LORAIN *Products Corporation*

SEMINAR MANUAL

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Design

LORAIN PRODUCTS CORPORATION LORAIN, OHIO

PREFACE . . . . .

The development, growth, and progress of man has been closely linked to the ability and means by which man is able to express and communicate ideas.

Every advancement in the art of communications has heralded a corresponding advancement in man's progress and growth.

The process of man's growth in developing and advancing the art of communications has been a lesson of historic achievement. This process is in motion today and is the challenge for all concerned with communications in the future.

Lorain Products Corporation has designed and manufactured a wide variety of communications power and signaling equipment since 1936.

This manual describes many types of signaling and power apparatus manufactured by Lorain Products Corporation under trade names, such as, SUB-CYCLE, FLOTROL, BAT-TAP AND LORAIN.

The people at Lorain Products Corporation are planning for the future, and at the same time, are designing and building signaling and power equipment needed for today's ever-expanding communications network. Lorain Products Corporation is proud to be able to do its part in filling this need.

LORAIN PRODUCTS CORPORATION

C. P. STOCKER, PRESIDENT

MULTI-FREQUENCY AC OPERATED RINGING EQUIPMENT
MODEL K5 **SUB-CYCLE** RINGING CONVERTER

The Decimonic Ringing System using the Model K5 SUB-CYCLE is a truly reliable selective ringing system using tuned bells. The Decimonic System derives its name from the 10 cycle spacing between the ringing frequencies, which are 20, 30, 40, 50 and 60 cycles. Freedom from cross-ring, elimination of frequency drift, and reduction of operating costs, are only a few of the advantages offered by this system.

The Model K5 SUB-CYCLE is inexpensive, operates from the 60 cycle power line, consumes little power, has no moving or expendable parts, requires no maintenance, and supplies dependable, regulated ringing voltage. The ringing frequencies are positively locked with the 60 cycle supply frequency, so that the bells when once set to the proper frequency, are always operated at their peak efficiency.

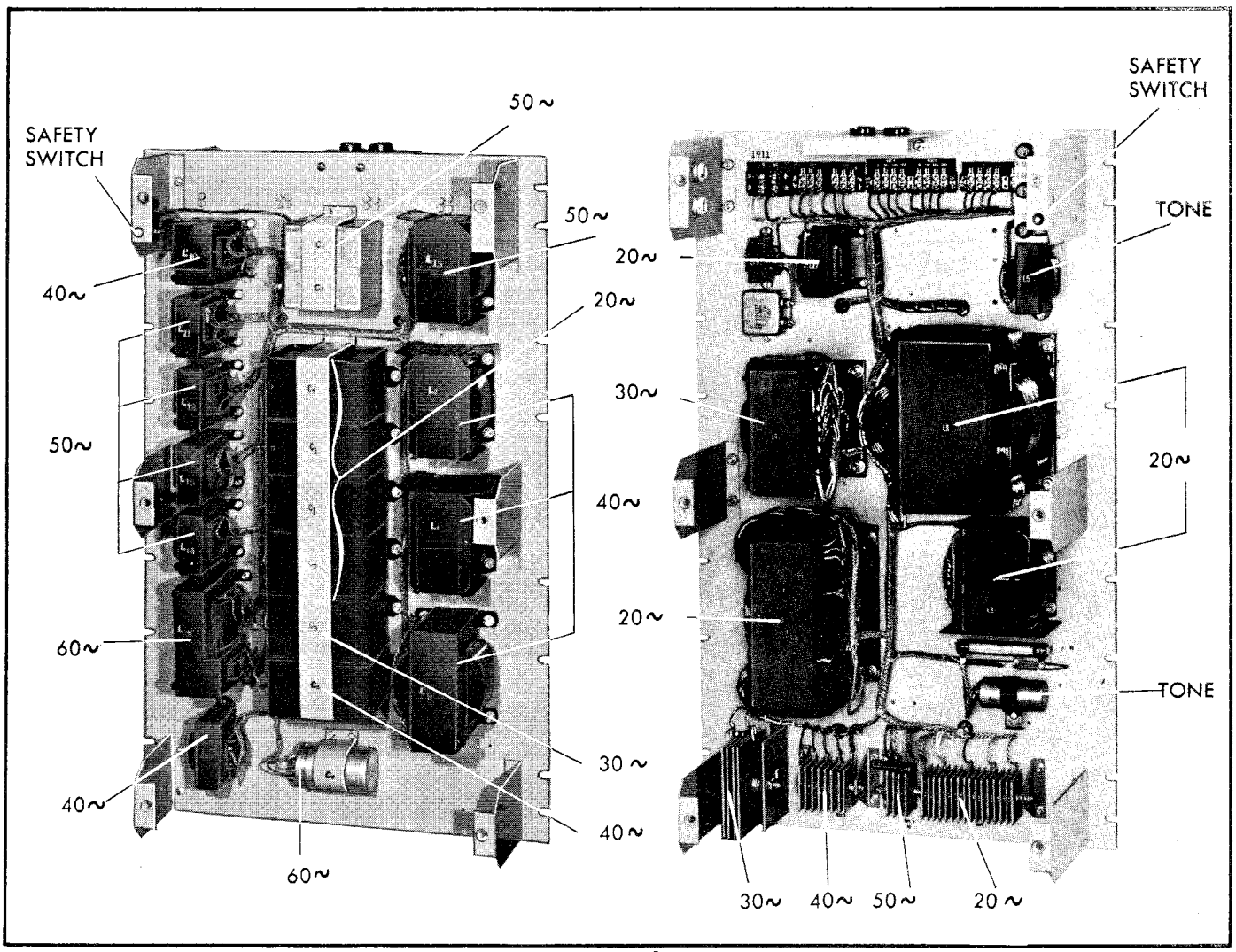


Fig. 1

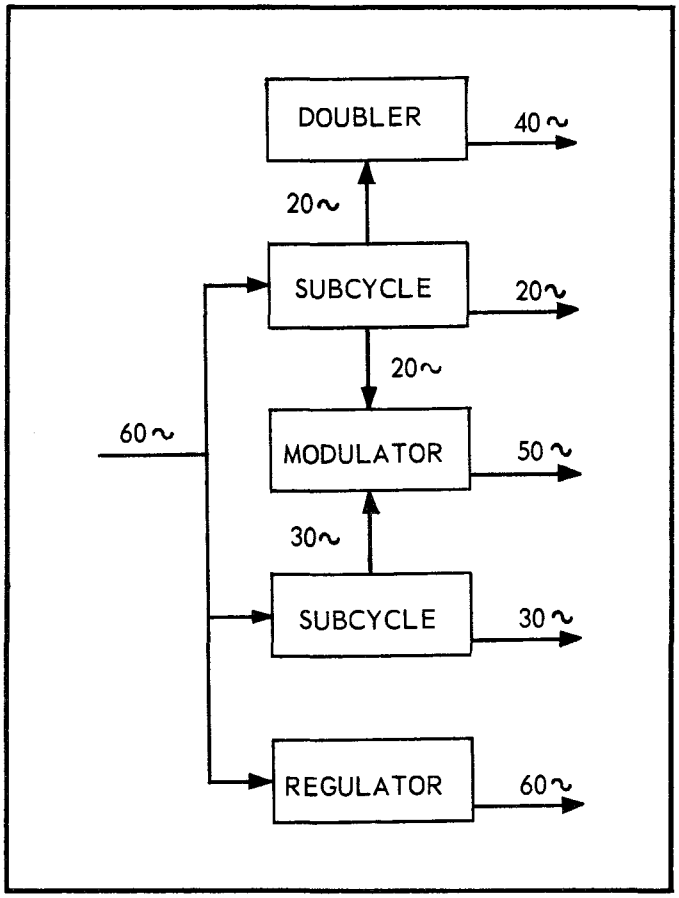


Fig. 2

The circuit components are mounted on the front and back sides of a steel panel which is provided with slots for rack mounting. The arrangement of parts can be seen on the inside Front and Rear Views of the Model K5, as shown in Fig. 1. The circuit elements, saturating transformers, resistors oil capacitors, and rectifiers are all of the highest quality and are operated conservatively to insure freedom from operating failures. The entire frequency conversion is accomplished by these elements and the circuit does not require a starting relay. The SUB-CYCLE can be operated satisfactorily on a start-stop basis if desired.

The K5 SUB-CYCLE was designed to meet the demand for a moderately priced static frequency generator to give 5 frequencies similar to the harmonic and synchromonic ringing systems. The unit is designed primarily for installations where a manual office is being replaced by a new system such as an automatic type of central office. However, some of the very earliest installations of the K5 SUB-CYCLE were conversion installations, that is, a synchromonic or harmonic system of ringing was replaced by the decimonic system of ringing. Where such a conversion is contemplated, it is recommended that the recommendations of the telephone manufacturing company supplying the bells should be followed in removing the old phones, readjusting the bells which will be retained and the purchase of new phones or bells.

The Model K5 SUB-CYCLE is applicable to both large and small systems. The unit has been used in installations of 100 lines and in larger installations of 2000 lines. This provides for ample growth of the exchange without purchasing additional ringing capacity.

Principle of Operation

The Model K5 SUB-CYCLE converts the 60 cycle input frequency to the five ringing frequencies in several stages. The method of frequency conversion is outlined in the block diagram shown in Fig. 2.

The 20 cycle and 30 cycle ringing voltages are obtained from self-starting frequency dividers operating directly on the 60 cycle line. The 60 cycle ringing voltage is obtained from a voltage regulator which also operates directly on the 60 cycle line. The 40 cycle ringing voltage is obtained from a frequency doubler which is energized from the 20 cycle generator, and the 50 cycle ringing voltage is obtained from a generator which operates from both the 20 cycle and 30 cycle frequencies, combining them to produce 50 cycles. From this outline it can be seen why the frequencies are absolutely fixed, since the frequency dividers (20 and 30 cycle generators) are locked to the 60 cycle supply frequency and can operate only on fixed ratios between their input and output frequencies. The 50 cycle generator can supply only the sum of the 20 and 30 cycle frequencies. Likewise, the 40 cycle frequency being obtained directly

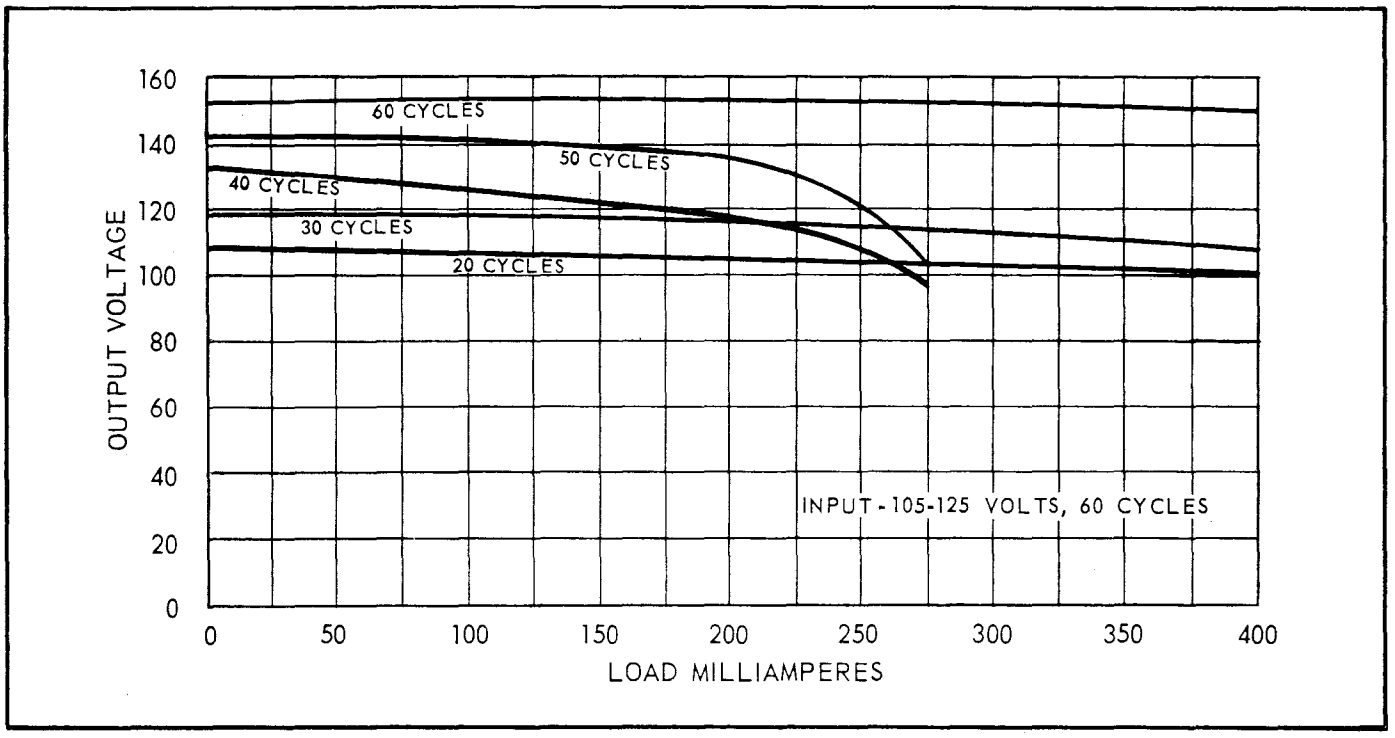


Fig. 3

from the 20 cycle generator cannot shift in frequency because the 20 cycles is locked to the 60-cycle supply frequency.

From the method of operation it can be understood why the Model K5 SUB-CYCLE provides a positive answer to the frequency stability problem, thereby eliminating trouble sometimes encountered in systems of selective ringing using tuned bells. In the K5 SUB-CYCLE each of the output frequencies is positively locked in a fixed ratio to the 60 cycle power frequency. This system becomes a distinct advantage to the operating man because there is no adjustment that can be made which will change the ringing frequencies. As long as ringing voltage is available, the frequency will be a fixed ratio of the 60 cycle input frequency. For example, should a momentary deviation in the 60 cycle supply frequency be as great as 1/2 cycle, the deviation in the 20 cycle frequency would be only 1/6 of a cycle. Obviously this would not cause any ringing difficulties.

Because of the freedom from frequency drift it is possible to operate all bells at their maximum efficiency. This eliminates the need for moving the bells closer together or otherwise adjusting the ringers in a manner which would tend to increase the probability of cross-ring. If a bell fails to ring, it simply means that the bell is out of adjustment because the converted frequency and voltage are fixed.

Other Features

As is well known the voltage regulation of the power supply plays an important part in eliminating the possibility of cross-ring, in multi-frequency ringing circuits. In any multi-frequency ringing system a high no load ringing voltage may cause cross-ring when the ringing generators are lightly loaded.

The Model K5 SUB-CYCLE provides excellent voltage regulation on each of the 5 ringing frequencies. The output voltage of each frequency is practically independent of variations in input voltage. Furthermore, the output voltage is practically constant from no load to full load. Typical regulation curves of the ringing voltages in the Model K5 SUB-CYCLE are shown in Fig. 3.

The power output of each frequency is conservatively rated at 0.200 amperes per output frequency. Because of the method of operation, the power output from the 5 frequencies is different. The maximum ringing power is available from the 60 cycle supply, then 30, 20, 40, and 50 cycles in that order. Because there is considerable ringing power available in the 30 cycle generator, we recommend that all straight line ringing be done from the 30 cycle generator. The output from the five frequencies is sufficient to supply ringing for offices up to approximately 2000 lines. By splitting the ringing load larger offices can be served.

The power consumed is approximately 175 watts at no load and with all frequencies operating at full load rating, the input is approximately 300 watts. Because the Model K5 SUB-CYCLE does not operate at unity power factor the input current under the full load conditions may reach a maximum value of 4.5 amperes. By way of comparison, the power consumed by the Model K5 SUB-CYCLE is approximately the same as the power required to operate a 1/4 horse power motor.

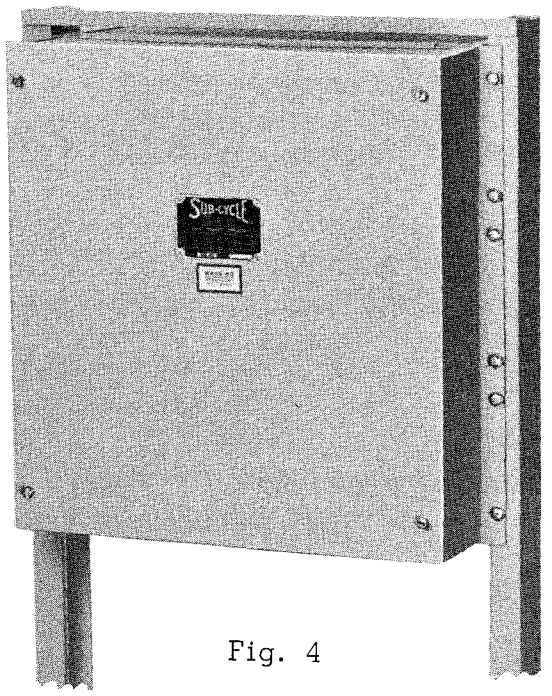


Fig. 4

The five Decimonic ringing frequencies used with tuned subscribers' bells provide selective ringing on party lines. Using metallic ringing, five-party fully selective or ten-party semi-selective ringing can be obtained. With a divided ringing circuit, fully selective ringing can be obtained on a ten-party line. The output windings of the K5 frequency generators are completely insulated from each other and from ground, so that maximum flexibility in the choice and arrangement of ringing circuits is assured.

When using divided ringing circuits, some care must be exercised where earth potentials are appreciable. Excessive 60 cycle earth potentials can produce cross-ring of the 60 cycle bells, although earth potentials up to 20 volts cause little ringing difficulty. Where earth potentials are a problem, the 60 cycle bells can be given the preference of location at the points of lowest earth potential.

The possibility of cross-ring in the decimonic ringing system when powered by the Model K5 SUB-CYCLE is eliminated because of two factors.

1. The harmonics are eliminated from the ringing voltages.

2. The ringing voltages are stepped, that is, the lowest frequencies require the lowest voltages. As the frequency increases, the ringing voltage is increased. In addition, voltage selection taps are provided so that a choice of output voltages can be obtained, as listed below. Voltages shown are nominal no-load values.

20 cycle	110	95	
30 cycle	120	105	
40 cycle	130	110	90
50 cycle	140	125	110
60 cycle	150	140	125

An analysis of the cross-ring problem indicates the possibility of cross-ring on

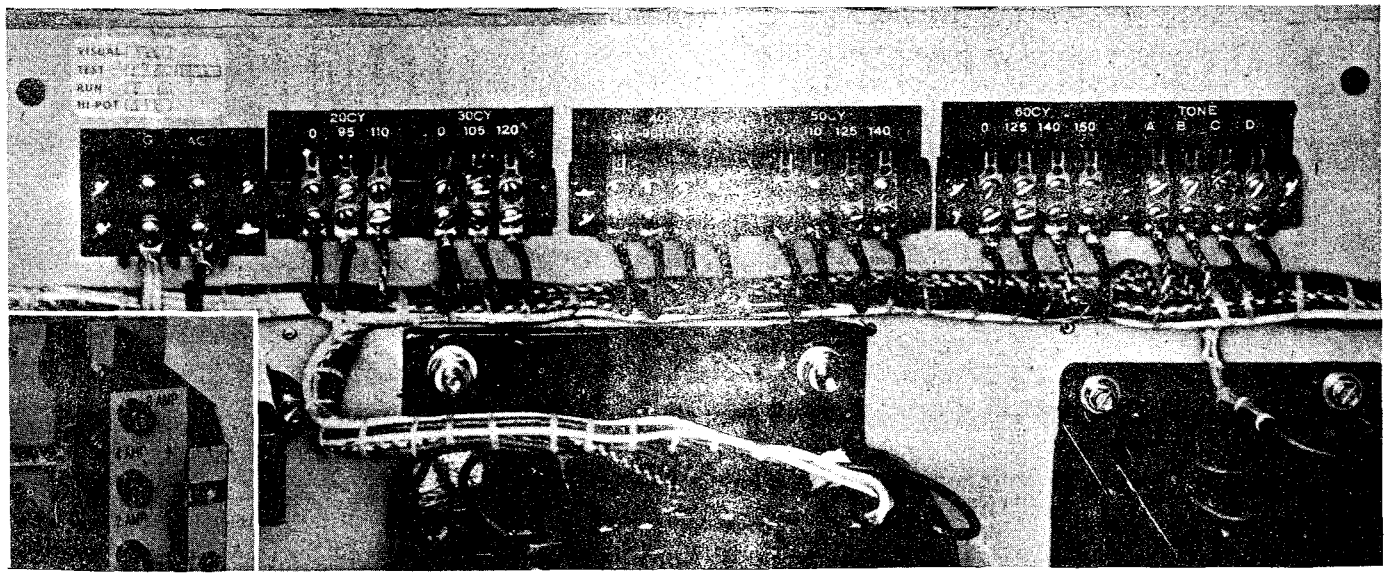


Fig. 5

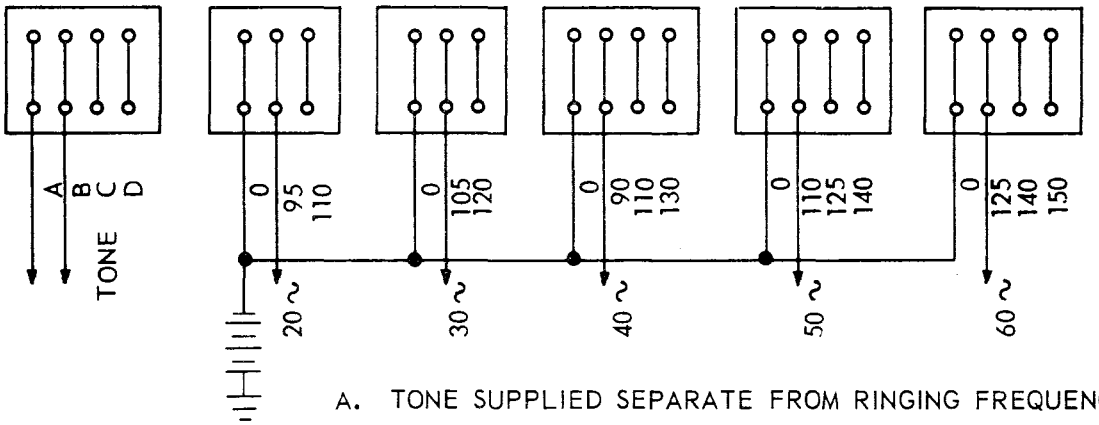
Fig. 6

the 40 and 60 cycles with respect to the 20 cycles. If the 20 cycles ringing voltage contained an even harmonic, the even harmonic might cause cross-ring on the 40 cycle bell. Likewise, an odd harmonic in the 20 cycle wave could adversely influence the 60 cycle bells. An even harmonic in the 30 cycle ringing voltage could cause interference with the 60 cycle bell. These factors were taken into account in the design of the Model K5 SUB-CYCLE so that the output voltages have smooth wave shapes, free from harmful high peaks of undesirable harmonics which might produce cross-ring or introduce noise into the telephone cables and talking circuits. The smooth wave shapes and regulated voltages are permanently maintained and do not depend upon the age of the machine or adjustment by the user. Therefore, it is reasonable to expect the K5 SUB-CYCLE to be free from cross-ring troubles during its entire life.

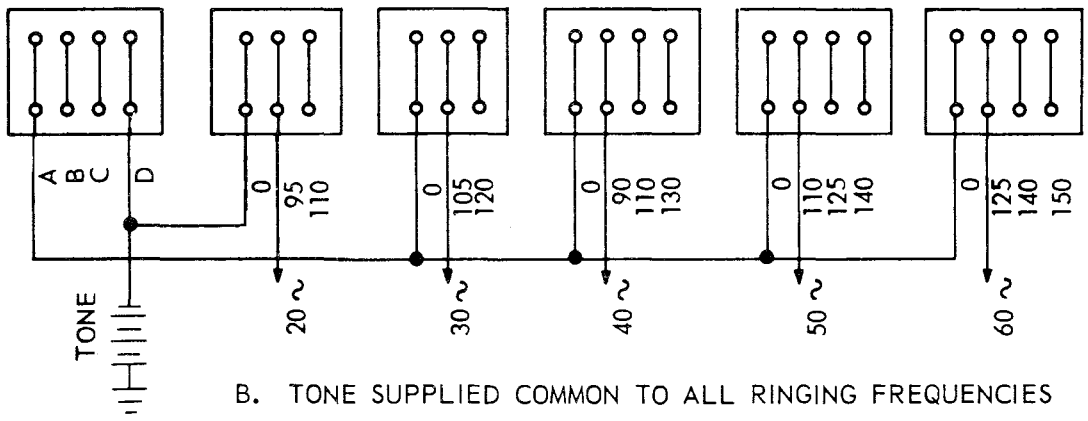
Because the various frequencies generated by the Model K5 are devoid of harmonics they are not capable of supplying reverting tone. Two terminals are therefore provided on the Model K5 which supply tone for use with any frequency. This method of supplying tone is standard practice with many telephone companies and should fit in with existing installations. The level of the tone is adjustable by means of taps on the tone generating transformer. The maximum voltage available is approximately 58 volts.

The subscribers' ringers in the frequencies of 20, 30, 40, 50, and 60 cycles can be obtained from most of the large telephone manufacturing companies. Where the Decimonic System is replacing a synchromonic or harmonic installation, the old bells usually can be returned or modified to operate on the Decimonic frequencies.

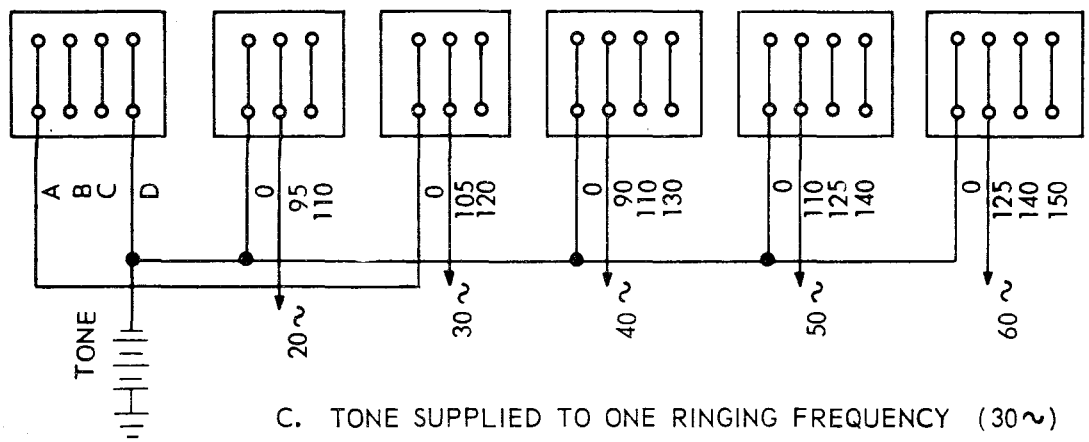
Because of the low power consumption requirements of the Model K5 SUB-CYCLE, it is recommended that the unit be operated continuously. However, where for some reason, continuous operation is undesirable, the K5 SUB-CYCLE lends itself to start-stop operation. It is, however, necessary to provide auxiliary relays for the start-stop operation feature. Although the K5 SUB-CYCLE does not require a warm up period before ringing voltage is available; the delay time between the application of power and the availability of full output voltage is in the order of 1 to 2 seconds depending upon the load and input voltage conditions. Unlike many other types of electrical devices, the Model K5 does not draw a heavy surge of starting current. This is a definite advantage because it contributes to the long life of the auxiliary starting relays mentioned above.



A. TONE SUPPLIED SEPARATE FROM RINGING FREQUENCIES



B. TONE SUPPLIED COMMON TO ALL RINGING FREQUENCIES



C. TONE SUPPLIED TO ONE RINGING FREQUENCY (30~)

Fig. 7

The K5 SUB-CYCLE is made in two different styles, in order to be adaptable to either 19 inch or 23 inch rack mounting. The K5-19 SUB-CYCLE is designed to mount on a standard 19 inch relay rack and is shown in Fig. 1. The K5-23 SUB-CYCLE is designed to mount on a standard 23 inch relay rack and is shown in Fig. 4, mounted in a 119E rack.

In installations where only 4 ringing frequencies are required, the Model K4 SUB-CYCLE may be used. The K4 SUB-CYCLE is exactly the same as the K5 except that the 60 cycle regulator is omitted.

The four ringing frequencies are then 20, 30, 40 and 50 cycles.

Installation

The input power line to the SUB-CYCLE should be heavier than normally required to carry the 4.5 amperes current in order to minimize the resistance in this circuit. The total loop resistance in the input power line should not exceed 0.6 ohms.

The a-c input to the SUB-CYCLE is provided with three fuses, an 8 amp fuse which is in the input to the 20 cycle converter, a 4 amp fuse which is in the input to the 30 cycle converter and a 2 amp fuse which is in the input to the 60 cycle regulator. These fuses will not blow from overloading the output of the SUB-CYCLE and they should not require replacement unless a line surge or a trouble condition occurs. The input connections and fuses of the Model K5 SUB-CYCLE converter are shown in Fig. 5.

The output ringing and tone voltages are supplied from completely separate transformer windings so that any of the ringing circuits may be grounded as required or some of them may be grounded and others left ungrounded. Output connection terminals are shown in Fig. 6.

Because of the smooth wave shape delivered by the Model K5 SUB-CYCLE, there is insufficient audible tone in the ringing voltage to provide the ringing tone. This tone is supplied from a separate circuit and brought out to the terminals marked "Tone". The level of this voltage is adjustable and may be changed as desired by changing the taps as noted on the wiring diagram. This tone may be used with ringing frequencies of 30, 40, 50 and 60 cycles. The 20 cycle ringing voltage has superimposed on it a high frequency reverting tone voltage designed to transmit through carrier telephone systems. Output connection diagrams are shown in Fig. 7.

The Model K5 SUB-CYCLE delivers the no load output voltages listed above for the various frequencies. These voltages are regulated and do not change noticeably with changing a-c input voltage. Some voltage drop may occur when a heavy ringing load is encountered but in general the output voltages remain very nearly constant. Although the output rating of each of the frequencies is given as 0.20 amperes, the power actually available is considerably more on some of the frequencies. The power available at 60 cycles is the greatest, that at 30 cycles next and the power at 20 cycles next greatest. The power available at 40 cycles or 50 cycles is only slightly in excess of the rated output and it is recommended that either the 30 cycle or 20 cycle frequency be used for straight line ringing.

The Model K5 SUB-CYCLE is designed to operate continuously, year after year without readjustment. There is no way that the output frequency can change except as a result of a change in the 60 cycle line frequency. The Model K5 SUB-CYCLE may also be operated on a start-stop or intermittent basis without damage to any of the circuit elements. There are no relays or other movable parts in the Model K5 SUB-CYCLE.

The circuit diagram which is supplied with the machine, see Fig. 8, shows the color code of the wiring and the general location of the terminals on the various units. The units L1, L2, L3, L17, L19, C1, C2, C9, R1 and rectifier 1 are all part of the 20 cycle output. The units L6, L7, L8, L9, L10, C5 and rectifier 4 are part of the 40 cycle circuit which operates from the output of the 20 cycle converter and supplies the 40 cycle ringing current. The units L4, L5, C3, C4 and rectifier 2 are the 30 cycle elements which operate from the 60 cycle line and generate 30 cycle ringing current. The units L11, L12, L13, L14, L15, C6, C7 and rectifier 3 are in the 50 cycle circuit which operates from

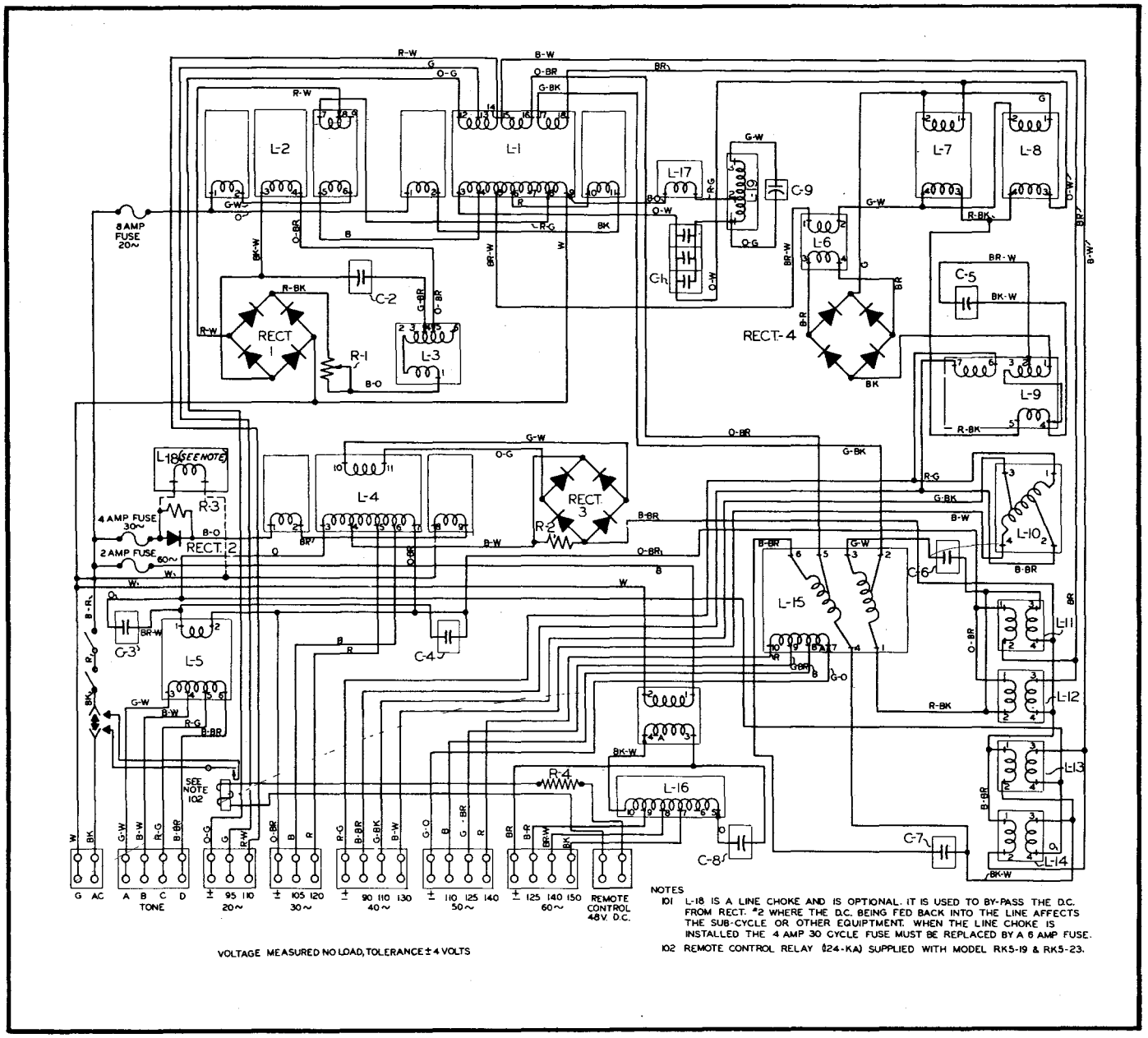


Fig. 8

the outputs of both the 30 cycle and 20 cycle generators and supplies 50 cycle ringing current. The units L16 and C8 comprise a 60 cycle voltage regulator which maintains a constant 60 cycle ringing voltage across the 60 cycle output terminals.

The input voltage range over which the Model K5 SUB-CYCLE is designed to operate is 105-125 volts, 60 cycles, it will operate when the input voltage is outside of this range but if the voltage is appreciably less than 105 volts some difficulty may be experienced when heavy loads are applied. With input voltages above 125 volts, the transformers may run at a somewhat higher temperature and the output voltages and wave shapes may depart somewhat from their standard values.

In case any trouble is encountered in the operation of the Model K5 SUB-CYCLE write the factory describing the operating conditions in detail, and stating the serial no. of the SUB-CYCLE.