KELLOGG
SWITCHBOARD & SUPPLY CO. CHICAGO.

FOUR PARTY HARMONIC RINGING EQUIPMENT

BULLETIN NO. 12

1918

A bulletin issued for four party ringing equipment, this bulletin also contains a complete description of how such a system works

KELLOGG
SWITCHBOARD & SUPPLY CO. CHICAGO

Branch Offices:

KANSAS CITY, MO. COLUMBUS, OHIO 409 Huntington Bank Bldg. SAN FRANCISCO, CAL.

BULLETIN No. 12.

Modernized Four-Party Harmonic Ringing Equipment

Fig. No. 1201.—No. 19A 5 frequency vibrator.

Lower unit for regular ringing, 4 upper units for selective service.

COMMERCIAL demands and conservation of materials require service extensions with a minimum of copper, lead and steel.

THIS BULLETIN GIVES THE ANSWER

INTRODUCTION

PRESENT CONDITIONS FORCING PARTY LINE SERVICE

TELEPHONE companies throughout the United States deserve great credit for the manner in which they have promptly cared for service demands, disregarding the high cost of materials and the slim prospect of early relief through increased service rates.

Expansion costs have fallen with particular weight on those exchanges which were caught with their lines and cables filled almost to capacity and who were without a satisfactory 4-party selective service to assist in weathering the storm of adversity which has confronted all utilities as a combination of 1917-1918 soaring expense coupled with 1897-1902 rates of revenue.

MODERN FOUR-PARTY HARMONIC MOST SUITABLE SYSTEM

The purpose of this bulletin is to call attention to the peculiar fitness of 4-party harmonic service to handle such situations as that now confronting the telephone industry, which is rapidly facing a condition where the most lavish expenditures will not procure material for outside plant additions and where 4-party harmonic service may be forced to the attention of many exchange managers who have never seriously considered it heretofore.

A STANDARDIZED KELLOGG PRODUCT

It is also our purpose to show that the Kellogg Company, which was the first to market harmonic equipment more than sixteen years ago, have improved and developed their system until the standardized apparatus is as simple and "fool-proof" as regular ringing equipment. It imposes no high voltages on cable plant and apparatus, and, above all, delivers results which are equally satisfactory to the patrons and to the management.

HISTORICAL CHAPTER FOR "DOUBTERS" AT END OF THIS BULLETIN

A complete description of this standard equipment follows, together with code numbers, circuits and brief outline to conserve time for the busy manager who is familiar with the system and knows what it will do. But for the benefit of doubters and those who may entertain honestly acquired prejudices against selective service, we have added a complete history of the selective ringing proposition from the birth of the telephone art to the present time. This description of some of the monstrous systems which have been extensively used in times past to torture the public and prejudice them against the selective ringing idea and party line service of any kind, will not only explain whatever prejudice may exist but will cause wonderment that the selective ringing proposition has been able to survive the crimes which have been committed in its name.

PARTY LINE SERVICE NEARLY UNIVERSAL

Selective service is right and is rapidly becoming a necessity in all except the smallest village exchanges. It is almost impossible to find Independent common battery plants not giving 4-party service or common battery Bell plants not giving at least 2-party service. Of late, many Bell plants, having nothing but 2-party service available, and being prejudiced against the harmonic systems of Independent development but unwilling to take on the complications of their "superimposed" 4-party scheme, are being forced

to "semi-selective," which is not selective service at all but merely the application of one and two rings from each side of the line to ground.

EXCHANGE PARTY LINES SHOULD BE FULL SELECTIVE

By introducing the so-called "semi-selective" service, we believe the Bell plants are making a great mistake and will render party line service odious to the subscriber and again bring it into disrepute, just as they formerly did, by clinging to the unreliable 4-party pulsating system for years before practically giving it up and limiting their selective service to 2-party.

TWO-PARTY SERVICE INSUFFICIENT

Apparently the Bell Company's motive in introducing 4-party semi-selective service with one and two rings, instead of full selective service, is to avoid returning to the use of selective ringing equipment in the exchange, and the liberality with which they use 2-party service in practically all of their plants and even use the 4-party semi-selective to some extent, shows that their prejudice is not against the idea of selective service, but is an honestly acquired prejudice against the idea of selective equipment inherited from their experience with primitive systems as hereinafter described.

The 2-party selective service which they use so extensively is, in reality, not selective ringing at all, as they merely use the two sides of the metallic circuit as separate grounded lines for ringing purposes and as a metallic circuit for talking purposes.

This, of course, avoids all special ringing equipment, as it is only necessary to permanently ground one side of the regular ringing machine and it will automatically select what they term the "W" party and by reversing the supply connection at the ringing key, it will select what they term the "J" party on the other side of the line.

THE "JACK PER STATION" MISTAKE

Many companies formerly made 2-party service extremely attractive to the subscriber and ideal from the operating standpoint, by giving each of the subscribers a separate string of multiple jacks in the switchboard and separate numbers corresponding thereto.

One string of multiple jacks was reversed, with reference to "tip" and "ring" connections, so that when the operator plugged into a number she would automatically get the proper party. This made it unnecessary to put any designations after selective numbers and it was impossible for any one to determine from the telephone directory whether a certain patron was on a party line or on a "straight" line.

This service, however, was so extravagant, as to the amount of multiple required, that switchboards became filled to their ultimate capacity too rapidly and the service is being generally discontinued and 2-party indicating keys are being used in connection with a single string of multiple jacks, while the directory carries "W" and "J" designations after the numerical portion of the "number."

TWO-PARTY MEANS PRIVATE LINE SERVICE AT TWO-PARTY RATES

This puts the proposition back on its old basis, and, in the larger plants especially, makes 2-party service a bad proposition for the telephone company, for the reason that this class of service, being used for parties of limited means and who move frequently, renders it impossible to keep 2-party lines

full, with the result that hundreds of subscribers are constantly getting straight line service at 2-party rates, since when either party moves off a 2-party line it is necessary to carry that station idle until after the next issue of the directory. And in the larger cities where thousands of families rent cottages in summer and flats in winter, they are almost constantly getting straight line service at party line rates.

ONLY A FRACTIONAL STATION GAINED

In other words, it is hardly worth while losing the prestige and extra value (either real or sentimental) which attaches to straight line service by changing a straight line to a party line when it is known in advance that it will be possible to keep only a fraction over one party thereon.

If a straight line is to be made a party line, it should have a capacity of not less than four parties, on a full selective basis, and this is where 4-party harmonic is everlastingly right, in that it enables the telephone company to operate without grounds and to keep the lines filled to an average of three parties or more instead of about a party and a half, as is the case where the service is limited to 2-party.

4-PARTY GAINS MORE THAN TWO STATIONS PER LINE

In fact, it is advisable to keep 4-party lines normally filled to only three parties until conditions become crowded, when the fourth station on each line comes in splendidly as a reserve, and, by operating on this basis, whenever one party moves off a selective line, it is possible to immediately place another thereon, using another designation so that the line still remains filled to three parties without confusion regardless of the old directory's still being out.

4-PARTY REALLY 3-PARTY, AND 2-PARTY REALLY SINGLE

In other words, 4-party service should be looked upon as 3-party service with the fourth station reserved for shifts and number changes, and, by the same token, 2-party service, with one station reserved, automatically reverts to single party service.

EQUALLY SATISFACTORY TO USER, IF FULL SELECTIVE

From the subscriber's standpoint, 4-party service, if full selective, is just as satisfactory as 2-party, for the reason that the sentimental value of straight line service is lost in either case and there will be to the patron no noticeable difference in the number of times per month or per year the line will be found busy.

FOUR-PARTY SERVICE ECONOMICALLY RIGHT

In fact, in ordinary medium sized towns, residence telephones are actually in use less than 3% of the day-time, and, as these outlying residences are the most expensive to reach and serve, it is utterly contrary to all ideas of economic efficiency that an expensive plant, for the purpose of serving these stations, should lie idle 97% of the time and be in use only 3% of the time, when by caring for these outlying residences on a 4-party selective basis, with one-third of the plant investment, by keeping the lines full to an average of three parties, they will still be idle more than 91% of the time. Or in other words, not one time in ten when the user goes to the telephone will he find the line engaged.

CARE NEEDED IN APPLICATION

The most successful 4-party exchanges are those in which the service has been applied with some degree of care and intelligence. It is usually possible for a telephone company, offering both straight line and 4-party selective service, to sell the outlying residences whichever they prefer to furnish and think the subscriber ought to have.

DON'T FURNISH TO HEAVY TOLL USERS

It is, of course, plain folly to install 4-party service for a heavy toll user who does considerable talking from his residence, as the loss of circuit time in holding up long distance connections would be serious, while if the line be set busy and held from the moment such a party puts in outgoing calls, the service to the other suscribers on the line will be annoying and unsatisfactory. Care should, therefore, be used in installing 4-party residence service for anyone likely to use the long distance lines frequently and a little explanation will usually suffice to avoid such installations, or to get the subscriber on a straight line basis once a heavy toll user has been discovered on a 4-party line.

AVOID DESK STANDS AND "ROCKING CHAIR" WALL SETS

A great many companies also enforce the excellent rule that no desk sets shall be installed on 4-party lines, and that no 4-party wall telephones shall be hung low enough to be used while sitting down.

These simple applications of plain "horse sense" render possible the very extensive application of 4-party residence service and automatically keep such service satisfactory. The free and unlimited installations of desk sets on party lines will encourage the holding of the line for long intervals, the fact that the user has to stand up to talk is the best way of automatically getting the subscriber to limit his conversation to five minutes.

EMPLOYED PRINCIPALLY IN OUTLYING DISTRICTS

Another fact not sufficiently appreciated in connection with selective service is that, when properly applied, it is limited largely to outlying stations and serves a class of subscribers representing a lesser order of social importance. This means that such subscribers will make many more calls than they will receive, so that the extra labor, if any, in calling such parties becomes almost negligible and the service is, to a large extent, **a one-way service.** This condition works out particularly in small and medium sized county seat towns where too little attention to selective ringing has been paid heretofore.

If the 4-party service is properly used and liberally employed in the outlying sections of the town it becomes much easier to limit it to the locations where it is desired and to keep the close-in residences, representing, in such towns, a higher order of social importance, on straight line service at higher rates.

LARGELY A "ONE-WAY" SERVICE WHEN PROPERLY APPLIED

The fact that 4-party service, when properly applied, is largely a one-way service, makes the 4-party master key desirable in such exchanges in preference to individual keys in each cord circuit. It is neither necessary nor advisable to change a fast operating cam type key-board into a cumbersome and complicated push button key-board in order to handle the outlying residence districts on a 4-party basis.

COMPLICATED AND COSTLY EQUIPMENT UNNECESSARY

Hundreds of medium sized exchanges have been prejudiced against 4-party service by the installation of too elaborate an outfit and by ruining their equipment for fast straight line operation, representing perhaps 95% of their traffic, in order to introduce 4-party service in outlying districts receiving only a slight percentage of the total calls.

Thus while the average exchange will never get anywhere introducing mere 2-party service in place of straight line service, it is almost equally disastrous to go to the other extreme and make too elaborate changes and too elaborate an expenditure in order to introduce 4-party service.

FOUR-BUTTON INDIVIDUAL INDICATING KEYS RARELY NEEDED

For the above reason the standard equipment which the Kellogg Company has developed for such exchanges contemplates operation on a 4-party master key basis and the installation of button type indicating keys only when an enormous development of 4-party traffic and the use of this service by all classes, socially important as well as otherwise, makes it necessary to have an automatic indication as to which party has been called.

ONLY KELLOGG SYSTEM USES MASTER KEY SUCCESSFULLY

With nearly all other systems of selective ringing it is practically impossible to use master key equipment for the reason that if the operator, working with both hands, is an instant late in setting the master key, or an instant early in restoring it, one party on the line will be rung falsely. This condition, it will be readily seen, practically necessitates installation of 4-party button type keys on each cord circuit as it has been found impossible for a rapid operator to work master keys without producing some interference. In fact the only way this could be done would be to have her operate the board with one hand tied behind her so she would have to set the master key first and restore it last.

WHY FIVE FREQUENCIES FOR FOUR-PARTY SERVICE

For this reason, as well as others to be explained later, the Kellogg 5-frequency system has been developed, with which it is possible to use master key equipment and operate the board speedily, using both hands, and without danger of interference. If the operator sets the master key an instant late, or restores it an instant too early, she merely projects the regular ringing current on the line during this interval and such regular ringing current so projected will not call any of the four parties on the line.

This is why the Kellogg Company's standard 4-party harmonic uses five frequencies. The fifth frequency adds but a trivial amount to the cost of the equipment, does not increase the cost of operation and makes it possible to have one ringing unit for all straight line ringing and four other units, mounted in the same case, dedicated exclusively to 4-party ringing and carrying current only when ringing is actually being done.

In other words, to get a selective system to be kept full to an average of three parties, it is necessary to install a 4-party equipment, and to operate a 4-party equipment it is in turn necessary to have a five frequency machine in order that master keys may be used without interference and the entire apparatus rendered simple, "fool-proof" and satisfactory. The equipment has been worked out so that the first cost is very reasonable and the additional complication practically nothing, inasmuch as the four selective units are

merely exact duplicates of the regular ringing unit running at different speeds.

REGULAR RINGING TRANSFORMER ONLY ONE KEPT "HOT"

By keeping current off the contacts and out of the transformers except when ringing is actually being done, the higher frequency units require practically no attention and will operate for long periods wholly without inspection. And when they do require it they need only the same attention as the regular ringing unit requires from time to time to take up the effects of mechanical wear.

DRY BATTERY CURRENT AT $20.00 PER K. W. HOUR —STORAGE AT 16c

All of the equipment operates on a storage battery basis, same being the only economical source of direct current available for telephone exchanges. Dry battery current now costs in the neighborhood of $20.00 per kilowatt hour as against 6c to 16c per k. w. hour for commercial current for charging storage batteries.

TUNGAR RECTIFIER FOR ALTERNATING CURRENT

In former years the only satisfactory and economical device for charging storage batteries from alternating current in small exchanges was an electrolytic rectifier, with its attendant muss and dirt and need for considerable attention to keep it clean and operating satisfactorily. Notwithstanding this, hundreds of exchanges are using such rectifiers with a very great degree of satisfaction, but in the development of their new Tungar rectifier, the General Electric Company have removed the last excuse for even the smallest telephone exchange being without the benefits of storage battery ringing.

RECTIFIER, BATTERY AND REGULAR RINGING EQUIPMENT NEEDED REGARDLESS OF HARMONIC

In other words, no telephone plant of any size can afford to be dependent on dry battery ringing or can afford to roll a large motor generator ringing set continuously, at a monthly cost of $7.00 or $8.00 for current, when a small set of 11 storage batteries, a Tungar rectifier and a transformer ringing set will provide absolutely reliable and efficient 24-hour ringing service, regardless of variations and possible interruption in the commercial current.

WILL SOON PAY FOR ITSELF WITHOUT PARTY LINE FEATURE

Therefore, the entire expense of a 5-frequency equipment should not be charged to the harmonic ringing installation, but it should be recognized that the storage battery, the rectifier and the single ringing unit is really necessary and will soon pay for itself in reduced cost of operation, even if the selective ringing equipment were not to be installed.

ACTUAL COST OF SELECTIVE FEATURE LESS THAN $100

Therefore the only proper additional charge to the selective ringing service is to charge same with the additional cost of the four extra vibrators and transformers and the 4-party selective keys. As such additional expense amounts to only about $100.00 in the average medium sized exchange,

the cost of equipment for installing 4-party service becomes so trivial that, in view of its advantages and the flexibility which it brings into the plant, no exchange in these times of prohibitive costs and difficulty in getting material for extensions should consider attempting to get along further without the assistance of a standard and reliable 4-party harmonic ringing system.

DUPLICATE OUTFITS UNNECESSARY

In the days when multi-frequency motor generator ringing sets were required for 4-party harmonic installations it was necessary to install two separate machines operating from separate sources of current to guard against the possibility of complete interruption of all party line service, since the four generators were all common to one motor and one driving shaft.

Following this precedent it was customary to provide two complete pole changers and transformer sets for many years after the latter equipment had displaced the rotary machines.

Later it came to be recognized that inasmuch as well made ringing transformers are practically trouble proof, an equally reliable reserve source was secured by providing two sets of vibrators in connection with a single set of transformers. This made it possible to switch a set of vibrators out of service while smoothing up the contacts, as it was practically impossible to work on them while they were "hot."

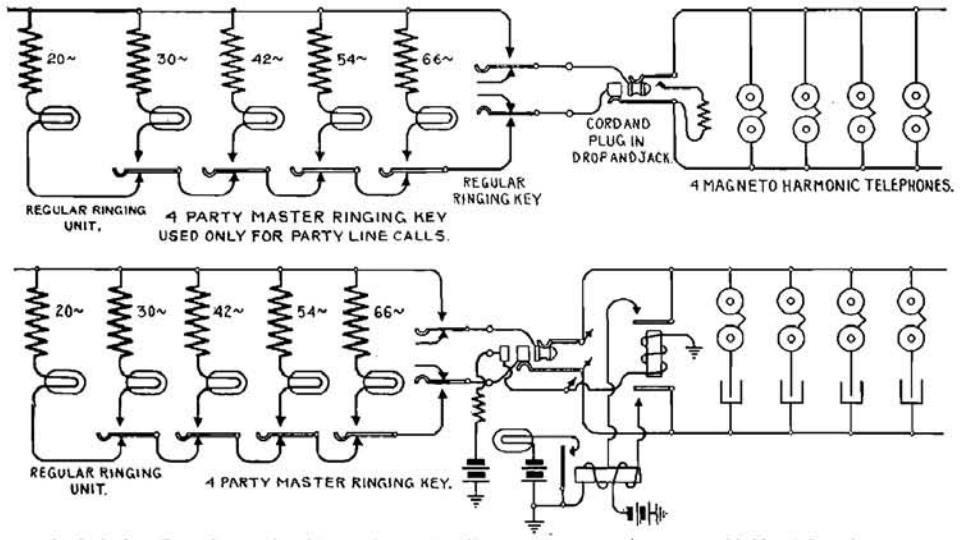


Fig. No. 1202.—Showing adaptability of harmonic ringing equipment to magneto or common battery without change.

Following this process of simplification to its logical conclusion the Kellogg Company now recommends but a single set of vibrators, having refined the entire equipment until it is as sure in operation as the current supply itself. The current supply is guaranteed by the fact that the equipment can be operated from a week to twelve days on 18 dry cells, in case of accident to the storage battery or rectifier or in case of interruption of the charging current itself.

This is made possible by the equipment being so arranged that current is normally supplied only to the one transformer used for regular ringing. This means that the contacts of the 4 selective vibrators can be worked on at any time without "shutting down," and, since they are not required to carry current constantly but only momentarily and at more or less infrequent intervals, they are subject only to mechanical wear, yet they are constantly in motion and ready to deliver a clear and distinct ring, experience having proven it is impractical to start a well designed vibrator between the time of operating the master key and the regular ringing key.

The regular ringing unit which carries current constantly should have its contacts smoothed up every few months and, at such times, it is only necessary to tilt all the master keys on the board to the 30 cycle position and use that frequency for regular ringing while working on the 20 cycle vibrator. In fact this completely solves the proposition of a duplicate emergency set for straight line ringing as it is possible to strap the 20 and 30 cycle leads together and operate indefinitely without the 20 cycle unit, though the latter is advisable to get better rings from worn rural bells and to prevent the possibility of occasional party line interference from setting the master key too late or restoring it too soon.

The possibility of irreparable damage to one of the 4-party vibrators is too remote to be seriously considered. Standard ringer coils are used to operate the vibrators and the fact that the regular 20 cycle vibrator can be cut out and its contacts used interchangeably on any other unit practically eliminates any possible chance for interruption of service and the necessity for a duplicate set of vibrators in any except extremely large exchanges where the additional cost of same would not be a serious consideration.

The standard circuit arrangement readily permits adding the second pole changer should it ever be considered necessary.

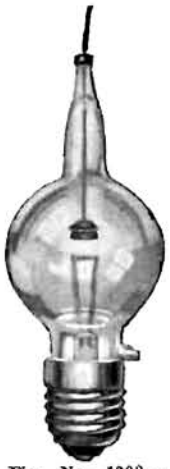
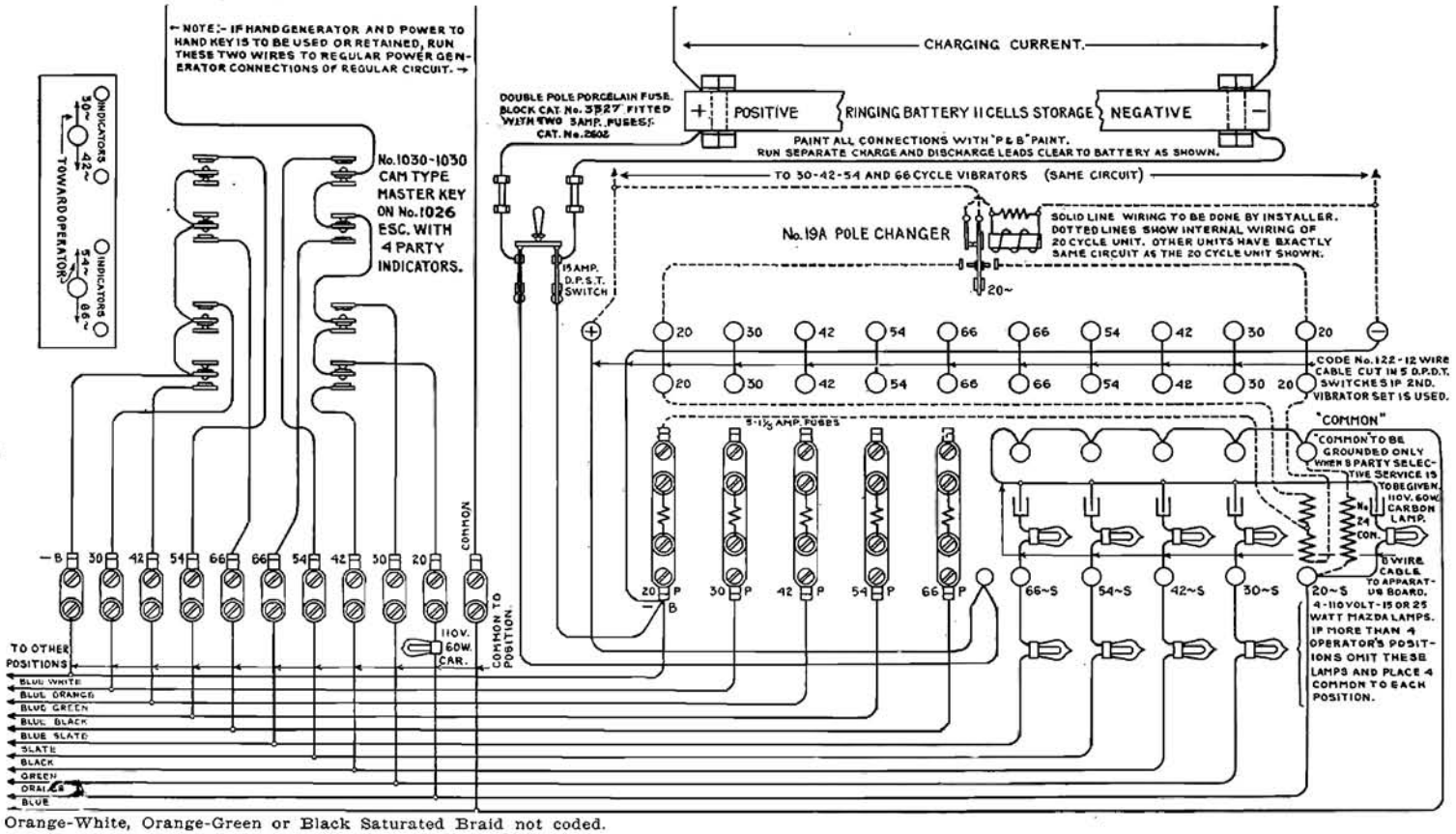


Fig. No. 1203.—Bulb for Tungar rectifier.

Fig. No. 1204.—Tungar rectifier.



Orange-White, Orange-Green or Black Saturated Braid not coded.

Fig. No. 1205.—Five frequency harmonic ringing system. 20 cycle, 100 volt current for regular ringing. 30, 42, 54 and 66 cycle, 100 volt current for 4-party lines. Battery normally on 20 cycle only. All transformer secondaries equipped with power condensers and resistance lamp to reduce induction when ringing single or 4-party grounded lines.

WHAT CAN BE ACCOMPLISHED WITH MODERN HARMONIC RINGING EQUIPMENT

Four telephones can be operated selectively on a metallic circuit with no grounds at subscriber's station or at the central office.

Four telephones can be operated selectively on a one wire grounded (or common return) line.

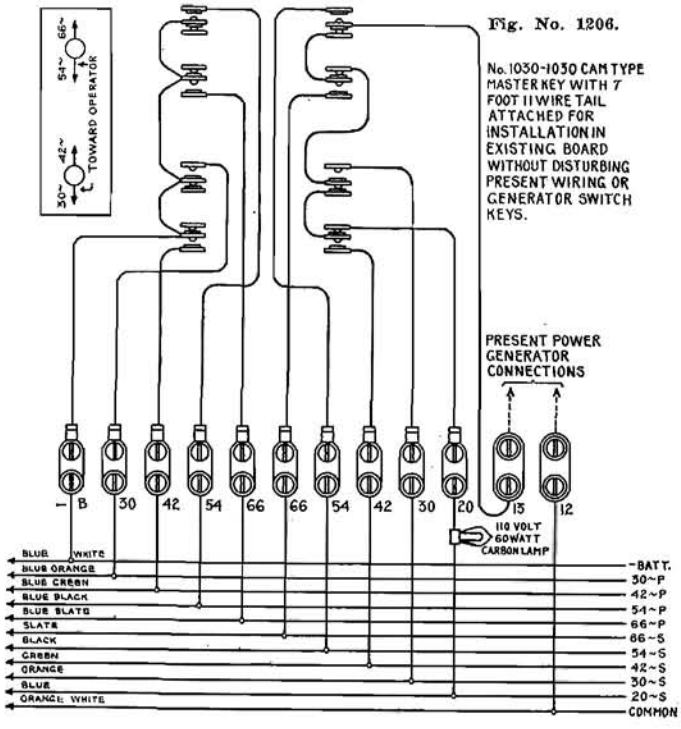
Eight telephones can be operated selectively on a full metallic circuit by bridging four bells from each side of the line to ground.

On magneto systems subscriber calls central and "rings off" absolutely without disturbing any bells on the line. Neither can any bell on the selective line be disturbed by a ring coming from any connected line. "Central" is the only person who can ring a bell on a selective line, and it is physically impossible for her to ring more than one party on any selective line at a time. When a magneto system is changed to common battery, or universal, every particle of harmonic ringing equipment can be retained, absolutely without change, and 4-party service can be given on both magneto and common battery lines.

Thus harmonic ringing equipment purchased for use in an old magneto exchange becomes a perfectly fitting part of the ultimate common battery plant and will help earn the money to make the latter an early reality.

WHAT CENTRAL OFFICE EQUIPMENT IS REQUIRED

Item 1. A No. 19A 5-frequency pole changer, as illustrated on cover, assembled on a heavy slate panel, fitted with glass front cover and arranged for wall mounting.



Item 2. A No. 18A 5-frequency transformer set with transformers, condensers, bus bars and fuses, all self-contained, and arranged for wall mounting.

Item 3. A No. 25800 auxiliary apparatus board with 5 No. 24 condensers and 5-110 volt, 16 c. p. carbon lamp resistances. On new metallic circuit plants this auxiliary equipment is not essential but is recommended wherever it is necessary to ring on grounded lines as the ringing induction, otherwise unavoidable on grounded lines, is thereby reduced to a

minimum with no noticeable increase in the amount of ringing current required.

Item 4. One double pole porcelain fuse block, Cat. No. 3327, fitted with two 3 ampere tubular fuses, Cat. No. 2602.

Four extra fuses, same as above.

Item 5. Twenty extra 1⅓ amp. fuses for transformer set.

Item 6. One double pole single throw 15 amp. knife switch, Cat. No. 454.

Item 7. One piece of Code No. 122, 12 wire cable from transformer set through the rear of all switchboard positions as indicated in complete diagram on page 10.

Item 8. One piece Code No. 122, 12 wire cable, same as above, from transformer set to pole changer. Pole changer should be mounted beside transformer set and where this can be done 4 feet of cable is sufficient for this item.

Item 9. One piece Code No. 105, 7 wire cable from transformer set to auxiliary apparatus board, and when latter is omitted, when new equipment is going into full metallic plants, this 7 wire cable is not required. Only 6 wires are used, the seventh being a "spare."

Item 10. One pair No. 14 B. & S. gauge copper wire, rubber covered and braided, from storage battery terminals through fuses and switch to transformer set. These wires must be run direct to storage battery terminals independent of the charging circuit wires or wires to other discharge circuits from the battery.

Item 11. Four 110 volt Mazda lamps, either 15 or 25 watt, with

Item 12. Four keyless porcelain receptacles, Cat. No. 9171. These are resistance lamps and sockets for the 4 harmonic frequencies.

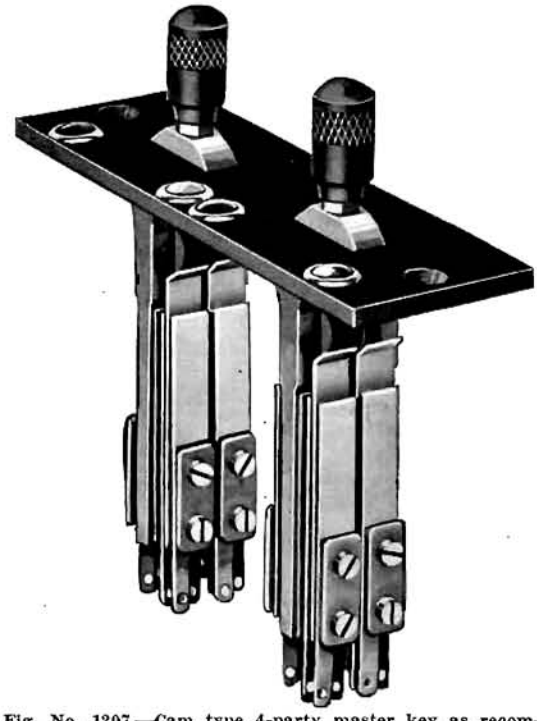


Fig. No. 1207.—Cam type 4-party master key as recommended herein. Special button type 4-party master key with 4 buttons and restoring lever can be furnished on special order.

Item 13. One 110 volt, 16 c. p. carbon lamp and Cat. No. 9171 receptacle for the 20 cycle branch lead at each operator's position. These latter lamps to be placed in the switchboard. Where extremely heavily loaded rural lines are to be handled it is advisable to use a 110 volt, 25 watt Mazda lamp and Cat. No. 9171 receptacle in multiple with the 110 volt, 16 c. p. carbon lamp in each operator's position.

Item 14. One No. 1030-1030 cam type master key with 7 foot, 11 wire tail attached for each operator's position. This two cam key is regularly mounted on a No. 1013 special escutcheon fitted with 4-party line indicators. This escutcheon can be used in any key shelves where the keys mount with

Couple Type Lead Storage Batteries as recommended herein.

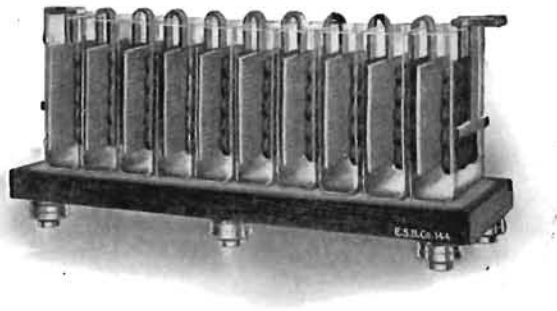


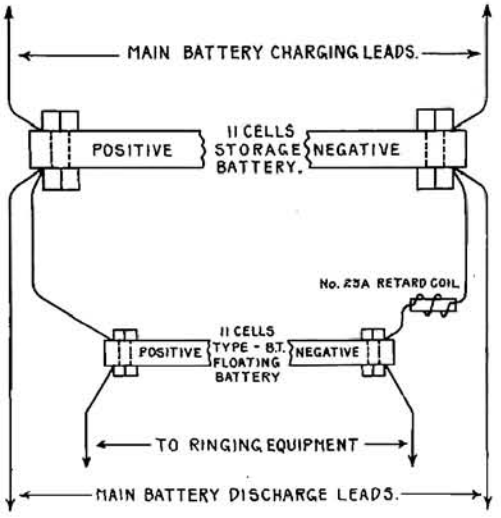
Fig. No. 1208.—11 cells of type "CT," 1½ Amp. N. C. R. Sand tray not required with these small size batteries as a 2-inch layer of sand on the battery shelf is just as good an arrangement.

Fig. No. 1209.—Type "BT", ¾ Amp. N. C. R.

Fig. No. 1210.—Type "PT", 3 Amp. N. C. R.

Fig. No. 1211.—Type "ET", 4½ Amp. N. C. R.

wood screws, also in late type Kellogg key shelves equipped with two cam keys, 1000 type, mounted flush with machine screws. Where special steel key frames are encountered in existing Kellogg key shelves, reference to the serial number of the switchboard should be given when ordering master keys to



SHOWING 11 CELLS TYPE B.T. RINGING BATTERY FLOATING ACROSS MAIN EXCHANGE BATTERY THROUGH A No. 23-A-NOISE KILLING RETARDATION COIL.

Fig. No. 1212.

mount therein. With boards of other than Kellogg make, a dimension sketch of the key escutcheon required should accompany the order. The 11 wire, 7 foot tail is color coded and can be installed in any existing switchboard without disturbing the present wiring in the least, as the circuit shown in Fig. No. 1206 is always used when tailing up keys for use in existing boards. After installation, the power to hand generator keys and the generator reversing keys, if used, will be found to operate just as they did before, as the current coming from the new 4-party master key is introduced into the present switchboard wiring at exactly the same point where the old power generator was formerly connected.

Item 15. Eleven No. 11 binding posts are also required at each operator's position. These are cut into the key tail before it branch splices into the No. 112 cable.

Item 16. A lead plate storage battery of 11 cells as shown in Fig. 1208. If this battery is to be used for ringing purposes only, 11 cells of the Electric Storage Battery Company's Type CT with a normal charging rate of 1½ amperes are recommended. If a battery of 11 cells is already in service the installation of this harmonic ringing equipment will result in no noticeable increase in the total current consumption, but if such existing battery is used for supplying talking current, a "floating battery" of 11-BT cells and a No. 23A retardation coil must be cut in series with the negative lead between the main storage battery and the ringing storage battery, arranged as per Fig. No. 1212.

If no storage battery equipment is now in service and it is desired to install one to supply current for ringing purposes and also for operator's transmitters and lamp transfer circuits, night bell, pilot lamps, etc., please write us, stating the total number of

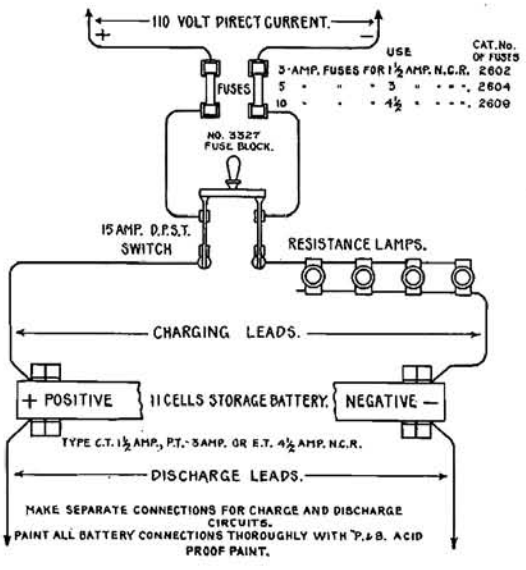


Fig. No. 1213.—Storage battery charged direct from 110 volts D. C. Battery can be used on ringing equipment while being charged, but cannot be used for any other purpose at such times.

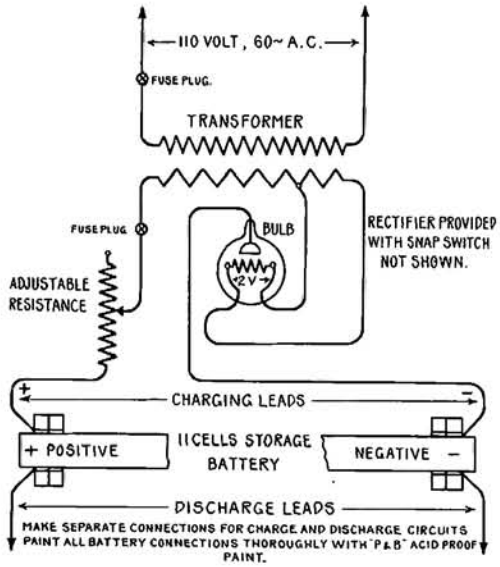


Fig. No. 1214.—G. E. tungar rectifier.

operators' positions in service, also the total number of "operator hours" per day, also the number of lamp transfer circuits, together with the make of the board and the voltage of transfer lamps now in service. We shall be glad to submit a special quotation on a suitable power equipment together with a list of the new apparatus needed to put the entire board on a standard 24 volt storage battery basis.

Item 17. A charging equipment suitable for charging the storage battery from the commercial current available. When the latter is 110 volt D. C. it is only necessary to connect it direct to the charging circuit leads of the storage battery through a double pole fuse block, and two fuses of amperage 50% to 100% in excess of the normal charging rate of the battery, and through a 15 amp. D. P. S. T. knife switch, R. E. Co.'s Cat. No. 454, inserting a 110 volt, 16 c. p. carbon lamp for each .4 amp. of the normal charging rate of the battery so that a battery of 1½ amp. normal charging rate requires 3 or 4 lamps of the type just described. It is advisable to start a full charge with 4 lamps and reduce to 3 near the end of the charge to avoid an excessive rise in voltage. If carbon lamps are not available, 100 watts of 110 volt Mazda lamp resistance should be used for each ampere of normal charging rate of the battery.

Where the only available current for charging storage batteries is 60 cycle alternating, some form of rectifier must be used. There are three types of rectifiers on the market suitable for charging the small storage batteries adapted to this work.

Electrolytic rectifiers are very inexpensive and so efficient and satisfactory in connection with small batteries that we

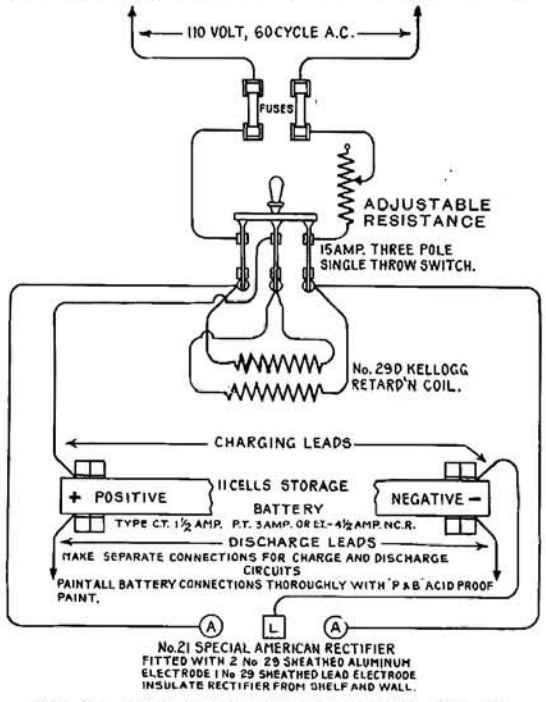


Fig. No. 1215.—Double Pole Fuse Block, Cat. No. 3327. 5 Amp. Fuse, for 1½ Amp. N. C. R., Cat. No. 2604. 10 Amp. Fuse, for 3-4½ Amp. N. C. R., Cat. No. 2609.

recommend their being retained where they are already in service and have proven satisfactory, as they must have a certain amount of care and attention and be kept clean to secure best results. Either the 2 point half wave type, using 1 aluminum and 1 lead electrode with controlling resistance, or the full wave type with 2 aluminum and 1 lead electrodes and a bridged impedance tapped at the neutral point and serving as an auto transformer may be used. The efficiency of existing 2 point, half wave rectifiers may be greatly increased by drilling the cover for a second aluminum electrode and installing a No. 29D Kellogg Retardation Coil as indicated in Fig. No. 1215.

For all new work where a set of 11 small storage batteries is to be installed, the rectifier to be considered is the General Electric Co.'s Tungar, which is as clean as a mercury arc rectifier and much simpler, is self-starting and capable of operation at low charging rates where it would be impossible to maintain a mercury arc.

For charging 11 cells of Type CT, 1½ ampere N. C. R. battery, we recommend Mfrs. No. 204170 Tungar rectifier as shown in Fig. 1204.

Where it is desired to install sufficient storage battery capacity to take care of operator's sets, night alarm and lamp transfer equipment, in large magneto exchanges, a special power recommendation will be made and quoted, based on information as to the total number of operator's sets, the approximate total number of "operator hours" per day and the number of transfer circuits, pilot lamps and other signals together with the other information previously requested under "Item 16," "Storage Battery," page 14.

The advent of the Tungar rectifier renders it highly advisable that all large magneto exchanges be put on a storage battery basis and dry cells dispensed with in the central office and we shall be glad to make special recommendations on receipt of the necessary information.

WHAT KIND OF TELEPHONES ARE NEEDED ON MAGNETO HARMONIC RINGING SYSTEMS

Magneto telephone fitted with any harmonic ringers can be used. Present telephones can be used by merely changing the ringers regardless of whether they have three, four or five bar generators, and regardless of whether the generators are of the direct, alternating or pulsating current type. In changing over series telephones, the generators should be wired in bridging. This can always be done without difficulty except in the case of very old series generators equipped with centrifugal or "pill box" shunts, which generators cannot be changed to bridging.

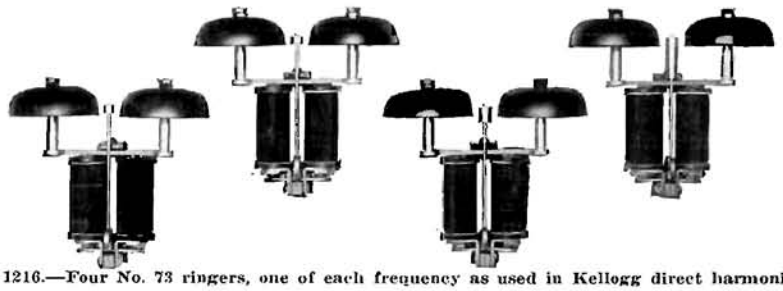


Fig. No. 1216.—Four No. 73 ringers, one of each frequency as used in Kellogg direct harmonic system.

Our standard new telephone for this work has a 3 bar alternating current generator and our improved No. 73 type, harmonic ringer, fitted with eccentric gongs, which afford the simplest and most reliable adjustment yet devised.

Types and codes of magneto telephones for 4-party harmonic service.

Fig. No. 1217. — No. 2807 compact wall set.

Fig. No. 1218.—No. 7 desk set.

Fig. No. 1219.—No. 6806G grabaphone set.

Fig. No. 1220.—No. 2804 residence type telephone.

Types and codes of common battery telephones for 4-party harmonic service. All these sets are provided with 2 M. F. condensers and large "Booster Type" induction coils in talking circuits.

On common battery systems any common battery telephone fitted with a No. 73 Kellogg Harmonic Ringer can be used regardless of the type or capacity of the condenser.

Fig. No. 1221.—No. 730HB oak set.

Fig. No. 1222.—No. 729HB oak set.

Fig. No. 1223.—No. 9742HB grabaphone set complete.

Fig. No. 1224.—No. 118HBF desk telephone.

Fig. No. 1225.—No. 118HBW desk telephone.

Fig. No. 1226.—No. 742HB steel set.

ADVANTAGES OF THIS SYSTEM FOR MAGNETO AND COMMON BATTERY EXCHANGES

1. No biasing springs or vibrating contacts on ringers. No adjustments to make on ringer except the usual gong adjustment.

2. Four-party metallic lines without grounds at subscriber's stations or at central office.

3. Unnecessary to trace out and observe "tip" and "sleeve" connections and no ground connections to fuss with at subscriber's premises; impossible to wrongly connect a telephone.

4. Pulsating or "split" current generators in telephone unnecessary. Neither is it necessary to use one bar A. C. generators or reverse bars or insert condensers with 3 bar generators in order to weaken the ringing current to avoid interference. With this system ANY KIND OF GENERATOR CAN BE USED IN THE TELEPHONES and all trouble in getting Central is thereby avoided.

5. Not necessary to have condensers in series with ringers at telephones.

6. Condensers may or may not be used in receiver circuit, at purchaser's option just as in the case of any bridging telephone.

7. All severe inductive disturbances and noise on adjacent lines when ringing is wholly avoided.

8. No danger of producing or aggravating existing trouble in old cables or switchboards by ringing currents of excessively high voltages.

9. Long life of the heavy contact points assured by absence of sparking and regular ringing unit being the only one normally alive.

10. All contact springs renewable without unsoldering any connections.

11. Heavy slab of slate for wall mounting of vibrators to minimize tendency to counter vibration on insecure walls. No floor space required.

12. Duplicate sets unnecessary.

13. Low voltage employed makes it possible to use harmonic ringing on existing common battery exchanges not provided with automatic generator cut-off in the cord circuit to prevent ringing subscribers in the ear.

APPLICATION UNIVERSAL

There are indeed but few exchanges, either magneto or common battery, not giving 4-party service where it could not be installed to advantage. The exchange that is "full up" and out of plant capacity can still get several more years out of the old plant, and at the same time introduce a service that will greatly reduce the cost of rebuilding and increase the revenue of the new plant when it has been built.

Magneto and common battery plants have equal need for a reliable and satisfactory 4-party system, and that there is an urgent demand for such service is eloquently proven by the willingness of telephone companies to put up with the complications and shortcomings of many of the systems heretofore available. With all these complications removed and shortcomings corrected by the system herein described, every manager should carefully consider if he cannot adopt this system to great profit. Those who have already started giving 4-party service by some inferior system should carefully consider if they cannot with profit change to this modern 4-party, low voltage system before incurring any further investment in other types of ringers.

Whatever your requirements are, do not fail to write us in regard to them, for we will account it a pleasure to give specific advice in each instance and you will be surprised to find how easily and at what small expense one of these simple 4-party selective ringing systems can be installed in your exchange.

If you desire a better revenue than can possibly be secured from an all "straight line" plant; if you want to change your outlying residence telephones from money losers to money makers, or if you want to replace a half successful 4-party selective system with one designed particularly for your needs which will be entirely successful and satisfactory both to yourself and to your patrons, the way lies clear in the adoption of this already tried and proven and comparatively inexpensive system.

SELECTIVE RINGING DESERVES WIDER APPLICATION

A strange and paradoxical situation is to be noted in the fact that while cable mills, during the past two years, have been running DAY AND NIGHT, grinding out cable purchased at 100 to 150 per cent advance over normal prices, very few exchanges have introduced 4-party service, and, although manufacturers have been able to deliver selective ringing equipment promptly and at a nominal advance over normal prices, their combined sales of selective ringing equipment have been lower than during any previous period in the days of low priced cable.

This condition would seem to indicate that 4-party selective service has either proven unsatisfactory or that an unwarranted prejudice exists against its use or that the telephone companies who have made, or are now contemplating, enormous expenditures for cable are not properly informed regarding the economy, simplicity and satisfaction of modern 4-party selective service.

As a matter of fact the real reason why 4-party service is not being more widely adopted at the present time is a combination of all three of the circumstances mentioned. Many 4-party systems have been tried and found wanting but when we consider that this field has been the favorite "stamping ground" of nearly every inventor in the business, it is not to be wondered at that a large number of "fearful and wonderful" devices have been brought into being to annoy the telephone company and prejudice its patrons against 4-party selective service.

Thus we find that whatever prejudice exists against selective service has been honestly acquired and is not due to the service itself, but "to the crimes which have been committed in its name."

However, some of the most successful and enthusiastic users of modern low voltage harmonic ringing are to be found among those who tried out the earlier systems and found them wanting but who refused to let so important a principle as selective ringing fall into disrepute because of errors in application during the formative period of the art.

It has also been found that a selective system that really works—smoothly and all the time—can be readily introduced in an exchange where 4-party service has been previously installed and discarded.

So to drive in the fact that a great and vital principle has been brought somewhat into disrepute through its wrongful and improper application, we have appended a brief history of selective ringing in which appears for the first time the real reasons for the failures and shortcomings of the earlier systems. While this historical matter will prove interesting and will explain the reasons for many failures and half successes, we hope it will also drive home the fact that if the selective ringing idea were not funda-

mentally and economically sound it would long since have been killed beyond resurrection by the gross misuse to which it has been subjected.

Formerly elaborate multi-frequency equipment was required for 4-party harmonic ringing. It was formerly necessary to provide two sets of these machines, operating from separate power sources, at a cost upwards of $1,000.00, which explains why harmonic ringing received such limited application during the early days and also shows how the use of 2, 4, 6 and 8 pole machines forced the use of the 1, 2, 3, 4 frequency ratios with their marginal features and tendency to interference, all of which difficulties have been overcome in the simple and inexpensive non-marginal equipment now offered.

HISTORY OF SELECTIVE RINGING

The purpose of the following is to prove the indestructibility of the selective ringing idea, by setting forth the details of some of the fearfully and wonderfully made systems which it has had to survive. We believe the following description of these early systems, many of which have not been fully obsoleted, will explain the reason for whatever prejudice may now exist against the selective ringing idea.

THE BIASED RINGER SYSTEM

Principle: This is the oldest of all applied selective ringing schemes. The fundamental idea is that of applying a biasing spring to an ordinary polarized ringer so that the tapper will always be held over toward one gong, and will consequently not respond to direct current impulses through the ringer in the direction in which it is already biased, while the ringer will be responsive to direct current impulses in the opposite direction, provided the latter are of sufficient strength to overcome the biasing spring and allow it to perform the function of making the tapper strike the opposite gong during the periods between direct current impulses.

Misapplication: The idea is extremely simple, but as a matter of history, its application was fearfully bungled and selective ringing was brought into disrepute from the moment of its birth, through the failure of its inventors to provide a machine which would produce proper and suitable pulsating current.

Wrong Machine Design: The early machines were so arranged that during the interval between pulsations the ringer was short circuited, and, as every student now knows, under such circumstances, the stored up magnetic energy in the ringers caused them to continue the current during this interval, which caused the ringer to "stick" in the operated position, thereby giving the idea that the springs were "too slow" in action.

Ringer Wrongfully Blamed: Instead of producing a new and correct type of generator, the early engineers continued in an effort to find some substitute for brass and steel biasing springs, having such "molecular valence" that the tension would assert itself instantly instead of lagging as they erroneously supposed the biasing springs were doing. In other words, they were tinkering with the biased ringers, which were all right, instead of getting at the real source of the trouble and producing a proper current by opening the circuit between pulsations, thereby wholly interrupting the current and giving the biasing springs a chance to operate.

Defective System into Service: Thousands of stations were installed, operating on this improper system, which was gotten barely within commercial

margins by using comparatively high voltages and low frequencies with wide armature gaps at the ringers so they could dissipate their stored up energy and allow the current to drop below the strength of the biasing spring before a fresh impulse was received from the generator.

Hair Splitting Adjustments: Each station required individual adjustment. The rule being to set the biasing spring up until the ringer was non-operative, due to the springs being stiffer than the operating currrent; then to gradually slack off the spring until the ringer started to operate; then to continue slackening the spring until the ringer "stuck" and then to tighten half way to the point where it started to operate. Then after a drenching rain had taken several hundred ohms of resistance out of the ground rod, it was necessary to visit this station and readjust the ringer and again pay it another visit during the next dry spell and keep up this performance, according to the seasons and weather. Under these conditions it is not to be wondered at that some of the telephone pioneers acquired a deep-seated prejudice against selective ringing in general, and the idea gained prevalence among the subscribers, that a party line was an abomination regardless of whether it was selective or not.

System Retained Seven Years: As a matter of history, it was nearly seven years from the time the first biased ringer selective systems were put in service that the fundamental trouble in the design of the generator was discovered. While a correct commutator, with an open circuit interval, made the biased ringing systems operative in magneto systems, but comparatively small advantage was taken of the new discovery. This was due to the deep-seated prejudice which had been engendered against the selective system and the natural lack of publicity, even in telephone engineering circles, regarding the simplicity of the stumbling block which had rendered selective ringing systems a dread during all of the preceding years.

Early "Pole Changers" Unsuitable: The further application of the biased ringer selective system was also hindered at this time because, in practically all magneto exchanges, the rotary ringing machines had given way to ordinary vibrating dry battery pole changers, and, while the latter were presumably wired for selective ringing, they contained this same defect of short circuiting the ringer during the dead interval and thereby preventing the proper operation of the biasing spring.

Double Duty for Dry Cells: It is true that the pole changers were later produced with six brushes, or contact points, instead of four as had been formerly used. But as a single set of dry batteries was still used for general ringing purposes, 4-party selective service was brought into still further disrepute through the necessity of permanently grounding one side of the alternating circuit, which tended to increase disturbance in most magneto plants. Another difficulty was that ringing a large number of 80 ohm series bells on heavily loaded rural lines soon pulled the dry batteries down to a point where they did not have sufficient strength to operate the stiffly biased bells. It must be noted that in applying the system to magneto service it was necessary to set the biasing springs up so stiffly that the bells would not be disturbed when ringing in, or by the ring off current coming through the cord circuits from telephones on connected lines. This required a stiff biasing spring, which, in turn, required a powerful pulsating current, not capable of being produced by dry batteries also used for regular ringing.

No Trouble with Proper Equipment: In just a few plants the importance of selective ringing was so fully realized that a separate pole changer with separate ringing batteries was provided and used for the production of

pulsating current. And the fact that quite a number of these systems are still in use, having given satisfactory service for a period of over fifteen years, proves that both the telephone manager and his subscribers were really patient and long suffering with the selective ringing proposition, and that had it not been for the shortcomings of practically all of the early installations, the selective ringing proposition would be looked upon in a far different manner than it is today.

Four-Party Pulsating Suitable for Magneto Only: In many exchanges where proper conditions were provided for successful selective ringing with biased ringers, the fact that the system would not be applicable after the rapidly growing, large magneto plant had been changed to common battery, caused many managers to discard 4-party biased systems, which were operating satisfactorily, and install the earlier harmonic systems. These were not wholly suitable for use with magneto equipment, with the result that the selective ringing idea in such plants gradually played out, and the harmonic ringing equipment was finally junked when a sufficient quantity of new cable had been strung to put all parties on individual lines.

"DIRECT CURRENT" BIASED RINGER

A variation of the standard pulsating system, that should be mentioned in passing, is the so-called "direct current" selective system which came into being to overcome the lack of suitable equipment for producing pulsating current.

Principle: In this system, a set of dry cells was provided in the central office, and instead of using an interrupter with two contacts in the central office for the purpose of interrupting the plus and minus direct currents an interrupter contact was provided on each ringer, so that the plus and minus direct current was carried clear to the telephone and there made into pulsating current by the interrupter contact on the ringer itself.

Advantages and Disadvantages over Pulsating System: This system possessed several disadvantages, but after all some material advantages over the straight pulsating system. The principal disadvantage was the increased cost of maintaining hundreds of interrupter contacts scattered all over the system, one in each subscriber's telephone, in place of the more sensible system of providing a single interrupter with two contacts in the central office.

To offset this, however, was the fact that on a weak battery the ringer would simply "soak" longer before operating, so that while they operated at a very high frequency on fresh, full strength ringing battery and at a low frequency on a weak ringing battery, the fact remained that the ringers continued to operate under both conditions and on a current which would not have been strong enough to operate them at a predetermined frequency.

Not a Credit to Selective Ringing: The direct current system, with vibrating contact on each ringer, was furthermore subject to other ludicrous defects, such as the operation of all the telephone bells in a certain part of town while a heavily loaded trolley car was climbing a hill in that neighborhood. And while, in general, the smaller magneto exchanges had much better luck with the direct current system than with the straight pulsating system, there was nothing about either to make them enthusiastic over the selective ringing proposition, regardless of the enormous savings effected in construction, but the latter incentive was, in many cases, sufficient to make them stick to the system in spite of its defects, which only resulted in embittering their subscribers against the selective ringing propositon.

Freak Equipment: It is also hardly necessary to mention, in passing,

that inventive genius developed still another "direct current" selective system in the form of a polarized relay, which was designed to close a contact and operate an ordinary door bell by means of the talking battery, which absurd system was fortunately "throttled" before the manufacturer fathering same had an opportunity to put it on the market.

Extreme Difficulty on Common Battery: The biased ringer system, together with its various modified forms, was really applicable to magneto systems only. But, notwithstanding this, large operating companies have attempted to operate it in common battery exchanges and it is to this condition probably more than to the shortcomings of the early harmonic systems, that the present prejudice against selective ringing on the part of these same companies is due.

In order to use the biased ringer system on common battery lines it is necessary to allow current to leak to earth through the ringers 24 hours per day, and, in order to reduce this loss of current so that it would not be prohibitive, it was customary to use extremely high resistances in series with each ringer and then attempt to operate a biased ringer with pulsating current, which was very difficult; in fact, almost impossible, even with the late and proper types of equipment for producing suitable pulsating current.

The extreme difficulties of this caused many companies to go to the extra trouble of installing expensive relays in the telephones and selecting the relay instead of the ringer and allowing the relay to connect the desired bell.

With such a system and with the necessity of the installer using a level in hanging the telephone, so that the relay would function properly, the prejudice against selective ringing can be still more clearly understood.

The Superimposed System, as the latest effort to make biased ringers operate on common battery has been christened, is so called from the fact that it uses distorted alternating current in place of pulsating, which distortion is accomplished by placing two sets of storage batteries of opposite polarity, in series with a low voltage alternating current, thereby making the waves of one polarity very strong and reducing the waves of opposite polarity below the strength of the biasing spring.

While it possesses some advantages over pulsating current for common battery systems the superimposed scheme is inferior to pulsating for magneto plants. Both systems, on either magneto or common battery, of course require strict observance of "tip" and "sleeve" or "tip" and "ring" sides throughout the plant, and also a strict observance of polarities throughout the central office equipment, all of which, taken with the fact that they require a ground at every telephone, means the system cannot be compared with the full metallic harmonic system which requires no grounds and cannot be hooked up wrong.

Three-Party Biased on Common Battery: The ludicrous part of these supreme efforts to force the 4-party pulsating system to operate on common battery exchanges is the fact that all this extra effort is gone through merely to get the fourth party on the line. In a few exchanges where this condition was understood, 3-party pulsating selective systems were installed and are still in use, two ordinary biased ringers being connected from the "dry" side of the line to ground and rung with plus and minus pulsating current, while an ordinary ringer, with condenser in series, is connected from the "wet" side of the line to ground and rung either with alternating or pulsating current.

In the latter system, it is unnecessary to change the original subscriber's equipment when a straight line is to be changed to selective, as the original

party's bell can be connected with condenser in series, from the "wet" side of the line to ground, and two bells, without condensers and without resistance coils or relays, or other paraphernalia, can then be connected from the "dry" side of the line to ground and operated with pulsating current as successfully as in a magneto system.

But in this case, the fact that all the trouble was due to the fourth party was not discovered or appreciated in time to save the system, which had already been condemned in the esteem of many of the large companies because of the dissatisfaction resulting from its attempted use as a full 4-party system.

As a result, many large companies went from 4-party clear back to 2-party, which is not, from an equipment standpoint, a selective ringing system, inasmuch as the two sides of the metallic circuit are merely used as two separate grounded lines for ringing purposes.

We have already touched upon many of the reasons why a 2-party system is not satisfactory from a commercial standpoint, the principal reason being that it is impossible to hold an extra station on the line and immediately install a new party on the line in place of a removal, without waiting for the next issue of the directory.

Had the 3-party system been retained, it would have, without doubt, become very popular with the large operating companies. It enables a 2-party system to work to full efficiency, just as a good 4-party system makes it possible to keep all party lines up to three parties all the time and still have one position vacant either for emergency, or for immediately replacing a vacating subscriber without confusion from the old directory.

THE MARGINAL STRENGTH FREQUENCY SYSTEM

Principle: The first applied attempt to get away from the biased ringer selective system was in the form of a 20 and 60 cycle non-harmonic frequency system, which attempted to take advantage of the fact that a condenser offers low resistance to high frequency currents and high resistance to low frequency currents, whereas an impedance coil performs in exactly the opposite manner, by offering low resistance to low frequency current and high resistance to high frequency currents.

By properly juggling an impedance coil and condenser in each telephone, it was found possible to prevent the operation of an ordinary polarized ringer, except by the high or low frequency, according to which way "the trap was set".

Limited Application, Supplanted by Harmonic: While this system was freely and gleefully hailed by many large independent companies as a deliverance from the almost impossible difficulties in connection with biased ringers, it rapidly gave way to the earlier harmonic systems which followed it up almost immediately, although it is doubtful if any great operating advantage was gained by the substitution of 20 and 60 cycle harmonic ringers.

A few large plants are still in service, using harmonic ringers on some stations and polarized ringers with diverting condensers and impedance coils at other stations, and report equally high maintenance under both conditions.

This non-harmonic frequency system received only a very limited application in the magneto field and created no noticeable impression, although for a time there was an attempt to use it in connection with polarized relays to secure a fearfully and wonderfully made 8-party system, which together with the many shortcomings of the system as applied to 4-party work, helped to bury the 4-party idea still deeper.

THE HIGH VOLTAGE RATIO FREQUENCY SYSTEM

This earliest harmonic system was first sold by the Kellogg Company in 1902. It was a real 4-party selective system while all of the systems previously discussed were in reality but 2-party and were made into 4-party only when the 2-party selection was applied on each side of the line to ground, thereby constituting a compound condition, by the use of which the new 4-frequency harmonic system automatically became 8-party instead of a 4-party.

Principle: The theory of the harmonic ringer will not be considered here, and while the theory of operation of the harmonic ringer was the same in 1902 as it is today, great difficulty was encountered at that time in getting a suitable machine for generating the ringing current, and, as in the case of the older biased ringer system, the difficulties encountered with the early harmonic systems were not due to any fault of the ringers, but to the lack of a suitable device for producing proper ringing current.

Ratio Frequencies Wrong but Unavoidable: From the pendulum principle on which all harmonic ringing operates, the merest novice can see that definite ratios are to be avoided, or there will be a tendency to false operation, as a child in a swing will swing when pushed every other time just as well as when pushed every time, the only difference being in a greater amplitude of vibration when pushed every swing.

But in spite of this recognized principle and with full realization of the difficulties which were going to be encountered, the 1, 2, 3, and 4 ratio was forced upon the engineers of the early harmonic system because they were dependent on two, four, six and eight pole generators, mounted on a common shaft with the driving motor.

With all five armatures mounted on a single shaft, considerable difficulty in securing absolute speed regulation was encountered with the fluctuations of commercial current, and it was realized that any attempt to introduce gears in order to break up the frequency ratio of the several generators would render speed regulation impossible under the variations of commercial current and under the variations in the ringing load itself.

For this reason, and because of the fact that vibrating pole changers for this service were at that time unknown and would not have been considered by the engineers of that period for the extremely large exchanges under consideration, the ratio frequencies had to be adopted and the attendant difficulties overcome in another manner.

To make the story short, it was necessary to use low resistance ringers in series with low capacity condensers, which is the worst possible condition for efficient results from the ringer.

System Largely Marginal: But as the system was partly marginal strength and partly harmonic, it was absolutely necessary to so "ballast" the ringers that in connection with the difficulties of ringing them purposely imposed, the difference between the longest and shortest lines on any exchange would become negligible.

Had the four ringers been wound to 1,000 ohms each and had 2 M. F. condensers been used, as is the present practice with modern harmonic ringers, interference would always have been present and helpless confusion would have resulted.

By the use of 500 ohm ringers for the three higher frequencies and of a 2,500 ohm ringer for the lowest frequency and the use of 1 M. F. condensers in series with the ringers, a system was secured which operated in a very satisfactory manner on a common battery plant where the fluctuations in battery

voltage were not too great. In single battery offices where the potential was likely to fluctuate from 22 to 28 volts, it was usually necessary to employ end cell switches, or switches to cut in counter E. M. F. cells while the storage battery was being charged. Hundreds of exchanges are still using this old system at the present time and are getting good commercial results, although there is still enough maintenance to prevent any enthusiasm regarding the 4-party proposition either on the part of the management or the maintenance men or among the subscribers themselves.

One of the reasons why the ratio harmonic system is not in better repute is the excessively high voltages which must be used to ring the higher frequency bells under the ballasted conditions which have been imposed to prevent interference.

The Kellogg ratio system contemplated the use of 100 volt current for the 16⅔ cycle bell, of 135 volt current for the 33⅓ and 50 cycle bells and of 150 volt current, as a maximum, for the 66⅔ cycle, or highest frequency.

Other Systems Still Higher Voltage: Practically all other manufacturers have found it necessary to go to 175 volts as standard for the highest frequency, the use of which current, it must be admitted, is not the best of practice in ordinary paper insulated telephone cables.

Two Hundred to Two Hundred and Twenty Volts Often Used—System "Commercial" but Not Satisfactory: In addition to this, the fact that rotary machines are now rarely used, makes it possible for the maintenance man, with a single twist of his screw-driver in setting the contacts excessively close, to shoot the voltage up 25 to 40 points higher than the standard voltage should be, and this is frequently done in order to cause refractory high frequency bells to ring, with the result that it is not uncommon to find 200 and even 220 volt ringing current, with extremely sharp top waves, in actual use in many telephone exchanges. So that we again state that there is nothing about the ratio 4-party system to cause either the maintenance men or the management, or the subscribers to become enthusiastic about it, and many of such systems have been discarded by perhaps over-conservative plant men who would not stand for the use of these high voltage, high frequency currents in their cables.

THE MODERN LOW VOLTAGE HARMONIC SYSTEM

This modern 4-party system, put out by the Kellogg Company nine years ago, took cognizance of the fact that the ratio frequencies should have been abandoned on the advent of the vibrating pole changers, and, as any desired frequencies could be procured with the pole changer equipment, it was decided to place the lowest 4-party frequency at 30 cycles, which is well above the range of an ordinary hand generator, while the remaining three frequencies were arrived at by adding 12 cycles for each interval, thereby making the four frequencies 30, 42, 54, and 66.

Principle: It will be noted that the relation between these frequencies is arithmetical but not one of ratio. In the old ratio system it will be noted that the least common multiple of 16⅔ and 33⅓ is 33⅓, or a straight 1 to 2 ratio, whereas the least common multiple between 30 and 42 is 210, thereby relieving the ringers of all tendency to interfere, since it is only once in a "blue moon" that the current is in step with the natural vibration of any other ringer, and is then in step only for an instant and immediately gets out of step and destroys any tendency for interference which might have been created.

As a result, it is possible to wind each of the four bells to the standard exchange resistance of 1,000 ohms and to use in series with each bell on common battery systems the 2 M. F. condensers which are now recognized as essential to the best and most efficient transmission.

The absolute correctness and non-marginal properties of this system are further demonstrated by the fact that on magneto exchanges no condensers whatever are needed and it is possible to bridge the four bells "raw" across a zero loop and operate same to full voltage without the slightest interference. In other words, the four bells can be used on zero loops, or on loops of the most extreme resistance, and the condensers used at each bell may vary from ½ M. F. to unlimited capacity, or the condensers may be dispensed with altogether on magneto systems and the bells bridged directly across the line.

System Equally Suitable on Magneto or Common Battery: This means that when magneto plants are changed to common battery all of the central office ringing equipment can be retained and the ringers themselves utilized in common battery telephones, ordered less ringers. Furthermore, and regarded by many as most important of all, is the fact that this new harmonic system requires only a maximum of 100 volts for the operation of all frequencies, so that cables are not subjected to any currents stronger than those used for regular single party ringing, and the resulting discomfort to the subscriber in case he be rung in the ear on an unprotected system, is no greater than when this happens in single party exchanges.

Twenty Cycles Best for Regular Ringing: As 100 volt current at a frequency of 30 cycles is a little too fast for best results on old and heavily loaded rural lines, having badly worn, long stroke ringers, it was decided to build the new pole changers in five frequency units, employing 20 cycle current for regular ringing and dedicating the four higher frequencies to selective ringing only.

Fifth Frequency for Regular Ringing Makes Four-Party "Fool Proof:" In addition to securing better results when ringing on heavily loaded toll and rural lines, the fifth frequency also plays a very important part in making 4-party service satisfactory to the subscriber, for the reason that when the operator, through any negligence or mistake, rings on a line in the regular manner she will not disturb the bells of any party thereon, whereas on all systems where one of the harmonic frequencies is used for regular ringing, this party is being continually rung falsely.

The foregoing is particularly true in the hundreds of smaller exchanges where it is neither necessary nor advisable to provide 4-party button type individual indicating keys in each cord circuit.

Individual Indicating Keys Not Required: In practically all exchanges, both magneto and common battery, 4-party selective ringing is first installed on a comparatively small scale and without any means of determining in advance the extent to which it may be used.

For this reason, in practically all cases, master keys should be installed at the beginning and the 4-button indicating keys should never be put in except in those cases where their installation becomes advisable through an enormous 4-party development.

The practice of too many manufacturers, in recommending that an exchange install several hundred dollars' worth of 4-button indicating keys before installing twenty 4-party harmonic telephones, as a starter, has had a great deal to do with bringing 4-party service into disrepute.

Cam-Type Keys Better and Faster for Regular Service: Operators invariably and quite naturally prefer the familiar and readily operated cam type ringing and listening keys to any 4-party indicating button keys which might be installed, so that the removal of the cam type keys and the wholesale installation of the button type indicating keys to take care of perhaps 1% of the total calls, is certainly nothing but plain folly, and we believe that in all exchanges starting 4-party harmonic ringing service on a limited scale, master keys should be used so that the 4-party service will in no way interfere with or affect the regular service, and we further believe that the master keys should never be changed to individual 4-party keys until the 4-party development has reached a point where this latter change is really demanded.

Four-Party Outbound Traffic Extremely Light: The point that has been too generally overlooked in connection with the whole 4-party proposition is the fact that when 4-party service is properly applied, the selective telephones are installed in the outlying districts of the city, in the residences representing a lesser order of social importance, and that these stations do not receive anywhere near as many calls as do the stations of even average social importance. In other words, 4-party service, when properly used, is largely a one-way service, and in view of the fact that it is not frequently necessary to call these telephones in proportion to the number of calls which they make, there is no reason why a master key is not wholly sufficient to care for even a very large development, and this is borne out by the fact that among the smaller and medium sized companies, those who have made the greatest success and profit with 4-party service have operated on a master key basis, whereas nearly 100% of the exchanges who have abandoned 4-party ringing have attempted to operate a small development with the unnecessary complication of full 4-party indicating keyboards.

A thorough appreciation of this matter and the realization that it is not necessary to disturb a fast operating cam type keyboard in order to install 4-party telephones in the outlying districts, should result in the starting of 4-party harmonic service in hundreds of exchanges where it is now considered too much trouble for the savings and benefits to be derived.

Regular Ringing Should Be 20 Cycles: As a matter of engineering history, it should be mentioned that the selection of 20 cycles as the regular ringing frequency was not a matter of accident. Both 16⅔ cycles and 20 cycles were already standard frequencies, but the 20 cycle frequency was selected because of its lack of tendency to interfere with any of the other frequencies when the operator neglects to set the 4-party key, or sets it too late, or restores it too early.

This condition formerly made it practically impossible to get results on other selective systems by the use of a master key, for in spite of all warnings, no fast operator can avoid setting master keys an instant late and more especially restoring them an instant too early, and the five frequency system is the only one which avoids a resultant false ring.

First Used for Magneto Only: When this improved five frequency system was first put in service some nine years ago, it was erroneously presumed by many that its use was limited to magneto systems and that the low voltages employed would not be sufficient to ring the bells on a common battery system through the condensers, which it would then be necessary to use. As a matter of fact, the insertion of any commercial condenser in series with the ringer makes no appreciable difference in its operation, and the advantages of the low voltage, five frequency non-ratio system for common

battery exchanges are even greater than on magneto exchanges. And for this reason, it has been the policy of the Kellogg Company for many years past to recommend the installation of the low voltage, non-ratio harmonic system on all new installations, both magneto and common battery, and to change over to this system all existing high voltage ratio equipments where the investment in ringers has not reached a prohibitive figure.

First Systems Operated "Direct" from Dry Cells: In order to bring the new system into the smaller magneto exchanges, which were then without any satisfactory 4-party system, it was the practice of the Kellogg Company, for many years, to furnish the new system for operation from dry cells, without the use of transformers, thereby getting the original investment down to an almost negligible figure, as it was only necessary to purchase a 5 frequency vibrator, a barrel of dry cells and a couple of master keys and the magneto plant was ready to give 4-party service.

This, however, resulted in the purchase of 4-party harmonic outfits by a great many extremely small magneto plants which were not really justified in giving 4-party harmonic service and some of whom purchased the equipment because of its trivial cost, largely for experimental use.

As a matter of fact, no exchange should, in our opinion, consider the installation of a 4-party system until sure that at least fifty telephones can ultimately be placed on such service, and where this number of 4-party stations is in sight, the installation of a standard storage battery harmonic equipment is recommended.

The disadvantage of the dry cell harmonic system is that the requirements of regular ringing rapidly pull the dry batteries down until they are not up to standard condition for the operation of the 4-party bells, this being the same old trouble that was encountered in the early days of the biased ringing system, when it was found that the same battery could not be successfully used for generating the regular ringing current and the selective ringing current.

In the most successful magneto harmonic exchanges, storage battery outfits were installed at the very beginning, and the only other magneto exchanges meeting with complete and continued success are those in which a small storage battery has been installed for the purpose of driving the vibrators and of doing all the regular ringing, while a set of dry cells, dedicated to that particular purpose, has been used for the operation of the 4-party bells.

This relieves the dry cells of all load and drain, except when actual harmonic ringing is being done, and several cases have come to light where a set of dry cells, dedicated to the harmonic ringing, have been used for three-year periods and, of course, at negligible expense.

The idea of the small battery suitable for driving the vibrators and doing regular ringing, but not large enough to keep all five transformers "hot," was to keep the battery small enough to be successfully charged with an electrolytic rectifier, which was, until recently, about the only inexpensive commercial device for charging storage batteries from alternating current.

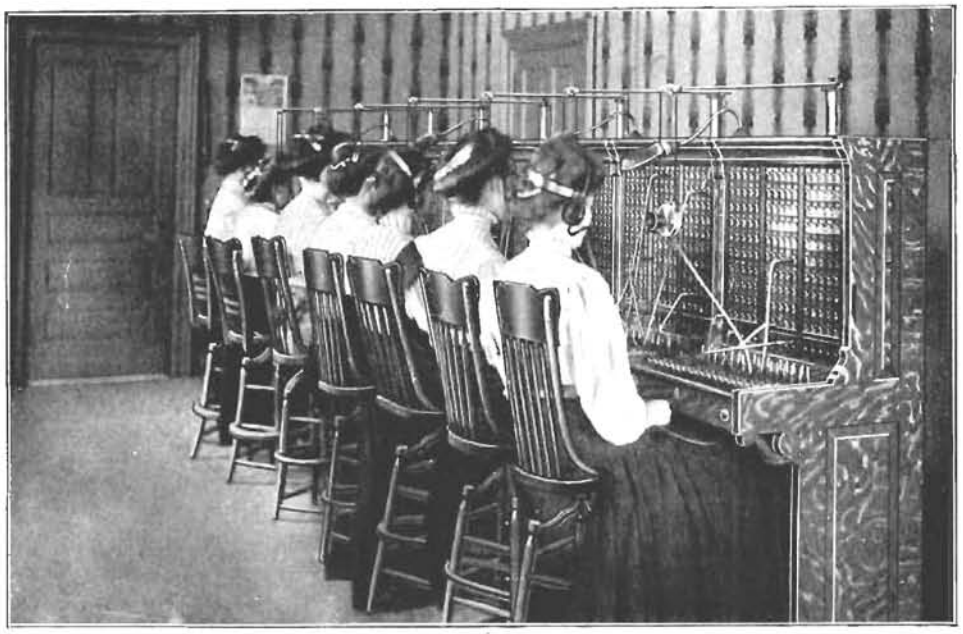
However, a few exchanges, realizing the advantages of storage battery ringing for the harmonic service, were willing to go to the extra trouble of wiring up their master keys so as to close the harmonic transformers only when it was desired to ring from them, and the remarkable and uniform success in such exchanges has resulted in recommending this as standard practice, so that small and inexpensive storage batteries may be used in magneto plants and the current drain kept negligibly low in common battery installations.

Modern Equipment Ideal: With the advent of the inexpensive Tungar rectifier to replace the mussy and somewhat unsatisfactory electrolytic rectifier, and with an increase of nearly 100% in the cost of dry cells, there is no reason why any magneto exchange of any size should be without the benefits of storage battery ringing equipment. And where same is to be installed, it costs so little more to provide 4-party ringing equipment that wherever this service can be used to advantage and an ultimate of 50 stations or more can be secured for the service, it should, by all means, be installed.

Of course in common battery systems, the storage battery is already present and there is no "source of power" to be provided, under which circumstance every common battery plant running short of cable capacity should purchase the necessary equipment to install 4-party service in their outlying districts and so conserve what cable they have left.

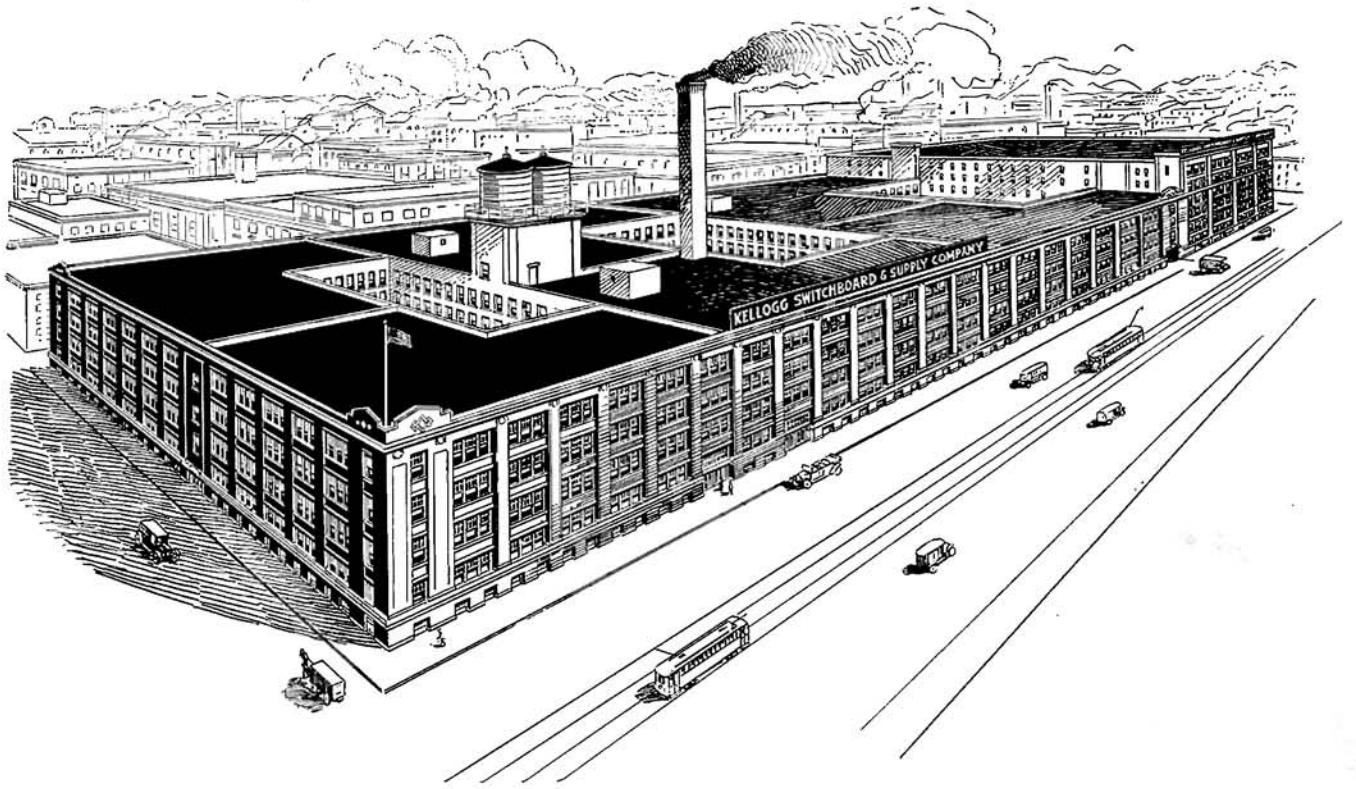
Such is the story of the selective ringing proposition, and, in view of the fact that it has withstood the effects of gross misuse and improper application during a period of over twenty years, it is bound to rapidly grow in favor with the advent of so satisfactory and entirely commercial and "fool-proof" a system as is now available. And because of the almost prohibitive cost of extending construction to the thinly populated outlying districts of small and medium-sized towns, we predict, during the next few years, an unparalleled development and increased use of 4-party harmonic service, which, after so long a time, is really just beginning to come into its own.

Write us of the conditions and needs of your plant and we will outline the necessary equipment for efficient, economical service.



The purchase and installation of Kellogg harmonic ringing equipment on the above overgrown magneto exchange in 1913 made possible the retention of all the equipment without loss in connection with the new equipment shown below installed in 1916. FOUR PARTY PLANTS PROSPER.

Universal Switchboard at Beloit, Kansas, 600 lamp lines. An exact duplicate of this equipment subsequently purchased for their Clay Center exchange.



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