1529.

CENTRAL STATION FOR SMALL COUNTRY VILLAGE TELEPHONE EXCHANGE.

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Central Station for Small Country Village Telephone Exchange.

Visitors at the Centennial Exhibition in 1876 were astonished on hearing the voices of friends brought to them over a wire that extended the length of Machinery Hall - a distance of but a few hundred feet. Today, it is possible to talk between Omaha and New York, a distance of fifteen hundred miles. Scarcely more than a decade ago, the telephone was regarded as a luxury. Today it has become a business and, almost a household necessity. Millions of capital are invested in the telephone industry and employment is furnished to thousands. Nearly every country village and hamlet has its telephone exchange. Farm lines extend every where. The country is being bound into one great community. Man's horizon is broadening. The telephone is bringing man into closer touch with his fellows, is fostering feelings of interdependence, and helping to unite him into one common brotherhood.

For each subscriber to have facility to call up directly any other subscriber, would require so many lines as to make the scheme impracticable, if not impossible. To obviate this, some central point to which all lines converge and where connections may be made between any two of them, must be chosen. Such a point is called a Central Station or Central.

The location of central is an important factor in the building and maintenance of a telephone exchange. It should be located at what is called the telephonic center. This is such a point at which all subscribers can be reached by the use of the least possible amount of wire. In the location of this point, not only present conditions but also future developments must be considered. It is evident, that the proper location of central will minimize the cost of installation, the loss in depreciation, and the expense of maintenance.

The company, even though a small one, should own the building and the grounds occupied by the central office. In an exchange of any size, the building must be suited to the needs demanded by the business. It is not an easy task to adapt the business to the building. The difficulties of removing the equipment presents a very serious problem should a change in location become necessary. The operation of the plant must necessarily be suspended while a removal is in progress. This would entail a serious loss in the earnings.

The room in which the switchboard is placed should be well lighted, well ventilated, and of ample size so that there need be no crowding of the apparatus. In an exchange of this size, the distributing board and protective apparatus, would be placed in the same room with the switchboard. This would be an economic arrangement besides it would facilitate the testing of circuits for trouble.

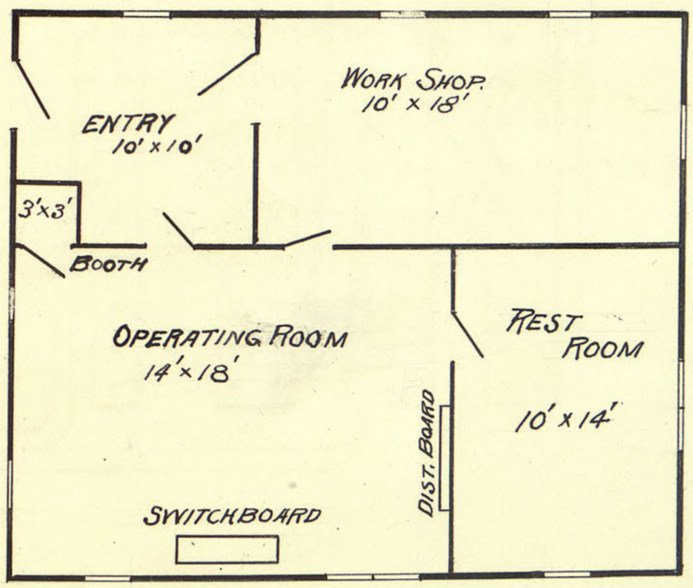


Fig. 1. Ground Plan of Central.

FIG. 2. SECTION OF DISTRIBUTING BOARD.

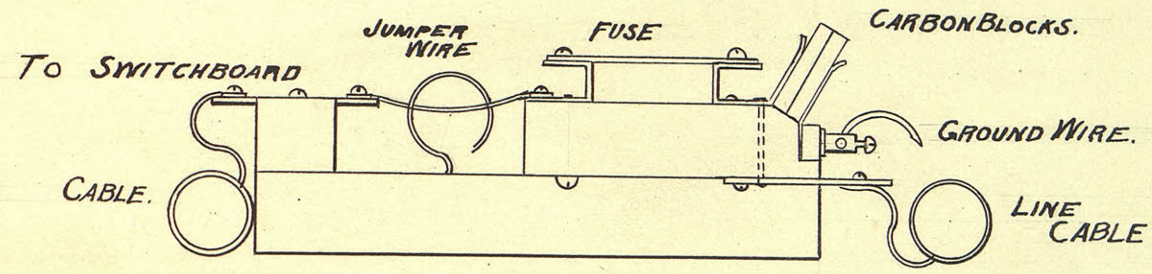
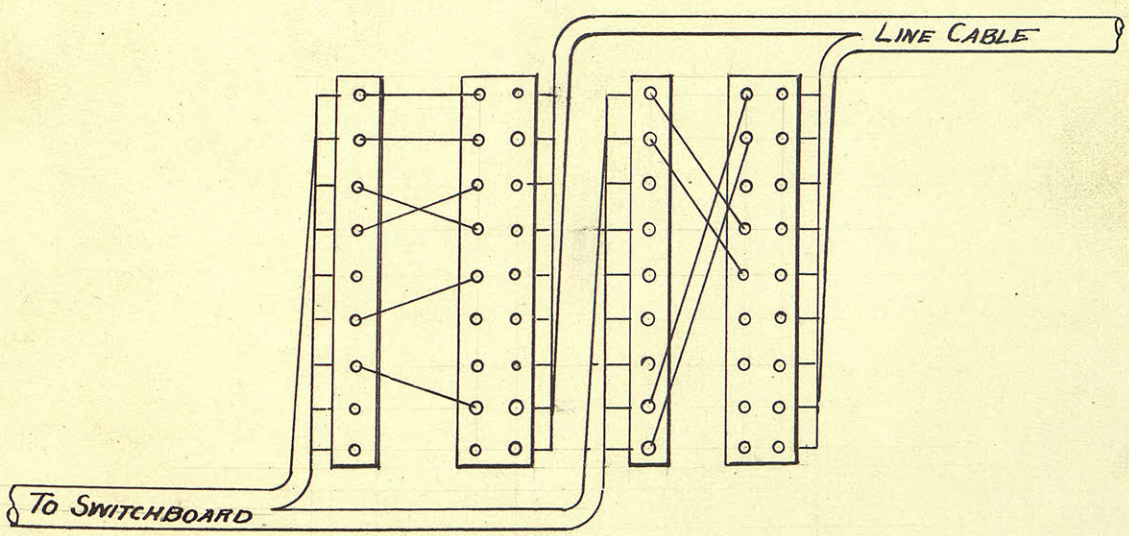


FIG. 3. DISTRIBUTING BOARD AND CABLES.



For the exchange, let a floor space twentyfour by twentyeight feet be given. Divide it into four rooms as Fig. 1. shows. The main operating room is fourteen by eighteen feet. In this room will be found the distributing and switchboards, a desk for the manager, and such other furniture as the need shall demand. Opening from this room, will be a toll booth three feet square, also a rest room ten by fourteen feet. The latter room will be used by the night operators as a sleeping apartment. Besides the above rooms, there will be ample space for an entry and a work shop. The work shop is a well lighted room ten by eighteen feet. No provision has been made for a place to store line construction material. This may be provided for in some convenient place near the exchange.

As the line enters the central office by means of a cable, the piece of apparatus encountered is the distributing board. The purpose of this board is to afford an easy method of changing the relation of the wire plant circuits to the switchboard circuits. The distributing board may be dispensed with as it is possible to fan out the pole cable and to connect directly to the switchboard. But this would necessitate an extra amount of labor and trouble in cutting the wires when a change in the relation of the wires was needed.

In large offices, the distributing board is a highly complicated affair. In very small offices, it may be but a strip of wood carrying two rows of pins to which the subscriber's line and the switchboard line is attached and between which jumper wires run.

As the distributing board is an intermediate point in the line between subscriber and the switchboard, it becomes a logical point at which to start to test for trouble. From this point, the inspecter may test the line to the switchboard or the line towards the subscriber. The distributing board is also a natural location for the protective devices. Thus it is seen that this board has the three following functions.

I. It enables a temporary connection to be easily and quickly made between any incoming line and the switchboard.

II. It lends itself readily to operations for locating trouble.

III. It provides a convenient location for protective devices.

One of the simplest distributing boards will be used. See Figs. 2. and 3. The base is made of hard maple, thoroughly seasoned and well varnished. Each section is made of three pieces. The strip on the left carries clips to which the switchboard cable is attached. On the right, the protective devices are arranged in a row with the same spacing as the clips on the left. These protective devices consist of a carbon block arrester combined with a low carrying capacity fuse. The carbons provide a ready path to the ground for the high potential lightning charges. The fuse melts before sufficient current to damage the apparatus passes through it.

For two hundred lines, if but one strip is used, the board would be eight or more feet in length. If placed in an upright position, the upper lines would not be easy of access. To obviate this, the strip might be set horizontally. A better way would be to use two strips and fan out the cables as shown in Fig.3.

A two hundred self restoring drop magneto switchboard will be used in the central office.It is hardly probable that the number of subscribers will exceed four hundred. Allowing one hundred twenty drops for the city phones,eighty will be left for the rural service.

Fig. 4.

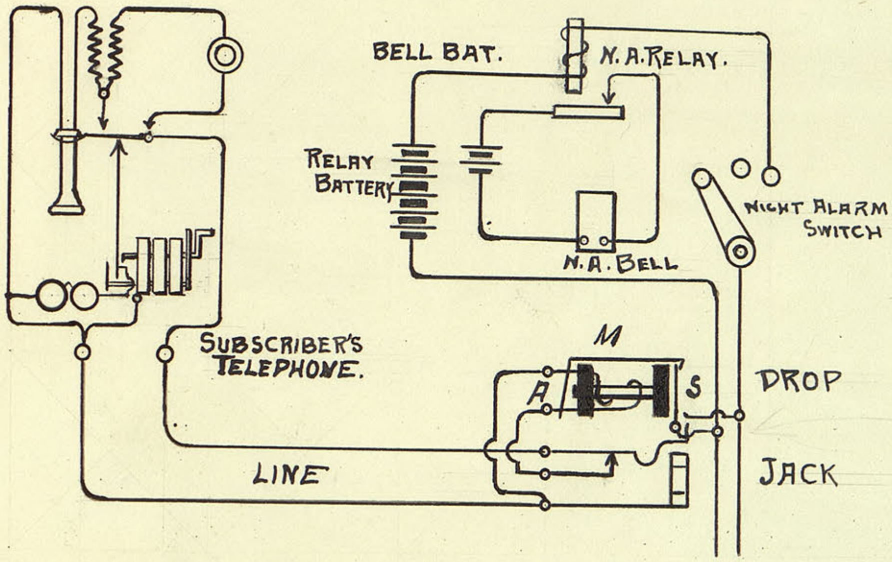
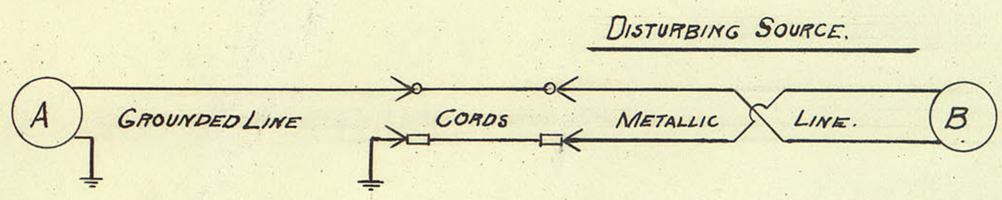
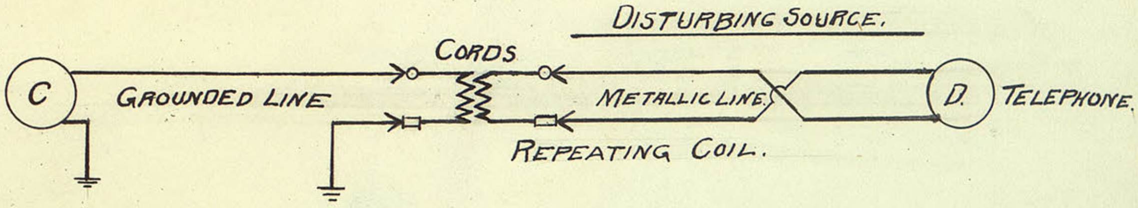

BELL BAT.
N.A. RELAY.
RELAY BATTERY
NIGHT ALARM SWITCH
N.A. BELL
M
SUBSCRIBER'S TELEPHONE.
A
S
DROP
LINE
JACK

Fig. 5.


DISTURBING SOURCE.
A
GROUNDED LINE
CORDS
METALLIC
LINE.
B

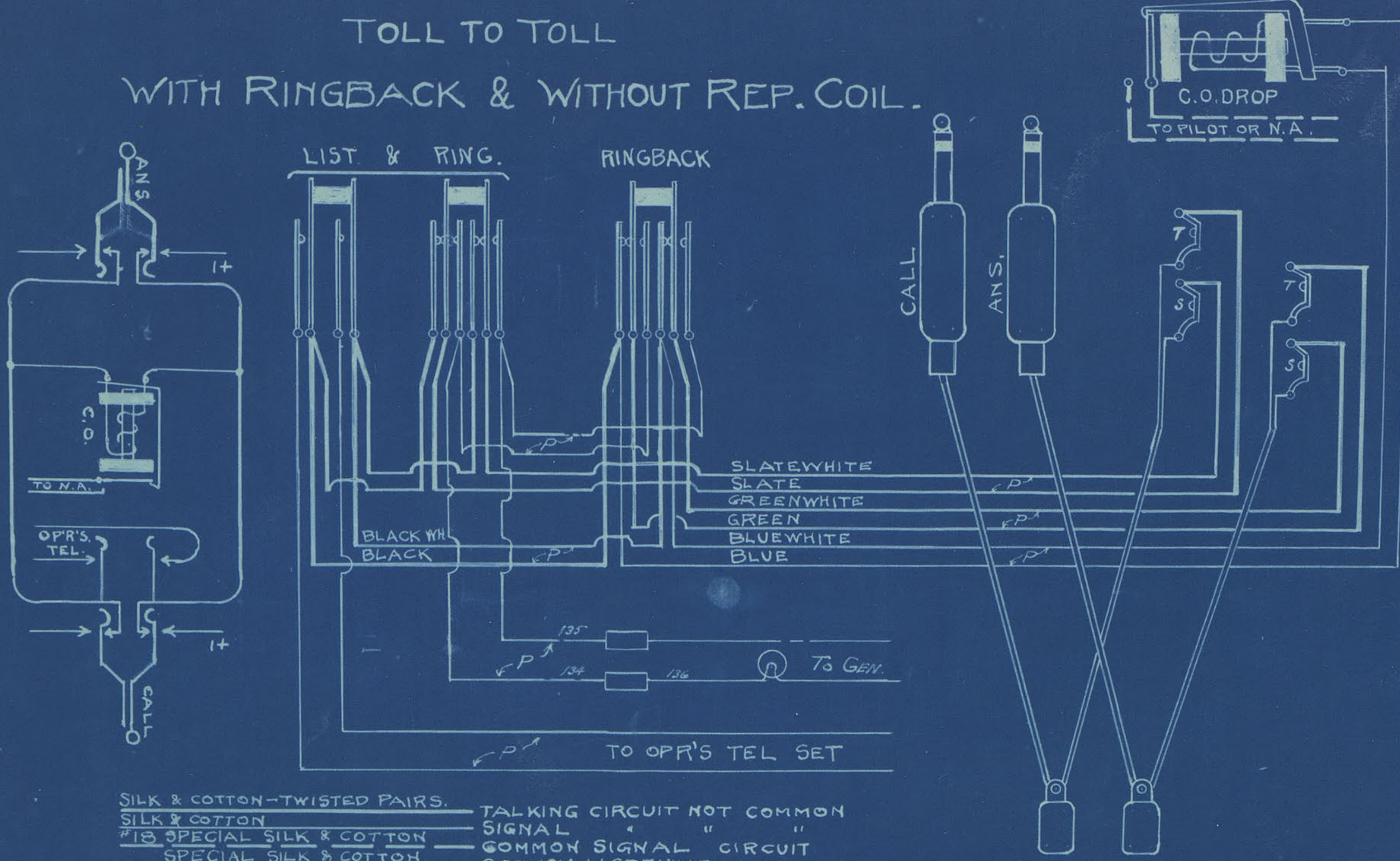
(6.)


DISTURBING SOURCE.
CORDS
C
GROUNDED LINE
METALLIC LINE.
D.
TELEPHONE.
REPEATING COIL.

TOLL OP'R'S. CORD CIRCUIT

TOLL TO TOLL

WITH RINGBACK & WITHOUT REP. COIL.



SILK & COTTON—TWISTED PAIRS.	TALKING CIRCUIT NOT COMMON
SILK & COTTON	SIGNAL " " "
#18 SPECIAL SILK & COTTON	COMMON SIGNAL CIRCUIT
SPECIAL SILK & COTTON.	COMMON LISTENING "
SPECIAL SILK & COTTON	" RINGING "

"P" DENOTES A TWISTED PAIR

Most rural lines will be party lines, so the board will give ample accommodations for all demands.

The purpose of the switchboard is to link the subscribers togethin talking relations. This is accomplished by a system of circuits. These various circuits are shown in figures 4, 6, 7, 8, and 9.

Fig. 4. shows the subscribers circuit in detail. This circuit has its beginning in the home or office of the subscriber and terminates in the drop and jack of the switchboard. It contains means whereby he may signal the operator. The subscriber on ringing in energizes the electro-magnet in the drop M. (Fig.4). This attracts the armature A which releases the drop S. The drop falls and notifies central if she be sitting at the board. At night or at other times when the calls are few, the operator may leave the board. In this case, the falling of the shutter makes connections between two points at S that completes a circuit to the night alarm. The ringing of this bell calls the operator.

The night alarm bell may be placed directly in the circuit completed by the falling of the drop. A better and surer way is to use a relay to complete the bell circuit as the cut shows. The relay is worked by a smaller current than is necessary to successfully operate the bell. This small current does not fuse and blacken the contacts thus insuring a more positive closing of the circuit than when the bell is connected in directly.

After a subscriber has attracted the attention of central by throwing the drop or ringing the bell, the step necessary in establishing a communication is for the operator to answer the call, learn the number desired, and to place them in connection. This is accomplished by means of the cord circuit. The cord circuit ends in two

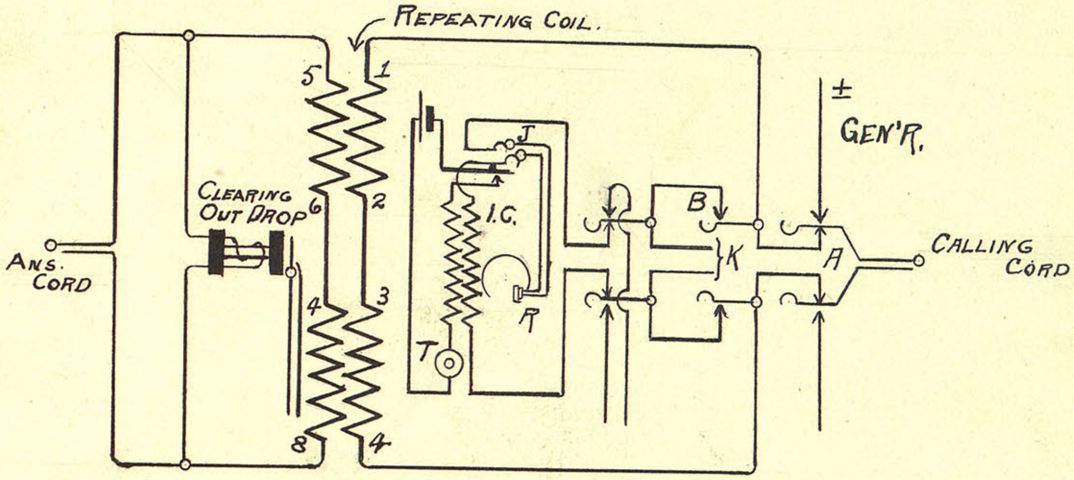

REPEATING COIL.
± GEN'R.
CLEARING OUT DROP
ANS. CORD
I.C.
B
K
A
R
T
CALLING CORD
1
2
3
4
5
6
4
8

FIG. 6.

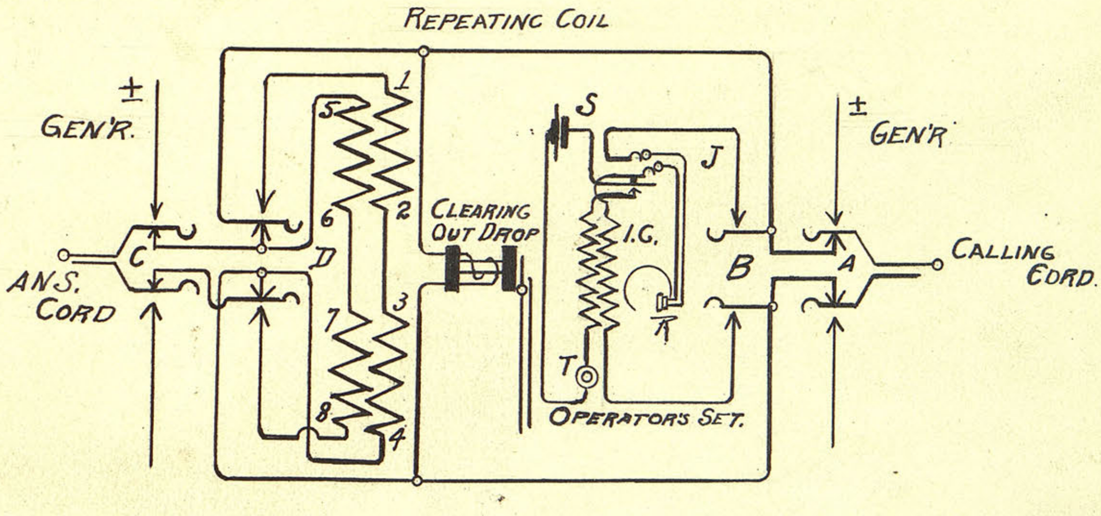

REPEATING COIL
± GEN'R.
ANS. CORD
C
D
1
2
3
4
5
6
7
8
CLEARING OUT DROP
S
J
I.C.
R
T
OPERATOR'S SET.
B
A
± GEN'R
CALLING CORD.

FIG. 7.

plugs, which are inserted into the jacks of the parties wishing to talk. See Figs. 6 and 7 for details of this circuit. A, B, and C are keys or switches connected in this circuit. A is the ringing key. B is the listening key, C the ring back key. For greater detail, see figures 8 and 9. Keys A and C put the generator in circuit and permit the operator to ring out on either cord at will. This is done without changing or removing a plug. Key B shunts the operator's set across the lines. This set consists of a head receiver R, an induction coil I.C., a transmitter T, and a battery S. A listening-in key B is wired in connection with each cord circuit so that the operator's set may be cut into any cord circuit that she may happen to use.

When subscribers have completed their conversation, the operator is notified by a disconnect signal called the clearing out drop. This drop is bridged across the two sides of the circuit. It is similar in construction to a drop but has a higher resistance. It may h have a resistance of from five hundred to two thousand ohms. A regular drop varies in resistance from eighty to one thousand ohms. The high impedence of the clearing out drop does not shunt the voice currents to any appreciable extent, while it readily responds to the generator currents in ringing off.

The cord circuit also may contain a repeating coil. It may be permanently wired in the circuit as shown in Fig. 6 or it may be so arranged that by pressing a key it may be cut into the circuit when necessary. The latter form is shown in Fig. 7.

The repeating coil is essentially a transformer. It has two separate coils of wire wound on the same core. Unlike the induction coil, it has both primary and secondary windings equal as to number of

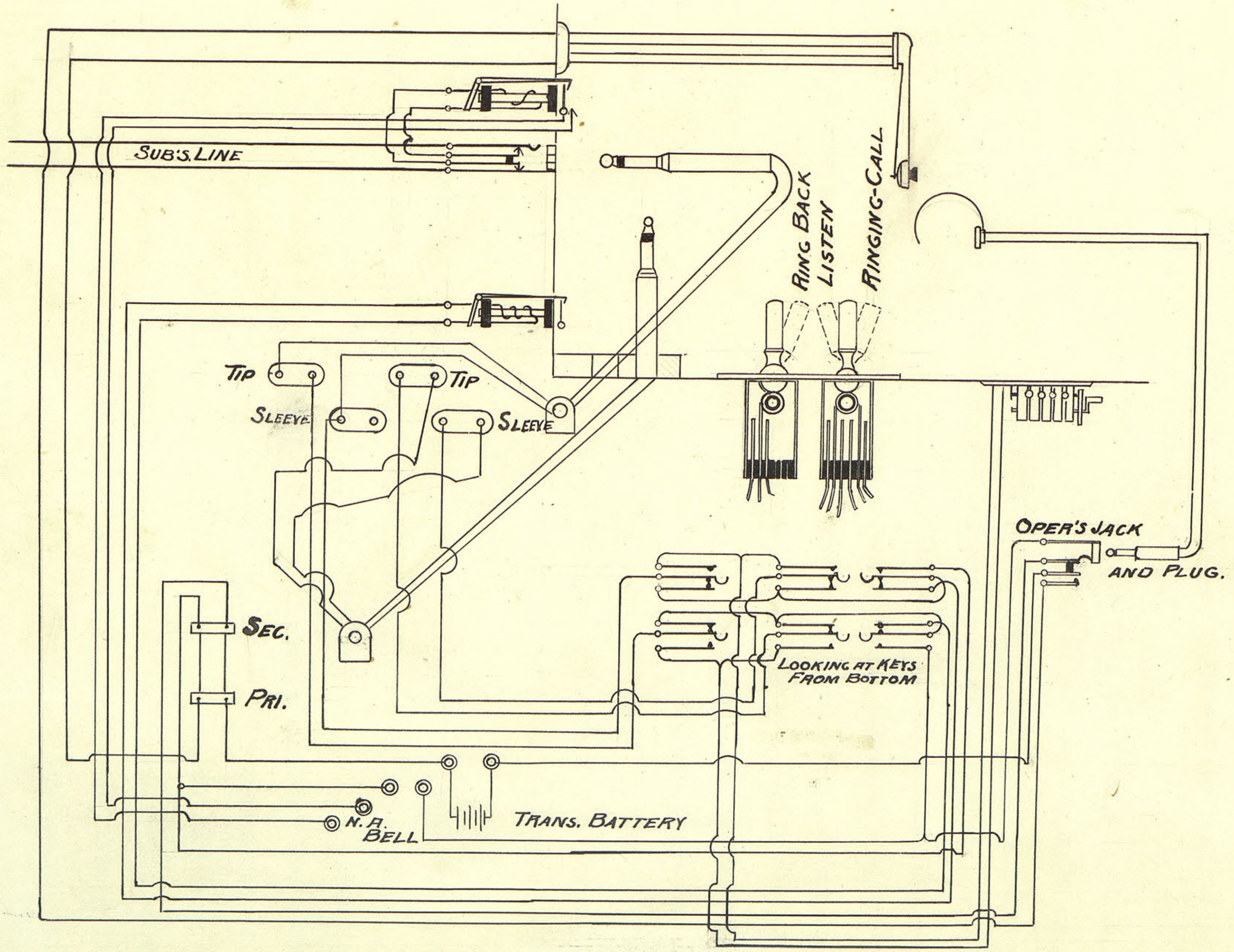


FIG. 8. A COMPLETE BOARD CIRCUIT.

turns and resistance. The coil is usually enclosed in iron to cut down the reluctance of the magnetic circuit.

Repeating coils that are wired permanently in a circuit should be different in construction to those that may be cut in and used only for voice currents. In the former case, it is necessary to ring through the coil in signalling. The ringing current is of low frequency and considerable magnitude. In order to repeat it with but little loss of energy, a small transformer would be necessary. This must contain a large amount of iron and have a great many turns in the coils. In this way, the current after repeating would still be of sufficient strength to throw the drop. Voice currents are weak but of high frequency. Magneto currents have a frequency of but fifteen to twenty cycles, while voice currents have a frequency from one thousand five hundred to two thousand. Thus an efficient coil for talking purposes, will require a small amount of iron and few turns of winding.

The purpose of the repeating coil is chiefly to provide a quiet connection between telephone lines of dissimilar construction. In connecting grounded lines to a full metallic circuit, a repeating coil should be used to avoid unbalancing the metallic line by grounding one of its ends. Figure 5 shows a grounded line connected to a metallic circuit. A disturbance is near the full metallic circuit. By proper transposition, the line of itself is balanced. But when connected to the grounded line this balance is destroyed. Both lines in themselves may have been quiet, but when joined, both became noisy. Figure 5b shows the use of a repeating coil in this connection. The balance of each line is preserved.

A repeating coil is not a panacea for all evil effects of electro magnetic or electro- static induction. Proper precautions must be taken in the construction of the line. The coil assists in keeping the lines balanced.

Large central stations are equipped with motor-generators and storage batteries from which power is secured for signalling. In a small country it is seldom possible to secure current from power companies to be so used. In fact, the ringing machine would be too expensive for use in a small exchange. To meet this demand for power generators, the Warner Pole Changer may be used. Its purpose is to alternately make and break the circuit of a large battery and to deliver positive and negative impulses of current to be used by the operator in ringing.

The apparatus consists of an electro-magnetic vibrator, having necessary circuit terminals, batteries, condenser, and relay. See Fig. 10. A closed circuit battery 31 energizes the magnet 34 and by means of the circuit breakers 25 and 26, the arm 23 is kept in vibration by the impulses thus set up. This arm carries four contact points connected to battery 50 by wires running in along the vibrator. The relay 56 is also in this circuit. The relay cuts the condenser into the circuit at the proper time to alleviate sparking at the points near P and Q. It will be seen that posts 61 and 63, one on either side of the vibrator arm, are connected together and to post 71. Posts 62 and 64 are in a similar way connected to post 72. As the arm vibrates back and forth, circuits will be completed and alternate pulsations of energy will pass out over the line to bell 66, which represents the subscriber's telephone.

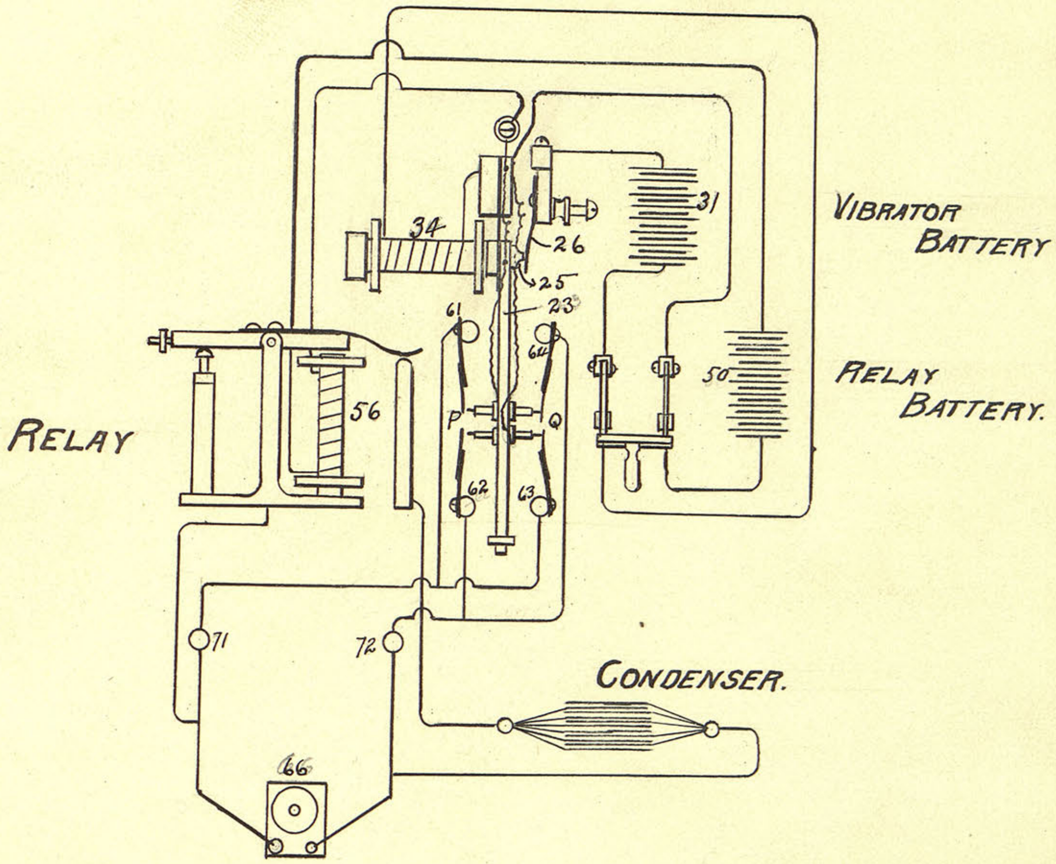


FIG. 10. WARNER POLE CHANGER.

In a small country village, a lot for a building site would not cost over $150. The building itself would cost in the neighborhood of $600. $750 should furnish building and site.

A magneto self restoring drop switchboard will cost $2.5o a drop. For 200 drops the cost will be $500.

The distributing board with the protective apparatus will cost 25 cts. a pair. 200 pair will be $50.

About 50 feet of cable will be neede to bring lines from the distributing pole. A 150 pair cable will cost 40 cts. per foot or 50 feet will cost $20.

Allow $100. for office furniture and fixtures.

A Warner Pole Changer will cost $40.

The total cost will be -

Building and lot	$750.00
Switchboard	500.00
Pole Changer	40.00
Distributing Board	50.00
Cable	20.00
Furniture and Fixtures	100.00
Total	$1460.00

The drops and the jacks can be placed in as needed. If all the drops are not needed, the first cost might be lessened in this way. The above estimate is for a complete outfit.

Four persons will be neede to run the system. One man will be needed to make repairs and to look after the business. He will be a sort of a manager. The toll service will be small,so that three girls can do the operating.

A competent man cannot be secured for less than $75 per month. Allow $20 per month for each girl. The following will be a statement of expense for salaries per month:-

1 Man at $75.	$75.00
3 Girls at $20	60.00
Total expense for salary per Mo.	$135.00
" " " " " year	$1620.00

In figuring the above, no allowance has been made for repairs or depreciation. Ten percent is the usual allowance made for these items. Experience has shown that ten is a fair estimate for this. Thus $146 must be added to the above wage expense to get the total for the year.

Salaries for one year	$1620.00
Depreciation and Repairs	146.00
Total for one year	$1766.00

The writer has had no experience in the telephone business. Information and ideas have been gathered from various sources. He has taken the plant now enstalled at White City as a type for all small exchanges. This has been a basis from which he has mase estimates for equipment and maintenance of all similar exchanges.