.0	415	1-4	1-5
1.05M or 1.07M	1.09M	14.0	17.0	434	1-5	1-5

TABLE 3

(150B1+150C1) or (150D1+150E1) Wave Shaping Sets

Line Termination Plan (LT) For Wave Shaping Set		Approximate Equivalent Inductance of Stable Coil In Henries		Approximate D-C Resistance In Ohms	*Coil Terminals		
					Set No. 1 150C1 or 150E1		Set No. 2 150B1 or 150D1
(150B1+150C1)	(150D1+150E1)	60 Mil Loop	20 Mil Loop		(A) Coil	(B) Coil	(A) Coil
1.12A	1.14A	13	16	415	1-5	1-4	Not used
1.12B	1.14B	14	17	434	1-5	1-5	Not used
1.12C	1.14C	15	18	490	1-5	1-5	1-2
1.12D	1.14D	16	19	545	1-5	1-5	2-3
1.12E	1.14E	17	20	576	1-5	1-5	2-4
1.12F	1.14F	18	21	595	1-5	1-5	2-5
1.12G	1.14G	19	22.5	601	1-5	1-5	1-3
1.12H	1.14H	20	24	632	1-5	1-5	1-4
1.12J	1.14J	21	26	651	1-5	1-5	1-5

TABLE 4

Two 150C1 or Two 150E1 Wave Shaping Sets

Line Termination Plan (LT) For Wave Shaping Set		Approximate Equivalent Inductance of Stable Coil in Henries		Approximate D-C Resistance in Ohms	*Coil Terminals			
					Set No. 1 150C1 or 150E1		Set No. 2 150C1 or 150E1	
Two 150C1 Sets	Two 150E1 Sets	60 Mil Loop	20 Mil Loop		(A) Coil	(B) Coil	(A) Coil	(B) Coil
1.13A	1.15A	20	24	632	1-5	1-5	1-4	Not used
1.13B	1.15B	21	26	651	1-5	1-5	1-5	Not used
1.13C	1.15C	22	27	707	1-5	1-5	1-5	1-2
1.13D	1.15D	23	28	762	1-5	1-5	1-5	2-3
1.13E	1.15E	24	29	793	1-5	1-5	1-5	2-4
1.13F	1.15F	25	30	812	1-5	1-5	1-5	2-5
1.13G	1.15G	26	31.5	818	1-5	1-5	1-5	1-3
1.13H	1.15H	27	33	849	1-5	1-5	1-5	1-4
1.13J	1.15J	28	35	868	1-5	1-5	1-5	1-5

*These coil terminals do not correspond to the wave shaping set terminals. For purposes of making connections, reference should be made to the LT plans in the P series of Bell System Practices.

4. CENTRAL OFFICE AND TELETYPEWRITER STATION ARRANGEMENT INDEX AND LOOP LENGTH LIMITS

4.01 Index: The following index shows the proper association of the central office and station arrangements, as indicated by the Figures, with each other. For the purpose of this section, the 101A and 102A line concentrating units are referred to as a "central office" and the 94A1 and 94A2 repeaters at 69A1 and 69B1 teletypewriter switchboards as a "station". The index is divided into two main sections "Private Line Service" and "TWX Service", according to the type of service. Each in turn is subdivided in accordance with the various types of equipment. Where an asterisk (*) is shown instead of a figure, no wave shaping arrangements are required, although resistance adjustments may be required to obtain the proper loop or station line current.

PRIVATE LINE SERVICE

Type of Repeater	Fig.For Central Office	Fig.For Station
Differential Loop Repeater		
Resistance Wave Shaping		
Single Service	1	12, 34
Duplex Service "S" Leg	*	12
Duplex Service "R" Leg	*	36
Single Service - Thru Operation to Diff. Loop Repeater	3	12, 34
Single Service - Thru Operation to 12A1 or 12A2 Repeater	2	12, 34
Service to 94A1 or 94A2 Repeater	1	18
Inductance Wave Shaping		
Single Service	1	13, 34
Duplex Service "S" Leg	*	13
Duplex Service "R" Leg	*	36
Single Service - Thru Operation to Diff. Loop Repeater	3	13, 34
Single Service - Thru Operation to 12A1 or 12A2 Repeater	2	13, 34
Service to 94A1 or 94A2 Repeater	1	19
12A1 and 12A2 Repeaters		
Resistance Wave Shaping		
Single Service	4	12, 34
Duplex Service "S" Leg	5	12
Duplex Service "R" leg	6	36
Single Service - Thru Operation to 12A1 or 12A2 Repeater	7	12. 34
Single Service - Thru Operation to Diff. Loop Repeater	2	12, 34
Service to 94A1 or 94A2 Repeater	4	18
Inductance Wave Shaping		
Single Service	4	13, 34
Duplex Service "S" Leg	5	13
Duplex Service "R" Leg	6	36
Single Service - Thru Operation to 12A1 or 12A2 Repeater	7	13, 34
Single Service - Thru Operation to Diff. Loop Repeater	2	13, 34
Service to 94A1 or 94A2 Repeater	4	19
One-Way Polar Repeater		
Resistance Wave Shaping	8,11	12, 14
Inductance Wave Shaping	8,11	13, 15
Single Line Repeater Using Polar Relays		
Resistance Wave Shaping	9	12, 34
Inductance Wave Shaping	9	13, 34
Split Loop Repeater		
Resistance Wave Shaping	11	14
Inductance Wave Shaping	11	15
Misc. Type of Equipment Non-Repeatered Loops		
Inductance Wave Shaping	10	13, 34
No. 67A2 TTY Swbd.		
Local Loops	*	16
Extension Loops	*	16
No. 1 Telegraph Service Board (90A1 Loop Repeater)	35	17
No. 65B1 TTY Swbd.	22	28, 31
No. 69A1 or 69B1 TTY Swbd. (90B1 or 90B2 Repeater)	*	33

TWX SERVICE

Type of Switchboard	Fig.For Central Office	Fig. For Station
No.1	20	26,27,34
No.1A	20	26,27,34
No.3	21	28, 34
No.3A	21	28, 34
No.5	*	29, 34
No.65B1	22	28,31,34
No.4 Morse Board ††	23	28,31,34
No.4 Morse Board †	24	28, 34
No.5 Toll Test Board ††	23	28,31,34
No.5 Toll Test Board †	24	28, 34
No.9 Telegraph Test Board ††	23	28,31,34
No.9 Telegraph Test Board †	24	28, 34
No.101 Line Concentrating Unit	*	30
No.101A and 102A Line Concentrating Units	25	32

†† Closed Line † Open Line

4.02 Loop Length Limits: The loop length is limited by transmission considerations and loop current. The station figures listed in the "Index" under paragraph 4.01 give limiting considerations from a transmission standpoint. The central office figures listed in the "Index" give the limiting conditions for obtaining the proper loop current.

5. NOMENCLATURE

5.01 As used in this section, the connection between the central office and the subscriber station is called a "loop" in the case of private line service and a "subscriber line" in the case of TWX service.

5.02 The designations (R1),(R2),(R3),(R4), and (N), when used in connection with the private line circuit arrangement figures and associated tables of this section, always have the same meanings, as follows:

(R1) - Loop current regulating resistance in repeater.
(R2) - TLT battery tap resistance in loop.
(R3) - Battery tap resistance in repeater battery supply. For purposes of this section, the (R3) resistance is considered as part of the repeater and not as resistance external to the repeater.
(R4) - Wave shaping resistance at station.
(N) - Network at central office to prevent "kick-off" of repeater relays in loop.

5.03 The resistance designations shown in the figures in the case of teletypewriter switchboard subscriber line circuits, test board line circuits, teletypewriter subscriber sets and certain resistance designations in 12A1 and 12A2 repeaters are the same as the apparatus designations for these resistances on the SD drawings.

6. APPLICATION OF CIRCUIT ARRANGEMENT FIGURES

6.01 General: The circuit arrangements for the various conditions are covered on pages 8 to 49 .The association of the various figures with each other is covered in 4.01. The figures on pages 8 to 49 are schematics used for the purpose of showing certain resistances, coils and batteries, which are referred to in the associated tables or notes. They are not intended to be complete schematics of the circuits and, therefore, do not necessarily show all the resistance in the circuit. A 307E retardation coil may be used instead of the 207E retardation coil shown in the figures.

6.02 Bias Corrector-Differential Loop Repeater: When the data in this section are applied to a differential loop repeater having a bias corrector, the bias corrector shall not be used.

6.03 Mixed Gauges: In the case of loops or subscriber lines made up of mixed gauges, the proper arrangement is determined by considering that the loop, or subscriber line, is made up of the lowest numbered gauge (largest diameter of wire) of which there is 1/4 mile or more. The total loop, or subscriber line resistance, is the combined resistance of all gauges.

6.04 Bridged Taps: The data in this section are based on conductors having no bridged taps. Where there are bridged taps the initial wave shaping arrangements should be the same as if there were no bridged taps. A more exact arrangement should then be determined by transmission tests.

6.05 Loop Current Adjustment: In connection with loops over 10 miles, it is essential from a transmission standpoint that the loop current be set with respect to the voltage existing at the time the adjustment is made. In some cases this information is covered by the SD drawing or other BSP sections. Where it is not covered elsewhere, the current should be set in accordance with the following tables:

130 Volt Operation

Total Voltage Available	Current Adjustment
250V	.060 amp.
254V	.061 amp.
258V	.062 amp.
262V	.063 amp.
266V	.064 amp.
270V	.065 amp.

48 Volt Operation

Total Voltage Available	Current Adjustment
92V	.019 amp.
94V	.0195 amp.
96V	.020 amp.
98V	.0205 amp.
100V	.021 amp.

6.06 Teletypewriter Adjustment: It is assumed that the teletypewriter at a station is adjusted to obtain optimum tolerances over the particular loop or subscriber line to which it is connected.

6.07 Pulling Magnet Teletypewriter - Line Relay: A line relay shall be used in the teletypewriter when a pulling magnet is used.

6.08 Private Line Service - Resistance VS Inductive Wave Shaping: In private line service, with only one teletypewriter at the station, resistance wave shaping where specified will give satisfactory results. Where more than one teletypewriter is at the station or where the wave shaping resistance cannot be conveniently mounted in the teletypewriter, use inductance wave shaping.

6.09 Wave Shaping Sets With No. 26 Teletypewriter: Wave shaping sets without spark killers should be used with the 26 teletypewriter since a spark killer is provided with this teletypewriter.

6.10 Loops in Series: In connection with the use of the data in this section for loops in series, the total length should be taken as the sum of all lengths of all loops.

6.11 No. of Teletypewriters In Loop: The station data in this section for TWX service is based on only one teletypewriter in the loop. For private line service with resistance wave shaping only one teletypewriter may be in the loop but with inductive wave shaping one or more teletypewriters may be in the loop unless otherwise specified on the figures. The number of holding magnet teletypewriters in private line loops is covered on the individual figures. Although the maximum number of teletypewriters with line relays that may be in the same loop is not known, 5 or 6 should operate satisfactorily.

6.12 Full Duplex-Through Operation: Where the "R" leg of one repeater is connected to the "S" leg of another repeater through a station, each repeater should be considered separately in accordance with the individual figures. For example, considering the "S" leg of a differential loop repeater and the "R" leg of a 12A1 repeater, use Fig. 1 for the "S" leg and Fig. 6 for the "R" leg.

7. NOISE INFLUENCE

7.01 Station: Where either resistance wave shaping or no wave shaping is used at the station and noise induction trouble caused by the station is encountered, a reduction in noise influence may be obtained by employing inductance wave shaping. For best results the spark protection equipment should be connected directly across the teletypewriter sending contacts, as in the 15C TTY base, and the inductance should be connected in series with the line in the opposite side from the line relay or magnet. The LT plans specified in this section should be used except for short loops where inductance wave shaping is not specified. Where inductance wave shaping is not specified for transmission purposes, the 150B1 or 150D1 wave shaping set should be used and should be connected according to plan LT 1.06D or 1.08D, respectively.

7.02 Central Office: Where noise is introduced at the central office in a private line loop, a loop noise suppression circuit may be added at the central office. This circuit and the place to introduce it is covered by SD-70338-01. Figure A below shows the schematic of this circuit.

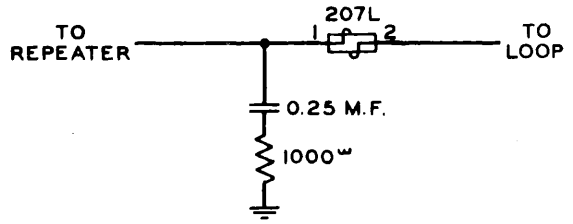


Fig. A

8. TESTING METHODS AND RESULTS

8.01 Because of variations in the particular arrangements of different loops or subscriber lines, and uncertainties introduced by mixed gauges or cable circuits, bridged taps and differences in repeater and station equipment, the best arrangement obtainable with a particular telegraph loop or subscriber line may not always be that indicated in this section. It is important, therefore, to make tests over the loop, or subscriber line, and if the transmission results do not appear entirely satisfactory to endeavor to effect improvement. In

these tests, the arrangement specified in this section will ordinarily be the best "initial" setup with which to start testing. In connection with 75 speed service, a greater departure from the "initial" setup may be necessary than for other speeds.

8.02 In connection with the following tests, it may be noted, in the case of differential loops, that wave shaping arrangements at the subscriber station have little effect on the quality of the signals as received at the station.

From Subscriber to Central Office

8.03 Teletypewriter signals should be transmitted from the subscriber station to the central office, using the station distributor or a portable test distributor if available, and if not using the teletypewriter keyboard, and transmission measurements should be made at the central office. The wave shaping arrangements should be adjusted to give the best results. Marking bias in the signals from the subscriber station to the central office is an indication that more series inductance is required, while spacing bias ordinarily indicates that too much inductance has been included.

From Central Office to Subscriber

8.04 Test signals should be sent to the station for the following purposes:

(1) To test the final adjustment of the wave shaping apparatus in the case of open and close repeaters.

(2) To test for "kick-off" in the case of differential loop repeaters. In some cases, arrangements are available for observing "kick-off". In other cases, the fact that a satisfactory orientation range is obtained at the subscriber station may be considered as evidence that there is probably no trouble from this source.

9. REFERENCE LIST OF CENTRAL OFFICE DRAWINGS

SD-70122-01 - Central Office Network Circuits For TTY Station Line Wave Shaping.

SD-70338-01 - Loop Noise Suppression Circuit.

ED-64004-01 - Miscellaneous Relay Rack Equipment

Note: The above drawings are not attached to this section.

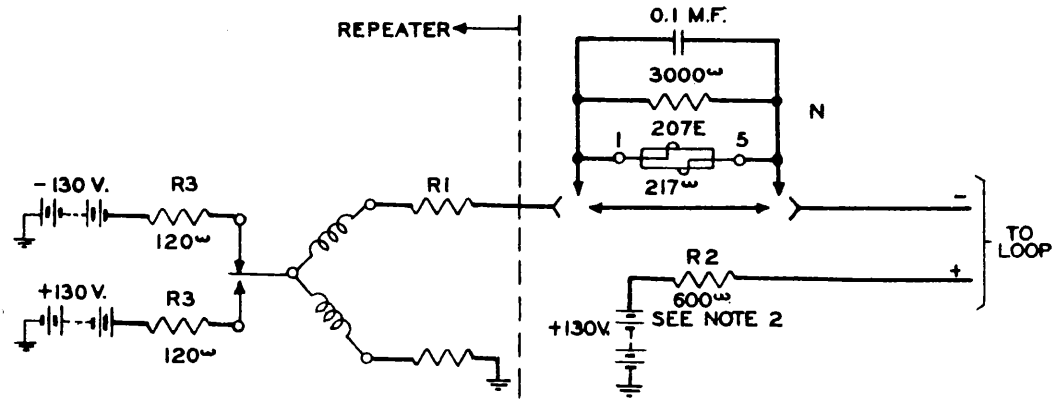


FIG. 1

PRIVATE LINE SERVICE - CENTRAL OFFICE

REPEATERS WITH DIFFERENTIAL LOOP

SINGLE SERVICE

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION
ONE LOOP TO 94A1 OR 94A2 REPEATER (69A1 OR 69B1 TTY SWBD.)

TABLE 1 (See Notes 1 to 3)

Cable Gauge	Resistance External to Repeater	R1 Min.	N Network
19	0-2300ω	1400ω	OUT
19	2300-3500ω	200ω	IN
22	0-2600ω	1100ω	OUT
22	2600-3700ω	0	IN
24	0-3000ω	700ω	OUT
24	3000-3700ω	0	IN

TABLE 2 (See Notes 1 to 3)

Cable Gauge	Resistance External to Repeater	R1 Min.	N Network
19	0-2200ω	1500ω	OUT
19	2200-3400ω	300ω	IN
22	0-2500ω	1200ω	OUT
22	2500-3700ω	0	IN
24	0-3100ω	600ω	OUT
24	3100-3700ω	0	IN

NOTES

1. For repeaters where R1 is varied in 300ω steps, Table 2 applies instead of Table 1.

2. The values given for R1 in the table and R2 in the sketch are normally minimum values. Either or both may be increased as required to obtain the proper loop current. When the N network is used, R1 shall not exceed 800ω. While desirable to keep R2 at least 600ω, it may be reduced to not less than 120ω when necessary to obtain the proper loop current.

3. When single line repeaters, or other equipment, are located in the loop at the central office they shall be located in the side of the loop connected to the repeater. In this case the minimum values given for R1 may be reduced by an amount equal to the resistance of the added equipment to obtain the proper loop current. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the resistance of the added equipment is greater than the minimum values given for R1, the limits of resistance external to the repeater shall be reduced by an amount equal to the difference between the resistance of the added equipment and the minimum values given for R1, to obtain the proper loop current.

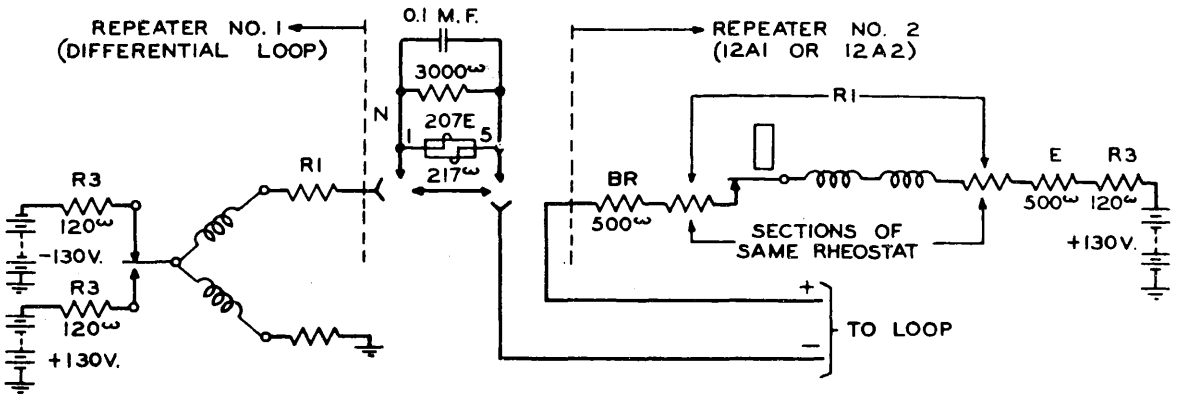


FIG. 2

PRIVATE LINE SERVICE - CENTRAL OFFICE

REPEATER WITH DIFFERENTIAL LOOP CONNECTED TO

12A1 OR 12A2 REPEATER

USED FOR THROUGH OPERATION

SINGLE SERVICE

One Loop with Resistance Wave Shaping at Station
One or More Loops with Inductance Wave Shaping at Station

Cable Gauge	Resistance External to Both Repeaters	No. 1 Repeater R1 Min.	No. 1 Repeater N Network	No. 2 Repeater R1 Min.
19	0-1050ω	1500	OUT	300
19	1050-2100ω	300	IN	300
22	0-1750ω	900	OUT	200
22	1750-2450ω	0	IN	200
24	0-2150ω	600	OUT	100
24	2150-2550ω	0	IN	100

NOTES

1. The values given for R1 are minimum values and may be increased to obtain the proper loop current. Each R1 should be increased approximately the same amount.

2. When single line repeaters, or other equipment, are located in the loop at the central office, the minimum values given for R1, associated with the repeater which is connected to the single line repeater, may be reduced by an amount equal to the resistance of the added equipment, to obtain the proper loop current. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the resistance of the added equipment is greater than the minimum values given for the R1 resistance under consideration, the limits of resistance external to the repeater shall be reduced by an amount equal to the difference between the resistance of the added equipment and the values given for R1, to obtain the proper loop current.

3. The E resistance shall not be short circuited to obtain the proper loop current.

4. The BR resistance may be short circuited to obtain the proper loop current.

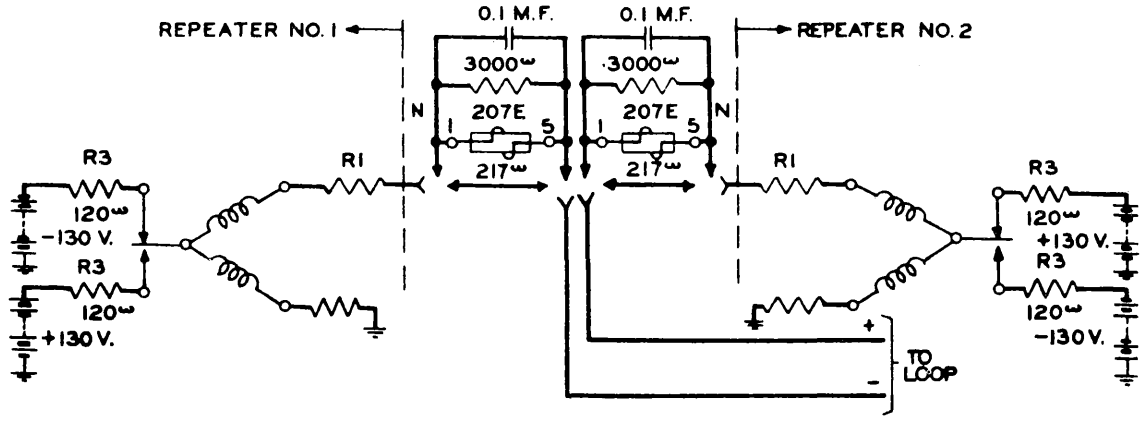


FIG. 3

PRIVATE LINE SERVICE - CENTRAL OFFICE

REPEATERS WITH DIFFERENTIAL LOOP

USED FOR THRU OPERATION

SINGLE SERVICE

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION

TABLE 1 (See Notes 1 to 4)

Cable Gauge	Resistance External to Both Repeaters	No. 1 Repeater R1 Min.	No. 1 Repeater N Network	No. 2 Repeater R1 Min.	No. 2 Repeater N Network
19	0- 900ω	1200ω	OUT	1200ω	OUT
19	900-1700ω	1400ω	OUT	200ω	IN
19	1700-2900ω	200ω	IN	200ω	IN
22	0-1500ω	900ω	OUT	900ω	OUT
22	1500-2300ω	1000ω	OUT	0	IN
22	2300-3300ω	0	IN	0	IN
24	0-1900ω	700ω	OUT	700ω	OUT
24	1900-2600ω	700ω	OUT	0	IN
24	2600-3300ω	0	IN	0	IN

TABLE 2 (See Notes 1 to 4)

Cable Gauge	Resistance External to Both Repeaters	No. 1 Repeater R1 Min.	No. 1 Repeater N Network	No. 2 Repeater R1 Min.	No. 2 Repeater N Network
19	0- 900ω	1200ω	OUT	1200ω	OUT
19	900-1500ω	1500ω	OUT	300ω	IN
19	1500-2700ω	300ω	IN	300ω	IN
22	0-1500ω	900ω	OUT	900ω	OUT
22	1500-2400ω	900ω	OUT	0	IN
22	2400-3300ω	0	IN	0	IN
24	0-2100ω	600ω	OUT	600ω	OUT
24	2100-2700ω	600ω	OUT	0	IN
24	2700-3300ω	0	IN	0	IN

NOTES

1. For repeaters where R1 is varied in 300ω steps, Table 2 applies instead of Table 1.

2. The values given for R1 are minimum values and may be increased to obtain the proper loop current. Each R1 should be increased approximately the same amount.

3. When single line repeaters, or other equipment, are located in the loop at the central office, the minimum values given for R1 associated with the repeater which is connected to the single line repeater, may be reduced by an amount equal to the resistance of the added equipment, to obtain the proper loop current. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the resistance of the added equipment is greater than the minimum values given for the R1 resistance under consideration the limits of resistance external to the repeater shall be reduced by an amount equal to the difference between the resistance of the added equipment and the minimum values given for R1, to obtain the proper loop current.

4. Different arrangements are given for the two repeaters so that in some cases it will not be necessary to provide a network in each repeater.

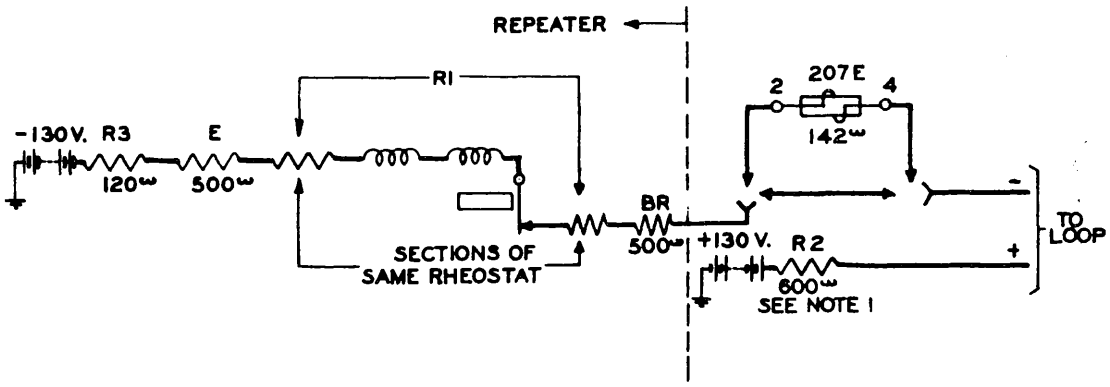


FIG. 4

PRIVATE LINE SERVICE - CENTRAL OFFICE

12A1 AND 12A2 REPEATERS

SINGLE SERVICE

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION
ONE LOOP TO 94A1 OR 94A2 REPEATER (69A1 OR 69B1 TTY SWBD.)

See Notes 1 to 4

Cable Gauge	Resistance External to Repeater	R1 Min.
19	0-2700ω	500ω
22	0-2800ω	400ω
24	0-2900ω	300ω

NOTES

1. The values given for R1 in the table and R2 in the sketch are normally minimum values. Either or both may be increased as required to obtain the proper loop current. While desirable to keep R2 at least 600ω, it may be reduced to not less than 120ω, when necessary to obtain the proper loop current, after the BR resistance has been short circuited.

2. When inductance wave shaping is used at the station and the loop current is too low even with R1 set at the minimum value specified, short circuit the BR resistance. If this does not increase the current sufficiently, R1 may be reduced further to any value providing the 2-4 winding of the 207E retardation coil is inserted in the circuit, next to the repeater, as shown.

3. When single line repeaters, or other equipment, are located in the loop at the central office they shall be located in the side of the loop connected to the repeater. In this case the minimum values given for R1 may be reduced by an amount equal to the resistance of the added equipment, to obtain the proper loop current. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the resistance of the added equipment is greater than the minimum values given for R1, the limits of resistance external to the repeater shall be reduced by an amount equal to the difference between the resistance of the added equipment and the minimum values given for R1, to obtain the proper loop current.

4. The E resistance shall not be short circuited to obtain the proper loop current.

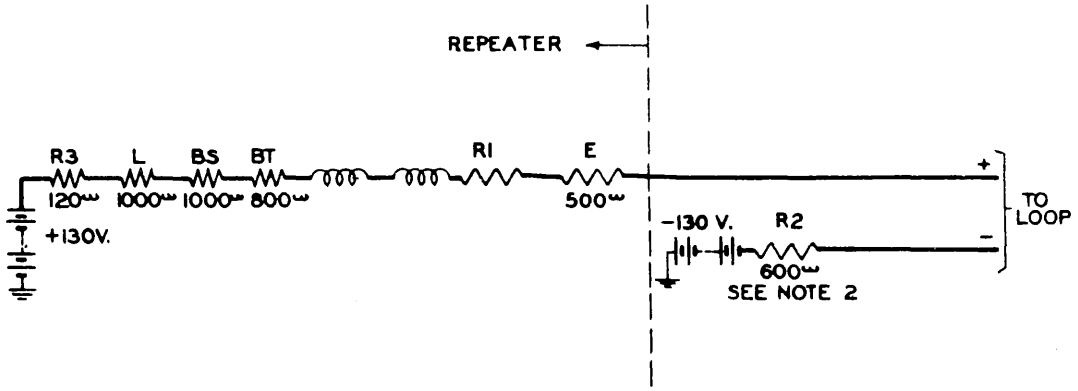


FIG. 5

PRIVATE LINE SERVICE - CENTRAL OFFICE

12A1 AND 12A2 REPEATERS

DUPLEX SERVICE - "S" LEG

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 to 3

Cable Gauge	Resistance External to Repeater	R1 Min.
19	0-3700ω	0
22	0-3700ω	0
24	0-3700ω	0

NOTES

1. The E, L, BS or BT resistance or all may be short circuited, if necessary, to obtain the proper loop current.

2. The values given for R1 in the table and R2 in the sketch are normally minimum values. Either or both may be increased as required to obtain the proper loop current. While desirable to keep R2 at least at 600ω, it may be reduced to not less than 120ω when necessary to obtain the proper loop current.

3. When single line repeaters, or other equipment, are located in the loop at the central office they shall be located in the side of the loop connected to the repeater. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the proper loop current cannot be obtained with R1 at zero and after the E, L, BS and BT resistances have been short circuited, the limits of resistance external to the repeater shall be reduced by an amount equal to the resistance of the added equipment.

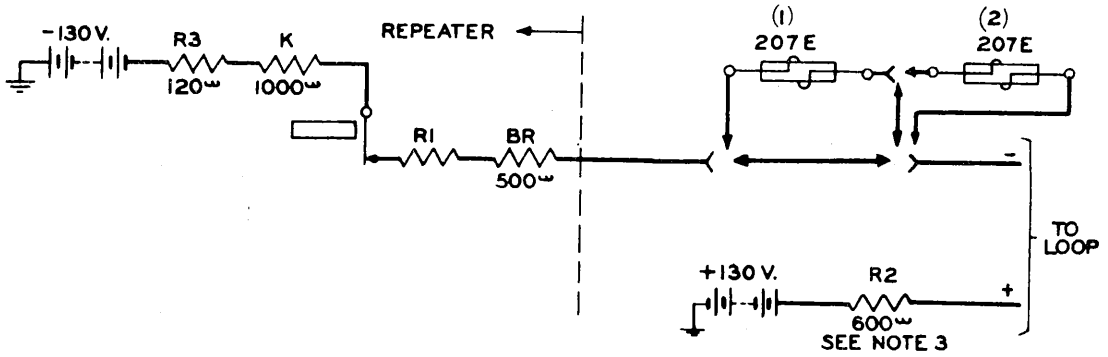


FIG. 6

PRIVATE LINE SERVICE - CENTRAL OFFICE

12A1 AND 12A2 REPEATERS

DUPLEX SERVICE - "R" LEG

ONE OR MORE LOOPS WITHOUT WAVE SHAPING AT STATION

See Notes 1 to 4

Loop Conditions	R3	R1	R1 + R3 Minimum	207E Coil Connection
For loops not exceeding 12 miles and not exceeding 2300ω external to repeater	120ω	See Note 2	600ω	Not Required
For loops exceeding 12 miles but not exceeding 2900ω or between 2300ω and 2900ω external to repeater	120ω	See Note 3	-	See Note 4

NOTES

1. The loop lengths and the resistance values external to repeater, given in the table, are the totals of the loops involved in case of two or more loops.

2. For loops not exceeding 12 miles in length and where the resistance external to the repeater does not exceed 2300ω, R1 should be of such a value as to obtain the proper loop current. If the loop is of such a length that R1 cannot establish the proper loop current, R3 may be increased beyond 120ω as required. The BR resistance may be short circuited to obtain the proper loop current.

3. For loops exceeding 12 miles in length but not exceeding 2900ω or where the resistance external to the repeater is between 2300ω and 2900ω, R1 should be as near 600ω as possible, consistent with obtaining the proper loop current. In order to meet this, the BR resistance may be short circuited. If this does not increase the current sufficiently, R2 may be reduced to not less than 120ω. In case the proper loop current cannot be obtained with R1 at 600ω, R2 may be increased beyond 600ω as required.

4. For loops exceeding 12 miles in length but not exceeding 2900ω or where the resistance external to the repeater is between 2300ω and 2900ω, connect one or two 207E retardation coils in the circuit as shown above in accordance with the following:

Cable Length in Miles	Terminal Connections Coil (1)	Coil (2)
5-8	2-4	None
8-11	2-5	None
11-15	1-3	None
15-19	1-4	None
19-26	1-5	None
26-30	2-4	1-3

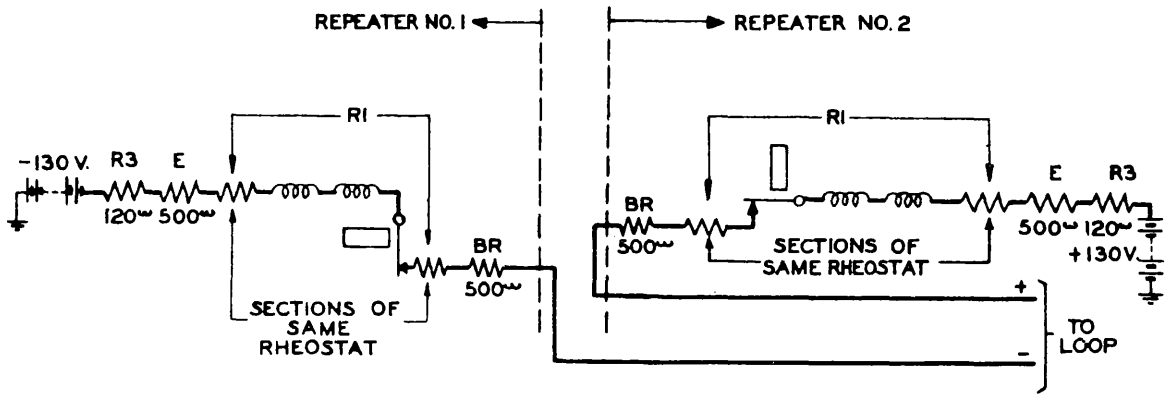


FIG. 7

PRIVATE LINE SERVICE - CENTRAL OFFICE

12A1 AND 12A2 REPEATERS

USED FOR THRU OPERATION

SINGLE SERVICE

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 to 4

With Resistance Wave Shaping at Station

Cable Gauge	Resistance External to Both Repeaters	No. 1 Repeater R1 Min.	No. 2 Repeater R1 Min.
19	0-1700ω	300ω	300ω
22	0-1900ω	200ω	200ω
24	0-2100ω	100ω	100ω

See Notes 1 to 4

With Inductance Wave Shaping at Station

Cable Gauge	Resistance External to Both Repeaters	No. 1 Repeater R1 Min.	No. 2 Repeater R1 Min.
19	0-1500ω	400ω	400ω
22	0-1700ω	300ω	300ω
24	0-1900ω	200ω	200ω

NOTES

1. The values given for R1 are minimum values used and may be increased to obtain the proper loop current. Each R1 should be increased approximately the same amount.

2. When single line repeaters, or other equipment, are located in the loop at the central office, the minimum values given for R1, associated with the repeater which is connected to the single line repeater, may be reduced by an amount equal to the resistance of the added equipment, to obtain the proper loop current. Where the added equipment contains adjustable resistance, this resistance shall be set at the minimum value. If the resistance of the added equipment is greater than the minimum values given for the R1 resistance under consideration, the limits of resistance external to the repeater shall be reduced by an amount equal to the difference between the resistance of the added equipment and the values given for R1, to obtain the proper loop current.

3. The E resistance shall not be short circuited to obtain the proper loop current.

4. The BR resistance may be short circuited to obtain the proper loop current. In case the BR resistance of one repeater is short circuited, the BR resistance of the other repeater should also be short circuited to keep each repeater resistance approximately the same.

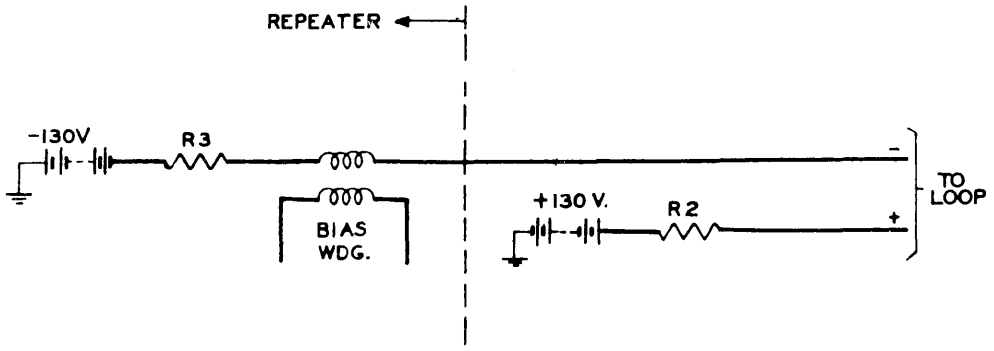


FIG. 8

PRIVATE LINE SERVICE - CENTRAL OFFICE

ONE WAY POLAR REPEATER

ONE LOOP WITH RESISTANCE OR INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 to 3

Cable Gauge	Resistance External to Repeater	R2 Min.	R3 Min.
19	0-3400ω	600ω	600ω
22	0-3400ω	600ω	600ω
24	0-3400ω	600ω	600ω

NOTES

1. The values given for R3 are minimum values. If R3 is 600ω, the resistance external to the repeater is as given in the table. If R3 is increased beyond 600ω, the limits of resistance external to the repeater should be reduced the same amount that R3 is increased.

2. While desirable to keep R2 and R3 at least at 600ω, either or both may be reduced to not less than 120ω, when necessary to obtain the proper loop current. If R3 is reduced below 600ω, the resistance external to the repeater may be increased the same amount that R3 is reduced.

3. If the service requires that the loop be switched from a one way polar repeater to other repeaters, the arrangements provided at both the subscriber station and the central office shall be those given for a single line repeater rather than those normally used with a one way polar repeater.

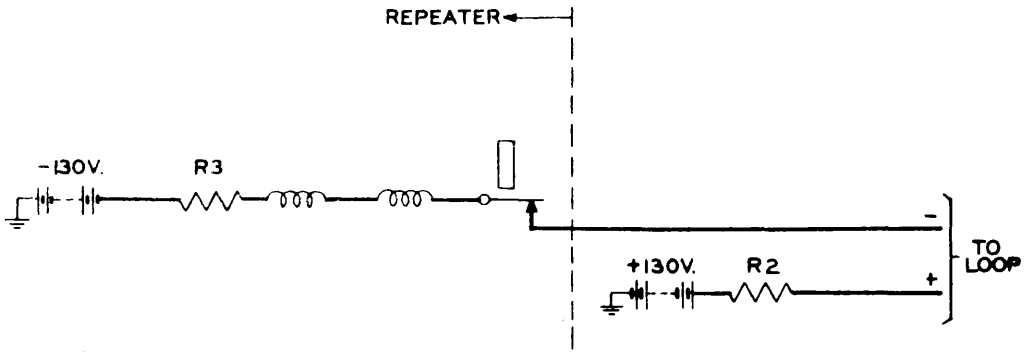


FIG. 9

PRIVATE LINE SERVICE - CENTRAL OFFICE

SINGLE LINE REPEATER USING POLAR RELAYS

ONE LOOP WITH RESISTANCE WAVE SHAPING AT STATION
ONE OR MORE LOOPS WITH INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 and 2

Cable Gauge	Resistance External to Repeater	R2 Min.	R3 Min.
19	0-2700ω	600ω	1300ω
22	0-2800ω	600ω	1200ω
24	0-2900ω	600ω	1100ω

NOTES

1. The values given for R3 are minimum values and should be increased, where possible, to 1500ω for all cases. In this case, the limits of resistance external to the repeater should be reduced by an amount equal to the difference between 1500ω and the minimum values given for R3, if necessary to obtain the proper loop current.

2. While desirable to keep R2 at least at 600ω, it may be reduced to not less than 120ω when necessary to obtain the proper loop current.

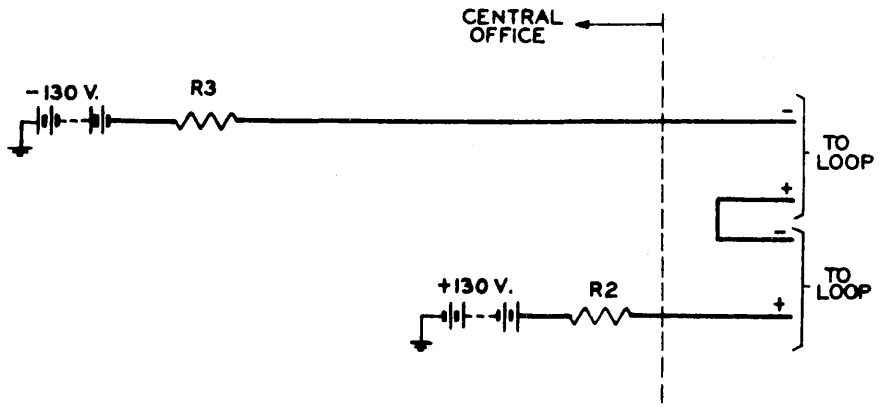


FIG. 10

PRIVATE LINE SERVICE - CENTRAL OFFICE

NON-REPEATERED LOOPS

INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 to 3

Cable Gauge	Resistance External to Central Office	R2 Min.	R3 Min.
19	0-2800ω	600ω	1300ω
22	0-2300ω	600ω	1200ω
24	0-2400ω	600ω	1100ω

NOTES

1. The values given for R3 are minimum values and should be increased, where possible, to 1500ω for all cases. In this case, the limits of "Resistance External to Central Office" as given in the table should be reduced by an amount equal to the difference between 1500ω and the minimum values given for R3, if necessary to obtain the proper loop current

2. R2 should normally be 600ω, in which case the maximum resistance is as given in the table under "Resistance External to Central Office". While desirable to keep R2 at least at 600ω, it may be reduced to not less than 120ω when necessary to obtain the proper loop current. In this case, the "Resistance External to Central Office" as given in the table may be increased by the amount that R2 is reduced.

3. If a teletypewriter is used at the central office, it shall be inserted in the subscriber loop between resistance R3 and the loop.

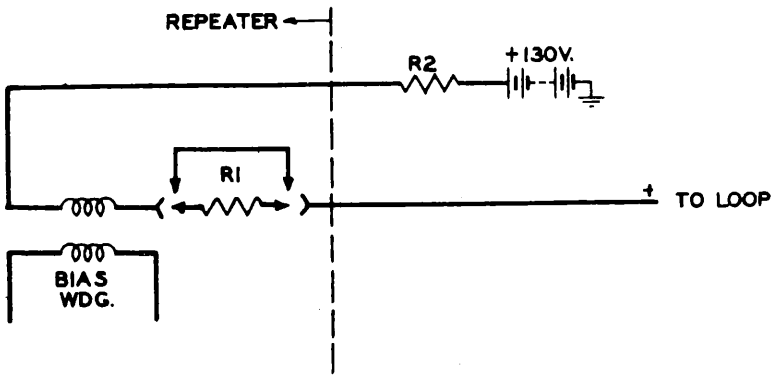


FIG. 11

PRIVATE LINE SERVICE - CENTRAL OFFICE

SPLIT LOOP REPEATER

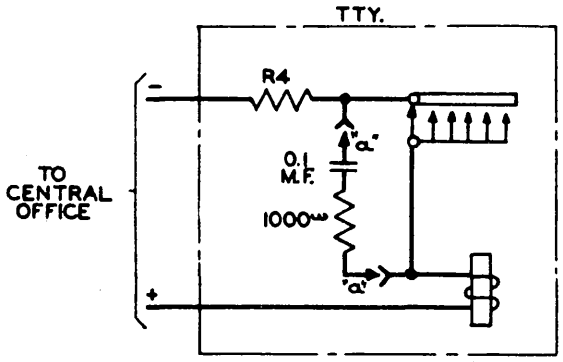
ONE LOOP WITH RESISTANCE OR INDUCTANCE WAVE SHAPING AT STATION

See Notes 1 and 2

Cable Gauge	Resistance External to Repeater	R1 Min.	R2 Min.
19	0-1300ω	0	600ω
22	0-1300ω	0	600ω
24	0-1300ω	0	600ω

NOTES

1. R2 should normally be 600ω, in which case the maximum resistance external to the repeater is as given in the table. While desirable to keep R2 at least at 600ω, it may be reduced to not less than 120ω when necessary to obtain the proper loop current. In this case, the resistance external to the repeater and the value of R4 plus the cable resistance given in Fig. 14 (when resistance wave shaping is used), may be increased by the amount that R2 is reduced. Similarly if R2 is increased beyond 600ω, the external resistance should be reduced a corresponding amount.
2. The value of R1 shall be such as to provide the proper loop current.



"a" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 12

PRIVATE LINE SERVICE

SUBSCRIBER STATION

RESISTANCE WAVE SHAPING

TTY WITH OR WITHOUT SPARK PROTECTION APPARATUS

REPEATERS WITH DIFFERENTIAL LOOP
SINGLE SERVICE

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0-1900ω	1200ω	1,2 & 6
22	0-2300ω	1000ω	"
24	0-1800ω	1000ω	"
24	1800-2700ω	600ω	"

REPEATERS WITH DIFFERENTIAL LOOP
DUPLEX SERVICE - "S" LEG

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0-2000ω	*1500ω	1,2,5 & 6
22	0-2000ω	*1500ω	"
22	2000-2300ω	1200ω	"
24	0-2300ω	1200ω	"
24	2300-2700ω	800ω	"

REPEATERS WITH DIFFERENTIAL LOOP
USED FOR THRU OPERATION
SINGLE SERVICE

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0- 600ω	800ω	1,2 & 6
22	0-1000ω	600ω	"
24	0-1400ω	600ω	"

LOOP OF ONE WAY POLAR REPEATERS

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0-2200ω	*1500ω	1,2,3,5&6
22	0-2200ω	*1500ω	"
22	2200-2500ω	1200ω	"
24	0-2500ω	1200ω	"
24	2500-2900ω	800ω	"

12A1 AND 12A2 REPEATERS
OR SINGLE LINE REPEATERS USING POLAR RELAYS
SINGLE SERVICE

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0-1000ω	*1500ω	1,2,5 & 6
22	0-1100ω	*1500ω	"
22	1100-1400ω	1200ω	"
24	0-1500ω	1200ω	"
24	1500-1900ω	800ω	"

12A1 AND 12A2 REPEATERS
DUPLEX SERVICE - "S" LEG

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0-2100ω	*1500ω	1,2,4,5&6
22	0-2100ω	*1500ω	"
22	2100-2400ω	1200ω	"
24	0-2100ω	*1500ω	"
24	2100-2400ω	1200ω	"
24	2400-2800ω	800ω	"

(Continued on Page 20)

(Continued from Page 19)

12A1 AND 12A2 REPEATERS
USED FOR THRU OPERATION
SINGLE SERVICE

Cable Gauge	Cable Resistance	R4 Min.	See Notes
19	0- 600ω	1000ω	1,2 & 6
22	0-1000ω	800ω	"
24	0-1400ω	600ω	"

NOTES

1. The value given for R4 for 19 gauge cable may be used to some advantage for the other gauges, where the required loop current can be obtained.

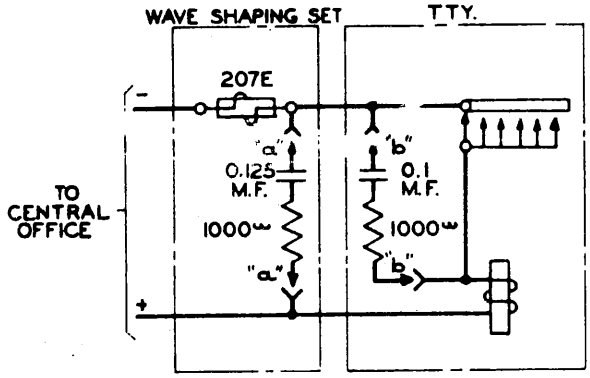
2. If the resistance of the equipment in the TTY (other than R4) is greater than 85ω, R4 may be reduced by an amount equal to the difference between the resistance of the other equipment and 85ω, if the proper loop current cannot be obtained with minimum resistance in the repeater.

3. The loop shall not exceed 14 miles. For longer loops, use inductance wave shaping per Fig. 13.

4. When it is desired to switch from duplex to single service without readjustment, the data for single service shall be used at the station.

5. In certain teletypewriters, R4 is a single 18 type resistance, which is located in the line resistance mounting of the teletypewriter, while in others it is a vitreous resistance located in the teletypewriter. Where an 18 type resistance is used and 1500ω is specified (marked *) a 1200ω resistance shall be used instead to avoid overheating. Where a vitreous type resistance is used, the values specified are obtained from the taps on the resistance.

6. Not more than 1 teletypewriter with or without a line relay shall be in the same loop. The limits in the tables apply to both a holding magnet teletypewriter with or without a line relay and to a pulling magnet teletypewriter.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER

"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 13

PRIVATE LINE SERVICE

SUBSCRIBER STATION

INDUCTANCE WAVE SHAPING

REPEATERS WITH DIFFERENTIAL LOOP OR 12A1 AND 12A2 REPEATERS USED FOR TERMINAL OR THRU OPERATION - SINGLE SERVICE OR "S" LEG OF DUPLEX SERVICE OR SINGLE LINE REPEATERS USING POLAR RELAYS OR NON-REPEATERED LOOPS - SINGLE SERVICE

Cable Length In Miles	See Notes	TTY Without Spark Killer		TTY With Spark Killer			
				150B1 or 150C1 Set		150D1 or 150E1 Set	
		Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-1	1, 4 & 5	None	None	None	None	None	None
1-2	1 & 4	150B1	1.04B	150B1	1.06B	150D1	1.08B
2-4	1	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-9	1 & 3	150B1	1.04F	150B1	1.06F	150D1	1.08F
9-13	1 & 3	150C1	1.05C	150C1	1.07C	150E1	1.09C
13-16	1 & 3	150C1	1.05B	150C1	1.07B	150E1	1.09B
16-21	1 & 3	150C1	1.05D	150C1	1.07D	150E1	1.09D
21-26	1 & 3	150C1	1.05F	150C1	1.07F	150E1	1.09F
26-32	1 & 3	150C1	1.05G	150C1	1.07G	150E1	1.09G

SENDING LOOP OF ONE WAY POLAR REPEATER

Cable Length In Miles	See Note	TTY Without Spark Killer		TTY With Spark Killer			
				150B1 or 150C1 Set		150D1 or 150E1 Set	
		Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
4-12	2	150B1	1.04C	150B1	1.06C	150D1	1.08C
12-16	2	150B1	1.04D	150B1	1.06D	150D1	1.08D
16-22	2	150B1	1.04E	150B1	1.06E	150D1	1.08E
22-26	2	150B1	1.04F	150B1	1.06F	150D1	1.08F
26-34	2	150C1	1.05C	150C1	1.07C	150E1	1.09C
34-38	2	150C1	1.05D	150C1	1.07D	150E1	1.09D
38-43	2	150C1	1.05E	150C1	1.07E	150E1	1.09E

(Continued on Page 22)

(Continued from Page 21)

1. Where two or more loops are connected in series, each loop shall be provided with inductance wave shaping as though it were used alone. When a final check test is made, each loop shall be tested alone with the loop current adjusted in each case to the proper value. Any number of loops may be connected in series without further adjustment at the subscriber station, providing the proper loop current is obtained. Loops shall be arranged so that the shortest one is connected to the repeater, then the next shortest, etc.

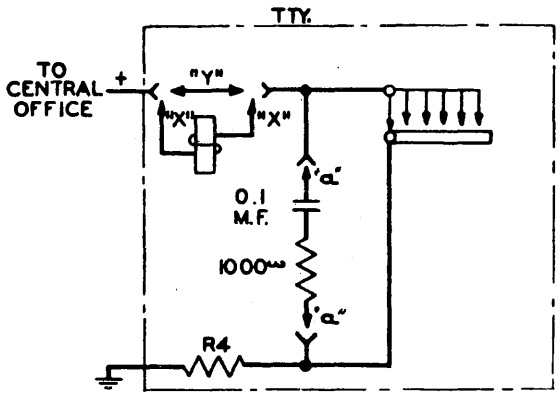
2. Relays of additional one way polar repeaters may be inserted in the loop at the central office. If more than two additional relay windings are added and the loop exceeds 10 miles in length, the plan used should be that given for the next longer range.

3. When holding magnet or pulling magnet teletypewriters with line relays are used, the loop length should not exceed 32 miles as given in the table. When holding magnet teletypewriters without line relays are used, the loop length shall not exceed the limit given below. For loops connected in series the sum of the loop lengths shall not exceed the loop limit given for one loop and the number of teletypewriters shall not exceed the number given for one loop.

Repeater	Loop Limit
Differential Loop Repeater (Terminal or Thru)	
1 TTY, 1 Loop	25 Miles
2 TTY, 1 Loop	18 Miles
3 TTY, 1 Loop	12 Miles
12A1, 12A2 (Terminal or Thru) or Single Line or Non-Repeatered Loop	
1 or 2 TTY, 1 Loop	10 Miles
Differential Loop (Terminal or Thru) +12A1, 12A2 (Terminal or Thru) or Single Line	
1 or 2 TTY, 1 Loop	6 Miles

4. Use a 150F1 wave shaping set when 2 or 3 holding magnet teletypewriters without line relays are in the same loop. For loops in series where the total loop is less than 2 miles use one 150F1 wave shaping set in the loop nearest the repeater.

5. On loops one mile or less, where no wave shaping set is used, disconnect spark killer in base of TTY.



"a" WIRING EXISTS FOR TTY WITH SPARK KILLER

"x" WIRING FOR SENDING AND MONITORING TTY

"y" WIRING FOR SENDING ONLY TTY

FIG. 14

PRIVATE LINE SERVICE

SUBSCRIBER STATION

RESISTANCE WAVE SHAPING

TTY WITH OR WITHOUT SPARK KILLER
SENDING LOOP OF SPLIT LOOP REPEATER

See Notes 1, 2 and 3

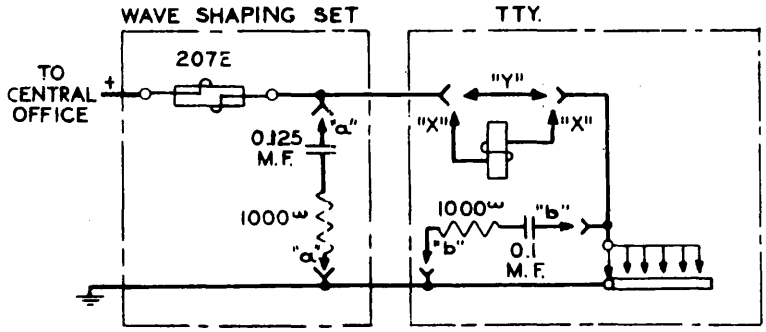
Cable Gauge	Cable Resistance	R4 + Cable Resistance
19	0- 600 Ohms	1200 Ohms
22	0- 800 Ohms	1200 Ohms
24	0-1000 Ohms	1200 Ohms

NOTES

1. If the resistance of the equipment in the TTY (other than R4) is greater than 85 ohms, R4 may be reduced by an amount equal to the difference between the resistance of the other equipment and 85 ohms, if the proper loop current cannot be obtained with minimum resistance in the repeater.

2. The arrangement given for 19 gauge cable may be used for simplexed pair and simplexed phantom 16 and 19 gauge loaded and non-loaded cable loops. Where the proper loop current cannot otherwise be obtained, R4 may be 200 ohms less and the cable resistance 200 ohms more. For all 22 gauge simplexed pair and simplexed phantom loaded and non-loaded cable loops and for 16 and 19 gauge loops longer than 30 miles of simplexed pair or 20 miles of simplexed phantom cable, a 150B1 or 150D1 wave shaping set should be connected at the station as shown in Fig.15. The particular LT plan to be used in connection with the wave shaping set should be determined by tests. R4 in the TTY should be as large as practicable, consistent with obtaining the proper loop current.

3. No loop shall have more than one teletypewriter. The teletypewriter shall be equipped with a line relay.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER

"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

"x" WIRING FOR SENDING AND MONITORING TTY

"y" WIRING FOR SENDING ONLY TTY

FIG. 15

PRIVATE LINE SERVICE

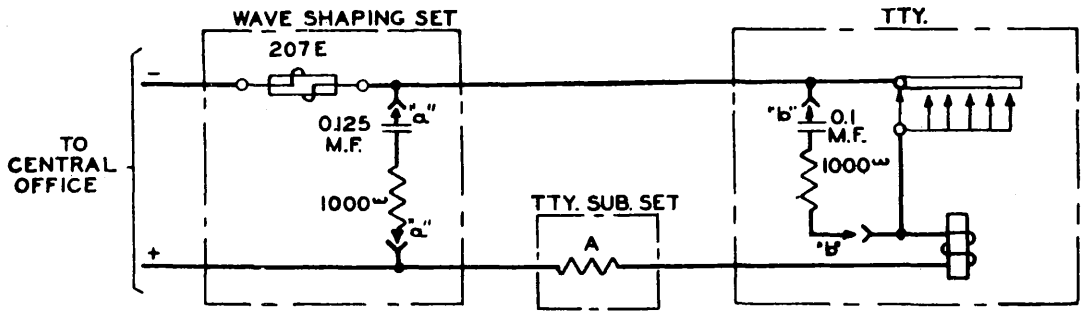
SUBSCRIBER STATION

INDUCTANCE WAVE SHAPING

SENDING LOOP OF SPLIT LOOP REPEATER

	TTY Without Spark Killer		TTY With Spark Killer				
			Cable	150B1 or 150C1 Set		150D1 or 150E1 Set	
Cable Length In Miles	Wave Shaping Set	LT Plan No.	Length In Miles	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-3	None	None	0-3	None	None	None	None
3-6	150B1	1.04B	3-6	150B1	1.06B	150D1	1.08B
6-10	150B1	1.04C	6-10	150B1	1.06C	150D1	1.08C
10-16	150B1	1.04D	10-16	150B1	1.06D	150D1	1.08D
16-24	150B1	1.04E	16-24	150B1	1.06E	150D1	1.08E
24-34	150B1	1.04F	24-34	150B1	1.06F	150D1	1.08F
34-42	150C1	1.05C	34-42	150C1	1.07C	150E1	1.09C

Note: The teletypewriter shall be equipped with a line relay.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 16

PRIVATE LINE SERVICE

SUBSCRIBER STATION

120C1, 125A2, 126A1, 126A2 AND 584DG TELETYPEWRITER SUBSCRIBER SETS
FOR USE WITH
NO. 67A2 TELETYPEWRITER SWITCHBOARD

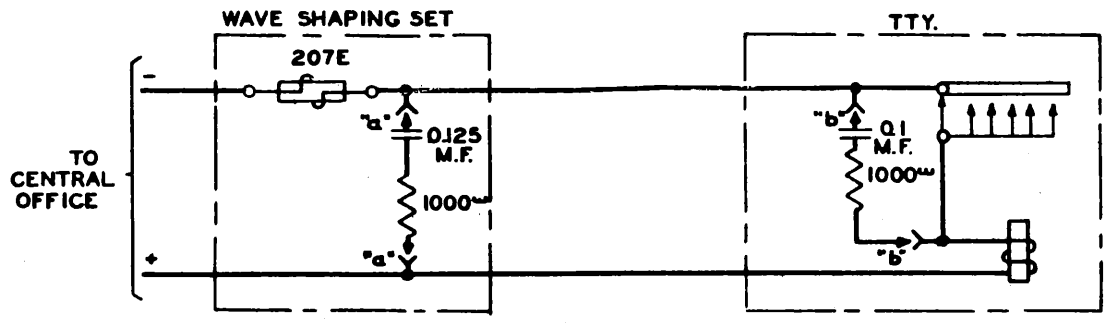
HALF LOOPS (See Note 1)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer 150B1 or 150C1 Set		TTY With Spark Killer 150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-4	0- 500ω	1200ω	None	None	None	None	None	None
0-4	500- 700ω	1000ω	None	None	None	None	None	None
0-4	700- 900ω	600ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
0-4	900-1500ω	0	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-7	0- 700ω	600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-7	700-1500ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-10	0- 700ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-10	700-1500ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
10-12	0-1500ω	0	150C1	1.05C	150C1	1.07C	150E1	1.09C
12-15	0-1350ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G

EXTENSION LOOPS (See Note 1)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer 150B1 or 150C1 Set		TTY With Spark Killer 150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-12	0-2900ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
0-12	2900-3500ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
12-26	0-2900ω	600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
12-26	2900-3500ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
26-30	0-3500ω	0	150C1	1.05C	150C1	1.07C	150E1	1.09C
30-34	0-3400ω	0	150C1	1.05E	150C1	1.07E	150E1	1.09E
34-38	0-3400ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G

Note 1: A line relay shall be used with a holding magnet TTY and only one TTY shall be in the same loop.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER

"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 17

PRIVATE LINE SERVICE

SUBSCRIBER STATION

INDUCTANCE WAVE SHAPING

90A1 REPEATER (NO. 1 TELEGRAPH SERVICE BOARD)

1 Or 2 TTY - Each With Line Relay

Cable Length In Miles	See Note	TTY Without Spark Killer: Wave Shaping Set	TTY Without Spark Killer: LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set: Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set: LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set: Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set: LT Plan No.
0-1	1	None	None	None	None	None	None
1-2		150B1	1.04E	150B1	1.06E	150D1	1.08E
2-12		150B1	1.04F	150B1	1.06F	150D1	1.08F
12-15		150B1	1.04G	150B1	1.06G	150D1	1.08G
15-19		150C1	1.05D	150C1	1.07D	150E1	1.09D
19-24		150C1	1.05E	150C1	1.07E	150E1	1.09E
24-30		150C1	1.05G	150C1	1.07G	150E1	1.09G
30-34		150C1	1.05H	150C1	1.07H	150E1	1.09H
34-38		150C1	1.05J	150C1	1.07J	150E1	1.09J

1 Holding Magnet TTY Without Line Relay

Cable Length In Miles	See Note	TTY Without Spark Killer: Wave Shaping Set	TTY Without Spark Killer: LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set: Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set: LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set: Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set: LT Plan No.
0-1	1	None	None	None	None	None	None
1-2		150B1	1.04C	150B1	1.06C	150D1	1.08C
2-12		150B1	1.04E	150B1	1.06E	150D1	1.08E
12-17		150B1	1.04F	150B1	1.06F	150D1	1.08F
17-22		150B1	1.04G	150B1	1.06G	150D1	1.08G
22-30		150C1	1.05D	150C1	1.07D	150E1	1.09D
30-34		150C1	1.05E	150C1	1.07E	150E1	1.09E
34-38		150C1	1.05G	150C1	1.07G	150E1	1.09G

Note 1: On loops of two miles or less, where no wave shaping set is used, disconnect the spark killer in the base of the TTY.

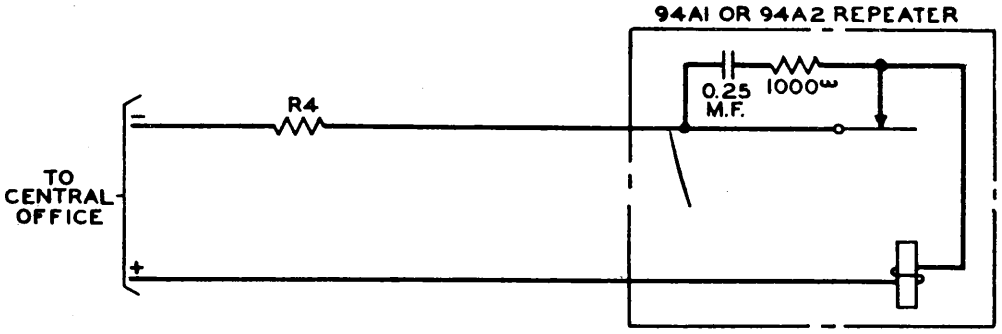


FIG. 18

PRIVATE LINE SERVICE

SUBSCRIBER STATION

RESISTANCE WAVE SHAPING

94A1 OR 94A2 LOOP REPEATER (69A1 OR 69B1 TTY SWBD)

94A1 or 94A2 Repeater Connected to Distant Differential Loop Repeater

Cable Gauge	See Note	Cable Resistance	R4 Min.
19		0-1900ω	1200ω
22	1	0-2300ω	1000ω
24	1	0-1800ω	1000ω
24	1	1800-2700ω	600ω

94A1 or 94A2 Repeater Connected to Distant 12A1 or 12A2 Repeater

Cable Gauge	See Note	Cable Resistance	R4 Min.
19		0-1100ω	1500ω
22	1	0-1100ω	1500ω
22	1	1100-1400ω	1200ω
24	1	0-1500ω	1200ω
24	1	1500-1900ω	800ω

Note (1) The values given for R4 for 19 gauge cable may be used to some advantage for the other gauges when the required loop current can be obtained.

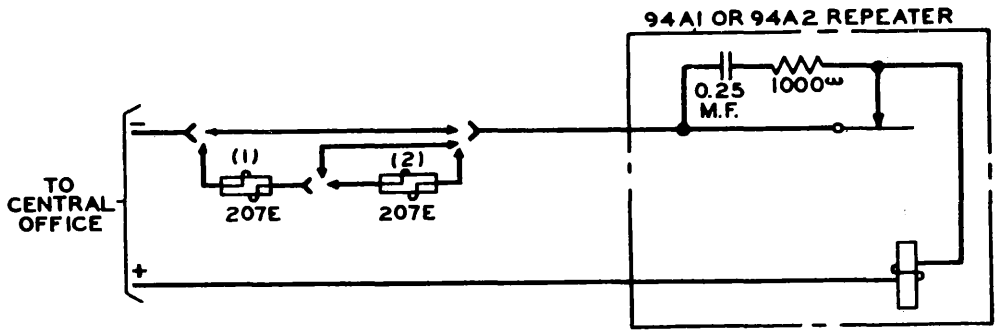


FIG. 19

PRIVATE LINE SERVICE

SUBSCRIBER STATION

INDUCTANCE WAVE SHAPING

94A1 OR 94A2 LOOP REPEATER (69A1 OR 69B1 TTY SWBD)

94A1 Repeater Connected to Distant Differential Loop or 12A1 or 12A2 Repeater

Cable Length In Miles	207E Coil Terminal Connections	
	Coil (1)	Coil (2)
0-2	None	None
2-5	1-3	None
5-9	1-4	None
9-13	1-5	None
13-16	2-3	1-3
16-21	2-4	1-3
21-26	2-3	1-5
26-32	2-4	1-5

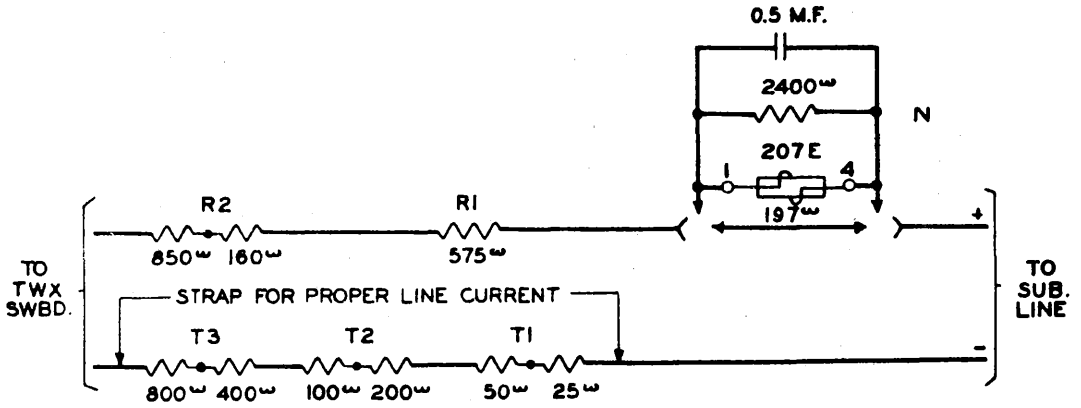


FIG. 20

TWX SERVICE - CENTRAL OFFICE - SUBSCRIBER LINE CIRCUIT

NO. 1 AND 1A TELETYPEWRITER SWITCHBOARDS

Cable Gauge	Cable Res.	R1 + R2	"N" Network
19	0- 350ω	575ω	Out
19	350-2200ω	1010ω	Out
19	2200-3100ω	See Note 1	In
22	0- 700ω	575ω	Out
22	700-2400ω	850ω	Out
22	2400-3100ω	See Note 1	In
24	0-2800ω	575ω	Out
24	2800-3100ω	See Note 1	In
26	0-2800ω	575ω	Out
26	2800-3100ω	See Note 1	In

Note (1) R1+R2 shall normally be 0. Where "kick-off" of the relay in the card circuit repeater is not suppressed, R1+R2 may be strapped as required to provide a resistance not exceeding 400 ohms. In this case, the cable resistance will be correspondingly reduced.

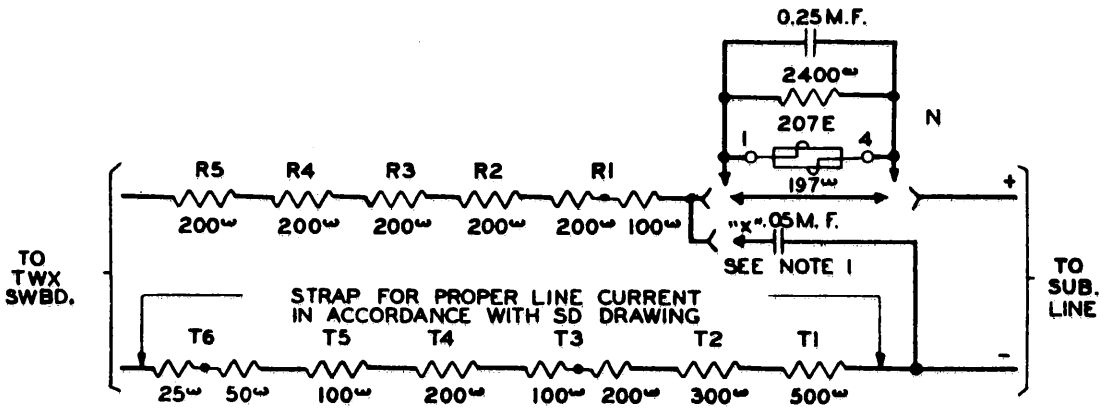


FIG. 21

TWX SERVICE

CENTRAL OFFICE SUBSCRIBER LINE CIRCUIT

NO. 3 AND 3A TELETYPEWRITER SWITCHBOARDS

Cable Gauge	See Note	Cable Res.	R1 + R2 + R3 + R4 + R5	"N" Network
19	1	0- 350ω	700ω	Out
19		350-2000ω	1000ω	Out
19		2000-2800ω	0	In
22	1	0-2300ω	700ω	Out
22		2300-2800ω	0	In
24	1	0-2700ω	400ω	Out
24		2700-2800ω	0	In
26	1	0-2700ω	400ω	Out
26		2700-2800ω	0	In

Note (1) "X" wiring shall be provided on loops of 2 miles or less.

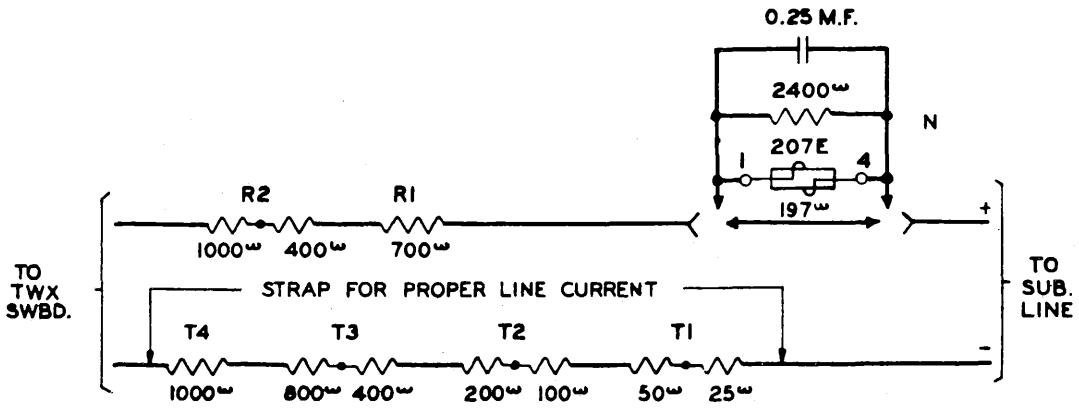


FIG. 22

TWX AND PRIVATE LINE SERVICE

CENTRAL OFFICE SUBSCRIBER LINE CIRCUIT

NO. 65B1 TELETYPEWRITER SWITCHBOARD

Cable Gauge	Cable Res.	R1 + R2	"N" Network
19	0- 350ω	700ω	Out
19	350-2000ω	1000ω	Out
19	2000-2800ω	0	In
22	0-2300ω	700ω	Out
22	2300-2800ω	0	In
24	0-2700ω	400ω	Out
24	2700-2800ω	0	In
26	0-2700ω	400ω	Out
26	2700-2800ω	0	In

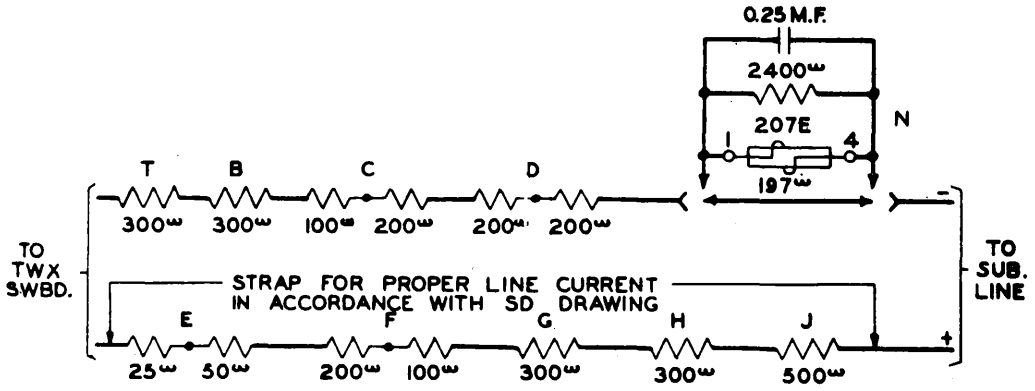


FIG. 23

TWX SERVICE

CENTRAL OFFICE SUBSCRIBER LINE CIRCUIT

NO. 9 TELEGRAPH TEST BOARD
NO. 5 TOLL TEST BOARD
NO. 4 MORSE BOARD

CLOSED LINE OPERATION

Cable Gauge	Cable Res.	B + C + D + T	"N" Network
19	0- 350ω	1000ω	Out
19	350-2000ω	1300ω	Out
19	2000-2800ω	0	In
22	0-2300ω	1000ω	Out
22	2300-2800ω	0	In
24	0-2700ω	700ω	Out
24	2700-2800ω	0	In
26	0-2700ω	700ω	Out
26	2700-2800ω	0	In

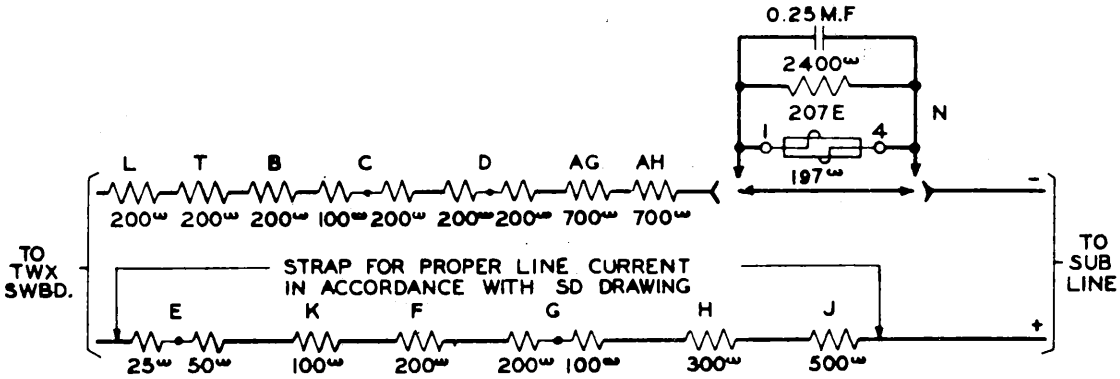


FIG. 24

TWX SERVICE

CENTRAL OFFICE SUBSCRIBER LINE CIRCUIT

NO. 9 TELEGRAPH TEST BOARD
NO. 5 TOLL TEST BOARD
NO. 4 MORSE BOARD

OPEN LINE OPERATION

Cable Gauge	Cable Res.	B + C + D + L + T + AG + AH	"N" Network
19	0- 350ω	1000ω	Out
19	350-2000ω	1300ω	Out
19	2000-2800ω	0	In
22	0-2300ω	1000ω	Out
22	2300-2800ω	0	In
24	0-2700ω	700ω	Out
24	2700-2800ω	0	In
26	0-2700ω	700ω	Out
26	2700-2800ω	0	In

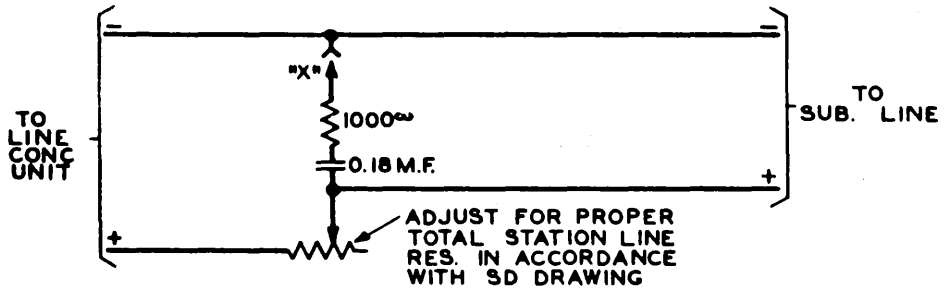


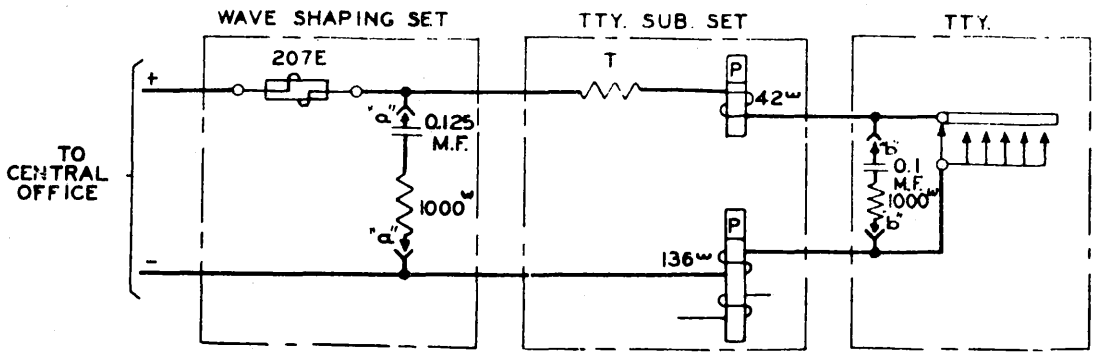
FIG 25

TWX SERVICE

CENTRAL OFFICE SUBSCRIBER LINE CIRCUIT

NO. 101A AND 102A LINE CONCENTRATING UNIT

Note (1) Provide "X" wiring when connected to a station line of one mile or less when the teletypewriter at the station is not equipped with a spark killer.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

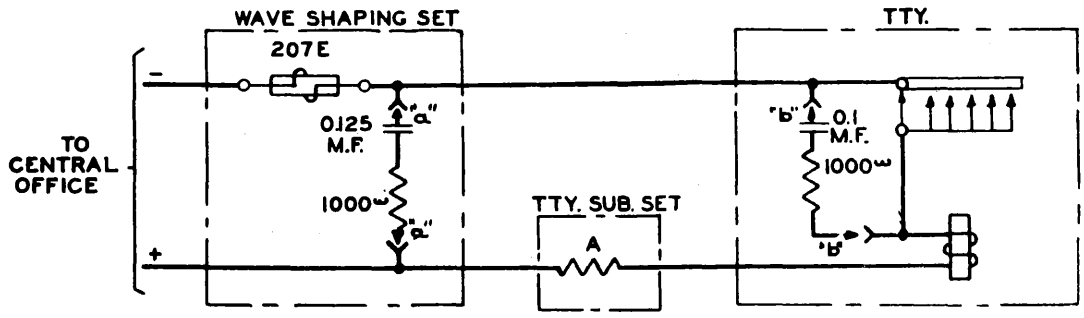
FIG. 26

TWX SERVICE

SUBSCRIBER STATION

120A1 OR 120B1 TELETYPEWRITER SUBSCRIBER SET
FOR USE WITH
NO. 1 AND 1A TELETYPEWRITER SWITCHBOARDS

Cable Length In Miles	Cable Res.	T	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-4	0-1300ω	1600ω	None	None	None	None	None	None
0-4	1300-1700ω	1200ω	None	None	None	None	None	None
4-7	0-1200ω	1200ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-7	1200-1700ω	685ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-7	1700-3100ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-11	0-1200ω	1200ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-11	1200-1700ω	685ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
7-11	1700-3100ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
11-15	0-1700ω	685ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
11-15	1700-3100ω	0	150C1	1.05D	150C1	1.07D	150E1	1.09D
15-19	0-3100ω	0	150C1	1.05E	150C1	1.07E	150E1	1.09E
19-24	0-3100ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G
24-35	0-3100ω	0	150C1	1.05H	150C1	1.07H	150E1	1.09H



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 27

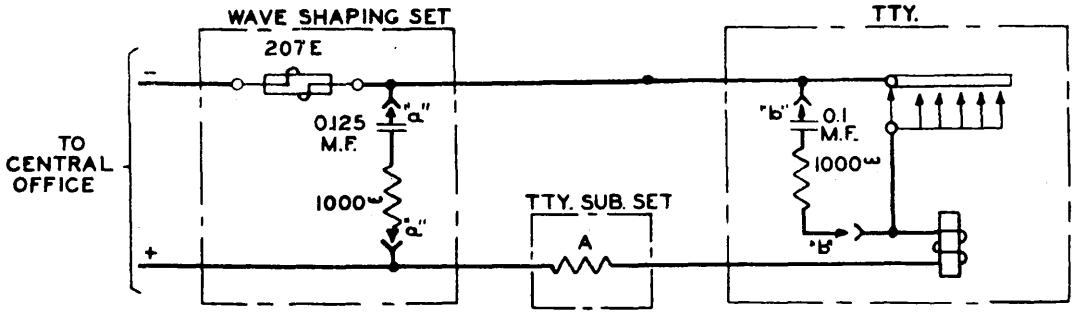
TWX SERVICE

SUBSCRIBER STATION

120D1, 125A2, 126A1, 126A2 and 584DG TELETYPEWRITER SUBSCRIBER SETS
OR LOCAL LINE ATTENDED CIRCUIT
FOR USE WITH
NO. 1 AND 1A TELETYPEWRITER SWITCHBOARDS

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-4	0-1300ω	1600ω	None	None	None	None	None	None
0-4	1300-1700ω	1200ω	None	None	None	None	None	None
4-7	0-1400ω	1000ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-7	1400-1800ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-7	1800-3100ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-11	0-1400ω	1000ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
7-11	1400-1800ω	600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
7-11	1800-3100ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
11-15	0-1800ω	600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
11-15	1800-3100ω	0	150C1	1.05D	150C1	1.07D	150E1	1.09D
15-19	0-3100ω	0	150C1	1.05E	150C1	1.07E	150E1	1.09E
*19-24	0-3100ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G
*24-35	0-3100ω	0	150C1	1.05H	150C1	1.07H	150E1	1.09H

* Note 1 - A line relay shall be used with a holding magnet teletypewriter when the station line length exceeds 20 miles.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 28

TWX SERVICE (ALSO PRIVATE LINE SERVICE FOR 65B1 TTY SWBD)

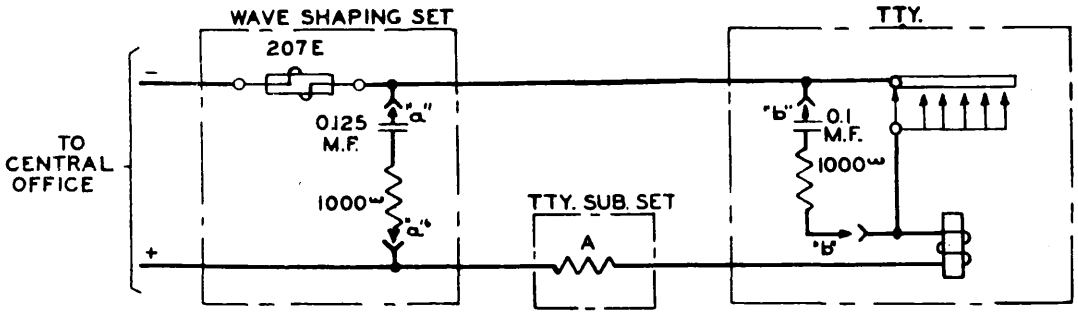
SUBSCRIBER STATION

120C1, 125A2, 126A1, 126A2 AND 584DG TELETYPEWRITER SUBSCRIBER SETS
OR LOCAL LINE ATTENDED OR UNATTENDED CIRCUIT
FOR USE WITH OPEN LINE OPERATION IN CONNECTION WITH
NO. 3 AND 3A TELETYPEWRITER SWITCHBOARDS
NO. 9 TELEGRAPH TEST BOARD
NO. 5 TOLL TEST BOARD
NO. 4 MORSE BOARD

125A2, 126A1, 126A2 AND 584DG TELETYPEWRITER SUBSCRIBER SETS
OR LOCAL LINE ATTENDED CIRCUIT
FOR USE WITH CLOSED LINE OPERATION IN CONNECTION WITH
65B1 TELETYPEWRITER SWITCHBOARD
NO. 9 TELEGRAPH TEST BOARD
NO. 5 TOLL TEST BOARD
NO. 4 MORSE BOARD

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-4	0- 900ω	1600ω	None	None	None	None	None	None
0-4	900-1300ω	1200ω	None	None	None	None	None	None
0-4	1300-2800ω	1200ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-9	0-1000ω	1000ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
4-9	1000-1400ω	600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-9	1400-2800ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
9-15	0-1400ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
9-15	1400-2800ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
15-20	0-2800ω	0	150C1	1.05B	150C1	1.07B	150E1	1.09B
*20-26	0-2800ω	0	150C1	1.05D	150C1	1.07D	150E1	1.09D
*26-32	0-2800ω	0	150C1	1.05F	150C1	1.07F	150E1	1.09F

* Note 1 - A line relay shall be used with a holding magnet teletypewriter when the station line length exceeds 25 miles.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 29

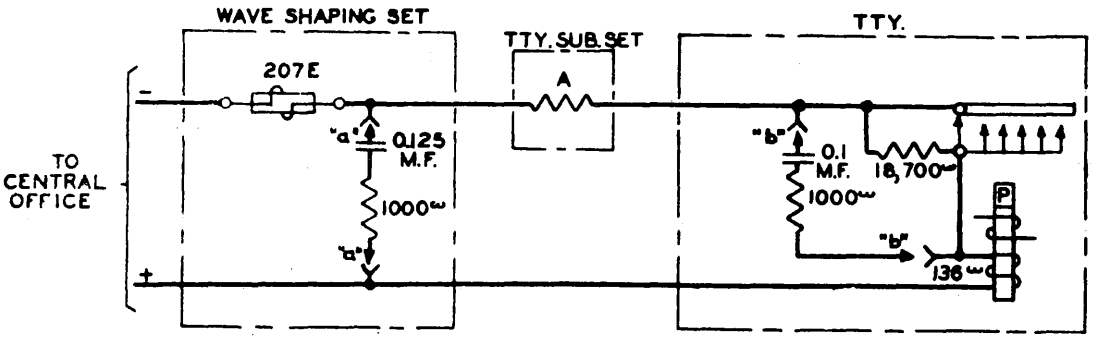
TWX SERVICE

SUBSCRIBER STATION

120C1, 125A2, 126A1, 126A2 and 584DG TELETYPEWRITER SUBSCRIBER SETS
OR LOCAL LINE ATTENDED OR UNATTENDED CIRCUIT
FOR USE WITH
NO. 5 TELETYPEWRITER SWITCHBOARD

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-8	0-1400ω	1600ω	None	None	None	None	None	None
0-8	1400-1800ω	1200ω	None	None	None	None	None	None
0-8	1800-2000ω	1000ω	None	None	None	None	None	None
0-8	2000-2300ω	600ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
0-8	2300-2900ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
8-14	0-1900ω	1000ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
8-14	1900-2300ω	600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
8-14	2300-2900ω	0	150B1	1.04E	140B1	1.06E	150D1	1.08E
14-19	0-2300ω	600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
14-19	2300-2900ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
19-23	0-2300ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
19-23	2300-2900ω	0	150C1	1.05C	150C1	1.07C	150E1	1.09C
*23-27	0-2800ω	0	150C1	1.05B	150C1	1.07B	150E1	1.09B
*27-32	0-2800ω	0	150C1	1.05D	150C1	1.07D	150E1	1.09D

* Note 1 - A line relay shall be used with a holding magnet teletypewriter when the station line exceeds 25 miles.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 30

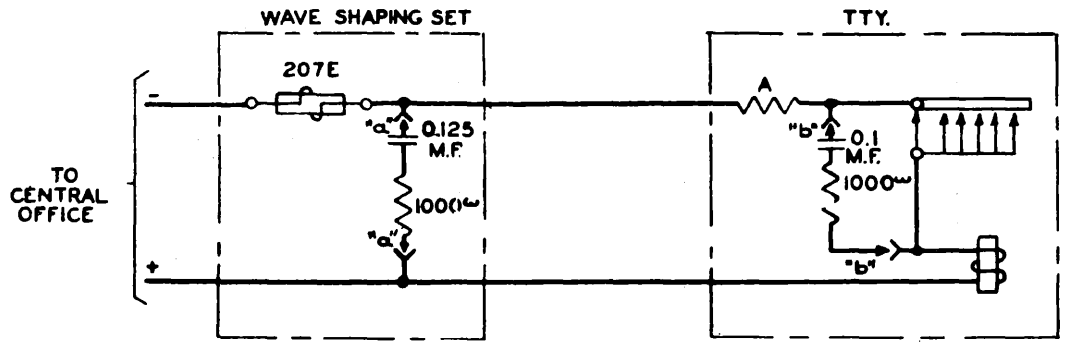
TWX SERVICE

SUBSCRIBER STATION

120C1, 126A2 AND 584DG TELETYPEWRITER SUBSCRIBER SETS
FOR USE WITH
NO. 101 LINE CONCENTRATING UNIT

Cable Length In Miles	Cable Res.	Note	A	TTY Without Spark Killer		TTY With Spark Killer			
						150B1 or 150C1 Set		150D1 or 150E1 Set	
				Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-3	0-1300ω	1	1600ω	None	None	None	None	None	None
3-8	250-3400ω	1	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-23	700-3400ω	1	0	150C1	1.05C	150C1	1.07C	150E1	1.09C
23-26	2000-3300ω	1	0	150C1	1.05E	150C1	1.07E	150E1	1.09E
26-32	2300-3300ω	1	0	150C1	1.05F	150C1	1.07F	150E1	1.09F
32-36	2800-3200ω	1	0	150C1	1.05H	150C1	1.07H	150E1	1.09H

Note: (1) A line relay shall always be used with a holding magnet teletypewriter.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 31

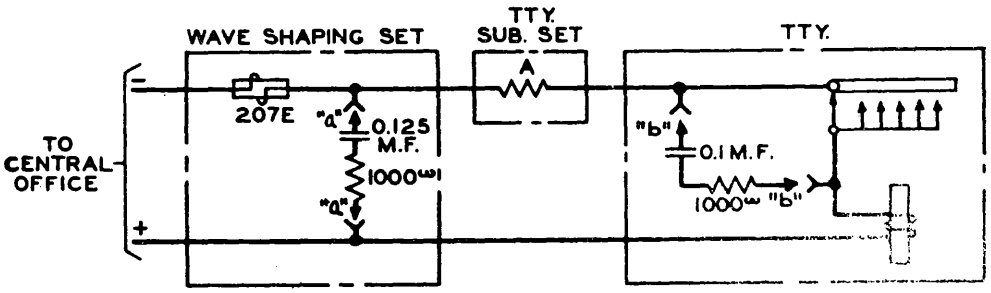
TWX SERVICE (ALSO PRIVATE LINE SERVICE FOR 65B1 TTY SWBD)

SUBSCRIBER STATION

124A1 AND 124B1 TELETYPEWRITER SUBSCRIBER SETS
FOR USE WITH
NO. 65B1 TELETYPEWRITER SWITCHBOARD
NO. 9 TELEGRAPH TEST BOARD
NO. 5 TOLL TEST BOARD
NO. 4 MORSE BOARD

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-4	0-1300ω	1200ω	None	None	None	None	None	None
0-4	1300-2800ω	1200ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-9	0- 800ω	1200ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
4-9	800-1400ω	600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-9	1400-2800ω	0	150B1	1.04E	150B1	1.06E	150D1	1.08E
9-15	0-1400ω	600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
9-15	1400-2800ω	0	150B1	1.04F	150B1	1.06F	150D1	1.08F
15-20	0-2800ω	0	150C1	1.05B	150C1	1.07B	150E1	1.09B
*20-26	0-2800ω	0	150C1	1.05D	150C1	1.07D	150E1	1.09D
*26-32	0-2800ω	0	150C1	1.05F	150C1	1.07F	150E1	1.09F

* A line relay shall be used with a holding magnet teletypewriter when the station line length exceeds 25 miles.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 32

TWX SERVICE

SUBSCRIBER STATION

LOCAL LINE ATTENDED OR UNATTENDED CIRCUIT
FOR USE WITH
NO. 101A OR 102A LINE CONCENTRATING UNIT

TELETYPEWRITER EQUIPPED WITH LINE RELAY

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-2	0-1000ω	1600ω	None	None	None	None	None	None
2-4	0-2000ω	1600ω	150B1	1.04C	150B1	1.06C	150D1	1.08C
4-6	0-1200ω	1600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
4-6	1200-1800ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-6	1800-2700ω	1000ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
6-8	0-2400ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
6-8	2400-3500ω	1000ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
8-10	0-1800ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-10	1800-2800ω	1000ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-9	2200-3600ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G
10-12	0-1100ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
10-12	1100-2200ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
10-12	2200-3600ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G
12-13	0-1200ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
12-13	1200-2500ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
12-13	2500-3800ω	0	150C1	1.05H	150C1	1.07H	150E1	1.09H
13-14	0-1300ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
13-14	1300-2500ω	1000ω	150C1	1.05E	150C1	1.07E	150E1	1.09E

(Continued on Page 42)

(Continued from Page 41)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer: Wave Shaping Set	TTY Without Spark Killer: LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set: Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set: LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set: Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set: LT Plan No.
14-16	0-1500ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
14-16	1500-2900ω	1000ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
16-18	0-1600ω	1600ω	150C1	1.05E	150C1	1.07E	150E1	1.09E
16-18	1600-3200ω	400ω	150C1	1.05J	150C1	1.07J	150E1	1.09J
18-20	0-1800ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
18-20	1800-3600ω	0	150B1+ 150C1	1.12B			150D1+ 150E1	1.14B
20-22	0-2000ω	1600ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
22-24	0-2200ω	1600ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
24-26	0-2300ω	1000ω	150C1	1.05J	150C1	1.07J	150E1	1.09J
26-28	0-2500ω	1000ω	150C1	1.05L	150C1	1.07L	150E1	1.09L
28-30	0-2700ω	1000ω	150B1+ 150C1	1.12B			150D1+ 150E1	1.14B
30-32	0-2900ω	400ω	150B1+ 150C1	1.12F			150D1+ 150E1	1.14F
32-34	0-3000ω	400ω	150B1+ 150C1	1.12G			150D1+ 150E1	1.14G
34-36	0-3200ω	0	2-150C1	1.13B			2-150E1	1.15B
36-38	0-3400ω	0	2-150C1	1.13D			2-150E1	1.15D

TELETYPEWRITER NOT EQUIPPED WITH LINE RELAY

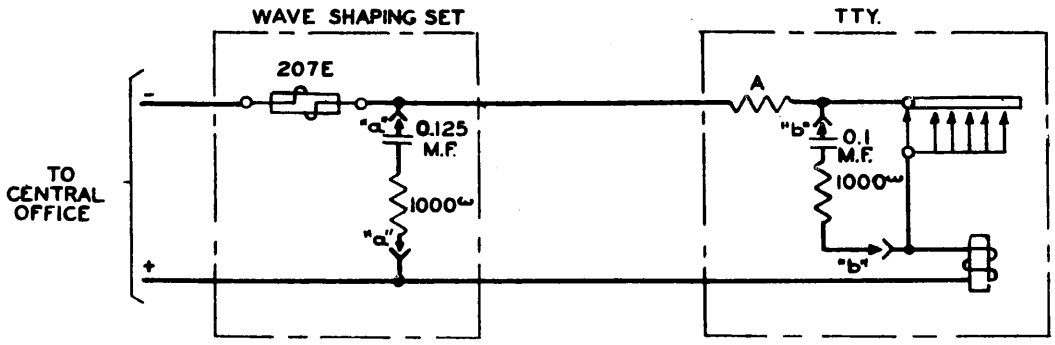
Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer: Wave Shaping Set	TTY Without Spark Killer: LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set: Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set: LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set: Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set: LT Plan No.
0-1	0- 500ω	1600ω	None	None	None	None	None	None
1-4	0-2000ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-6	0- 600ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
4-6	600-2700ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
6-8	0-1400ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
6-8	1400-2400ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
6-8	2400-3500ω	600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-10	0-1800ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-10	1800-2800ω	1000ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-9	2800-4000ω	0	150C1	1.05F	150C1	1.07F	150E1	1.09F
10-12	0-2200ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
10-12	2200-3600ω	0	150C1	1.05C	150C1	1.07C	150E1	1.09C
12-13	0-2500ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
12-13	2500-3800ω	0	150C1	1.05E	150C1	1.07E	150E1	1.09E

(Continued on Page 43)

(Continued from Page 42)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
13-14	0-1300ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
13-14	1300-2500ω	1000ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
14-16	0-1500ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
14-16	1500-2900ω	1000ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
16-18	0-1600ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
16-18	1600-3200ω	400ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
18-20	0-1800ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
18-20	1800-3600ω	0	150B1+ 150C1	1.12B			150D1+ 150E1	1.14B
20-22	0-2000ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
22-24	0-2200ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
24-26	0-2300ω	1000ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
26-28	0-2500ω	1000ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
28-30	0-2700ω	1000ω	150C1	1.05J	150C1	1.07J	150E1	1.09J
30-32	0-2900ω	400ω	150C1	1.05L	150C1	1.07L	150E1	1.09L
32-34	0-3000ω	400ω	150B1+ 150C1	1.12B			130D1+ 150E1	1.14B
34-36	0-3200ω	0	150B1+ 150C1	1.12F			150D1+ 150E1	1.14F
36-38	0-3400ω	0	150B1+ 150C1	1.12G			150D1+ 150E1	1.14G

Note: (1) When the line requires two wave shaping sets and a 15 or 19 TTY is used, a spark killer is required in the teletypewriter base. The 15C base is equipped with a spark killer. The 98387M set of spark protection parts is required for each 15A or 15B base not previously modified to add the spark killer.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER
"b" WIRING EXISTS FOR TTY WITH SPARK KILLER

FIG. 33

PRIVATE LINE SERVICE

SUBSCRIBER STATION

LOCAL LINE ATTENDED OR UNATTENDED CIRCUIT
FOR USE WITH
STATION CONNECTED TO 69A1 OR 69B1 TTY SWBD.

TELETYPEWRITER EQUIPPED WITH LINE RELAY

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
0-1	0- 500ω	1600ω	None	None	None	None	None	None
1-2	0-1000ω	1600ω	150B1	1.04D	150B1	1.06D	150D1	1.08D
2-4	0-2000ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-6	0-1200ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
4-6	1200-1800ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
4-6	1800-2700ω	1000ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
6-8	0-2400ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
6-8	2400-3500ω	600ω	150C1	1.05D	150C1	1.07D	150E1	1.09D
8-10	0-1800ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
8-10	1800-2800ω	1000ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
8-9	2800-4000ω	0	150C1	1.05H	150C1	1.07H	150E1	1.09H
10-12	0-1100ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
10-12	1100-2200ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
10-12	2200-3600ω	0	150C1	1.05J	150C1	1.07J	150E1	1.09J
12-14	0-1300ω	1600ω	150C1	1.05E	150C1	1.07E	150E1	1.09E
12-14	1300-2500ω	1000ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
12-14	2500-3900ω	0	150C1	1.05L	150C1	1.07L	150E1	1.09L
14-16	0-1500ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
14-16	1500-2900ω	1000ω	150C1	1.05H	150C1	1.07H	150E1	1.09H

(Continued on Page 45)

(Continued from Page 44)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer Wave Shaping Set	TTY Without Spark Killer LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set LT Plan No.
16-18	0-1600ω	1600ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
16-18	1600-3200ω	400ω	150C1	1.05L	150C1	1.07L	150E1	1.09L
18-20	0-1800ω	1600ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
18-20	1800-3600ω	0	150B1+ 150C1	1.12E			150D1+ 150E1	1.14E
20-22	0-2000ω	1600ω	150C1	1.05J	150C1	1.07J	150E1	1.09J
22-24	0-2200ω	1600ω	150C1	1.05L	150C1	1.07L	150E1	1.09L
24-26	0-2300ω	1000ω	150B1+ 150C1	1.12D			150D1+ 150E1	1.14D
26-28	0-2500ω	1000ω	150B1+ 150C1	1.12F			150D1+ 150E1	1.14F
28-30	0-2700ω	1000ω	150B1+ 150C1	1.12G			150D1+ 150E1	1.14G
30-32	0-2900ω	400ω	2-150C1	1.13C			2-150E1	1.15C
32-34	0-3000ω	400ω	2-150C1	1.13D			2-150E1	1.15D
34-36	0-3200ω	0	2-150C1	1.13F			2-150E1	1.15F
36-38	0-3400ω	0	2-150C1	1.13G			2-150E1	1.15G

TELETYPEWRITER NOT EQUIPPED WITH LINE RELAY

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer Wave Shaping Set	TTY Without Spark Killer LT Plan No.	TTY With Spark Killer 150B1 or 150C1 Set Wave Shaping Set	TTY With Spark Killer 150B1 or 150C1 Set LT Plan No.	TTY With Spark Killer 150D1 or 150E1 Set Wave Shaping Set	TTY With Spark Killer 150D1 or 150E1 Set LT Plan No.
0-1	0- 500ω	1600ω	None	None	None	None	None	None
1-2	0-1000ω	1600ω	150B1	1.04E	150B1	1.06E	150D1	1.08E
2-4	0-2000ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
4-6	0-1200ω	1600ω	150B1	1.04F	150B1	1.06F	150D1	1.08F
4-6	1200-1800ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
4-6	1800-2700ω	1000ω	150C1	1.05D	150C1	1.07D	150E1	1.09D
6-8	0-2400ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
6-8	2400-3500ω	600ω	150C1	1.05E	150C1	1.07E	150E1	1.09E
8-10	0-1800ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
8-10	1800-2800ω	1000ω	150C1	1.05E	150C1	1.07E	150E1	1.09E
8-9	2800-4000ω	0	150C1	1.05G	150C1	1.07G	150E1	1.09G
10-12	0-1100ω	1600ω	150C1	1.05C	150C1	1.07C	150E1	1.09C
10-12	1100-2200ω	1600ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
10-12	2200-3600ω	0	150C1	1.05L	150C1	1.07L	150E1	1.09L

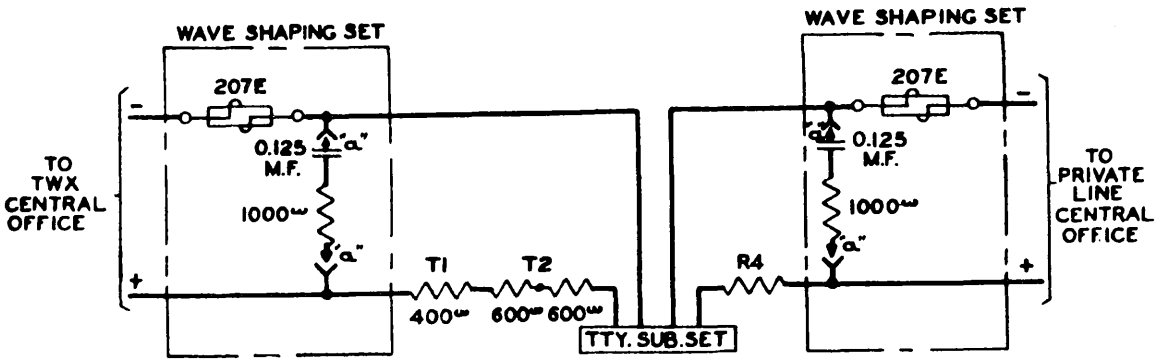
(Continued on Page 46)

(Continued from Page 45)

Cable Length In Miles	Cable Res.	A	TTY Without Spark Killer		TTY With Spark Killer			
					150B1 or 150C1 Set		150D1 or 150E1 Set	
			Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.	Wave Shaping Set	LT Plan No.
12-14	0-1300ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
12-14	1300-2500ω	1000ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
12-14	2500-3900ω	0	150C1	1.05H	150C1	1.07H	150E1	1.09H
14-16	0-1500ω	1600ω	150C1	1.05F	150C1	1.07F	150E1	1.09F
14-16	1500-2900ω	1000ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
16-18	0-1600ω	1600ω	150C1	1.05G	150C1	1.07G	150E1	1.09G
16-18	1600-3200ω	400ω	150C1	1.05L	150C1	1.07L	150E1	1.09L
18-20	0-1800ω	1600ω	150C1	1.05H	150C1	1.07H	150E1	1.09H
18-20	1800-3600ω	0	150B1+ 150C1	1.12E			150D1+ 150E1	1.14E
20-24	0-2200ω	1600ω	150C1	1.05J	150C1	1.07J	150E1	1.09J
24-26	0-2300ω	1000ω	150B1+ 150C1	1.12C			150D1+ 150E1	1.14C
26-28	0-2500ω	1000ω	150B1+ 150C1	1.12D			150D1+ 150E1	1.14D
28-30	0-2700ω	1000ω	150B1+ 150C1	1.12F			150D1+ 150E1	1.14F
30-32	0-2900ω	400ω	2-150C1	1.13B			2-150E1	1.15B
32-34	0-3000ω	400ω	2-150C1	1.13C			2-150E1	1.15C
34-36	0-3200ω	0	2-150C1	1.13D			2-150E1	1.15D
36-38	0-3400ω	0	2-150C1	1.13E			2-150E1	1.15E

Notes: (1) When the line requires two wave shaping sets and a 15 or 19 TTY is used, a spark killer is required in the TTY base. The 15C base is equipped with a spark killer. The 98387M set of spark protection parts is required for each 15A or 15B base not previously modified to add the spark killer.

(2) Not more than one teletypewriter without a line relay shall be in the same loop.



"a" WIRING EXISTS FOR TTY WITHOUT SPARK KILLER

FIG. 34

TWX AND PRIVATE LINE DUAL SERVICE

SUBSCRIBER STATION

122A2 AND 123A2 TELETYPEWRITER SUBSCRIBER SETS

Type of Service or Board	Refer to Fig.	Remarks
Private Line Wave Shaping	12 and 13	
No. 1 Teletypewriter Switchboard	27	
No. 1A Teletypewriter Switchboard	27	
No. 3 Teletypewriter Switchboard	28	
No. 3A Teletypewriter Switchboard	28	
No. 5 Teletypewriter Switchboard	29	
No. 65B1 Teletypewriter Switchboard	28	123A2 TTY Sub. Set Only
No. 9 Telegraph Test Board	28	
No. 5 Toll Test Board	28	
No. 4 Morse Board	28	

Note: Strap (T1) and (T2) resistances to obtain value given for (A) resistance for Figs. 27, 28 and 29.

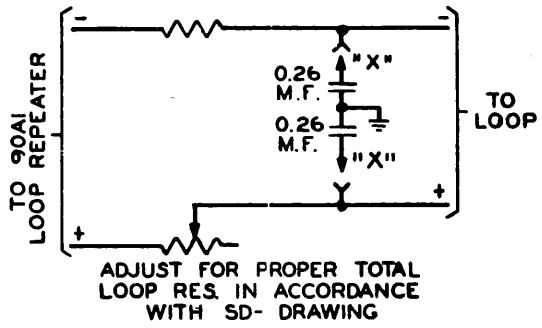


FIG. 35

PRIVATE LINE SERVICE

CENTRAL OFFICE

90A1 LOOP REPEATER
ARRANGED FOR ± 48 VOLT, .020 AMPERE LOOPS

Note 1: Provide "X" wiring when connected to a loop of two miles or less with a wave shaping set or loops of one mile or less without a wave shaping set.

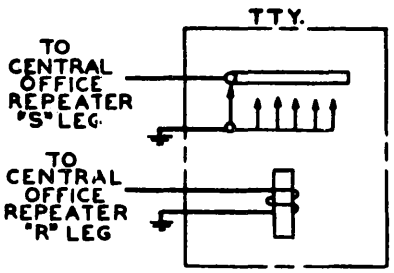


FIG. 36

DIFFERENTIAL LOOP OR 12A1 OR 12A2 REPEATER
DUPLEX SERVICE - "R" LEG

Note 1: When holding magnet teletypewriters without line relays are used, the loop length shall not exceed the limit given below:

Repeater	No. of TTY's	Loop Limit
Differential Loop	1	25 miles
" "	2	18 "
" "	3	12 "
12A1 or 12A2	1 or 2	10 "

Note 2: No wave shaping equipment is required in the "R" leg.