

**STROMBERG-CARLSON TELEPHONE MFG. CO.**

**ROCHESTER, N.Y. CHICAGO, ILL.  
KANSAS CITY, MO. TORONTO, ONT.**

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EDITION FB

## **Exchange Ringing Equipment**

**Pole Changers · Generators · Motor Generator Sets  
Harmonic Converters**



## Exchange Ringing Equipment

A standard polarized telephone ringer operates satisfactorily when alternating current, having a frequency of 15 to 35 cycles and a potential of 60 to 100 volts, is applied to its terminals. To generate such current for signalling purposes local battery type telephones are equipped with a hand generator wound and geared to deliver electric current at the proper voltage and frequency, when the generator crank is turned at a normal rate of speed. Hand generators are also used for small switchboards but cannot be used to advantage for larger equipments because the continual cranking necessitated by the increased number of calls would soon tire the operator and impede the service. It is therefore necessary to use ringing current generated by some one of the following methods.

Ringing current for telephone exchanges can be generated by any of the following equipments, all of which are thoroughly practical.

### For Straight Ringing Systems

- (a) Pole Changer Type Converter deriving its source of power from a battery consisting of either dry or storage cells. Page 2
- (b) Direct Ringing Vibrator Converter for use where commercial 60 cycle alternating current circuits are available. This apparatus reduces the frequency of the current from 60 to 16 or 20 cycles and the voltage from 110 to 90 or 100 volts. Page 4
- (c) Power Generator consisting of a magneto type alternating current generator equipped with a pulley for belt connection to a water-meter, gas engine, line shaft or other rotary machinery. Page 6
- (d) Direct Ringing Satic Transformer for use in connection with 25 cycle alternating current power circuits. A transformer which steps down the line voltage to 90 or 100 volts, the frequency remaining unchanged. Page 5
- (e) Ringing Motor-Generator Set for use where either alternating or direct current power circuits are available. Apparatus consists of a motor of proper type direct connected to an alternating ringing current generator and mounted on a common base. Page 6

### For Harmonic Ringing Systems

When the harmonic system of party line ringing is employed the selection of the various stations on the lines is accomplished by the use of currents of different frequencies, usually 16-2/3, 33, 50 and 66-2/3 cycles. These may be generated in either of the following ways.

- (f) Harmonic Converter operating from either dry or storage cell battery, preferably the latter. Page 8
- (g) Composite Multi-cycle Motor-Generator Set operating from either direct or alternating current power circuits and delivering ringing currents at the four standard voltages and frequencies. Page 13

Pulsating positive and negative direct currents for selective party line systems using "biased" ringers can be generated by means of any of the equipments "a", "b", "c", and "e" when special attachments are used.

## Ringing Equipment

**No. 1 Pole Changer Type Converter**

This apparatus provides a simple, efficient and self-contained ringing equipment for exchanges serving 500 to 2000 subscribers depending upon whether dry or storage batteries are used. It consists of an electrically driven vibrator which carries contact springs arranged to reverse a 24 volt direct current from 16 to 20 times per second thus giving a 24 volt alternating current at a frequency of 16 to 20 cycles depending upon the adjustments. The alternating current obtained in this manner is put through a transformer which is also included in the equipment and stepped up to approximately 90 volts. This completes the transformation and the current is delivered to the ringing current terminals of the pole changer at the proper voltage and frequency. The primary current for the operation of the pole changer can be supplied by a battery of 36 dry cells connected in multiple-series with 18 cells per series or by 11 storage cells. The battery is also used for operating the vibrating element.

The complete equipment is contained within a well-built cabinet which occupies a space 12 inches x 12 inches and stands 14½ inches high. It is provided with a hinged cover and a dust-proof glass top compartment



**Fig. 1—No. 1 Pole Changer Converter with cover raised**

for vibrator, as shown in the accompanying illustrations. The operation of the vibrator can be readily observed without opening the cabinet. The vibrators and transformers used in pole changers of this type are the same as those used in our famous harmonic converters in which the ringing current voltages and frequencies must be very accurately defined, therefore the same degree of constant high efficiency may be expected from this equipment. All parts of the vibrator are mounted upon a heavy slate base which maintains a high insulation between parts having different potentials and also prevents loss of adjustment due to moisture and temperature changes. A close-up view of the vibrator is shown in Fig. 9

When operated with dry cells, special contacts and a starting relay are included in the equipment. These conserve the energy of the dry cells as the vibrator operates only



**Fig. 2—No. 1 Pole Changer Type Converter closed for operation**

during the ringing period, or in other words while the operator is actually holding a ringing key in its ringing position.

The specifications for our standard pole changer outfits are as follows:



Fig. 3—Showing transformer compartment of No. 1 Pole Changer Type Converter

#### **No. 1-A Converter—Single Frequency Type**

Standard frequency 16 cycles. Consists of 1 Vibrator and 1 Transformer with associated equipment mounted in cabinet. This pole changer is adaptable for either Dry or Storage battery operation.

#### **No. 1-B Converter—Single Frequency Type**

Standard frequency 20 cycles. Consists of 1 Vibrator and 1 Transformer with associated equipment mounted in cabinet. This pole changer is adaptable for either dry or storage battery operation.

We are also prepared to furnish pole changers equipped to deliver frequencies other than 16-20 cycles for special purposes. Prices applying to such equipments will be furnished upon application. In placing orders for pole changers please specify the frequency of the ringing current desired and whether the equipment is to operate from dry or storage battery.

Shipping weight of pole changer approximately 50 pounds. Size of packing case 14" x 14" x 17".

## Ringing Equipment

## Direct Ringing Vibrator Converter

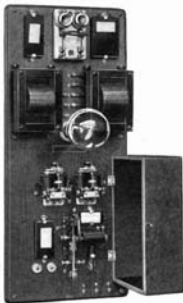
This equipment is designed to operate in direct connection with 110 volt alternating current circuits having the commercial frequency of 60 cycles. The converter changes the frequency of the current from 60 cycles to 16 or 20 cycles and reduces the voltage to the proper value for telephone ringers, viz; 90 or 100 volts.

The operation of the converter is quite simple. The 60 cycle alternating current is first changed to direct current by means of two vibrating rectifiers. This rectified current is, in turn, changed to a 20 cycle alternating current by a pole-changing element and sent through a transformer which delivers the alternating current at 90 volts and 20 cycles. Terminals are also furnished for the delivery of 100 volts—20 cycle current. The pole changer element is provided with extra weights for the vibrator so that the frequency can be decreased to 16 cycles per second, if desired.

All of the apparatus is mounted upon a substantial oak backboard with a glass covered dustproof housing over the vibrators which also serves to deaden the slight humming sound when the converter is in operation. The complete converter occupies a wall space 29 x 12 inches and projects 5¼ inches from the wall, exclusive of the lamp. The control switch, the double-pole fuse block with ½ ampere plug fuses and power circuit terminals are located at the top of the backboard. A stand-

**Fig. 4—Direct Converter, closed** Tungsten lamp serves as resistance to protect the converter against short-circuits and overloads. When three or more operators positions are served by the converter a lamp of higher wattage should be used in place of the standard lamp. The ringing current terminals are at the lower end of the backboard and are plainly marked to facilitate proper connections.

The contacts used in this converter are all interchangeable and are made of a very hard contact metal which wears exceedingly well and will operate a long time without attention. Practically the only attention they require is occasional cleaning of contact surfaces with fine emery cloth or a fine-grained file. The converter requires only 10 watts per hour for its operation—about half that required for an ordinary size electric lamp. The total power cost per month ranges from 18 to 86 cents depending upon the hours of service and the cost of the power.



No. 5—Direct Converter, open

### Standard Direct Ringing Vibrator Converters

- No. 7-A Converter furnishes 20 cycle alternating current for straight line ringing. Operates from 110 volt—60 cycle power or lighting circuit.
- No. 8-A Converter furnishes 20 cycle alternating current for straight line ringing and positive and negative pulsating currents for biased ringer selective party line signalling. Same as No. 7-A but equipped with extra vibrator springs and additional terminals at the lower end of the backboard. Shipping weight, approximately 80 pounds.

## Direct Ringing Static Converter

Where 110 or 220 volt, 25 cycle alternating current power or lighting service is available this direct ringing transformer outfit will answer the requirements of small exchanges in which straight alternating ringing systems are used exclusively.

The direct ringing converter consists of an oak backboard upon which are mounted a combination fuse block and knife switch and a 25 cycle transformer. The transformer takes current from the power mains at its rated voltage of either 110 or 220 volts and reduces its potential to approximately 90 volts which is sufficiently high for ringing purposes. The knife switch provides a convenient means of disconnecting the source of power and the fuse block protects the equipment from damage resulting from overloading a short circuit.

The operating expense of this outfit is very low as it consumes current only when the operator is ringing on a line—the no-load current is not sufficient to start the electric meter. There are no moving parts and since there is no wear there is no maintenance expense.

Direct ringing converters are simple to install. To place the equipment in operation it is only necessary to connect the lighting circuit to the fuse terminals and the ringing leads from the switchboard to two of the lower terminals.

Ringing equipment of this type is furnished for two standard voltages as follows:

No. 5-A Converter for operation from 110 volt-25 cycle circuits.

No. 5-B Converter for operation from 220 volt-25 cycle circuits.

Mounting space 12 inches x 7½ inches. Shipping weight approximately 20 pounds.

Direct ringing converters can not be supplied for frequencies other than 25 cycles nor can they be supplied with pulsating current attachments.

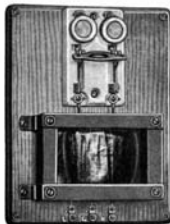


Fig. 6—Direct Ringing Static Converter

## Ringing Equipment

## Power Generators



Fig. 7—Type M. S. Generator

We supply power generators for use in exchanges of any size up to and including 1,800 subscribers. These are fitted with pulleys so that they may be driven by a belt from some source of mechanical power. If electric power is available the motor-driven sets of types shown on page 7 or the direct ringing vibrator converters on Page 4 should be used.

## Type M. S. 1 Power Generator

The type M.S. power generator illustrated by Fig. 7 is made in three sizes. The smallest size, the M.S. 1 will furnish power sufficient for the operation of 50—1600 ohm bells simultaneously and is, therefore, capable of supplying power for exchanges of from 100 to 500 subscribers. The M.S. 2 has a larger current output and will supply power for exchanges of from 500 to 1000 subscribers. The M.S. 3, which is the largest of this type, will care for exchanges of 1500 subscribers very satisfactorily. The magnets used in this type of generator are made of Tungsten steel to insure permanent field strength. The shaft and bearings are substantially built and the lubrication system is such that the machine may be kept in constant service without attention other than occasional oiling. In order to develop their full rated outputs at the proper frequency and voltage generators of this type must be driven at their normal speed, viz; 1150 revolutions per minute.

## Standard Generators

Gen. No.	No. of Bars	Cycles	Watt Output	Shipping Weights
MS1	6	19	7	35 lbs.
MS2	8	19	11	45 lbs.
MS3	12	19	15	50 lbs.

Equipment includes 2½-inch pulley with 1⅛-inch crown face.

Prices on power generators with pulsating current attachment will be quoted upon application. These generators can be furnished with belt tightening sub-base and with pulsating current attachment for biased ringer selective signalling systems.

## Ringing Motor-Generator Sets

A motor-generator set consists of a motor direct connected by means of a shaft and coupling to a generator mounted on a common base. A motor-generator set is most suitable for use in exchanges where direct current power circuits are available and is an alternate method of converting alternating current at power circuit voltages and frequencies to ringing current voltages and frequencies. We list combinations that will operate on direct current circuits of 115 or 230 volts, also upon 110 or 220 volts, 60 cycle, single phase alternating current circuits, these being the more common kinds of electric service. Motor-generator sets for operation on currents of other frequencies, voltages and number of phases can be supplied but are special. Prices on such sets will be furnished upon application.

## Ringing Equipment

As shown in the illustration the equipment is mounted on a heavy slate base which insulates the machine from any grounds. The slate base is in turn mounted upon a wood sub-base which not only protects the slate from cracking but also serves as additional

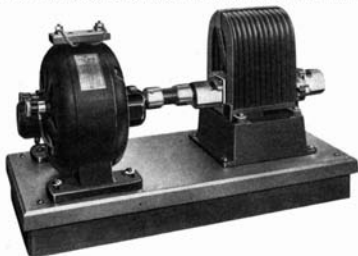


Fig. 8 - Ringing Motor-Generator Set

insulation. The motor and generator are connected by a flexible spring coupling made up of two springs wound in opposite directions. This coupling steadies the load on the motor and prevents any undue wearing of the bearings on either motor or generator, if the alignment is not exactly correct. Both machines are fitted with long bearings which are lubricated by a ring oiling system which automatically furnishes a film of oil at each bearing. The motor is equipped with two line terminals on the top of the frame and does not require a rheostat or other starting device except a plain knife or snap switch.

The generator is of the permanent field (magneto) type with Tungsten steel magnets to insure a constant field of maximum strength. Three sizes of generators all having the small general construction are furnished to meet the various operating requirements. When rotated at the normal motor speed, viz: 1150 R.P.M. they generate alternating current for straight ringing at 80 volts and 19 cycles. The MS1 generator is suitable for 500-subscriber exchanges, MS2 for 1000-subscriber exchanges and the MS3 for 1500-subscriber exchanges.

## Standard Motor-Generators

Motor	Gen.	Watt Output	Motor Cycles	Motor Volts	Shipping Weights
H.D. 18	M.S. 1	7	.....	115 D.C.	85 lbs.
H.D. 18	M.S. 1	7	.....	230 D.C.	85 lbs.
H.D. 18	M.S. 2	11	.....	115 D.C.	100 lbs.
H.D. 18	M.S. 2	11	.....	230 D.C.	100 lbs.
H.D. 18	M.S. 3	15	.....	115 D.C.	110 lbs.
H.D. 18	M.S. 3	15	.....	230 D.C.	110 lbs.
H.S. 18	M.S. 1	7	60	110 A.C.	85 lbs.
H.S. 18	M.S. 1	7	60	220 A.C.	85 lbs.
H.S. 18	M.S. 2	11	60	110 A.C.	100 lbs.
H.S. 18	M.S. 2	11	60	220 A.C.	100 lbs.
H.S. 18	M.S. 3	15	60	110 A.C.	110 lbs.
H.S. 18	M.S. 3	15	60	220 A.C.	110 lbs.

Mounting space 22 x 10 inches



Ringin~~g~~ Equipment

## Harmonic Converters

The function of the Harmonic Converter is to transform direct current at a potential of 24 volts into four separate and distinct ringing currents at the constant frequencies and voltages required by our harmonic party line signalling system. The standard voltages and frequencies delivered by the converters are as follows:

For	Frequency	Potential
1st Party	33- $\frac{1}{3}$ Cycles	105-110 Volts
2nd Party	50 Cycles	125-130 Volts
3rd Party	66- $\frac{2}{3}$ Cycles	135-145 Volts
4th Party	16- $\frac{2}{3}$ Cycles	80-88 Volts

These voltages and frequencies are accurately maintained and with wave forms closely approximating a sine wave without attention other than routine inspections and proper care of the operating batteries.

The converter is a development of the pole changer principle in that the reversing of the current at the required number of times per second is accomplished by means of an electromagnetically driven vibrator carrying the necessary contact points. Each vibrator in our converter is tuned and adjusted to a single rate of vibration by means of carefully machined reed springs and pendulum weights so that the resultant current frequency is constant while the converter is in operation. Fig. 9 shows the general arrangement of the vibrator unit. All parts of the vibrator are assembled upon a heavy slate base so that temperature changes or moisture cannot affect the alignment of the parts and their adjustment for correct operation. The contact points are made of a special hard contact metal which stands up under continuous operation. Our arrangement of condensers eliminates sparking at the contacts under the heaviest loads and assists in the maintenance of the specified secondary voltages and frequencies.

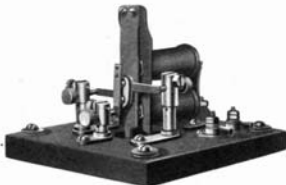


Fig. 9—Harmonic Converter Vibrator

The alternating currents established by each vibrator in the converter are stepped up to the proper voltages for ringing purposes by individual transformers which are accurately designed for most efficient operation at their rated frequencies. The transformers are enclosed within cast iron cases and are filled with an insulating and moisture proofing compound. The wiring between the vibrators and the transformers and to the terminal board is carried in a neatly formed cable made up of highly insulated rubber covered wires. All terminals are plainly marked with stamped letters to avoid improper connections when the equipment is installed.

All of the equipment is mounted within an oak cabinet which is handsomely finished in dull golden oak. The cabinet occupies a floor space 18 $\frac{1}{2}$  inches x 31 $\frac{1}{2}$  inches and stands 38 inches high. A removable front panel affords access to the transformer condenser and battery compartments and a removable glass-topped cover allows convenient inspection of the working parts and protects them from dust.



Fig. 10—Harmonic Converter, Open

Harmonic Converters are made in two general types, one for use when a 24 volt storage battery is available and the other for operation from dry cells. The vibrators and transformers are the same in both types and are suitable for all exchanges up to 10,000 lines capacity. The dry battery type converter is provided with a starting relay which is wired in the circuit so that the vibrators will remain idle when there is no demand for ringing current. The relay is operated by means of special contacts on our standard master or individual types of party line ringing keys.

#### No. 2-A Harmonic Converter—4-Frequency Type

Standard frequencies  $16\frac{2}{3}$ ,  $33\frac{1}{3}$ , 50,  $66\frac{2}{3}$  Cycles. Consists of 4 Vibrators and 4 Transformers with associated equipment mounted in cabinet. Wired and equipped for *storage battery operation only*. Shipping weight approximately 450 pounds.

#### No. 4-A Harmonic Converter—4-Frequency Dry Cell Type

Standard frequencies  $16\frac{2}{3}$ ,  $33\frac{1}{3}$ , 50,  $66\frac{2}{3}$  Cycles. Consists of 4 Vibrators and 4 Transformers, dry battery trays for 72 Dry Cells, and starting relay and all mounted within the cabinet. Shipping weight with dry cells approximately 450 pounds.

#### No. 3-A Harmonic Converter—Duplicate 4-Frequency Type

Standard frequencies  $16\frac{2}{3}$ ,  $33\frac{1}{3}$ , 50,  $66\frac{2}{3}$  Cycles. Consists of 8 Vibrators and 8 Transformers with associated equipment mounted within the cabinet. *For storage battery operation only*. Shipping weight approximately 500 pounds.

Ringin<sup>g</sup> Equipment



Fig. 11—Harmonic Converter, Closed

**No. 2-B Harmonic Converter Synchronomic Type**

Standard frequencies 30-42-54-66- $7\frac{1}{2}$  Cycles. Consists of 4 Vibrators and 4 Transformers with associated equipment mounted within the cabinet. *For storage battery operation only.* Shipping weight approximately 450 pounds.

**No. 3-B Harmonic Converter Duplicate Synchronomic Type**

Standard frequencies 30-42-54-66- $7\frac{1}{2}$  Cycles. Consists of 8 Vibrators and 8 Transformers, with associated equipment mounted in the cabinet. *For storage battery operation only.* Shipping weight approximately 500 pounds.

**No. 4-B Harmonic Converter Synchronomic Dry Cell Type**

Standard frequencies 30-42-54-66- $\frac{3}{4}$  Cycles. Consists of 4 Vibrators and 4 Transformers, dry battery trays and starting relay, all mounted in the cabinet. Shipping weight approximately 450 pounds.

**Noise Killer Equipment**

Where converters operate from an 11-cell "Central Energy" exchange storage battery it is necessary to install a No. 18 Impedance Coil in the battery leads and to connect a set of 10-cells of "floating" storage battery across these leads in order to eliminate the possibility of noise in the switchboard talking circuits while the converter is in operation. This auxiliary battery acts as a condenser of very large capacity and also prevents surging of the vibrators due to loading or variations in the potential of the main battery. When the main storage battery consists of 20 or 22 cells a tap is taken off including 11 cells so as to obtain the 24 volts necessary for the operation of the converter. The "noise killer" equipment and wiring is the same as for 11 cell main battery. The No. 18 Impedance Coil is mounted on the exchange power board or on the No. 1-N or No. 1 NT Converter Control Panel, when these panels are ordered with impedance coils. The

advantage of this arrangement is that only one impedance coil and "noise killer" battery is used with either one or two sets of central office batteries and with one or two Harmonic Converters.

Another method of connecting the 24 volt Harmonic Converter to the main battery when the latter consists of 20 to 22 cells is to "float" a small 11-cell (P.T. Type) converter storage battery across the leads of the main storage battery with sufficient series resistance to allow the smaller battery to get a gradual charge of approximately 1 ampere, depending upon the amount of converter service. Then the Harmonic Converter can be connected directly to the terminals of the small 11-cell battery in which the voltage remains uniform. This method avoids the use of end-cell switches for regulating the voltage and also insures a reserve charge in the small battery sufficient to operate the converter for a period of 24 to 48 hours if required in an emergency.

Dry cells for auxiliary dry batteries can be used and when used should consist of 17 cells, or groups of 17 cells each, in multiple series. However, the use of dry cells is not recommended for the following reasons:

- "A"—They dry out.
- "B"—Local action takes place in the cells.
- "C"—They require considerable attention and more or less frequent replacements depending on the above "A" or "B" and on the ringing load.

The standard practice is the use of a small set of storage cells for this auxiliary battery and consisting of 10 cells as follows:

Type "B.T." for plants up to 3500 lines. Type "E.T." for plants 3500 lines and over. All converters are designed to operate from 11 cells of storage battery only and the "noise killing battery" should always consist of 10 cells of storage battery. The difference of one cell allows sufficient current to go from main battery to "noise killing battery" to keep the latter in a charged condition which is necessary to maintain efficiency of the same.

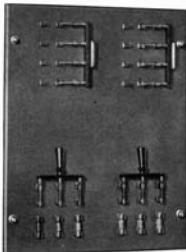


Fig. 12—Converter Control Panel

## Harmonic Converter Control Panels

### No. 1 Harmonic Converter Control Panel

Contains the following listed equipment for the control of either a single or a duplicate set of Harmonic Converters when the latter is to be operated from either a single or duplicate set of 11 cells of Converter Storage Battery. Equipment includes:

- 2 Triple pole, single throw switches for starting one or two converters.
- 1 Four pole, double throw switch for connecting the ringing current of either converter to the exchange.
- 1 Four pole, double throw switch for reversing the battery on the converter vibrator contacts.
- 1 Battery selecting switch to connect converter to either of two storage batteries.
- 6 Type "C" fuse mountings with enclosed tubular fuses for protecting the battery circuits of both converters.

Assembled on a slate panel 18 in. x 24 in. x 1 in. and wired on back between switch and other terminals. Shipping weight approximately 250 pounds.

Ringling Equipment

**No. 1-N Harmonic Converter Control Panel**

Same as No. 1 but with No. 18 Impedance Coil mounted and wired on back of panel for use with "Noise Killer" battery, when the converter is used in connection with the "Central Energy" Main Exchange Battery. Shipping weight approximately 300 pounds.

**No. 1-T Harmonic Converter Control Panel**

Same as No. 1 but with No. 1-E Toll Ringing Transformer mounted on back of panel. This transformer is used when it is desirable to have the ringing current for toll lines completely insulated from ground. Shipping weight approximately 300 pounds.

**No. 1-N-T Harmonic Converter Control Panel**

Same as No. 1 but with both the No. 18 Impedance Coil and No. 1-E Toll Ringing Transformer mounted on back of panel for the same purposes as given under No. 1-N and No. 1-T Converter Control Panels. Shipping weight approximately 350 pounds.

**No. 1-E Harmonic Toll Ringing Transformer**

Our No. 1-E Toll Ringing Transformer is an insulating transformer designed for use with our Harmonic Converters as a means of obtaining an ungrounded 16 cycle current for ringing toll lines.

It is the standard practice to connect the primary terminals of the transformer across the 16 cycle frequency wires which run from the converter to the switchboard and the secondary terminals directly to the ringing leads extending to the toll positions. This gives a 16 cycle current which is free from grounds so that it is possible to ring on a toll line successfully regardless of adverse line conditions.



The transformer has practically a one to one ratio between the windings, there being a slight increase in the voltage of the secondary current to assist in ringing over longer lines of toll circuits.

The toll transformer is usually installed in connection with the power board and across the leads which run directly from the power board to the operators' positions at the main switchboard. In this way only one toll transformer need be used when duplicate converters are installed as the transformer remains bridged across the main switchboard side of the converter selecting switch. This method of installing simplifies the control circuits and reduces the amount of switching apparatus to a minimum.

**No. 1-A Harmonic Test Bell Set**

For use in connection with 2-A, 3-A and 4-A standard harmonic converters for testing the adjustment of the converter vibrators. Each outfit contains the following:

- 1 Oak Cabinet for mounting apparatus.
- 4 Harmonic Ringers accurately tuned to 16 $\frac{1}{2}$ , 33 $\frac{1}{2}$ , 50 and 66 $\frac{2}{3}$  cycle respectively.
- 1 Non inductive test resistance.
- 1 Resistance shunt key.
- 1 Frequency key to switch any one of the 4 frequency ringing currents from the harmonic converter to the test bell circuit.

Shipping weight complete approximately 60 pounds.

**No. 1-B Synchronomic Test Bell Set**

Same as above with 4 accurately tuned synchronomic ringers of 30, 42, 54 and 66 $\frac{2}{3}$  cycles respectively for use in connection with 2-B, 3-B and 4-B Synchronomic Converters.

Shipping weight complete approximately 60 pounds.

## Composite Multi-cycle Motor-generator



Fig. 13—Composite Multi-Cycle Motor Generator

Our harmonic converter will handle the entire ringing load of exchanges of all types ranging in size up to 8,000 to 10,000 subscribers depending upon the calling rate. When the size of the exchange is greater than will permit the safe operation of one Harmonic Converter it is the usual practice to install a second converter serving the alternate operator's positions. The composite multi-cycle motor-generator set described in the following paragraphs provides another method of generating ringing currents at harmonic frequencies under such conditions.

This new type of ringing machine replaces the older type of machine in which a motor was direct coupled to four separate generators whose armatures were mounted on a common shaft. The composite multi-cycle motor-generator delivers the four separate frequencies at four different voltages from one generator field.

These motor-generators run at 1000 R. P. M. and deliver 50 watts from each winding at  $16\frac{2}{3}$ ,  $33\frac{1}{3}$ , 50 and  $66\frac{2}{3}$  cycles per second and at 75, 100, 135 and 175 volts respectively. We furnish these sets equipped with direct current or single phase alternating current motors as required. The direct current motor sets are direct connected and equipped with a speed governor—the alternating current motor sets require no speed governor but are equipped with a direct current exciter geared to the generator. Machines of this type are more economical to operate and maintain than the older four-generator type as one revolving field is used instead of four. The reduction in number of bearings, power losses and brush friction decreases the no load running wattage from 350 in the old type to 100 watts in the new single frame machine.

Prices and specifications on composite motor-generators will be furnished upon application. In writing for information be sure to give exact voltage of power circuits, if alternating current give frequency voltage and number of phases.

