POWER SUPPLY ARRANGEMENTS
P.B.X.'S, STATION SYSTEMS AND KEY EQUIPMENTS
GENERAL REQUIREMENTS

CONTENTS

1. GENERAL

1.01 This section covers the requirements and general information necessary in connection with the provision of battery and generator supply circuits for P.B.X.'s, station systems and key equipments which are usually installed by the Plant Department of the Telephone Company in accordance with the installation methods covered in the B and C series of Bell System Practices. It is reissued to make a general revision of the section consistent with new developments and arrangements, and due to the extent of this information, arrows indicating changes and additions are omitted.

1.02 The provision of battery and generator supply circuits for private branch exchanges, station systems and key equipments or power plant equipments on the subscriber's premises, offers a medium for the control of working efficiency of the exchange circuits or cable pairs and presents to the assignment bureau numerous opportunities in the effective and efficient use of these facilities. Improper assignment of cable conductors or assignment of conductors for battery supply circuits which may be needed in the near future for station growth may result in avoidable cable or terminal congestion and consequently increased installation labor and expense due to the need for the rearrangement of circuits or provision of local power plants on a deferred basis.

1.03 While it is not the responsibility of the assignment bureau to make cost or analysis studies of equipment or outside plant facilities which may be involved in the provision of battery and generator supply circuits, it is expected that there will be cases where a general knowledge of the relative values of these parts of the telephone plant would be helpful in selecting an economical as well as serviceable equipment arrangement. Therefore, approximate cost values in terms of average annual charges are included for this purpose in the Part 4. In this connection, it could be assumed that the method of furnishing power which results in the lowest annual charges should be used, however, where feeder pairs from the central office are involved which would utilize cable conductors not needed for other purposes, the feeder method should be used regardless of cost indications.

1.04 Existing installations should not be changed to agree with arrangements specified in the Practices unless operating difficulties indicate the change is necessary.

2. REFERENCE INFORMATION

2.01 In the application of the requirements and general information contained in this section it will be necessary to make reference to other sections of Bell System Practices for certain information which is omitted from this section to avoid unnecessary repetition. The following lists the principal Bell System Practice sections required for reference purposes and these sections are considered a part of this section:

A502.011	P.B.X. and Station System Battery Feeders - Main Distributing Frames
A505.135	Fuses and Fuse Panels Central Offices
A505.161	Resistance Lamps
B204.441	Resistance Measurements of Battery Supply Feeders - P.B.X.'s and Station Systems
B501.906	No. 101F Power Plant - Description, Installation and Supplies
B502.045	Protection and Fusing - Trunks, Generator and Battery Feeders
B502.051	Long Line Equipment - Installation
B502.053	Conference Equipment - Installation
B523.015	No. 101A Power Plant Installation
B523.017	No.'s 101A, 101B and 101D Power Plants
B523.219	Modification of No. 550 and No. 551 Type P.B.X. for Increased Loop Ranges
B555.021	No. 750A P.B.X. - Installation Tests and Adjustments
B556.021	No. 755A P.B.X. - Installation Tests and Adjustments
C53.104	No. 1 Order Turret, Tests and Adjustments
C53.114	Nos. 2 and 2A Order Turret, Tests and Adjustments
C53.254	Nos. 15A and 23A Key Equipments, Tests and Adjustments
C53.274	No. 100 Key Equipment, Tests and Adjustments
C53.408	Nos. 101A and 101B Key Equipments, Tests and Adjustments
C53.511	Power Supply Arrangements for Station Systems (SD-69091-01)

B523.218 Installation of 555 Type PBX (SD-66520-01)

3. CENTRAL OFFICE, P.B.X. AND STATION SYSTEM BATTERY RANGES AND FUSE REQUIREMENTS

(A) Central Office Battery Voltage Ranges

3.01 Table No. 1 lists the voltage limits of central office batteries which may be used as a source of battery supply for operating P.B.X. or station system equipments. The Normal Voltages given in the Table represents the normal day-to-day operating values and does not take into account commercial power service failure conditions or other irregular operating circumstances.

TABLE NO. 1
VOLTAGE RANGES AT SOURCE OF
P.B.X. AND STATION SYSTEM BATTERY SUPPLY

Source of D-C. Supply For Feeders	Normal Nominal Voltage	Normal Voltage Range Min.	Normal Voltage Range Max.
Step-by-Step Offices			
(A) Regulated 48 Volt Power Plant	24	24	26
	48	49	50
(B) Non-Regulated 48 Volt Power Plant	24	20	28
	48	45	50
Nos. 1,1C,1D in 2,10 and 11 Offices			
(A) Regulated 24 Volt Power Plant	24	23.75	24.75
	48	45	50
(B) Non-Regulated 24 Volt Power Plant (Continuous Charge)	24	21	28
	48	45	50
(C) Non-Regulated 24 Volt Power Plant (Charge-Discharge)	24	20	28
	48	45	50
Nos. 9D and 1248A Offices			
Non-Regulated 24 Volt Power Plant	24	20	28
Nos. 8 and 9C Offices			
(A) Non-Regulated 38 Volt Power Plant	38	31	43
(B) 24 Volt P.B.X. Battery Supply (38 Volt Batt. (With C.E.M.F. Cells))	24	24	29
(C) Separate 48 Volt Power Plant	48	45	50
No. 12 Standard and No. 12 Special Offices			
Regular 48 Volt Power Plant	48	45	50
No. 105 Special Com. Batt. Offices			
(A) Non-Regulated 24 Volt Power Plant	24	20	28
(B) Non-Regulated 48 Volt Power Plant	38	31	43
Community Dial Offices			
Nos. 350,355,360,370,375,385, 35E97 and CX Type Offices	48	48	50

(B) P.B.X. and Station System Battery Voltages and Capacity

3.02 Voltage limits and ampere hour capacities for the various batteries used with P.B.X.'s and station systems are shown in Table No. 2. A description of the power plant with which these batteries are associated is covered elsewhere in this section and in other sections of Bell System Practices.

TABLE NO. 2
VOLTAGE RANGES AND AMPERE HOUR CAPACITY
P.B.X. AND STATION SYSTEM BATTERIES

Power Plant Equipment	No. of Cells	8 Hour Ampere Hour Capacity	Voltage Range Min.	Voltage Range Max.
No. 101-A	8	10 and 15	15	20
No. 101-B	10	15 and 30	18	24
No. 101-D	8	30	15	20
No. 101-E	11	15 and 30	20	26
No. 101-F	10	15 and 50	18	25
No. 750-A P.B.X.	8	15	15	20
No. 755-A P.B.X.	10	15	18	25

(C) Fusing of Battery Supply Circuits

3.03 P.B.X. and station system battery supply circuits in central offices and at centralized power plants are equipped with fuses of fixed capacity which must be given attention in the provision of each battery supply circuit. The capacity of these fuses are predetermined in the design of the equipment and take into consideration such factors as carrying capacity of standard gauge wires and heat coils, requirements of circuits or equipment, etc. The various sources of battery supply and the capacity of fuses employed is as follows:

Source of Battery Supply	Battery Voltage	Standard Fuse Capacity	Replaced Non-Standard Fuse Capacity (See Par. 3.04)
Central Office	38 or 48 Volts	1-1/3 Ampere	2 Ampere
Central Office No. 101B and No. 101F Centralized Power Plants	24 Volts	2 Ampere	1-1/3 Ampere
	18-25 Volts	2 Ampere	-

Note: Other information as to the fusing of battery supply circuits is covered in Section C53.511. These requirements apply to P.B.X.'s as well as station systems.

3.04 Central office battery distribution panels with non-standard capacity fuses should be changed to standard capacity fuses as outlined in B.S.P. Section A505.135.

Note: The No. 35C 2 ampere fuse is arranged for mounting on fuse panels with either No. 6 or No. 10 mounting screws and is therefore interchangeable with No. 35A 1-1/3 ampere and No. 35B 2 ampere fuses.

3.05 One fuse is required for each battery supply feeder or feeder group. Two or more P.B.X.'s or station systems serving different subscribers should not be supplied with battery through the same fuse. Where two P.B.X. switchboards are installed in the same line-up and direct feeders are to be used, one 2 ampere fuse and a separate feeder is required for each switchboard position. Similar treatment is required for direct feeders of station systems such as 100 key equipment when the maximum current demand at peak load exceeds the 2 ampere capacity of the fuse.

3.06 The multipling of fuses or use of more than two groups of direct feeders in connection with any P.B.X. or station system is not approved if the total maximum current drains in the feeder is in excess of 5 amperes. This 5 ampere limit is required to avoid possible fire hazard at the subscribers premises should the ground return conductors in the feeder become grounded.

3.07 Where feeder pairs are employed for local battery charging the maximum charging current shall be limited to 2-1/2 amperes so as to avoid possible fire hazard should the ground return conductors to the central office become grounded. If this charging rate is exceeded a local charger should be provided.

3.08 One fuse and one feeder is required for charging the 15 ampere hour battery of Nos. 101-A and 101-E power plants and Nos. 750-A and 755-A P.B.X.'s, since the maximum charging rate of the batteries in these power plants is 1/2 ampere. Nos. 101-D and 101-E plants with 30 ampere hour battery have the same requirements, except that the charging rate is limited to .9 ampere. The maximum charging rate of Nos. 101B and 101F power plants used for building batteries is 2 and 2-1/2 amperes respectively. Fusing of charging feeders in the central office should be on the basis of one fuse and one group of feeder pairs for each .9 ampere of battery charging rate, but not in excess of the 2-1/2 ampere limit referred to in paragraph 3.07. Fuses or feeder groups must not be connected in multiple to obtain increased fuse capacity.

4. GENERAL FEEDER REQUIREMENTS

4.01 Battery feeder supply requirements are dependent upon the type and size of P.B.X., station system or key equipment installation, their relative locations with respect to the central office, and the potential of the central office battery which is available for supplying the battery current to the equipment. There are two methods of furnishing battery current from the central office batteries for the operation of private branch exchanges or station equipments, each of which requires the use of cable conductors. The two methods are covered in Parts "5" and "6" as follows:

(5) Direct Feeders
(6) Floater Battery Feeders

Note: The general requirements covered in paragraphs 4.02 to 4.08 apply also to feeders used to float a centralized building battery and to feeders from this battery to a P.B.X. or station system equipment.

4.02 A battery supply feeder may consist of a single non-loaded cable pair or two or more of these pairs connected in multiple depending upon the amount of current required and the resistance of the conductors. One feeder will usually supply sufficient current to operate a single P.B.X. switchboard, a station system or float a local battery. Where large P.B.X. or station systems are involved and the current demand exceeds the capacity of the battery supply fuse, two or more feeder groups may be used and each group fused as covered in paragraphs 3.05 to 3.08.

4.03 In the assignment of conductors for a feeder it is desirable that adjacent conductors should be selected for a feeder or feeder group so as to simplify connections at Main distributing frames and cross-connecting terminals. If more than one feeder group is required divide the conductors in the feeder into equal groups consistent with the number of fuses required. See paragraph 3.08.

4.04 In order to limit noise influence in talking circuits of P.B.X. and station systems where battery feeders are used to provide the power for operating the equipment it is important that ground return feeders should not be used. Battery supply circuits, both direct feeder and feeders for floating local batteries on subscriber premises, must therefore be metallic and spare or odd conductors must not be used.

4.05 The over-all resistance of a battery supply feeder should include all current carrying conductors between the main distributing frame in the central office or a building battery and the point of use at the P.B.X. or station.

4.06 If it is necessary to extend the central office cable pairs of a feeder to a P.B.X. or station over building riser cable conductors, a corresponding number of conductors in the building cable, should be assigned for cross-connection to the central office conductors. Where drop wire is used as a means of extending the conductors of an aerial cable into a building, one drop wire shall be provided for each two pairs of cable. Advantage may be obtained in attaining a desired minimum resistance value by increasing the conductivity in central office, building, riser or switchboard cables to compensate for a deficiency in one of the other parts of the feeder.

4.07 Loop conductor resistance values for standard gauge cable or wire are listed in Table No. 3 or if desired, Form E-2541, "Alignment Chart for Computing Conductor Resistances" may be used. For lengths other than those covered in the table, the resistance values may be interpolated as required.

TABLE NO. 3
LOOP CONDUCTOR RESISTANCE IN OHMS
STANDARD GAUGE CABLE OR WIRE
AT TEMPERATURE OF 68° FAHRENHEIT

Cable or Wire	10 Ft.	50 Ft.	100 Ft.	500 Ft.	1000 Ft.
19	0.16	.80	1.60	8.05	16.10
20	0.24	1.20	2.40	12.00	24.00
22	0.32	1.60	3.22	16.19	32.38
24	0.50	2.58	5.18	25.94	51.88
26	0.82	4.16	8.32	41.67	83.34
28	1.32	6.62	13.26	66.31	132.62

4.08 The economic use of cable conductors for battery supply feeders is not an important consideration provided the conductors will not be needed for station growth within a reasonable period of time. The value of a cable conductor is problematic due to such varying factors as size and length of cables, under ground ducts, pole lines, etc.; however, it can be assumed for comparative purposes that the annual charge is equal to the cost of a pair of conductors used in connection with an average subscriber line equipment, or approximately $12.00 per year. Approximate annual charges for power plant equipments for use in rough calculations where one or more arrangements are under consideration are as follows:

Power Plant Equipment	Approximate Average Annual Cost
	+25%
No. 101-A Power Plant (Cabinet and Battery)	= $ 15.00
No. 101-D Power Plant (Cabinet and Battery)	= 18.00
No. 101-E Power Plant (Cabinet and Battery)	= 28.00
No. 101-F Power Plant (Cabinet and Battery - Equivalent 101-B)	= 38.00
Storage Battery (15-20 Volt)	= 10.00
J-86205-A Rectifier	= 11.00
J-86205-B Rectifier	= 8.00
J-86205-C Rectifier	= 4.00
J-86205-F Rectifier	= 14.00
J-86205-H Rectifier	= 7.00
J-86567-A Rectifier	= 14.00
No. 1044-FR Raytheon Rectifier	= 23.00

4.09 Where battery feeder circuits are provided, one direct or floater feeder supply should be used for each P.B.X. or station system or each power plant for operating these equipments. Two or more equipments serving different subscribers shall not be supplied with battery over the same battery feeder circuit. Battery feeder circuits from a centralized building battery have the same limitations except that feeders from this source cannot be used for floating another battery.

5. DIRECT FEEDERS

5.01 Direct metallic feeders from the central office battery are usually used for small non-multiple switchboards and simple station systems or key equipments. They may be used also for large P.B.X.'s and station or key equipment installations if the equipment is located near the central office and sufficient cable pairs are available. The most common uses of direct battery supply feeders is shown in Fig. No. 1.

See 633.5.01

5.02 Power from a 38 or 48 volt source should not be used to supply current by means of direct feeders for the operation of P.B.X.'s or station systems. Direct feeders from these sources may be used for intercommunicating and signaling circuits of station systems, provided relays or lamps are not employed in the circuits. An exception to this rule is made in the case of the No. 4,48 volt type P.B.X. and P.B.X. long line circuits such as SD-65122-01 and SD-66087-01, where a separate 38 or 48 volt feeder is used for each circuit to obtain longer operating ranges.

5.03 Conference equipment and long line circuits of a P.B.X. may be supplied with battery from the direct feeder of the associated P.B.X. under the condition outlined in paragraphs 5.09 and 5.10. Where 15A, 23A, 100, 101A and 101B key equipments are installed as a part of a P.B.X. which is supplied with battery over a direct feeder, a separate feeder should be provided for the key equipment or consideration should be given to the provision of a local battery as outlined in Part 6 for operating both the key equipment and P.B.X.

See Part 6

5.04 Direct feeders may be used to supply battery to a P.B.X. or station system from a centralized building battery and the general requirements for these feeders is covered in Part 6, G.

(A) Nos. 4, 505, 506, 550 and 551 P.B.X.'s - (B-204.441)

5.05 The resistance of a direct feeder and the number of conductors necessary to provide sufficient current for the operation of a P.B.X. is dependent upon the maximum number of simultaneous connections, the distance from the central office to the equipment, and the gauge of the cable conductors. The resistance of a feeder should, therefore, be such that when the maximum number of simultaneous connections are established the voltage at the P.B.X. will not drop below the minimum voltage requirements.

5.06 The maximum number of simultaneous connections which may be established on a P.B.X. switchboard position cannot always be interpreted as the number of cord circuits, since the positions are usually equipped with a predetermined amount of line, trunk, and cord circuit equipment. Method of determining the probable number of simultaneous connections and the maximum allowable resistance of a direct feeder based on the number of connections are covered in Section B204.441.

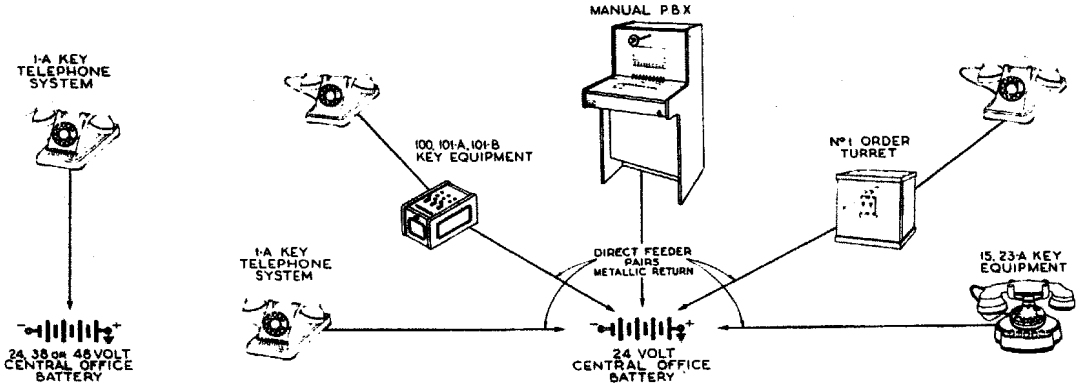


Fig. 1 - Direct Feeder Power Supply Arrangements

(B) P.B.X.'s Modified to Provide Increased Ranges (B523.219)

5.07 The station supervision ranges of 550 and 551 type P.B.X.'s may be increased by reducing the resistance of the feeder and maintaining a higher minimum voltage of the battery supply at the P.B.X. Methods for obtaining increase ranges under these conditions are covered in Section B523.219 and resistance values for the direct feeder are specified in Section B204.441. However, it is expected that the direct feeder arrangement of furnishing battery will not always prove satisfactory and, therefore, consideration should also be given to the use of a local battery as outlined in Part 6.

Note: These arrangements require the approval of the State Engineer.

5.08 Where P.B.X. cord circuits are modified to provide increased station and trunk ranges, by replacing the cord circuit retardation coils, the resistance of the direct feeder should be adjusted in accordance with the instructions covered in Section B523.219. This modification also requires the approval of the State Engineer.

(C) P.B.X. Conference Equipment (B502.053)

5.09 Battery for the operation of manual conference equipments that may be provided for use with 550 or 551 type P.B.X. should be obtained from the same source of supply as the P.B.X. with which the conference equipment is to be associated. If the P.B.X. is supplied with battery over a direct feeder from the central office storage battery, the resistance in the feeder should be readjusted to care for the additional current that will be required at peak loads. The additional feeder capacity required at peak load periods may be considered equal to that required by the addition of three cord circuits. Thus a P.B.X. having eight cord circuits and a conference equipment would have the same size feeder as a P.B.X. having eleven cord circuits.

(D) P.B.X. Long Line Equipment (B502.051)

5.10 Battery for the operation of long line equipment located at a P.B.X. may be obtained from the feeded supply of the P.B.X. provided the voltage of the supply is within the required limits and that the feeder has sufficient conductivity. Information covering these and other requirements for long line equipment is covered in Section B502.051.

(E) No. 2 P.B.X. (B516.201)

5.11 Feeder requirements for the No. 2 Intercommunicating type P.B.X. are covered in Section B516.201.

(F) Nos. 750-A (B555.021) and 755-A (B556.021) P.B.X.'s

5.12 The maximum current demand under peak load conditions is such that it is generally advisable to use a local battery rather than a direct feeder for supplying the battery. Requirements for local batteries used with these type P.B.X.'s are covered in Part 6.

(G) Key Equipment, Key Telephone Systems, Wiring Plans and Order Turrets

5.13 Resistance values of direct feeders or formulas for calculating the maximum allowable resistance of a feeder are given in the section of Bell System Practices for the various equipments as follows:

No.'s 15A and 23A Key Equipments	C53.254
No. 100 Key Equipment	C53.274
No.'s 101A and 101B Key Equipments	C53.408
No. 1 Order Turret	C53.104
No. 2 Order Turret	See Note
Power Supply Arrangement for No. 1A Key Telephone System and Wiring Plans	C53.511 (SD-69091-01)

Note: Direct feeders should not be employed to supply battery for the operation of No. 2 order turrets since these turrets are usually required in connection with a P.B.X. in which case a local battery should be employed as outlined in Part "6".

6. LOCAL BATTERY WITH FLOATER FEEDER OR RECTIFIER

6.01 In the provision of storage battery power plants it is important that the battery selected should have sufficient capacity to care for all loads to which the battery will be subjected. Generally the capacity should be such that the daily ampere hour drain is 50 to 70 per cent of the rated capacity of the battery in order to care for unusual peak loads and to provide some margin of capacity in case the charging source is interrupted. Where centralized building batteries are provided consideration should be given to the possibility of future systems being served from the same battery.

6.02 The efficiency of a storage battery is the ratio of output to input. With storage batteries various efficiencies may be considered. The one most commonly referred to, is the ampere-hour efficiency which represents the effectiveness of the cell as a storage reservoir for energy. It is taken as the ratio of current output times the duration of a discharge, divided by the current input times the duration of the charge required to restore the cell to its original condition. Specified conditions of temperature, current rate and final voltage must be observed. For a battery in good condition this should approximate 90%. On partial discharges followed immediately by recharges under conditions which will not waste current in gassing, considerably higher values may be attained.

6.03 If the average voltages of discharge and charge are expressed as a ratio, a voltage efficiency is obtained, this depending to a considerable extent upon the current rates. The voltage efficiency will generally fall between 75% and 85%.

6.04 The true power ratio is the watt-hour efficiency, the ratio of work done on discharge compared with the work necessary to recharge. This is the product of ampere-hour and voltage efficiencies and may run from 65% to 70%, more or less, and with constant voltage charging it may be as high as 80%.

6.05 The daily ampere hour load shown in Table No. 4 is computed for a 24 hour day and the corresponding battery charge rate is calculated to include 25% internal battery loss. As one week is assumed to complete a working cycle, the charging rate should be averaged over a 7 day period. To do this multiply

the daily ampere hour load by the number of days per week in use and divide by 7. Applying the figure thus calculated to Table No. 4, the hourly battery charging rate and the maximum allowable feeder resistance may be determined. An example is shown using the daily ampere hours as determined in paragraph 4.03 of Section C53.511.

$$\frac{1.50 \text{ daily A.H.} \times 5 \text{ days in use}}{7 \text{ Days}} = 1.00+ \text{ Average Daily A.H.(for 7 days)}$$

From Table No. 4 1.00 A.H. = .050 amperes charge current

The approximate allowable resistance of battery feeders for batteries floated from a 24, 38, or 48-volt central office battery in this case as determined from Table 4 is 120, 400, or 600 ohms respectively.

TABLE NO. 4
MAXIMUM ALLOWABLE RESISTANCE-FLOATER BATTERY FEEDER NOS. 101A,101B,101D,101E OR 101F POWER PLANTS

Average Daily Load A.H.	Bat. Chg. Rate	Max. Bat. Feeder Res. Central Office Bat. Of. 24V	38V	48V
1.00	.05	120.00	400.00	600.00
1.50	.08	75.00	250.00	375.00
2.00	.10	60.00	200.00	300.00
2.50	.13	46.15	153.85	230.77
3.00	.16	37.50	125.00	187.50
3.50	.18	33.33	111.11	166.67
4.00	.21	28.57	95.24	142.86
4.50	.23	26.09	86.96	130.43
5.00	.26	23.08	76.92	115.38
5.50	.29	20.69	68.97	103.45
6.00	.31	19.35	64.52	96.77
6.50	.34	17.65	58.82	88.24
7.00	.36	16.67	55.56	83.33
7.50	.39	15.38	51.28	76.92
8.00	.42	14.29	47.62	71.43
8.50	.44	13.64	45.45	68.18
9.00	.47	12.77	42.55	63.83
9.50	.49	12.24	40.82	61.22
10.00	.52	11.54	38.46	57.69
10.50	.55	10.91	36.36	54.55
11.00	.57	10.53	35.09	52.63
11.50	.60	10.00	33.33	50.00
12.00	.63	9.52	31.75	47.62
12.50	.65	9.23	30.77	46.15
13.00	.68	8.82	29.41	44.12
13.50	.70	8.57	28.57	42.86
14.00	.73	8.22	27.40	41.10
14.50	.76	7.89	26.32	39.47
15.00	.78	7.69	25.64	38.46
15.50	.81	7.41	24.69	37.04
16.00	.83	7.23	24.10	36.14
16.50	.86	6.98	23.26	34.88
17.00	.89	6.74	22.47	33.71
17.50	.91	6.59	21.98	32.97
18.00	.94	6.38	21.28	31.91
18.50	.96	6.25	20.83	31.25
19.00	.99	6.06	20.20	30.30
19.50	1.02	5.88	19.61	29.41
20.00	1.04	5.77	19.23	28.85
20.50	1.07	5.61	18.69	28.04
21.00	1.09	5.50	18.35	27.52
21.50	1.12	5.36	17.86	26.79
22.00	1.15	5.22	17.39	26.09
22.50	1.17	5.13	17.09	25.64
23.00	1.20	5.00	16.67	25.00
23.50	1.22	4.92	16.39	24.59
24.00	1.25	4.80	16.00	24.00

6.06 "Floater Battery Feeders" for maintaining the charge in a local storage battery at the location of the P.B.X., station system or key equipment are usually suitable for large installations and for small installations where cable facilities are congested or the equipment is located some distance from the central office. This method may be used also to float a building battery which may serve a number of P.B.X.'s or station equipments, as covered in Part "G".

6.07 The arrangement and requirements of floater battery feeders are in general the same as covered in Part 5 for direct feeder, except that different fusing limitations apply and less conductivity is required in the feeder due to spreading the battery charging over periods of light or no load, instead of using a feeder designed to care for momentary peak loads.

6.08 Since current drains vary with the type of equipment, number of circuits involved, calling rate, and holding time, it is not possible to establish a definite value for the charging rate of a battery. Current drain values for the different equipments or formulas for calculating the drain are given in the sections of practices covering the equipment.

6.09 Where severe non-periodic load conditions are anticipated which would materially reduce the available capacity in the battery each day, No. 101A power plants should be equipped with a charge control relay. This condition should not generally obtain on loads of less than 4 or 5 ampere hours per day if the proper size battery is provided. See paragraph 6.01.

6.10 The resistance of a feeder for floating a battery of power plants equipped with a charge control relay is a fixed value based on the voltages of the charging source and the approximate .400 ampere maximum charging rate of the battery. Feeder resistance values for plants equipped with charge control relay are given in Section B523.015. These values apply regardless of whether the plant is used for P.B.X.'s or station system battery supply.

6.11 Where rectifier equipment is to be installed for charging a local battery or to provide power for the operation of a station system equipment, a survey of the subscriber's premises should be made by a representative of the Telephone Company in cooperation with the customer or his authorized representative to determine the requirements for power (105-125 volt 50-60 cycle, a-c., commercial supply for rectifier), wiring and equipment locations. All power wiring including convenience outlets should be installed by an electrician under the direction of the customer in advance of the installation of equipment by the Telephone Company. The installation costs of power feeder equipment including conduits, convenience outlets, etc., and subsequent current consumption are born by the customer. The Telephone Company shall provide the necessary wiring for connecting the rectifier to the power supply.

Caution: Avoid using an outlet in combination with a switch which is liable to cut off the power supply.

6.12 The general plan of local battery use where cable pairs are available for floating from the central office battery is shown in Fig. 2. If the floater feeder method is not feasible the rectifier charging method shown in Fig. 3 should be provided.

(B) P.B.X. and Station System Power Plants, No. 101A

6.13 The No. 101A power plant is designed for use with P.B.X.'s and station systems where a local battery is required and ~~a 15 to 20 volt, 10 to 15 ampere supply will provide sufficient current for operating the equipment~~. (See Paragraph 6.01.) The power plant is furnished in two cabinet arrangements depending upon the equipment it is used with, and is shown in Figs. 2 and 3. ~~The upright wooden cabinet is used at the end of a 550 type P.B.X.~~ and the metal cabinet may be used with either key equipments or P.B.X.'s. A description and method of ordering No. 101 type power plants is covered in Sections B523.017 and C53.511.

6.14 The battery of a No. 101A power plant has a voltage range of from 15 to 20 volts with an average voltage of approximately 17.5 volts when floated from a central office battery or J86205-B rectifier. The battery may be floated on a metallic basis from any one of the available 24, 38 or 48 volt central office batteries. In cases where 24 and 48 volt central office batteries are available for floating, the 24-volt battery should be used unless the number of conductors required in the feeder exceeds one pair, in which case the feeders should be connected to the 48-volt central office battery.

6.15 The maximum allowable resistance of a feeder for floating the battery of a No. 101A power plant not equipped with a charge control relay should be determined from Table No. 4 using ampere hour values or formulas for calculating the value, given in the sections of practices covering the particular equipment. Where the battery is to serve more than a single P.B.X. position or station equipment or a mixture of equipments on the same premises, the resistance of the feeder should be based on the total ampere hour drain of all equipments. The following sections of Bell System Practices included ampere hour drains or formulas for calculating the drains for the various equipment which may be supplied with battery from a local battery power plant.

No.'s 505, 506, 550 and 551 Type P.B.X.'s	B523.015
No.'s 15A and 23A Key Equipments	C53.254
No. 100 Key Equipment	C53.274
No.'s 101A and 101B Key Equipments	C53.408
No. 1 Order Turret	C53.104
No. 2 Order Turret	C53.114
Power Supply Arrangements for No. 1A Key Telephone Systems and Wiring Plans	C53.511 (SD-69091-01)

6.16 The current drains of the conference circuits paging equipment announcing stations and station auxiliary signals in general are small enough so that they can be disregarded in calculation the size of local batteries and associated battery supply feeders. Where long line equipment is installed which requires 15 to 20 volts local battery supply, the ampere hour drain for long trunk circuits may be assumed to equal one P.B.X. cord circuit and long station lines approximately one half this amount.

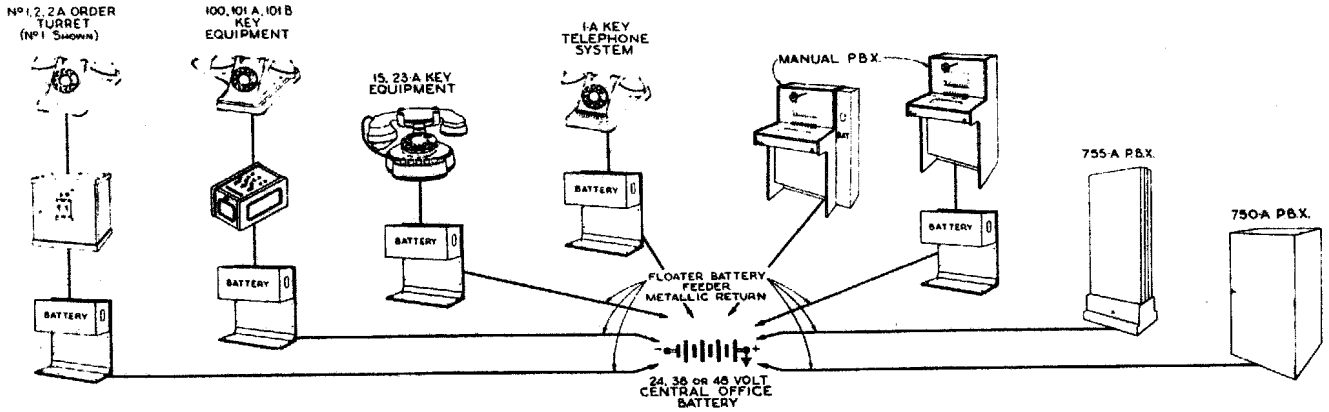


Fig. 2 - Local Power Plant - C. O. Battery Feeder

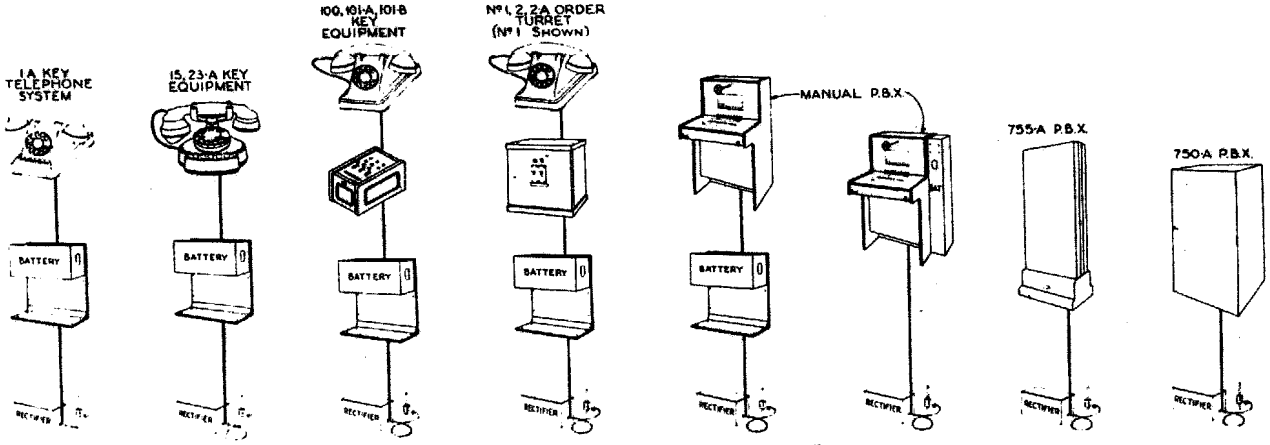


Fig. 3 - Local Power Plant - Rectifier Charge

(C) No. 101-D Power Plant

6.17 This power plant is designed for use in connection with No. 551-D multiple type P.B.X.'s and is covered in detail specifications prepared by the Engineering Department for each installation. The plant includes a 30 ampere hour battery and may be installed at the end of the No. 551A or B type P.B.X. where the No. 101A 15 ampere hour power plant will not provide sufficient capacity. Resistance of feeder for floating the battery may be determined in the same manner as covered in Paragraphs 6.15 and 6.16 for No. 101A power plants.

(D) No. 101-E Power Plant

6.18 This power plant is designed for use with No. 102A key equipment installations and is usually furnished in detail specifications issued by the Engineering Department. The plant is supplied equipped with an 11 cell 20 to 25 volt 15 or 30 ampere hour battery and may be used for P.B.X. installations where increased station ranges are authorized for the P.B.X. When used for this purpose the increased range obtainable may be based on the maximum voltage of the plant. Ranges and requirements are given in Section B523.219.

6.19 The use of this power plant is permissible in connection with key equipment installations other than 102 key equipment where the current demand of the equipment requires a battery of 30 ampere hours capacity.

6.20 The No. 101E power plant is arranged for either floater battery charging or rectifier charge and since the plant is equipped with a charge control relay the resistance of a floater feeder is a fixed amount based on a .5 or 1. ampere maximum charging rate as follows:

Charging Rate and Capacity of Battery	Maximum Resistance of Feeder — Average Cent.Off.Batt.Volts		
	24 Volt	38 Volt	48 Volt
15AH Batt. .500 Ampere Chg. Rate	-	26 Ohms	46 Ohms
30AH Batt. 1. Ampere Chg. Rate	-	13 Ohms	23 Ohms

A description and the method of ordering No. 101E power plants is covered in ~~Section 0532.1??~~.

(E) No. 750-A P.B.X. Power Plant

6.21 The 8 cell local battery used in connection with No. 750-A P.B.X. has a voltage range of from 15 to 20 volts with an average voltage of approximately 17.5 volts when floated from a central office battery. This battery may be floated from any one of the available 24, 38, or 48 volt central office batteries. In cases where 24 and 48 volt central office batteries are available for floating, the 24 volt battery should be used unless the number of conductors required in the feeder exceed one pair, in which case the feeder should be connected to the 48 volt central office battery.

6.22 When the number of cable pairs required in a feeder for floating the battery of a No. 750-A P.B.X. exceeds 10, it is advisable to consider the use of a local rectifier. Resistance values for floater battery feeders are specified in Section B555.021.

(F) No. 755-A P.B.X. Power Plant

6.23 The 10 cell local battery used in connection with No. 755-A P.B.X. has a voltage range of from 18 to 25 volts with an average voltage of approximately 21.5 volts when floated from a central office battery or rectifier. This battery may be floated from any one of the available 36, 38, or 48 volt central office batteries or from a rectifier at the P.B.X., if a sufficient number of cable pairs are not available. A 24-volt central office battery is not suitable for this purpose. Resistance values for floater battery feeders are specified in Section B556.021.

(G) Centralized Power Plants

6.24 A No. 101-F power plant, described in Section B501.906, should be used for a centralized source of battery supply where several P.B.X.'s, wiring plans, order turrets, and key equipments are located in the same building and where space is available for the installation of a power plant. The battery and ground feeders for each P.B.X. wiring plan, key equipment, etc., are wired to the centralized plants and fused in the control cabinet of the power plant. The superseded No. 101-B, described in ~~Section [illegible]~~, power plant which is mechanically and electrically equivalent to the No. 101-F plant may be used if available. The 101-B power plant is not arranged for use with a rectifier.

6.25 The centralized power plant will offer all of the advantages from an equipment standpoint of an individual plant and in many cases it will result in considerable savings in power supply costs. These reductions are mainly due to the lower maintenance of one large battery as compared to several small ones, to the lower first cost of a centralized plant and to small conversion losses of a larger battery.

6.26 Late type 101-B power plants are equipped with 28 two-ampere protectors for fusing battery supply feeders to P.B.X.'s, key equipments, wiring plans, etc. Existing 101-B power plants having 15 protectors may be modified, if additional protectors are necessary, to provide the maximum capacity of the new power plant. ~~The method of increasing the number of discharge protectors in existing 101-B power plants is covered in Section B523.017~~.

6.27 Table No.4 gives daily ampere hours load values, corresponding charging rates of battery and floater battery feeder resistances applicable to the battery of a centralized power plant. The charging current values in this table may be used also in the selection of a rectifier, where this charging method is to be employed.

6.28 When a centralized battery is to be provided to supply current for the operation of several different equipments, the current drain for each equipment should be calculated in order to determine the size of battery to be furnished and the maximum allowable resistance of the feeder which should be provided to float the battery.

6.29 Due to the low charging potential obtained where a battery receives its charge from a 24-volt central office battery, it is usually advisable to float the 10-cell battery of No. 101-B power plants from the 48-volt central office battery.

6.30 Due to the high charging rate required to maintain the charge in a centralized building battery, a charge control relay should be provided to avoid overcharging the battery during light load periods.

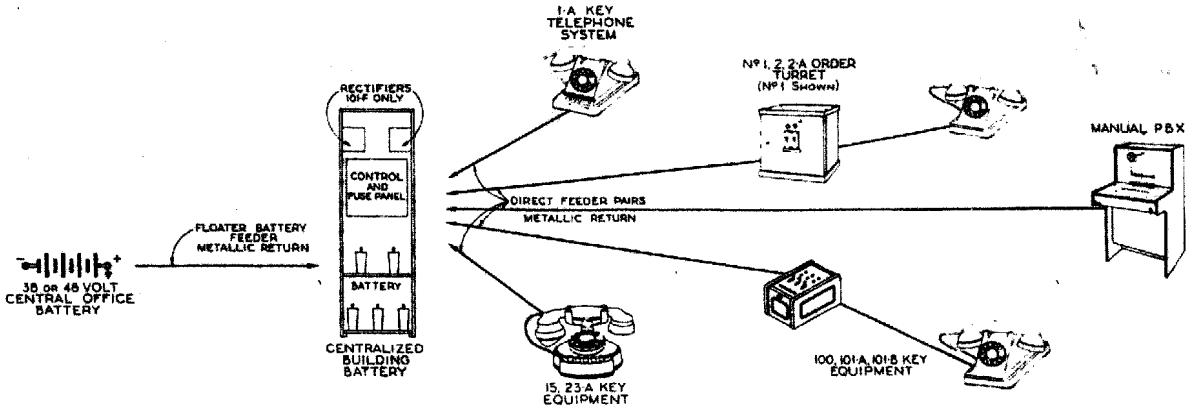


Fig. 4 - Centralized Power Plant - Rectifier or C.O. Battery Feeder

6.31 Fig. 4 shows the general plan of a centralized battery distribution system with arrangements for floating the associated battery from the central office battery or using a local rectifier to provide the charging current.

6.32 The size or capacity of battery to be provided for a centralized system and the charging rate of the battery which effects the resistance of a floater feeder if used, or type of rectifier, is dependent upon the current drains to which the battery will be subjected. Ampere hour loads for each equipment which will be connected to the power plant must therefore be determined and this information may be obtained from the practices covering the equipment as follows: No 555 SEE Table 6.06 Addendum

No.'s 505, 506, 550 and 551 Type P.B.X.'s	B523.015
No.'s 15A and 23A Key Equipments	C53.254
No. 100 Key Equipment	C53.274
No.'s 101A and 101B Key Equipments	C53.408
No. 1 Order Turret	C53.104
No. 2 Order Turret	C53.114
Power Supply Arrangements for No. 1A Key Telephone Systems and Wiring Plans (SD-69091-01)	C53.511

(H) Miscellaneous Power Plant Arrangements

6.33 Several power plant arrangements are available for supply current for the operation of key equipments, key telephone systems and wiring plans where the current requirements is small and the use of feeder supply from a central office or a local battery at the location of the equipment would not be economical or practical.

6.34 These arrangements generally consist of a rectifier operated from the 110 volt 60 cycle lighting service of the subscribers which provides the required operating current direct to the equipment without the use of a local storage battery. Dry cell batteries and door bell type transformers may also be used and these arrangements together with the various rectifier are covered in Sections C53.511 and C53.513. Other uses of these arrangements and other power supply features or station systems are employed for station auxiliary signals in Division C54.300 of these practices.

6.35 There are certain limitations as to the use of a rectifier source of power supply as covered in the preceeding paragraphs. These limitations are as follows and must be met if rectifier or transformer power supply is to be used.

SEE 6.07 Add

(a) Rectifiers or transformers should not be furnished for use with station systems provided for Police and Fire Departments, Hospitals, etc., and other places where failure of the local intercommunicating feature the equipment would seriously affect the customer's service.

(b) Idle cable pairs are not available for supplying battery for the operation of equipment direct from the central office storage battery.

(c) A-c. power service on the subscribers' premises is of the proper potential (50-60 cycle, 105-125 volts) and is dependable and free from interruptions.

(d) The Commercial Department of the Telephone Company has arranged for the provision of a power outlet and the use of the subscribers' power service.

6.36 The J86205-A rectifier power supply unit may be used for a source of battery supply for a No. 15A or No. 23A key equipment as outlined in the C Series practices covering the installation of these equipments.

6.37 SEE 6.08 FOR USE 101G POWER PLANT

7. ISOLATED POWER PLANTS AND EMERGENCY OR TEMPORARY POWER ARRANGEMENTS

SEE 7.01 Add

7.01 Where single position 14 to 26 volt No.'s 505, 506, 550, 551-A or 551-B P.B.X. switchboard are required for seasonal installations such as are required in resort areas a Raytheon No. 1044-FR Rectifilter should be considered as a source of power for operating the equipment. This power unit may also be suitable for use with key equipment installation under the conditions applicable to P.B.X.'s.

SEE 7.02

7.02 The power unit operates from a 60 cycle 110 volt supply and has a 23 to 25 volt output from no load to one ampere, however in order to obtain a maximum life of the rectifying elements load should not be more than three busy hours at one ampere and the remaining hours should not exceed .6 ampere per hours.

SEE 7.03, .04 ADD

7.03 A local battery is not required with this power unit since the load is connected direct to the unit, however, a dry cell battery must be provided for use in case of power failures.

7.04 The No. 101A power plant and a J86205B rectifier should be provided for those seasonal installations where a rectifilter described in Paragraphs 7.01 and 7.02 is not considered satisfactory for use.

7.05 Automobile storage batteries should be used in cases of emergency and for other temporary service where it is not possible to obtain feeders from the central office, and where a-c. power is not available to operate a rectifier in conjunction with a local battery.

8. GENERATOR CIRCUITS

8.01 Ringing current for the operation of manual P.B.X. switchboard, Nos. 750A and 755A dial system P.B.X.'s and certain station systems is usually supplied from the central office over cable pairs. The number of cable pairs required for the generator supply feeder varies from one cable pair per P.B.X. in cases of isolated installations down to one cable pair to serve three to ten P.B.X. switchboards or station systems located in the same building. Fig. No. 5 and Table No. 5 shows the general requirements for ringing current supply circuits.

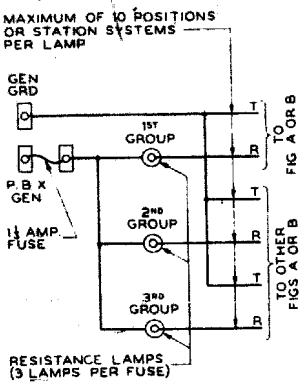


FIG. 5
RINGING CURRENT SUPPLY

FIG. A
TYPE 'A' DIST. FRAME

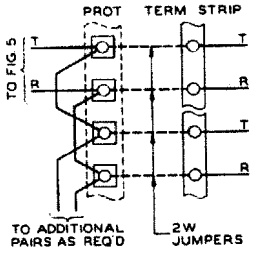
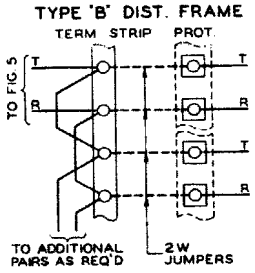


FIG. B
TYPE 'B' DIST. FRAME



8.02 Cable pairs for generator supply feeders shall be metallic throughout and spare or odd conductors which are not paired should not be assigned for these feeders.

8.03 The generator supply in the central office should provide 95-105 volts with a frequency of 16-2/3 to 20 cycles. Superimposed or a-c. - d-c. ringing current is not suitable for P.B.X. or station system generator supply and shall not be used. Resistance lamps in the supply leads should be of the type specified in Section A505.161.

8.04 The No. 359A vacuum tube used in No. 103A key equipment will not operate satisfactorily on other than a-c. d-c. or negative superimposed ringing current, therefore where 103A key equipment is installed in connection with extensions from manual P.B.X. switchboards, which normally would be rung with a-c. current only, it will be necessary to provide a d-c. component for the ringing current at the station as outlined in Section C53.411.

8.05 Where a ringing machine is required for a No. 750 or No. 755A P.B.X. instead of central office ringing power furnished over cable conductors, a KS-5523 static ringing generator and associated equipment should be provided as outlined in Section B556.005. Similar equipment is available for use with manual P.B.X. installations and will be furnished by the Chief Engineer through the regular lines of organization.

8.06 Ringing current for use with No.'s 750-A and 755-A P.B.X. should usually be supplied from the central office over one cable pair. A total of not more than 14 ringers in the trunks and the tone, ringing, alarm and common timing circuits should be operated from the same ringing supply. When buzzers or ringers and buzzers are to be provided one buzzer should be considered the equivalent of 4 ringers.

8.07 A maximum of 10 manual type P.B.X. positions or station systems may be supplied ringing current through one resistance lamp located in the central office. The ringing supply leads for these equipments may be bridged on one, two or three cable pairs as shown in Fig. 5. One resistance lamp in the central office is required for each No. 750A or No. 755A P.B.X. Multipling of ringing supply leads is not permitted with this type P.B.X.'s.

TABLE NO. 5

Type P.B.X. or Station Equipment	No. of P.B.X. Positions or Station Systems Per Res. Lamp	Loop Conductor Res. of Feeder
505,506,550 and 551 P.B.X. Positions	10	Same as P.B.X.Trk.or Long Trk. Range
750-A P.B.X.	1	650 Ohms
755-A P.B.X.	1	500 Ohms
Station System	10	Sub.Line or Long Line Ckt.Range
P.B.X.Long Station Line or Trks.	These circuits are usually connected to the associated P.B.X. generator supply.	

SECTION SEE 8.01 ADDENDUM

8.08 Each group of buzzers or station equipment shall be considered as the total number of buzzers fed from one ringing lamp at the station and shall be considered as the equivalent of one 505, 506, 550 or 551 P.B.X. position.

8.09 Generator supply for use with No. 2 order turrets is usually obtained from the same source of supply as the P.B.X. with which it is associated. If the order turret is not used in conjunction with a P.B.X. the ringing current should be supplied over a separate cable pair from the central office.

8.10 SEE 8.02 ADD

9. ALARM AND EMERGENCY TRANSFER KEY CIRCUITS

9.01 Connection of the alarm circuit of No.'s 750-A and 755A P.B.X.'s to the alarm annunciator equipment in the central office should not generally be required, since an emergency key for trunk service is provided at the P.B.X. to permit direct connection to one of the central office trunks under a trouble condition at the P.B.X. If an alarm connection is required, however, one cable pair should be assigned for the alarm circuit lead to the central office. The loop resistance of the alarm circuit leads shall be in accordance with the requirements shown on the central office alarm circuit.

9.02 Central office alarm circuits are usually available in the central office, if not, they may be installed upon application to the Chief Engineer through the regular channels in cases where they are justified from a service standpoint.