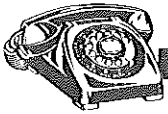


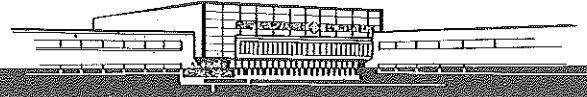
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WAYSTATION DIALING SYSTEM

by

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(Automatic Electric Laboratories, Inc.)

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WAYSTATION DIALING SYSTEM

A. Introduction

The present signalling system utilized by the railroads on their message lines, requires an intermediate agent or operator to complete a connection between a waystation phone and a PAX subscriber. The waystation calls the operator by a process of ringdown, and she in turn dials the desired PAX subscriber. The operator would monitor the circuit until the connection is completed, and return for disconnection when the parties have completed their conversation. For signalling a waystation the dispatcher or operator would operate a selector key or a special type dial which causes three groups of reversed high voltage pulses to be sent over the line to signal a particular waystation phone. Selectors at these stations would receive these pulses and selectively signal the particular waystation. If a PAX call existed, the operator would connect the PAX subscriber to the waystation line.

Up to the present time there has been no satisfactory method for giving the waystation full automatic dial signalling facilities without the use of this intermediate operator. Realizing the need for such a system the Automatic Electric Laboratories have developed a means whereby a waystation user can dial any party connected to a terminal PAX or a PAX subscriber can dial any waystation without assistance. The present design makes use of the existing selectors at the waystations which utilize 3-1/2 cycle signalling. In order to use these conventional waystation selectors a control circuit was developed to store the regular 10 per second dial pulses, common to automatic telephone equipment, and re-send them at the required 3-1/2 cycle rate for calls from the PAX to the waystation. Due to the long length of lines, and the auxiliary equipment sometimes encountered, conventional DC pulsing techniques were not considered practical. The use of the DC path for telegraph signals also further suggests the use of tone signalling as a simple means of signalling over long distances without disturbing the existing DC circuits.

The problem of signal imitation was minimized by a combination of many techniques. Signal imitation is the term used in telephony to describe the operation by speech currents of voice-frequency signalling equipment. There are means by which signal imitation can be reduced to any desired extent, but most techniques require a large amount of expensive equipment. This difficulty was minimized by utilizing a type of frequency shift technique for the transmission of the signalling tones. Line seizure by voice currents was minimized by using slow operate relays, and sporadic relay operations was eliminated by removing the detectors during a completed connection.

A prime consideration in the design of this equipment was to keep bridging losses and power consumption, particularly at the waystation, to an absolute minimum. This is done by connecting the waystation tone generator to the line and only during the interval of dialing.

Essentially this new system permits a waystation to dial any waystation in the system, or a waystation can dial any PAX telephone without the aid of an operator. Likewise, any PAX subscriber can dial any waystation without the aid of an operator or dispatcher.

B. Equipment

1. Waystation Unit

The waystation dialing unit is used in conjunction with the local battery phone at the waystation. This unit contains a dial and lever type switch, mounted on the front panel of the unit, as shown in Figure 1. It measures 4-5/16" x 5" x 4-1/32" and weighs approximately 2 pounds. Inside the unit is contained a small transistor oscillator to provide the necessary tones for seizure and dialing. The oscillator assembly is mounted on a printed wiring board.

The dialing unit is designed to operate from local dry cells of 3.0 - 4.5 volts for nominal distances of 50-60 miles on conventional facilities. For distances of 100 miles the supply voltage should be increased to 6.0 volts. If signal imitation is a problem the dialing unit's output level can be increased by an additional cell permitting the input level of the detector at the control unit to be reduced accordingly. The dialing unit can be operated at supply voltages as high as 20 volts without damage to the transistor. The power drain of this unit is limited to dialing time; consequently, battery life is no problem.

The dialing unit is provided with a 4 foot length of cord connected to a terminal block. Six screw type connections are contained in this terminal block for connection to the waystation battery, local phone, and line via the hookswitch of the local phone. If it is difficult to access the local phone, the dialing unit can be connected directly across the message line. In this case the dialing tones will be heard in the phone during dialing, causing a slight reduction in signal levels.

This unit also contains a filter which prevents interference and loading to any carrier channel above 3500 cps on the same circuit.

2. Control Unit

The control unit is used between the PAX and the waystation line. It is designed on a panel which mounts on a standard 19 inch relay rack. This panel occupies a vertical space of 10-1/2 inches and is provided with a cover 5-1/4 inches high. The unit is intended to mount near the PAX equipment and draw power from it.

The control unit operates from the conventional 48 volt exchange battery. This voltage is not critical but should remain between the limits of 44 and 52 volts. Power consumption is negligible during the idle condition. During dialing power requirements may reach 1.5 amperes, but only during the actual dialing interval.

This unit contains two incoming tone detectors which convert the waystation pulsed tones to conventional DC pulses of the type required for PAX operation. These detectors are both composed of two stages of tuned amplification, followed by a detector stage; all using transistors. Each detector channel contains an input level control to prevent overloading, and also to provide a degree of adjustment for controlling signal imitation. Storage and resender circuits are also contained in this unit for converting the conventional PAX 10 per second pulses into the 3-1/2 cycle type required to operate the waystation type 60 or equivalent selectors. A 1.5 minute instant reset timer is provided to hold a line until a connection is completed. This timer is also utilized to hold calls between waystations on different lines.

The control unit is connected to the PAX through a conventional line circuit for waystation to PAX calls. For signalling in the opposite direction the control circuit is accessed from a switch-through connector or a selector level, in order that the three waystation digits can be dialed beyond the PAX. The line circuit of the PAX should give reverse battery on answer by the PAX subscriber.

Reverse battery

C. Operation

Waystation Dials a PAX Subscriber (Figure 3).

To initiate a call to a PAX subscriber, the waystation subscriber begins by lifting his handset to monitor the line for busy condition. This monitoring does not in any way disturb the existing dialing or conversation of another subscriber if it exists. When

the line is found absent of signalling, the waystation subscriber would operate his dial unit lever key to the dial position for approximately 2 seconds. Operation of this key applies power to the transistor oscillator in the Waystation dialing unit, and connects a 1500 cycle tone on the line.

In the control unit this 1500 cycle tone is detected by the off-normal detector. The operation of this detector closes the circuit to the 1.5 minute timer which locks a termination on the line for PAX seizure. When the lever key is released at the end of the 2 second operation, dial tone should be heard from the PAX indicating that the main control circuit is ready to receive waystation signalling tones. If dialing does not follow or is not completed the PAX line and main control unit will be released after 1.5 minutes by the operation of the timer.

Operation of the waystation dial's off-normal springs places power on the transistor oscillator which again connects 1500 cycles across the line. During the dialing period the local phone is removed from the line to reduce loading or absorption of these tones. When the dial is released its pulse contacts change the oscillator frequency to 2000 cycles for each pulse.

This 2000 cycle tone is detected by the pulse detector in the main control unit and converted to conventional DC pulses. To minimize voice operation, a type of frequency shift technique is utilized. To register a digit the off-normal detector must momentarily restore before the pulsed digit takes effect. Thus, the simultaneous presence of both frequencies on the line will not cause any circuit operation.

If the waystation subscriber makes a mistake in dialing, or wishes to end the attempted call at that time, he can release the seized line by operating his lever key to the release position for about 2 seconds. This will place a 2000 cycle tone of long duration on the line which will release the timer at the control unit and

restore the line to the idle condition. He can then seize and redial if he so wishes. If the waystation subscriber should leave his phone at this point without releasing an incomplete call, the main control circuit and PAX line will be released by the operation of the timer after the 1.5 minute interval.

When the PAX subscriber answers, reverse battery on the line operates a shunt field relay, which removes the timer from the circuit. This places the release of the call under the control of the PAX subscriber. If the requirements exist to guard against PAX failure to disconnect, the connectors in the PAX serving this equipment should be equipped with connector time-out provisions.

PAX Subscriber Dials a Waystation (Figure 4)

The main control circuit can be accessed through a switch-through connector or through a selector level, in order that three digits required can be dialed beyond the PAX. When the PAX subscriber gains access into the control equipment by either of the above techniques, he must then dial the three digits necessary to signal the waystation selectors. Each of these digits are stored on a separate rotary switch. After the second digit is stored a ground is placed on the resender to apply a single clearing out pulse to the waystation selectors. This clearing-out pulse is necessary to reset all selectors (not previously reset) to their "home" position. This is necessary in order that all selectors will step from the same starting position.

When the last digit is received, a hunting or scanning circuit then scans each switch and resends these digits at a slower speed (in this case the 10 per second pulses are reduced in speed to 7 pulses per second). These slower pulses activate an ON-OFF relay group which effectively sends 3-1/2 cycle polar pulses needed to operate the waystation selector through the main control resender.

At the waystation selected, a bell or buzzer will operate when 17 pulses are received. This bell will ring for about two seconds, or until another pulse from the resender releases the selector and opens the bell circuit. This final pulse is a clearing out pulse for all selectors. If the pins on all selectors do not return to "home" position with this clearing out pulse, a second similar pulse is sent out when the second digit is initially stored, as described previously. While the bell is ringing, ring-back tone will be heard in the receiver notifying the initiating PAX subscriber that the bell is ringing.

All rotary switches and relays will remain as is until the PAX subscriber hangs up, in which case all relays and switches return to the normal, non-operate condition.

If a selector level is used for access into the control unit a holding ground or battery is provided in the control unit.

Waystation Dials a Waystation on Same Line (Figure 5).

Since a waystation line looks like any other line to the PAX, calls of this type would cause the same sequence of operation as that previously described (Waystation Dials a PAX Subscriber). The waystation subscriber would dial the selector access number, to be followed by the three called waystation numbers. The initiating subscriber can release the call at any time he desires by the usual release method described previously.

Since there is no reverse battery on a call of this type, the initial seizure timer will release after the 1.5 minute time interval, and thus another call can be placed to another waystation on the same line while the first conversation is in progress. Calls could be made consecutively to any number of waystations by this method if the control equipment is either released by the release key, or the 1.5 minute automatic release is

used. It is possible to place a Waystation to Waystation Call (Reverting Call) and then place a Waystation to PAX call, and finally to receive a PAX call at a waystation, all one after the other without interference if they do not occur simultaneously.

Waystation Dials a Waystation on Another line (Figure 6)

This type of call would be placed by the same method as the previous Waystation to Waystation (on the same line) with the exception that it will probably be necessary to dial several extra digits in order to get from one system to the next.

* Since there is no reverse battery on a call of this type, the circuit will release itself after the 1.5 minute time interval. To prevent this occurrence if the conversation time exceeds 1.5 minutes, it is necessary that the initiating subscriber operate his lever key to the dial position for a moment every 1.5 minutes. This will cause the seizure timer to reset itself to zero for a new cycle.

D. Field Performance

Field units have given very satisfactory performance if certain precautions are observed, thus:

1. It is absolutely necessary in this system to equip all waystations on the line with dialing units. This precaution is necessary because if all calls go through the control unit, circuitry is contained therein which will reduce the difficulty of signal imitation or voice operation of relays. When only a part of a line is so equipped those calls which would be handled by the operator or dispatcher would not go into this equipment and as a result the hazard exists.

2. When operating such a system it is desirable to use as high a level of outgoing signalling voltage from the waystation as possible. In most applications the use of a 4.5 volt supply for distances up to 50 miles and 6.0 volts above 50 miles has been found to be very satisfactory. Higher supply voltages may be used if noise conditions are excessive. (The waystation supply voltage should never exceed 20 volts.) At a 6.0 volt supply the waystation tone level on the line is about 0.8 volts (0 dbm on a 600 line). With this level, crosstalk limits are not exceeded, and the control detector's incoming level control can be reduced to further prevent extraneous operations.

In most installations where a 6.0 volt supply source is required, it would be obtained by the addition of one additional dry cell to the waystation battery. Since the life of this battery is its shelf life, the cost of this addition is unimportant.

The control circuit detectors are capable of handling inputs down to -30 dbm if their level controls are increased to the maximum, however, it is desirable to set these controls to a point where the off-normal and pulse relays operate satisfactorily with a 4.5 supply source at the waystation between 25 and 50 miles. The supply voltage can then be increased for the units beyond 50 miles to give comparable relay performance, and reduced for those closer than 25 miles (These distances are approximate for good open wire circuits). The waystation dialing unit will oscillate satisfactorily with a supply of 1.5 volts if the need arises.

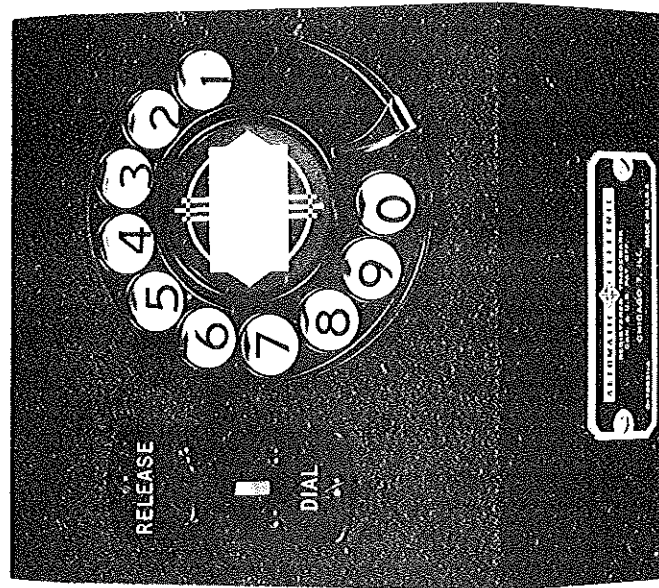
E. Conclusion

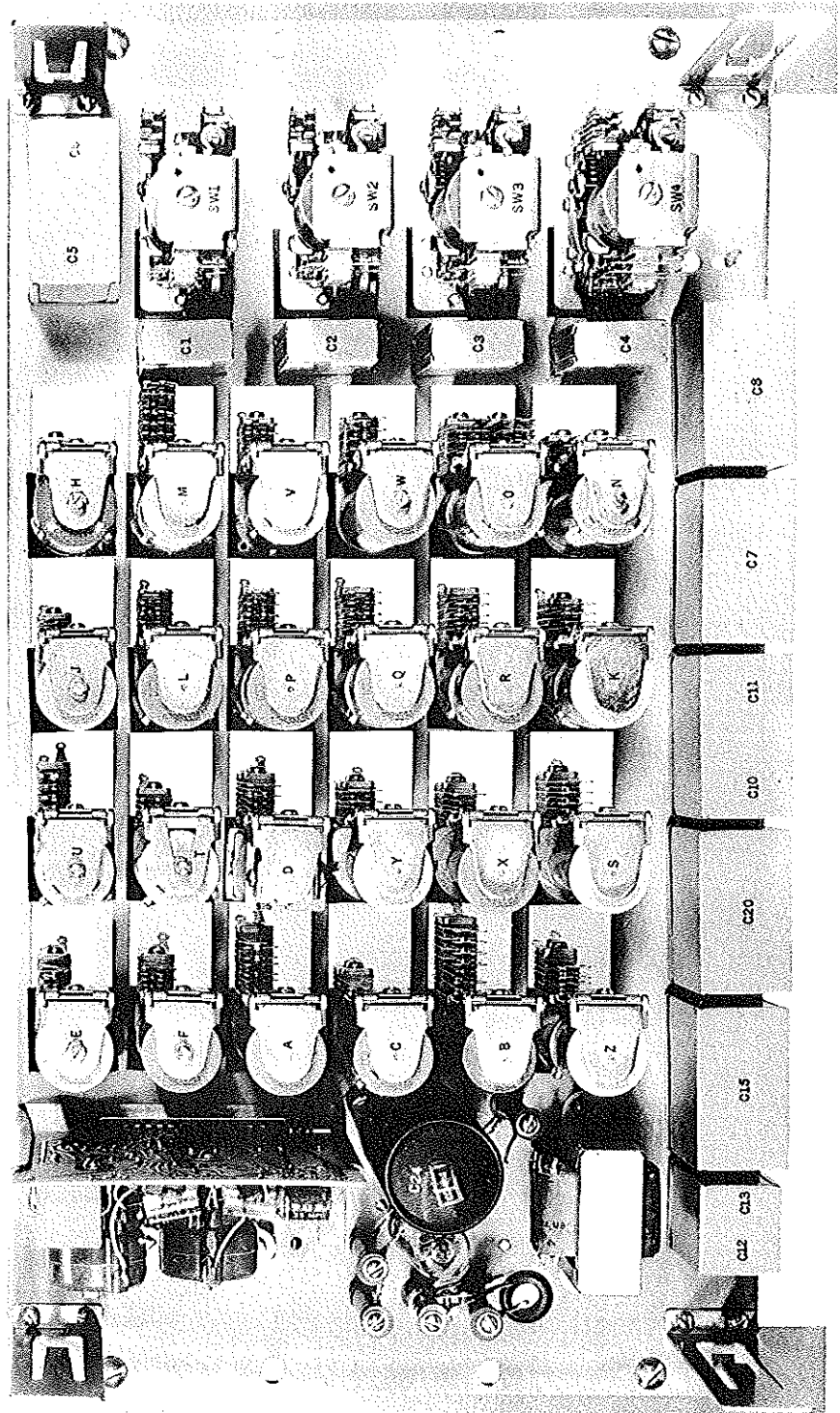
This waystation dialing system is the first satisfactory means of providing dialing facilities to existing railroad waystations. It does not require the use of the DC path for signalling which is so necessary

for present telegraph and teletype purposes. The present system follows a logical step because one can provide dial facilities and still keep some of the present equipment (selectors) in service. By changing to such a system a great outlay of money is not required.

Another advantage of this new system is that it permits dialing over almost any distance if the need arises. Use of tones for the signalling technique permits going through transformers and the like without special by-pass equipment. This system uses a waystation dialing unit whose power drain is limited to dialing time only. Also, the installation of this unit requires only connection to the line and battery.

This present system was designed for use on railroad waystation lines, however, there is no reason why it cannot be used for other services as well such as pipe lines etc. who use the type 60A selector or equivalent. The simplicity and economy of this system lends itself well to such systems.





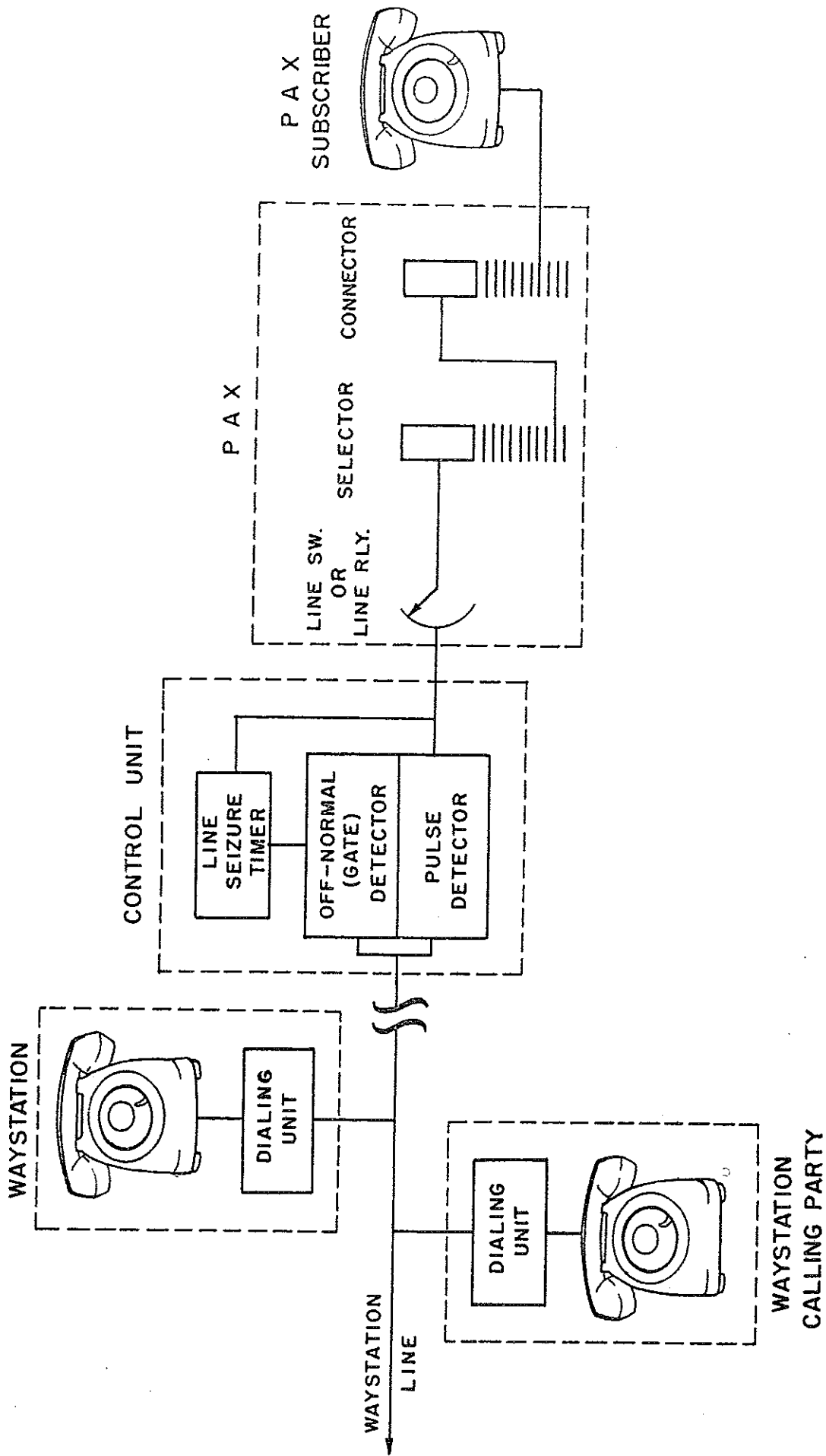


FIG. 3
WAYSTATION CALLS PAX SUBSCRIBER

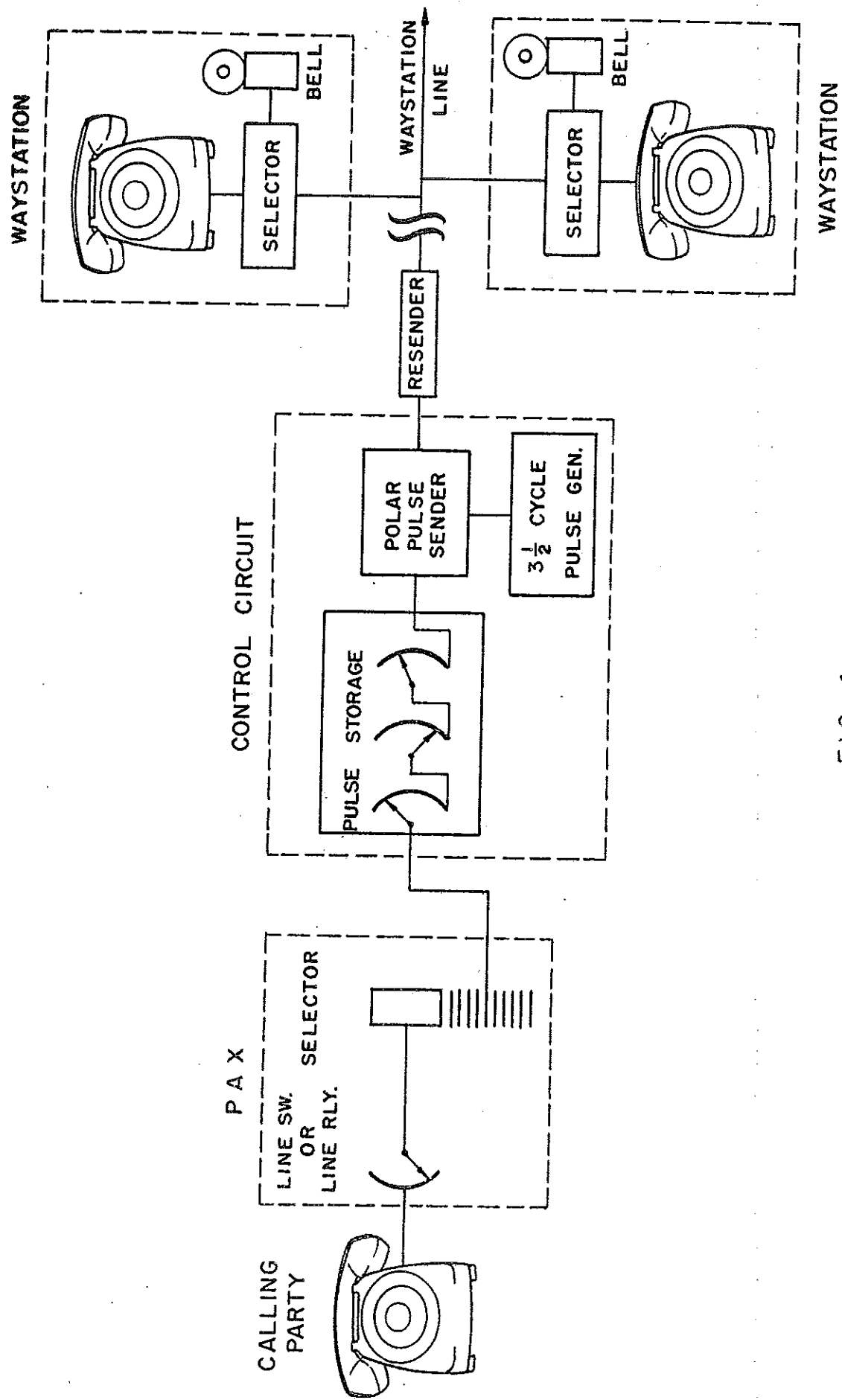


FIG. 4
P A X CALL TO WAYSTATION

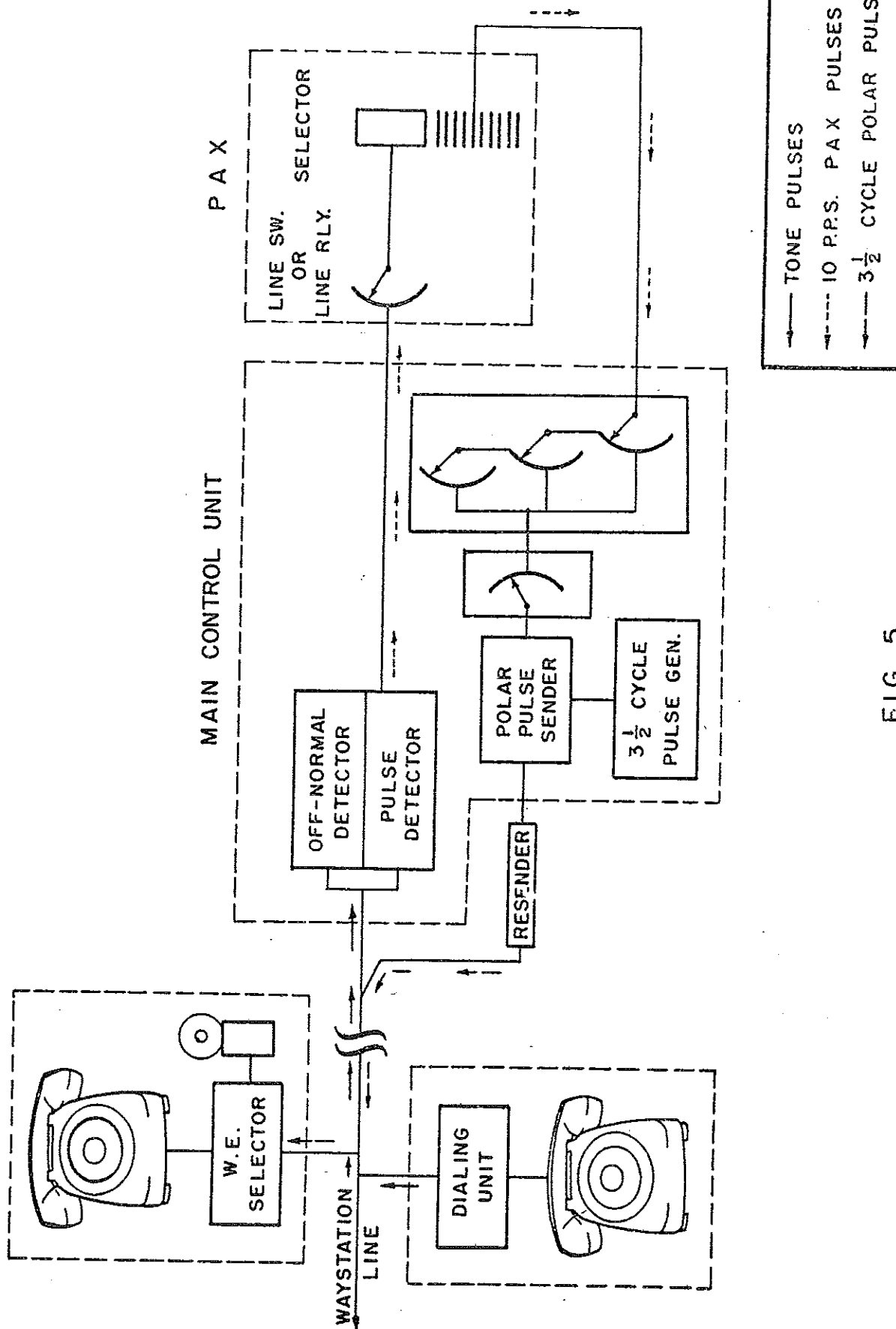


FIG. 5

WAYSTATION CALLS WAYSTATION ON SAME LINE

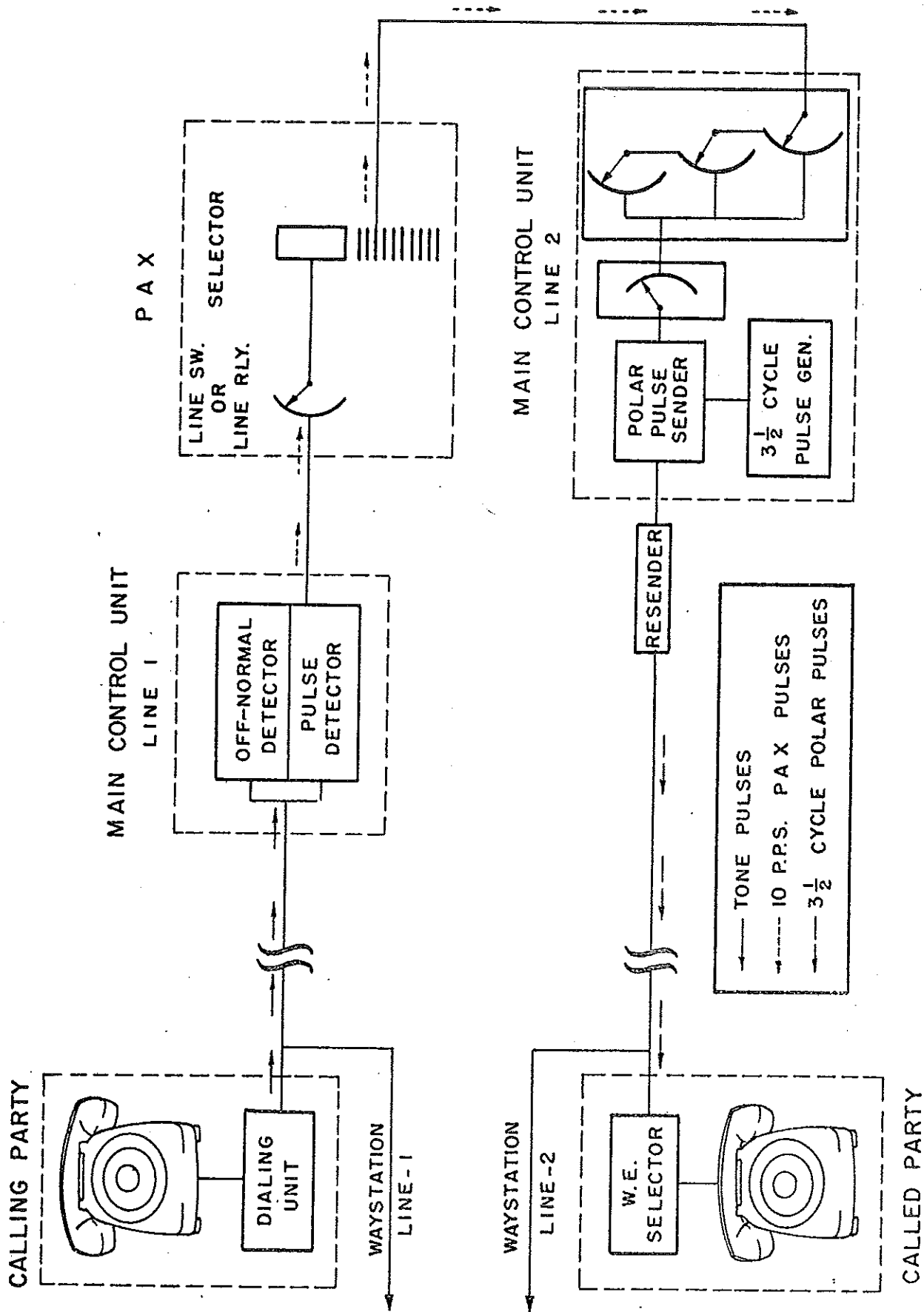


FIG. 6

WAYSTATION ON LINE ONE CALLS WAYSTATION ON LINE TWO

