# NATIONAL RADIO NEWS

**IN THIS ISSUE**

Home Construction of Radio Equipment

Servicing F.M. Receivers

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# HOW AND WHY

There is an exceptionally fine quotation I want to pass on to you. I do not recall the name of the author, but the truth in the quotation is unforgettable. Here it is:

"The man who knows HOW will always have a job—the man who knows WHY will be his boss."

Your NRI training fits this thought perfectly. You are being taught HOW to repair or operate Radio and Electronic equipment, so you can be prepared for work in this, your chosen field. Also, your training gives you the background of WHY this equipment functions as it does.

We want you to have an assured future and every opportunity to advance to the top. You will need only the touchstone of a little practical experience to weld "HOW and WHY" training into a single, compact unit of knowledge that can lead you wherever you wish to go.

J. E. SMITH,

President

# Problems Involved In Home Construction Of Radio Equipment

Louis E. Garner, Jr.

BY LOUIS E. GARNER, JR.

NRI Consultant

ONE of the greatest thrills which a student Radiotrician can receive is to point with pride at a newly built and operating piece of Radio equipment and say "I built it." Almost every successful Radioman has at one time or another built equipment for his own use, or for sale. Look in almost any Radio magazine and you will find numerous construction articles.

However, construction of Radio equipment is considerably more than simply putting parts together according to certain instructions. This is, perhaps, the simplest way to build Radio equipment—that is, assembling parts according to a pictorial diagram and according to specific step-by-step instructions. Since this is the case, it is the recommended method for beginners. In fact, for more complicated pieces of equipment, it is even the recommended procedure for more advanced technicians.

Such construction (pictorial diagram and step-by-step instructions) can be done by almost anyone, without previous knowledge of Radio. The only essential requirements are that the person be able to carry out basic mechanical operations—use a screw driver, soldering iron, etc.—and be able to recognize the various radio parts.

To build equipment from nothing more than a schematic diagram is something which can be successfully undertaken by skilled and well-trained technicians who have had years of experience to aid them in their work. This is something that should not be undertaken by a beginner, however. The problems involved in home construction are many and all of them could not be discussed in one short article. Because of this, it is felt that a series of questions and answers would enable us to best point out the many pitfalls awaiting prospective builders.

These questions are based partly on direct questions which have been asked by our students and graduates and partly upon composite questions—that is, questions made up of a series of similar questions. In answering each question, we will attempt to examine the major problems involved and the best methods for overcoming them. In some cases, no specific method will be mentioned—rather, we will imply that experience and additional training is the only remedy—this is true in most cases.

Let us proceed with the questions:

Q. IS HOME CONSTRUCTION EASY?

A. The proper answer to this question will depend upon the definition of "easy" and on what is being built and on what is being used to build it. That is, it is certainly easier to build a one-tube set, for example, than it is to build a 30-tube Television receiver. Further, it is much easier to assemble a kit from a set of parts than it is to build a set using only a schematic diagram.

If a kit of parts is used, a punched and drilled chassis will usually be included in the kit—this automatically eliminates a large percentage of the mechanical work necessary. With a kit, the construction becomes merely a matter of mounting the parts as shown on the pictorial diagram and wiring the set according to the pictorial.

If a piece of Radio equipment is to be built from a magazine construction article or from a schematic diagram, it is not only necessary to mount parts and wire the equipment, but it is also necessary to do the machine work necessary on the chassis. It becomes necessary to lay out, drill, and punch the various holes necessary for the mounting of the parts. Only after this is done can the wiring be undertaken. Such machine work requires that the builder have considerable equipment available and, usually, that the builder has had previous experience in sheet metal work and is familiar with the techniques involved.

Further, if one undertakes the construction of a piece of equipment simply from a schematic diagram, then the job is further complicated with lay-out problems—that is, the actual mechanical arrangement and physical location of the various parts used. We will discuss layout in more detail later.

Of course, if one undertakes the construction of an entirely new piece of equipment—for example, attempts to re-design a standard amplifier circuit for a special application, then a certain amount of experimentation may be necessary in order to get optimum results. It becomes necessary for the builder to sometimes try a number of different size resistors or condensers in various parts of the circuit to get the desired performance. If the builder has a knowledge of engineering practices and laboratory techniques, such experimentation can be reduced to a minimum. If the builder has no experience in the Engineering field and is not familiar with laboratory techniques, such experimentation may be time consuming and somewhat irritating.

Thus, to sum up, home construction of Radio equipment is not usually an easy job. It is easiest, of course, where the builder uses a kit of matched parts and builds a standard item without attempting changes in the design.

Q. IS THE EXPERIENCE GAINED IN HOME CONSTRUCTION OF VALUE?

A. This, also, is a debatable question. That is, the answer depends strictly upon the interpretation. It is true that there is a great deal of practical experience in soldering and assembling parts gained by constructing equipment. Further, if the builder runs into trouble and must "troubleshoot" the equipment himself, he will gain a good deal of valuable experience.

However, in general, not very much is gained by simply putting together equipment. Almost any person who is handy with tools and a soldering iron can put together Radio equipment if given the proper materials and instruction—no knowledge of Radio is to be gained by such assembly nor is the construction experience of value when repairing other sets. That is, a person may be able to build excellent equipment and may even be able to do design work and still may not be a good repairman.

The best experience can be gained, not by building equipment, but by carrying out a series of planned experiments designed to demonstrate certain fundamentals and certain circuits as is done in the NRI practical demonstration course. By carrying out such experiments, the worker not only gains the experience of handling and assembling Radio parts, but is also able to demonstrate theory for himself—by actually demonstrating fundamental principles, he can firmly fix them in mind and become familiar with basic circuit operation regardless of where he runs into the circuits.

For example, a series of experiments on a.c. power supplies will give the background necessary for work on any type of a.c. power supply—whether a tube is used as a rectifier or some other device (such as selenium rectifiers, copper oxide rectifiers, etc.). Further, the basic knowledge gained will be applicable to any similar circuit—whether it is a heavy duty high voltage supply or a low voltage low current supply such as is found in receivers.

To summarize our answer, we might say that there is some value in the experience gained by constructing equipment but this experience does not compare with the experience to be gained by carrying out a planned series of experiments.

Q. IS IT CHEAPER TO BUILD YOUR OWN EQUIPMENT?

A. As far as receivers are concerned, the answer to this is definitely *NO!*

In order to check the typical cost of building a set, a list of parts was made up based on the average number of parts used in a standard 5-tube superheterodyne receiver—all parts were included, resistors, condensers, cabinet, chassis, screws, terminal strips, etc. After this list was made up, each item was priced with the average net price based upon several listings obtained from wholesale catalogs. It was found that the cost of parts needed, together with shipping costs, was approximately $26. This, of course, is the net wholesale price. If the same parts had been purchased at list prices from a local Radio shop, the price of the parts necessary would run around $43 to $45. Note that this is for the basic parts only. Labor has not been included. The chassis is a blank chassis and would have to be drilled and punched. The parts would have to be mounted, the wiring carried out, and the final set mounted in the cabinet (necessitating cutting a hole in the cabinet for the dial and mounting a piece of "window"). The set would have to be aligned and adjusted, of course.

An equivalent 5-tube superheterodyne receiver can be purchased complete and ready for operation at about $16 to $17 wholesale. There are some sets available even cheaper than this.

On the other hand, kits of matched parts are available for building sets priced as low as $9.95 for a 5-tube set.

Of course, there are more expensive kits—the price of some kits running more than $20. Because of this, and because we are speaking of averages, one might take the figure of $15 as a fair average for a 5-tube superheterodyne kit complete with cabinet. This is quite cheap when compared to the net price of the parts purchased separately and even somewhat cheaper than a complete receiver purchased at wholesale prices. Also, the chassis furnished with the kit will be punched and drilled so that there will be a minimum of mechanical work involved.

A similar situation exists when one considers the construction of test equipment. As far as test equipment is concerned, however, this is not very well adapted to home construction—perhaps the biggest drawback is the need of accurately calibrating the equipment once it is built. To accurately calibrate the equipment, considerable precision laboratory equipment must be available. When one realizes that laboratory signal generators used for calibration will cost, in some cases, more than $500 and that most precision equipment will cost in the hundreds of dollars, then it becomes somewhat uneconomical for one to attempt to build and calibrate his own test equipment.

To sum up—in almost all cases it is far cheaper to purchase factory built equipment, receivers, amplifiers, etc., than to attempt home construction—even if the labor involved is not considered. About the only time that home construction of equipment becomes cheaper than factory-built equipment is where the item to be built is a very specialized device—that is, something which is not commercially available and which must be custom-built.

Q. IS ANYTHING MORE THAN A SCHEMATIC DIAGRAM NECESSARY FOR HOME CONSTRUCTION OF ELECTRONIC EQUIPMENT?

A. The answer to this question depends on the individual—for a skilled and experienced technician or engineer, thoroughly familiar with various electronic circuits, a schematic diagram is usually the only thing necessary—provided the schematic gives full details as to part values, coils, etc. The technician will then lay-out and wire the device according to the schematic diagram—depending upon his experience to enable him to select the most suitable lay-out to start. If he runs into any trouble with his lay-out, he will usually know where to look for the trouble and can correct it by changing the lay-out slightly.

For the beginning student or one who has had a limited amount of design or construction experience, considerably more than the schematic diagram is necessary. In most equipment, lay-out is fully as important as the original schematic. That is, bad lay-out can cause the equipment to function incorrectly—cause oscillation, squealing, etc., or, in some cases, even cause the finished equipment to be completely inoperative.

Further, if trouble is introduced due to bad lay-out, it is quite hard to find since all voltages may measure normal and all parts check properly. An experienced technician, of course, would be able to check the lay-out and note any errors. Even then, it would probably be necessary for the technician to experiment to some extent in order to get an optimum lay-out.

In commercially manufactured equipment, several lay-outs may be tried before the most suitable arrangement of parts is arrived at. Thus, you benefit by this experimentation when you purchase a commercially manufactured unit.

Nor can the rules for lay-out be written down simply so that anyone can follow them—proper lay-out technique is something that is gained by experience.

For example, a good rule to follow is to make all connections and leads as short as possible. This will be strictly dependent upon the lay-out of the parts.

If you will refer to Fig. 1, you will see that a condenser has been connected between pin 3 of one tube socket and pin 5 of another tube socket. This is about the shortest connection that can be made with that lay-out of sockets—that is, as long as we try to keep the lead from going across the other lugs themselves. However, by rotating one of the sockets 90°, as shown in Fig. 2, the lead length can be greatly reduced and the connection be made much more direct.

From this, we can see that the actual physical location of the sockets is not only important (and other parts, of course) but also the actual positioning of the sockets. Compromises must often be made—that is, some connections must be made longer so that other connections can be

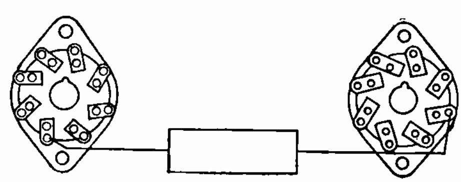

Fig. 1

made shorter and more direct. Which connections are critical will be dependent upon the circuit being used and other factors which will vary with the individual case.

Further, running direct leads is not always the best thing to do. In Fig. 3, for example, a lead is run between pin 8 of one tube socket and pin 8 of another tube socket. The lead is run reasonably direct and short—note, however, that it lies right alongside of the filament wiring. Because of this, in some circuits, considerable hum might be picked up.

Experimentation may show that running the lead on a less direct route such as is shown in Fig. 4 may prove more satisfactory. This, too, is something that must be determined by experience and by actual experiment with the particular circuit involved.

In some cases, it might be found more desirable to change the filament wiring rather than to increase the length of a lead which passes near the filaments.

The actual location and positioning of chokes, transformers and coils is of utmost importance. Hum can be easily picked up by a coil which is influenced by the magnetic field of another coil—this is true of r.f. circuits as well as a.f. circuits.

In Fig. 5, two coils or transformers are shown—this is not the best lay-out. A better lay-out would be to rotate one of the coils by 90° as shown in Fig. 6. In some cases, even a complete 90° rotation will not prove satisfactory and experimentation must be carried out to determine the best positioning of the coils for minimum hum pick-up or inter-action.

Lay-out is not the only thing which must be taken into consideration. For example, the schematic diagram seldom shows operating voltages. Because of this, the builder may inadvertently obtain a power transformer which will supply higher or lower voltages. In some cases, the voltages are not critical. In other cases, however, the use of different operating voltages from those used in the original equipment may cause distortion, may cause oscillation and squealing, and may render the equipment completely inoperative. This necessitates additional experimentation.

Of course, if the builder has had considerable experience and training, he may be able to distinguish between the critical and non-critical circuits and therefore avoid trouble in advance.

Where the builder wishes to add or to make circuit changes in a piece of equipment which has already been manufactured—for example, add a noise limiter to a receiver, additional problems are encountered. For one thing, the builder usually does not have engineering information available about the equipment on which he is working—that is, he does not know how much distributed capacity the manufacturer allowed for in designing the receiver, how much circuit loading is allowed on the tuned circuits, how much gain is necessary for optimum operation, etc.

Because he does not have this information available, any attempt to make engineering changes in a set may result in more trouble than was bargained for. In fact, the equipment may operate so unsatisfactorily that nothing can be done but to remove the changes and rebuild the set as it was originally. Because of these difficulties, it is not usually recommended that any attempt be made to change the basic receiver (or equipment) design.

Further, the time and money involved in attempting to experiment to find the proper lay-out or to try different parts values to obtain optimum operation, may amount to more than the cost of purchasing completely new equipment. After all, to the practical serviceman, time is worth money.

Q. IS THE PERFORMANCE OF HOME-BUILT EQUIPMENT GENERALLY BETTER THAN COMMERCIAL APPARATUS?

A.Generally speaking, NO! A little thought will enable you to see why—the builder of commercial equipment may spend several thousand dollars engineering and developing a single piece of equipment which may sell for as little as $30 or $40 (in quantity). Further, the manufacturer will have a staff or highly paid and well-trained engineers available for the development of his product and, in addition, will usually have a well-equipped engineering laboratory available with thousands of dollars worth of precision test equipment. Naturally, the home builder, with his limited resources, cannot expect to compete with the manufacturer.

It is true, of course, that a skilled technician with proper resources available may build a piece of specialized test equipment or a piece of specialized electronic apparatus cheaper than a commercial piece of equipment can be purchased—it may also operate better than a corresponding piece of commercial equipment. This is true primarily because most commercial eequipment must be manufactured on a quantity basis in order for the manufacturer to make a reasonable profit. Because of this, most manufacturers cannot profitably undertake the manufacture of highly specialized pieces of equipment and, therefore, such specialized equipment will not be generally available. Where it is available, the purchaser must usually pay for a large percentage of the engineering costs, since the equipment is practically "custom-built." Since the home builder (provided he is trained and has consid-

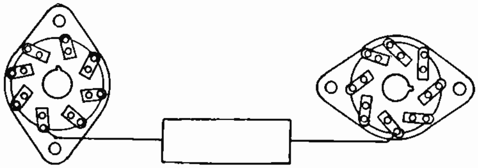

Fig. 2

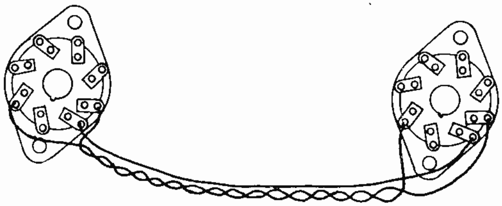

Fig. 3

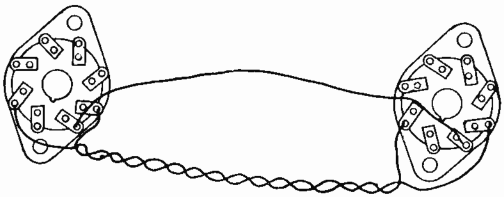

Fig. 4

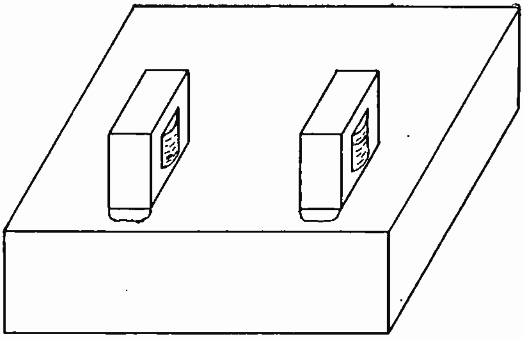

Fig. 5

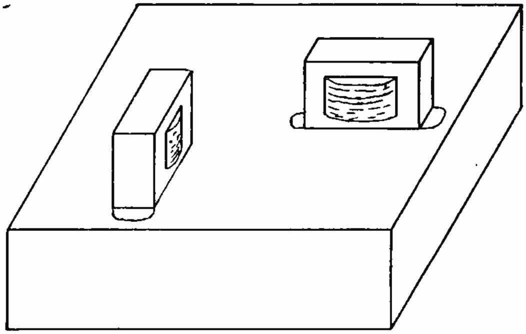

Fig. 6

erable experience) need not consider the engineering cost involved, his total cost may be cheaper than the purchase price of the commercial equipment.

If, however, he should figure his time at the rate usually charged for consulting engineering services, then he would probably find that the total cost of building a piece of specialized equipment would run about the same as the purchase price, if not more.

The average serviceman has no call for specialized equipment which is not commercially available, however. Further, almost any piece of equipment except those needed for special engineering applications are available commercially—that is, there are amplifiers, public address systems, commercial receivers, high quality phonograph reproduction systems, phono-oscillators, capacity operated relays, photo-electric relays, etc., available commercially. There is an additional advantage in using commercial equipment, the performance standards of commercial equipment are already set up and one may check quite easily to see if they will fit his requirements. The performance of home-built equipment, however, is a questionable factor and numerous tests must be run before any resemblance of accurate engineering information can be assembled.

Q. HOW ABOUT BUILDING TEST EQUIPMENT?

A. We have already pointed out many general problems which the builder of test equipment will run into. It would be well to itemize the special problems encountered when building test equipment.

Test equipment is usually used for one of two things—supplying something—an r.f. signal, an a.f. signal, a regulated voltage, etc. Or, for measuring something—voltages, observing wave shape, checking frequencies, etc. Because of this, the term "test equipment" implies something which uses a scale of some sort from which readings can be taken or facts observed. This further implies the need for accurately calibrating this scale.

That is, if one were to build a multi-tester, he would have to have equipment available for accurately checking voltages so as to compare them to the readings made on his home-built equipment. If one should build a signal generator or a tuned type signal tracer, it would be necessary to have equipment available for accurately checking the frequencies involved—

*(Page nine, please)*

# NRI Graduate Paul G. Miller
## Introduces Television in Maumee, Ohio

The above photo shows NRI Graduate Paul G. Miller (left) and his assistant, Carl Parker (right) making adjustments on the Television receiver which Graduate Miller constructed. In the photograph, Mr. Miller's assistant is holding a mirror in such a way that Mr. Miller can observe the image appearing on the Television receiver's screen while making final adjustments from the back of the Television set. Notice the fine layout of the service bench and test equipment shown in the background—ideally suited for fast and efficient Radio and Television service.

*Dear Mr. Smith*:

"By redesigning my Television set with an idea of my own, I am successfully bringing in Television programs from Detroit, eighty-five miles away. My antenna system consists of a director, dipole, and reflector, located only forty-four feet above the ground.

Anywhere from twenty-five to thirty persons are in every evening to watch Television broadcasts. Also, my Radio repair business doubled since I completed construction of this Television receiver.

Only three years ago I heard of the National Radio Institute's Course, and today I am considered an expert Radio and Television Technician. After the fifteenth lesson I started doing minor repair jobs, and by the twenty-eighth lesson I had earned enough to completely pay for my Course and $50 over. I could hardly wait until I started my first experiments. They were fascinating, and when you are through you really know Radio. The biggest thrill I got out of the whole Course was when I completed building the five-tube superheterodyne receiver and heard it play.

Now, thanks to the National Radio Institute, I am the owner of the *Miller Radio and Electrical*

*Appliance Company* in Maumee, Ohio. Besides doing service work for seven dealers, we give authorized service for Philco, General Electric, Stromberg-Carlson, Farnsworth, and Lear Radios. We handle all warranty work on these receivers. In addition to myself, there are four people employed in my organization.

We receive on the average of eight to ten receivers per day for repair. The Radio training that I received from NRI enables me to do fast, thorough, and dependable Radio repairs. In all, I have serviced over five hundred sets. Customer clientele come to us from a thirty-mile radius, and business is growing more and more every day.

I cannot praise NRI too much, as the training program you give in Radio and Television is "tops." My advice to anyone interested in following Radio and Television as a career is to get the proper training in theory and practice through NRI."

Sincerely yours,
PAUL G. MILLER,
329 W. Wayne Street,
Maumee, Ohio.

———— *n r i* ————

## Problems Involved in Home Construction of Radio Equipment

(*Continued from page seven*)

further, as far as a signal generator is concerned, the builder should have equipment available for checking the output voltage.

If one is to build a test amplifier or similar piece of equipment, he should have equipment available for checking the frequency response, amount of distortion introduced, etc. Otherwise, he will not know whether distortion he observes is introduced in the equipment under test or in the test amplifier itself.

Of course, if the builder has all of the test equipment necessary for calibrating and checking the equipment he builds, there is little point in building the equipment in the first place. Further, in most cases, the builder will find it difficult to obtain the precision parts necessary—these are made under special order for the manufacturers of test equipment and the builder who can only buy from local distributors or large mail-order houses has little opportunity to purchase such precision parts unless he purchases in manufacturer's quantities (say lots of 10,000).

Q. HOW SHOULD I "TROUBLE-SHOOT" IN HOME-BUILT ELECTRONIC EQUIPMENT?

A. "Trouble-shooting" home-built electronic equipment is quite a job—even for an experienced technician. In general, basic test techniques will be used.

For example, if a receiver has been built and it is inoperative, one would try to isolate the trouble by means of a circuit disturbance test. If the receiver were noisy or the signal was distorted, one would try to isolate the trouble by means of a stage blocking test, or some variation thereof.

Trouble-shooting in test equipment, however, is complicated by factors which are not involved when you trouble-shoot commercially-built equipment. In the first place, you cannot be absolutely sure that the equipment is wired correctly—even the best technician occasionally makes mistakes in wiring. Further, you cannot be sure the right parts were used in all cases—this is particularly true as far as r.f. components are concerned—coils, condensers, etc.

Since the lay-out is so important in some cases, this too complicates the trouble-shooting. That is, if the lay-out is incorrect, then considerable testing may not indicate the cause of the trouble.

If the equipment built is a newly designed piece of equipment—that is, something which has not been built and engineered previously, then there may also be some error or fault in the basic design. In a case like this, it is not a matter of finding the defective part but a matter of correcting an incorrect design.

One might sum up the complications quite easily. When trouble-shooting commercial equipment, it is usually a matter of finding a particular defective part which caused a piece of equipment to operate improperly. When trouble-shooting home-built equipment, it may be necessary to correct faults in lay-out, faults in basic design, and mistakes in wiring as well as locating any defective parts which may be in the unit. Further, since the home-built equipment may not have operated properly in the first place, you can never be sure when you have found and completely corrected the fault.

### SUMMARY

Now, let us summarize the points we have discussed. Perhaps the best way to summarize the points we have covered is to simply list them. The numerical rating of the following list, however, does not indicate the order of importance—the problems encountered are simply listed for convenience.

1. Home construction of electronic equipment is not easy, particularly if a punched and drilled chassis is not available and a pictorial lay-out is not available.

2. The experience gained in assembling electronic equipment is not of too much value as far as servicing and repairing equipment is concerned.

3. In general, it is not cheaper to build your own electronic equipment. In fact, in some cases, the cost will be (if labor is included) three to four times the cost of commercially built equipment.

4. Unless the builder has had considerable practical experience and is well trained, he should not undertake construction of complex electronic equipment with only a schematic diagram available.

5. Except in special cases, the performance of home-built equipment is not as good as that of commercially-built equipment.

6. Home-built test equipment is generally unsatisfactory due to the difficulty of calibrating the equipment properly unless precision laboratory equipment is available and the builder is familiar with its use.

7. If trouble is encountered in home-built equipment, trouble-shooting is likely to prove difficult—particularly for an inexperienced worker. Further, little help can be offered by someone not completely familiar with the equipment.

With the above points in mind, it is easy to see that home construction, regardless of the thrills involved, should not be undertaken until after the builder has gained a certain amount of experience and training. Further, for the first few projects, in any case, the builder should make use of the excellent kits available from any of the larger Radio supply houses—by making use of such a kit, he can have all of the thrill of building his own equipment and, at the same time, avoid much of the hard work and practically assure himself that the equipment will work once it is constructed. If equipment is to be built, and a suitable kit is not available, one should refer to a complete construction article such as those which appear in many of the Radio magazines and in the NATIONAL RADIO NEWS—by doing so, he will avail himself of the work which has been carried out as far as layout and design is concerned.

Further, in general, re-design and/or the addition of special circuits to commercially built equipment or equipment already in operation is not too advisable. For one thing, the builder seldom has information available as to distributed capacities, stage gain, and other design information of utmost importance as far as redesign is concerned.

The following firms are among the large mail order Radio supply houses which usually have a variety of kits available. If one is interested in building electronic equipment, it would be a good idea to write to several of these firms and request information on their kits.

Allied Radio Corporation
833 West Jackson Blvd.
Chicago, Illinois

Concord Radio Corporation
901 West Jackson Blvd.
Chicago, Illinois

Concord Radio Corporation
265 Peachtree Street
Atlanta, Georgia

Radio-wire Television, Inc.
100 Sixth Avenue
New York, New York

Radio Dealers Supply Company
135 Liberty Street
New York, New York

Radio Kits Company
120 Cedar Street
New York, New York

Radionic Equipment Company
170 Nassau Street
New York, New York

McGee Radio Company
1225 McGee Street
Kansas City, Missouri

Of course, the preceding list is not complete. Many local distributors have construction kits available also. However, enough firms have been listed so that the prospective builder will have a choice.

With the problems encountered in home construction in mind, it is up to the individual himself to decide whether he will build equipment or not and whether he will make use of some of the excellent kits available or will refer to construction articles which appear in the various Radio magazines. If you decide to build equipment—and run into trouble, don't be discouraged. Often, the first or second model of commercially designed equipment will not operate properly and many hours of work has to be spent trouble-shooting.

To those who follow the "building urge"—good luck!

# SOUND DISTRIBUTION SYSTEMS for CHURCH TOWERS

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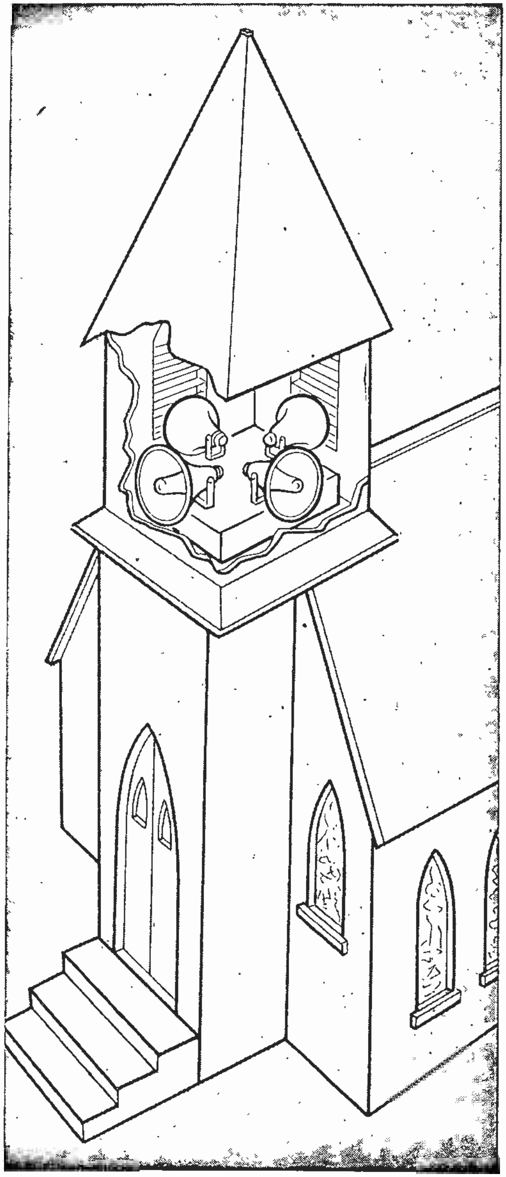
*White Plains, N. Y.*



### General

The ever increasing demand for church steeple sound distribution systems has created an opportunity to the alert and progressive sound dealer which could prove an excellent source of income.

The need for the church to advertise—to make its presence known and appreciated in the community which it serves, is a fact often overlooked. The most often used mediums are radio, newspapers, bulletin boards, lighted crosses and bells and chimes in the church tower. The latter is the most accepted and dignified manner in which the church for ages has broadened its influence by carrying sacred music to the surrounding environs.

### Disadvantages of Bells or Chimes

Tower bells and chimes of the traditional type possess a number of disadvantages which can provide an entering wedge for the salesminded sound dealer. Initial installation cost is high—usually from $20,000 to $30,000 minimum. Weight is excessive, requiring masonry and steel construction to support from 10,000 to 50,000 pounds.

Pitch is inconsistent and will vary with temperature. Exposure to weather will often cause failure of the striker mechanism and in many instances cracked bells and chimes will result in high maintenance costs and poor tone quality. Sound radiation is uncontrolled and can be very objectionable in the immediate vicinity of the church. Last but not least, conventional bells and chimes lack the versatility inherent in amplified systems.

### Advantages of Electronic Sound Systems

The disadvantages outlined above are all sales arguments which can be used effectively in favor of electronically amplified sound distribution systems. Amplified systems are inexpensive. The budgetminded church can purchase electronic systems for less than 2 to 3% of the cost of bells or chimes and be assured of incomparable quality of tone, virtually no maintenance costs and controlled and increased sound radiation. A tremendous amount of flexibility can be obtained by the following additional refinements: microphone pickup for organ, organ chimes and choir—to be used for steeple sound distribution, indoor sound reinforcement and hard-of-hearing aids for within the church.

### Equipment Requirements

The essentials of a church steeple sound distribution system are a record player, an amplifier and outdoor loudspeakers. In view of the thou-

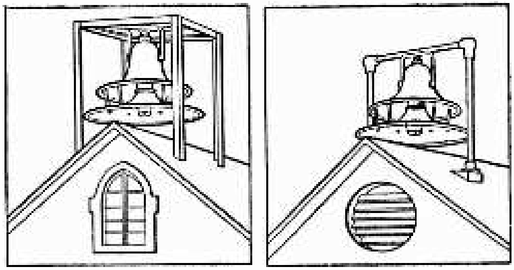


Fig. I Alternate Speaker Locations

sands of people who will listen and pass judgment on the quality of music, there should be no compromise in the quality of the individual components. Since chime and bell music have high audio peaks, the amplifiers and loudspeakers should have ample reserve power. Separate bass and treble controls should be incorporated in the amplifier to permit any desired degree of tonal range.

The response characteristics of horns and driver units should be carefully checked to insure a proper degree of low frequency reproduction. Attention to these important details will result in a quality of amplified music above criticism by the most discriminating listener.

Specal chime records are available in which excellent recordings have been made of very fine chime numbers such as Notre Dame, St. Peter's, University of Chicago Chapel, St. Paul Cathedral of New York, etc. These records are ideal and will give perfect reproduction. For best results, records of this type should be played individually on a manual record player rather than an automatic record changer. The motor must have exceptionally uniform speed, as slight irregularities in speed will result in a "wow" or momentary change in pitch which is extremely objectionable during musical numbers. The motor should be mechanically insulated by means of shock-absorbing rubber cushions or springs so that the motor vibrations are not transmitted to the motorboard and thus to the pickup arm. A lightweight pickup, carefully checked for needle scratch, should be used in conjunction with a good transcription type motor. Too much emphasis cannot be placed on the careful choice of motor and pickup.

### Loudspeaker Locations

Where churches have towers, the upper ventilation windows may be used for mounting the speakers. For churches having no towers, the speakers may be placed in the opening of the parapet where the bell is usually located or a simple framework may be fabricated for roof mounting the speakers. See Fig. 1.

### Loudspeaker Requirements

Loudspeakers must be of the outdoor type of heavy gauge metal construction. Corrosion resistant finishes on both horns and hardware are essential to permit withstanding any degree of exposure, such as wind, rain and snow. Driver units should be of the permanent magnet type and in addition to possessing good low frequency response, should provide high conversion efficiency to permit economical choice of an amplifier. The entire driver unit assembly should be enclosed in a hermetically sealed housing.

A variety of University reflex trumpets and driver units are available for every type of installation. Where extreme distance is not a factor, the model RLH radial reflex trumpet with a PAH driver unit will provide excellent 360° distribution at a relatively low cost. Power up to 50 watts may be obtained by using a 2YC connector with two PAH units. For systems requiring greater radius coverage, the models LH or GH Trumpets with PAH driver units are the solution. These may be installed in the belfry and the quantity will depend on the number of directions to be covered. Four speakers will usually be necessary to provide 360° distribution. The 2YC connector may also be used with two driver units for each trumpet for concentrated sound power. Where exceptionally fine low frequency response is desired, the model GH trumpet with PAH unit is recommended.

Many churches may wish to invest in systems where reliable sound distribution a mile or more is important. The model 4A4 super power loudspeaker is ideal for this purpose. Small and compact for easy installation, this speaker is capable of excellent response and can be heard at long distances. Where certain installations may require greater radius coverage in one direction than another, the model 4A4 may be combined with a number of LH or GH trumpets to provide the required sound distribution.

### Typical Church Tower Installation

Figure II is representative of a typical and economical type of church steeple installation. Consisting of a 35-50 watt amplifier, turntable and 360° radial speaker with two driver units, it is capable under average noise conditions of covering an area approximately one-quarter-mile in diameter.

In churches where the amplifier is located within a radius of 50 feet of the chime cabinet, a good quality high impedance crystal or dynamic microphone will prove satisfactory. The cable must be shielded to prevent hum pickup and extraneous electrical noises. An over-all outer insulating cover of rubber will provide the necessary mechanical protection and eliminate rustling and scraping noises from the loudspeakers as a result of the shield rubbing against metallic objects.

Where microphone cable length exceeds 50 feet, loss in output or frequency discrimination will

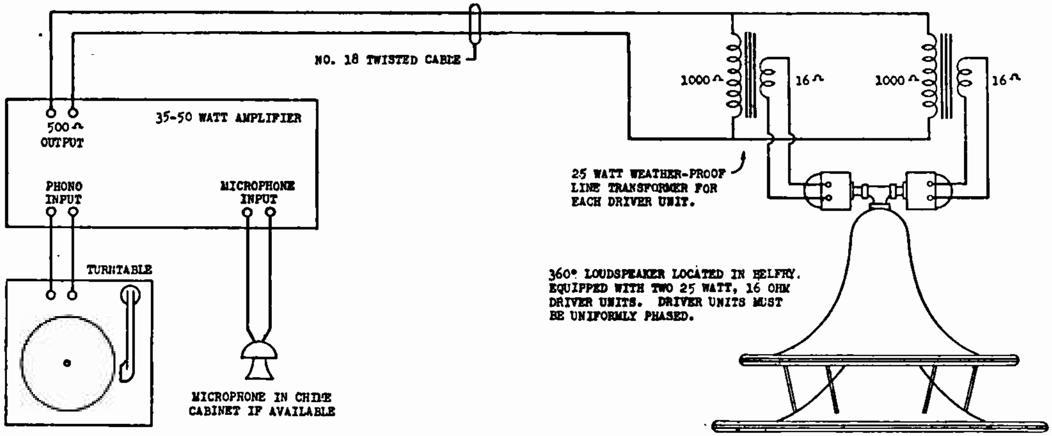



Fig. 11 Typical Church Steeple Installation

occur due to the capacitative effects of the shielding. A much better practice is to employ a low impedance dynamic microphone (50-200) ohms which will permit long cable runs with a minimum loss of output and attenuation of high frequencies. If the amplifier does not incorporate a low impedance input, a cable type matching transformer may be employed. The same cable precautions as outlined under high impedance microphones must be observed.

If it is necessary to provide a microphone for use at the pulpit, for sound re-enforcement within the church, an additional microphone input stage should be provided. An alternate method could be devised by using the chime cabinet microphone input for both purposes. A simple switching arrangement in the amplifier could connect either microphone to the common input, since at no times would the chimes and pulpit microphones be operated simultaneously. A similar type of switch could transfer the amplifier output to either the outdoor projectors or the indoor sound re-enforcement speakers.

Note that although line matching transformers have been specified, their need will depend on the length of transmission line required. In general, where the distance between the amplifier and loudspeakers is less than two hundred feet, lines run at voice coil impedances are satisfactory, provided sufficiently heavy cable is employed to minimize line losses. Table I indicates the wire sizes required for a given length of line (2 wires) at various voice coil impedances. Wire sizes and lengths in this table are calculated for a power loss of 15%.

| WIRE SIZE | LOAD IMPEDANCE | | |
|---|---|---|---|
| (B & S) | 4 OHMS | 8 OHMS | 16 OHMS |
| 14 | 125' | 250' | 450' |
| 16 | 75' | 150' | 300' |
| 18 | 50' | 100' | 200' |
| 20 | 25' | 50' | 100' |

Table I. Maximum Length of Line for 15% Power Loss-Low Impedance Lines

As an example, in an installation where the distance from the speaker is approximately 150', the two 16 ohm driver units may be paralleled for a total impedance of 8 ohms and connected directly to the 8 ohm output tap of the amplifier, dispensing with the line matching transformers entirely. A transmission line consisting of a pair of #16 B & S conductors would then be required to keep within the permissible 15% power loss.

In installations where the distance between speakers and the amplifier is greater than that indicated for a given wire size, or where a lower power loss than 15% is required, it is preferable to work at higher impedances. High impedance lines normally run from output transformer impedances of 125-600 ohms to impedance matching transformers. The impedance matching transformers in turn match the line impedance to the various coil impedances.

A table of wire sizes and lengths of transmission line (2 wires) for various line impedance is given in Table II. Since high impedance lines require matching transformers which in themselves possess inherent losses, all calculations in this table are based on a line power loss of 5%.

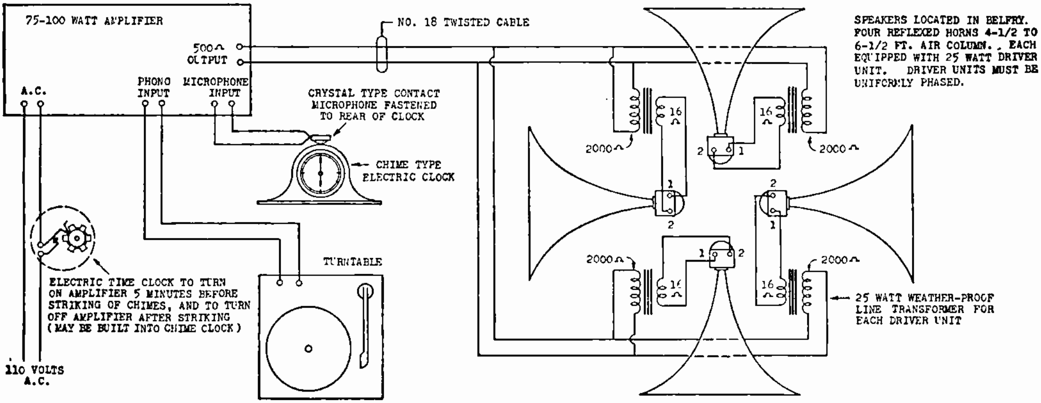



Fig. III 75-100 Watt Church Steeple Installation

| WIRE SIZE (B & S) | LOAD IMPEDANCE 100 OHMS | 250 OHMS | 500 OHMS |
|---|---|---|---|
| 14 | 1000′ | 2500′ | 5000′ |
| 16 | 750′ | 1500′ | 3000′ |
| 18 | 400′ | 1000′ | 2000′ |
| 20 | 250′ | 750′ | 1500′ |

Table 2. Maximum Length of Line for 5% Power Loss-High Impedance Lines

A word of caution with respect to driver units. To insure long life and foolproof operation, it is essential that the low frequency response of each loudspeaker be carefully controlled. As an example, where a trumpet and driver unit have a low frequency cut-off of 120 cycles, feeding a signal at a frequency lower than cut-off will result in excessive diaphragm movement due to insufficient loading at this frequency. Although the unit may not fail entirely, distortion and rattle will result. It is important, therefore, to control bass response within the cut-off limits of the loudspeaker.

Many churches wishing to install amplified sound systems may have delayed purchase due to the lack of a steeple for speaker placement. A simple solution is the fabrication of a framework for roof mounting similar to the ones illustrated in Fig. 1. Built of 2″ angle iron or standard pipe and finished with a few coats of anti-corrosion paint, it should provide lasting satisfaction at a relatively low cost.

## 100 Watt Church Tower Installation

The 75-100 watt system shown in Figure III is basically the same as the one previously discussed. However, it includes a number of additional features which merit attention. Hourly chimes are provided by a chime-type electric clock such as manufactured by General Electric and Telechron. Hourly ON-OFF operation of the amplifier is accomplished automatically by an electric time clock which can be set to turn on the amplifier 5 minutes before the hour and turn it off upon completion of the hourly chimes.

Where additional microphone inputs are required, they may be built in or modifications of existing inputs may be made as described above. Precautions regarding low and high impedance, transmission lines, microphone shielding, etc., are equally applicable to Figure III. Again, where transmission lines are relatively short, the 16 ohm driver units may be paralleled for a total impedance of 4 ohms and connected directly to the 4 ohm output tap of the amplifier.

## Phasing

Phasing is concerned with the utilization of two or more loudspeakers in such a way that the sound from any one speaker does not cancel the sound from other speakers, resulting in materially reduced sound output. This is an important consideration where speakers face the same direction. The connections to the voice coil, whether in series or parallel, must be made in such a manner that at any instant the diaphragms are in the same position. That is, all diaphragms must be moving outward at any instant or moving inward at any instant.

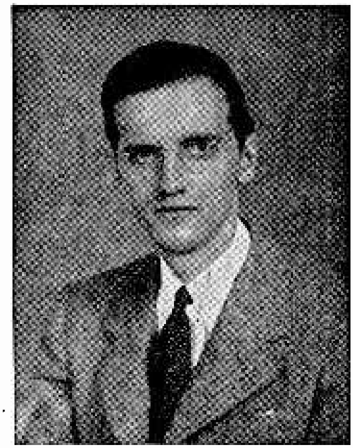
Where driver units are wired in-phase, the sound from the driver units will re-inforce each other and provide correct operation. This means that the like terminals of each unit must be connected together for electrical parallel operation, and if the speakers are wired in series, two unlike terminals must be used as a junction.

Phasing is of least importance where loudspeakers are pointing in opposite directions in an outdoor area. However, when installed indoors as two speakers are brought closer together in a smaller angular relationship, the necessity for in-phase operation becomes increasingly important.

# Servicing F. M. Receivers

By WILLARD R. MOODY

NRI Consultant



Willard R. Moody

THIS article will deal with very practical techniques that may be used in servicing modern FM receivers, and the assumption is made that the reader already has a knowledge of basic FM theory and principles. The fundamentals of FM are covered in the NRI Course. FM offers new and promising opportunities to the serviceman.

### Equipment Needed

Standard servicing equipment continues to be useful. The signal generator and the multitester are the basic and most necessary instruments. The tube tester, signal tracer, oscilloscope and vacuum tube voltmeter are useful and helpful but not absolutely necessary.

### Service Troubles

The FM receiver may develop hum, noise, distortion, become completely inoperative ("dead"), operate intermittently. In short they develop most of the troubles found in ordinary AM receivers, since both AM and FM sets use the same basic components—coils, condensers, tubes, resistors, transformers, etc.

Knowing what may go wrong in an FM set is essential if you are to know what may be responsible for certain symptoms observed in servicing. In other words, we interpret what we see and hear and base our conclusions on a knowledge of the causes of observed effects. We may use our ears to hear directly the effects of a defect; we may use our eyes to directly see broken parts, tubes or wires; or we may "see" indirectly into a circuit with a multimeter or other test instrument.

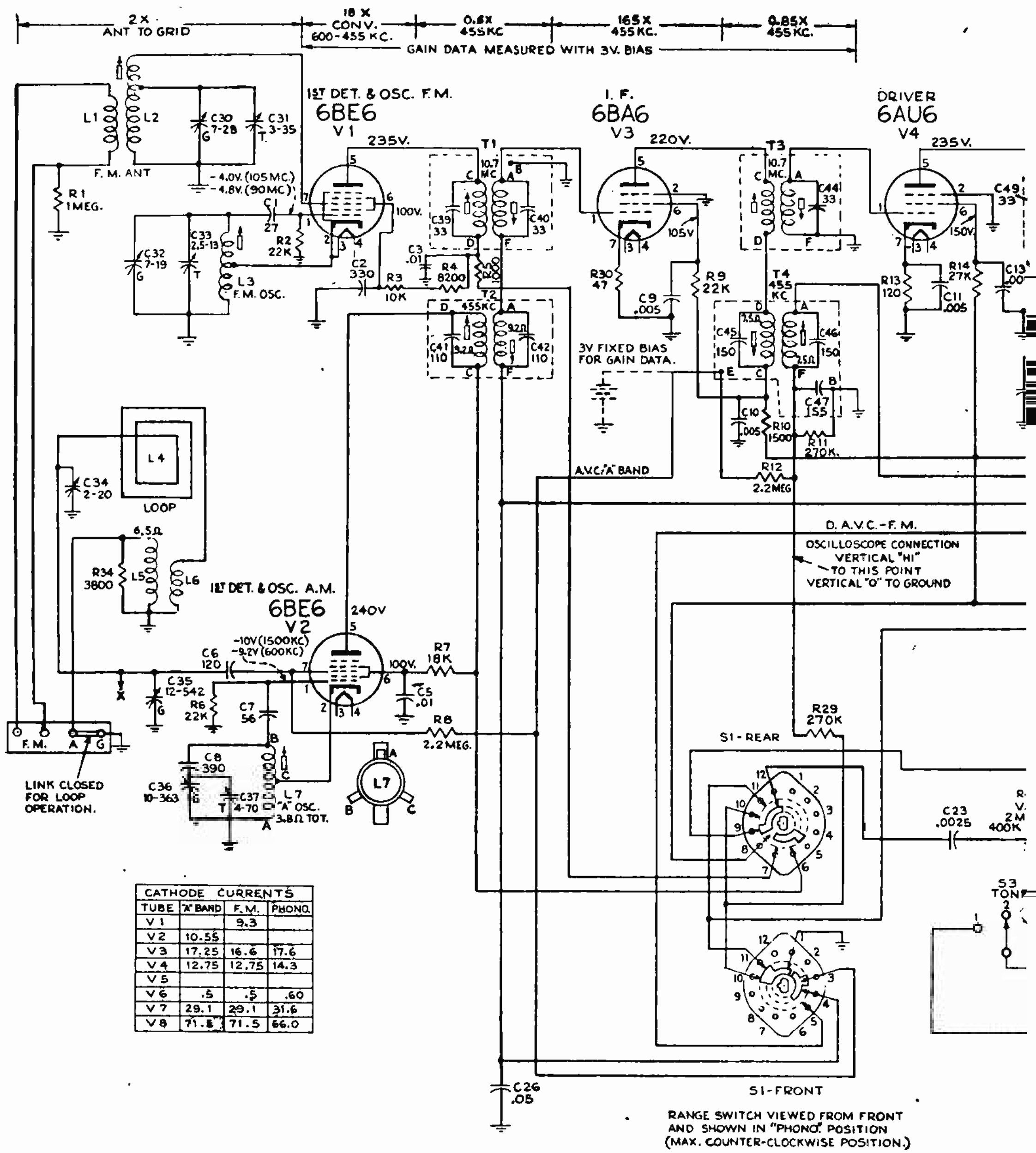
As basic knowledge is necessary for efficient servicing, and is the most important of the service tools, let's study a modern FM set to become familiar with the circuits.

### RCA Model 68R1

This set shown in Fig. 1, is a combination AM-FM receiver using eight tubes and incorporating two separate converters, one for the FM band and the other for the broadcast band. The FM detector is a "ratio detector." This type of circuit eliminates the need for a limiting stage preceding the detector because it responds poorly to *amplitude modulation* but functions efficiently on *frequency modulation*. Special care should be taken in alignment and all precautions should be carefully observed as specified in the alignment instructions of the manufacturer.

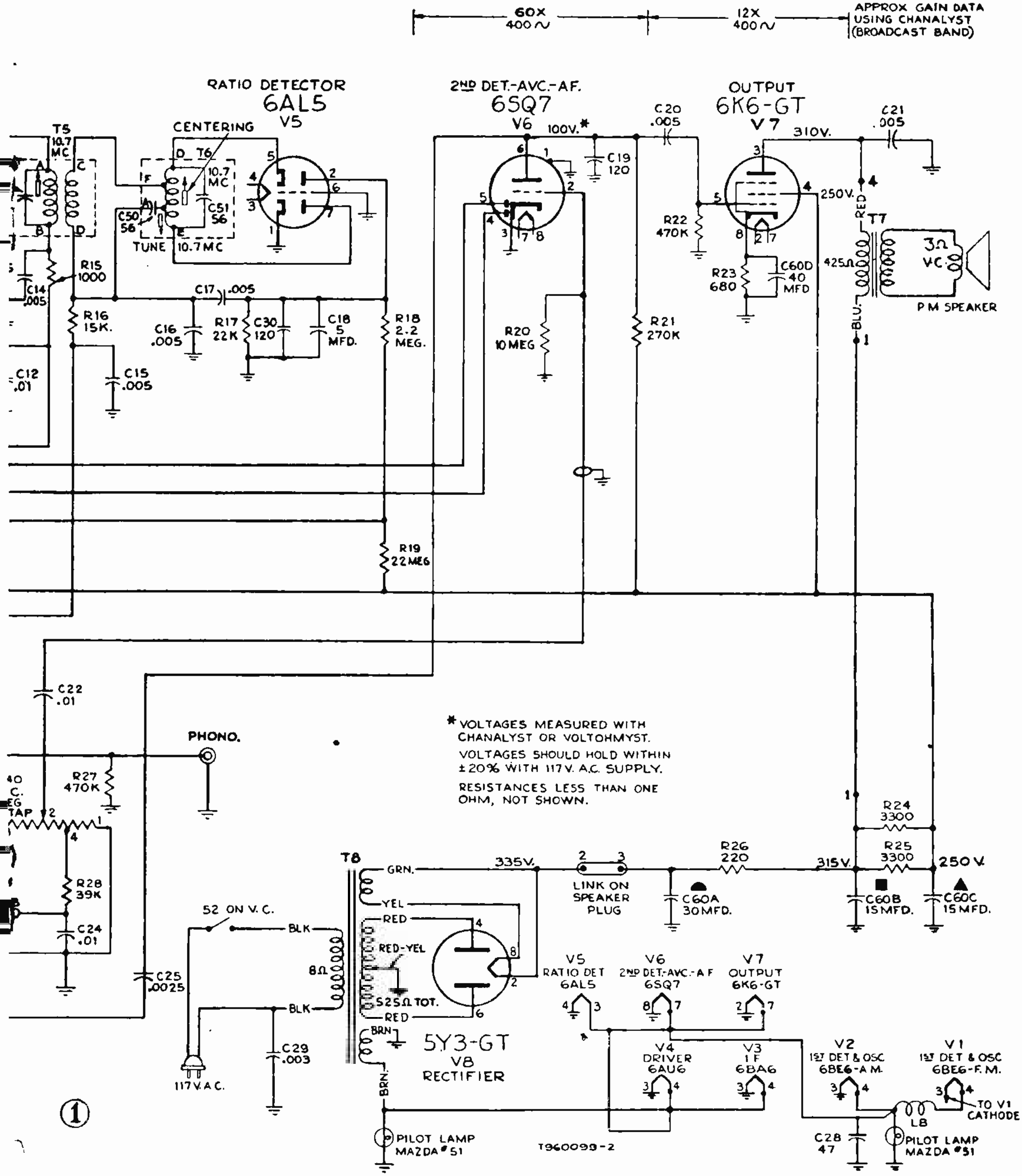
Two antennas, a loop for broadcast reception and a folded dipole for FM, are contained in the cabinet. Because of the directional characteristics of these antennas, it may be necessary, when interference is encountered, to adjust the position of the cabinet experimentally until a point of minimum interference is secured. In some locations, a phenomenon known as multipath reception exists which produces distortion on FM. The transmission time for one path may be different than for the other path. The phase differences of the r.f. signals then results in distortion in the receiver. An external antenna will eliminate or appreciably reduce this effect.

To install an external antenna for standard AM broadcasts, the link on the terminal board, on the chassis in the back of the cabinet, must be opened. Then connect the antenna to the terminal marked "A." A ground connection may be made to terminal "G."




| CATHODE CURRENTS | | | |
|---|---|---|---|
| TUBE | "A" BAND | F.M. | PHONO. |
| V1 | | 9.3 | |
| V2 | 10.55 | | |
| V3 | 17.25 | 16.6 | 17.6 |
| V4 | 12.75 | 12.75 | 14.3 |
| V5 | | | |
| V6 | .5 | .5 | .60 |
| V7 | 29.1 | 29.1 | 31.6 |
| V8 | 71.8 | 71.5 | 66.0 |

**Fig. 1. RCA Model 68R1 C**




## ...ombination AM-FM Receiver

The signal picked up by the folded dipole causes a current to flow in $L_1$. The magnetic field flux of $L_1$ then links with $L_2$ and induces a secondary voltage. This potential is built up by a resonant circuit action and the frequency modulation signal voltage across $L_2$ is applied to the mixer grid of the 6BE6 (pin 7) through the upper part of $L_2$ and from chassis to the 6BE6 cathode (pin 2) through the lower part of $L_3$.

The local oscillator operates on a frequency equal to the incoming center carrier frequency plus the center i.f. value of the receiver. The i.f. value is 10.7 megacycles. Therefore the oscillator tunes from $88 + 10.7 = 98.7$ mc. to 118.7 mc., according to the dial setting. The lowest frequency is obtained with the tuning condenser plates in full mesh, and the highest frequency at minimum capacity.

When the set is turned on there is a slow rise in current through the cathode circuit of the 6BE6. The rising current causes the growth of a magnetic field about the lower portion of $L_3$ and this field induces a voltage in the upper part of the coil. The "tank circuit" of $L_3$ and the capacity in shunt with it, $C_{32} + C_{33} +$ tube input capacity, is then "excited" as L and C form a resonant circuit. The tank circuit now oscillates, but because it has resistance in the leads and elements of the circuit, the oscillation would quickly die out but for the fact that the tube feeds more energy to the circuit. The cathode of the tube and B supply afford this needed energy.

The oscillator circuit has the ability to oscillate because a *small* amount of energy is taken from the L-C circuit by the tube and amplified; then a *greater* amount of energy is returned to the L-C circuit by the tube, in the proper phase to sustain the original oscillation. The lower part of $L_3$ can be thought of as the primary of an auto-transformer and the upper part of $L_3$ as the secondary. Changes in the cathode current result in grid potential variations since the cathode coil is a part of the grid-cathode circuit.

The screen, (pin 6) serves as the oscillator plate. The mixer plate current varies at the frequency of the local oscillator because the oscillator grid is in the electron stream between the 6BE6 cathode and plate. The plate is "electron coupled" to the oscillator and no special external coupling between oscillator and mixer circuits is necessary. The nature of this coupling is such that there is very little interaction between the tuning of the oscillator and r.f. input circuits, making for ease in alignment and tuning of the set.

The incoming FM signal and the signal from the local oscillator beat together in the mixer tube and the difference frequency of 10.7 mc. is the desired i.f. signal. This signal appears across the primary of $T_1$. The frequency variations in the incoming FM signal are reproduced in the i.f. signal.

The $R_5 - C_3$ combination keeps signals from getting into the B supply and serves to isolate the plate circuit of $V_1$.

The signal voltage induced in the secondary of $T_1$ by current flow in the primary is built up by resonant action and appears across $C_{40}$. This voltage is applied to pin 1 of $V_3$ directly and from the opposite terminal of $C_{40}$ to the $V_3$ cathode through $C_{42}$, $C_{26}$, chassis and $R_{30}$.

The impedance of $C_{42}$ is practically a short circuit at 10.7 mc. and this also is true of $C_{26}$. The i.f. tube $V_3$ amplifies the FM signal and a larger voltage appears across the primary of $T_3$. The primary current induces a voltage in the secondary of $T_3$. $C_{45}$ and $C_{10}$ have very little impedance at 10.7 mc.

The voltage across $C_{44}$ is amplified by $V_4$ and fed to $T_5$. The secondary voltage of $T_5$ is now applied to the center portion of $T_6$ through $C_{50}$. The total inductance of $T_6$ combines with $C_{51}$ to form a resonant circuit which is "excited" by this driving voltage. A resonant r.f. potential, accordingly, is built up across $C_{51}$.

Fundamentally, the two diodes of $V_5$ are in series so that they will conduct on the same half cycle and the rectified current through $R_{17}$ will cause a negative potential with respect to the chassis to appear at the diode plate connected to pin 2 of $V_5$ in the diagram. (Referred to hereafter as diode 2.)

The time constant of $R_{17}$ and $C_{18}$ is approximately 0.2 second so that the negative potential at the plate of diode 2 will remain constant even at the lowest audio frequencies to be reproduced.

Condenser $C_{17}$ is charged by the rectified current through diode 2 to a voltage proportional to the r.f. voltage applied to diode 2 and $C_{16}$ is charged to a voltage proportional to the r.f. voltage applied to diode pins 1-7 of $V_5$.

Since the voltage values differ according to the instantaneous frequency of the carrier, the voltages across $C_{16}$ and $C_{17}$ will differ proportionately, the voltage across $C_{17}$ being the larger of the two voltages at carrier frequencies below the i.f. resting frequency and the smaller at frequencies above the i.f.

These voltages are additive and the sum is fixed by the constant potential across $R_{17}$ and $C_{18}$. Therefore, while the *ratio* of the voltages will vary at an audio rate, the sum will always be constant and equal to the voltage across $R_{17}$ and $C_{30}$.

The potential at the junction point of $C_{17}$ and $C_{16}$ with respect to ground will vary at an audio rate whén an FM signal is applied to the detector, hence the audio voltage is extracted at this point and fed into the audio amplifier. The time constant of $R_{17}$ and $C_{18}$ is not too large to prevent average changes in carrier level from appearing as changes in voltage across this combination and the voltage is proportional to the average strength of the received carrier. As a result, we can use this voltage for automatic volume control purposes.

There is no "threshold" effect apparent in the ratio detector and there is no minimum carrier level which must be applied to the detector to cause noise attenuation as in other types of FM detectors requiring the use of a limiter stage preceding the detector.

**The fundamental principle involved is that the detector is responsive only to changes in the ratio of the diode voltages and insensitive to changes in the difference between these voltages. Thus, the detector converts frequency changes but does not respond to amplitude modulation.**

It can, therefore, allow elimination of the conventional limiter stage which is a considerable advantage in simplifying circuit design and reducing cost.

This signal voltage appearing across $C_{16}$ is now fed to the audio input through $R_{16}$, the switching assembly, and $C_{23}$. $R_{40}$ controls the volume. $C_{16}$ and $C_{15}$ have lower impedances at high frequencies than at low and medium frequencies and act to reduce the high frequency gain by a shunting action. Some high frequency attenuation is desirable (de-emphasis) to compensate for the boost in "highs" (pre-emphasis) at the transmitter. $C_{15}$ and $C_{16}$ also serve as r.f. bypass condensers, to keep r.f. out of the a.f. amplifier.

The volume control circuit is standard but the tone control system is somewhat unusual. When $S_3$ is set to position 2, $C_{25}$ is disconnected and $C_{24}$ is in series with $R_{28}$. If the volume control is set to high and medium positions, the effect of $C_{24}$ will be very slight. As the volume is lowered by moving the arm of $R_{40}$ closer to tap 4, the effect of $C_{24}$ becomes evident. At low audio frequencies the impedance of $C_4$ will be much higher than it is at medium and high audio frequencies. The effect, to the listener, will be a rise in the intensity of bass notes. This feature is called automatic bass compensation. Also, the treble response will be increased, regardless of the setting of $R_{40}$, by cutting $C_{25}$ out of the circuit.

**The bass compensation can be** removed by setting

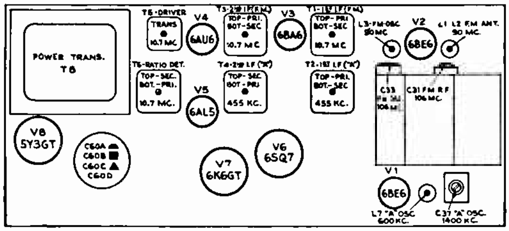
## Alignment Procedure

Test Oscillator—

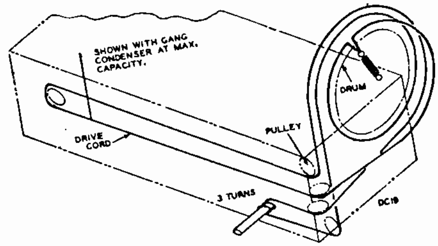
For all alignment operations, unless specified, keep the output as low as possible to avoid A.V.C. action. Ground lead of test-osc. to chassis ground, unless specified.

Output Meter—

To correctly observe the point of minimum a-f output, it is necessary to connect an output meter across the voice coil, and turn the receiver volume control to maximum.




*Tube and Trimmer Locations (Top View)*




*Dial-Indicator and Drive Mechanism*

Fig. 2

$S_3$ to 3. The tone may further be changed by setting $S_3$ to 1 which again restores bass compensation at low volume. $C_{25}$ is now connected as a shunt in the 6SQ7 plate circuit. Since its capacitance is small, it affects high frequency response chiefly and cuts down on "treble."

The audio output of the 6SQ7 ($V_6$) is fed to $V_7$ through $C_{20}$. The 6K6-GT drives the loudspeaker through $T_7$.

The power supply is conventional, using a 5Y3-GT full-wave rectifier. $R_{24}$ and $R_{25}$ are low wattage units. Putting these in parallel, a higher effective wattage rating and ½ the resistance is obtained.

The AM front end of the set, using the 6BE6 ($V_2$) is similar to the FM but a loop antenna is used. As the circuit is standard, we won't discuss

## FM Ratio Detector Alignment

Range Switch in FM Position

| Steps | Connect the high side of the test osc. to— | Tune test-osc. to— | Turn Volume control to— | Adjust |
|---|---|---|---|---|
| 1 | Connect a 680 ohm resistor between pins 5 & 7 of the ratio detector tube 6AL5. Connect the negative lead of a high resistance voltmeter, or VTVM, to the negative lead of the 5 mfd. electrolytic condenser C18. The common lead of the meter to ground. | | | |
| 2 | Driver grid, pin 1, of the 6AU6 in series with .01 mfd. | 10.7mc. 30% mod. 400 cycles (AM) Approx. .25 volt output | Maximum Volume | Driver transformer, T5 for maximum d-c across C-18. |
| 3 | Remove the meter leads and disconnect the 680 ohm resistor from the 6AL5. Connect two 68,000 ohms (± 1%) resistors in series, across the 22,000 ohm ratio detector load resistor R17. Connect the negative lead of a high resistance voltmeter to the center point of the 68,000 ohm resistors, and the positive lead to terminal "A" of the ratio detector transformer, T6. Set the meter to a low d.c. voltage range. | | | |
| 4 | Same as in Step 2. | Same as in Step 2. Approx. .25 volt output | Maximum Volume | *T6 bottom core for zero d-c balance.<br>T6 top core for min. audio output.† |
| 5 | Reconnect meter as in Step 1, omitting 680 ohm resistor. | | | |
| 6 | Repeat Step 2. | | | |
| 7 | Remove ALL connections. | | | |

*Near the correct core position the zero point is approached rapidly and continued adjustment causes the indicated polarity to reverse. A slow approach to the zero point is an indication of severe detuning, and the bottom core should be turned in the opposite direction. Note: If meter reads reverse polarity, reverse meter leads and adjust T6 bottom core for zero output.

†The zero d-c balance and the minimum a-f output should occur at the same point. If such is not the case, the two cores should be adjusted until both occur with no further adjustment of either core. It may be advantageous to adjust both cores simultaneously, watching the meter and the output meter, hooked across the voice coil, for the point at which both zero d-c and minimum a-f output occur.

Note: Two or more points may be found which will satisfy the condition required in Step 4. T6 top core should be correctly adjusted when approximately 1/8 inch of threads extend above the can, therefore, it is desirable to start adjustment with the top core in its furthest "in" position and turn out, while adjusting the bottom core, until the first point of minimum a-f and zero d-c is reached.

Fig. 3

it—particularly as we are concerned here only with FM.

We have examined the circuit in detail and as the alignment governs to a considerable extent the efficiency and general performance, let's study the alignment procedure next and then the service techniques.

### Alignment

First, refer to Fig. 2 in which the general layout and trimmer locations are shown. Now refer to Fig. 3 which shows the step-by-step alignment procedure for the ratio detector. (The ratio detector stage is aligned first.) A vacuum tube voltmeter would be useful for this work. The vacuum tube voltmeter does not load the circuit. However, relatively little loading effect occurs when a standard meter of 10,000 ohms/volt sensitivity, or 20,000 ohms/volt, is used in place of the vacuum tube voltmeter. The Model 44 NRI Professional Volt-Ohm-Mil-Ammeter is suitable for use in FM alignment.

Therefore, where VTVM (vacuum tube voltmeter) is called for in service notes, substitute a high resistance d.c. voltmeter if you do not have a vacuum tube voltmeter.

The alignment of FM i.f., r.f. circuits is tabulated in Fig. 4. The AM data is given in Fig. 5.

In making alignment adjustments on FM receivers, considerable care should be taken to follow the manufacturer's alignment instructions accurately. We must assume that the manufacturer knows more about his product than anyone else and can tell you how to get the best results from the receiver.

The use of 10.7 mc. for the i.f. and a tuning range of 88 to 108 mc. means that due to the high frequencies involved the adjustments will be more critical and require greater skill than adjustments at 455 kc. and 1500 kc. for the ordinary AM receiver. A relatively small movement of a wire in a high frequency circuit may mean a large frequency change because the operating frequency is high. For example, a 1% change at 1500 kc. is $1500 \times .01 = 15$ kc. while at 10.7 mc. (10,700 kc.) the same percentage change would result in a shift of $10{,}700 \times .01 = 107$ kc. and at 108 mc. (108,000 kc.) we would have a shift of $108{,}000 \times .01 = 1080$ kc!

The small change in capacity made by slightly shifting the position of a trimmer or the core of an iron-core transformer winding, therefore, is a more critical matter at high frequencies than at low frequencies.

### The Signal Generator

Because of the extreme difficulty of producing a stable, accurate generator at a price the serviceman can pay, manufacturers of reasonably priced generators have found it necessary to use harmonics of fundamentals for FM alignment work. The instruments may have scales which are calibrated at FM frequencies, but they are harmonic scales. Suppose, for example, that the generator is to supply a signal at 106 mc. as in step 6 of Fig. 4.

Fundamentally, we know that we can use 106/2 = 53 mc. as the signal because 106 mc. is the second harmonic of 53 mc. Therefore, we would set the generator dial to 53 mc. If the manufacturer has calibrated the instrument on a harmonic scale, we would simply adjust the generator dial pointer to the specified alignment frequency of 106 mc. and would read the value directly and very conveniently.

Similarly, for a frequency of 90 mc. we would use a fundamental frequency of 90/2 = 45 mc. The second harmonic of 45 mc. would give the required 90 mc. signal.

In all cases, to avoid detuning, it is necessary to use an insulated alignment tool rather than an ordinary screwdriver. A slight detuning may be tolerated on AM broadcast receivers but *proper FM alignment requires a very careful and precise technique.*

The i.f. tuned circuits in many FM sets will be shunted, or "loaded," with resistors to secure a broad bandpass characteristic which makes tuning broader. The r.f. and oscillator circuits have a much sharper selectivity characteristic and are more critical in alignment.

This concludes the section dealing with alignment. As we have examined the circuit of a typical set and its alignment, as a next step we are in a position to consider the service troubles that may arise and their remedies.

## Service Faults

Any of the service troubles commonly associated with the audio and power supply circuits of AM receivers may be found in FM sets, and as it is assumed the reader has had a certain amount of experience in AM servicing, this discussion will be limited to special troubles that are peculiar to FM sets.

### Check List of FM Service Tips

A. NOISE AND HISS

1. Noisy r-f or converter tube.
2. Defective antenna system.
3. Excessive plate voltage on limiter.
4. Regeneration.

## FM I.F R.F Alignment*

Range Switch In FM Position

| Steps | Connect the high side of the test-osc. to | Connect the ground side of the test-osc. to— | Tune test-osc. to— | Radio dial turned to— | Adjust |
|---|---|---|---|---|---|
| 1 | Connect the negative lead of a high resistance voltmeter to the negative lead of the 5 mfd. electrolytic condenser, C18, and the common lead to the meter to chassis ground. | | | | |
| 2 | To one terminal of the FM antenna in series with .01 mfd. | To the other terminal of the FM antenna. | 10.7 mc. 30% mod. at 400 cycles. (AM) | Maximum capacity. (Fully meshed) | †T3, bottom core for maximum d-c across C 18. Load the plate winding of T3 with a 680 ohm resistor.‡ |
| 3 | Same as 2. | | | | T3, top core for maximum d-c across C 18. Load the grid winding of T3 with the 680 ohm resistor used in Step 2. |
| 4 | Same as 2. | | | | T1, bottom core for maximum d-c across C 18. Load the plate winding of T1 with the 680 ohm resistor. |
| 5 | Same as 2. | | | | T1, top core for maximum d-c across C 18. Load the grid winding of T1 with the 680 ohm resistor. |
| 6 | To one terminal of the FM antenna in series with a 120 ohm resistor. | To the other terminal of the antenna in series with a 120 ohm resistor. | 106 mc. | 106 mc.§ | Condensers C33 and C31 for maximum d-c output across C18. |
| 7 | Same | Same | 90 mc. | 90 mc. | Coils L2 and L3 for maximum d-c output across C18. |
| 8 | Repeat steps 6 & 7 until further adjustment no longer improves calibration. | | | | |

*Correct alignment of the 455kc. I.F. requires that the 10.7 mc. FM I.F. be aligned previously.

†This method is known as alternate loading which involves the use of a 680 ohm resistor to load the plate winding while the grid winding of the same transformer is peaked. Then the grid winding is loaded with the resistor while the plate winding is peaked.

‡When the windings are loaded it may be necessary to increase the 10.7 mc. input since the gain will decrease resulting in a small or no reading across C18. This reading should be maintained at 2-4 volts, by adjusting the input, as each transformer is aligned.

§Completely mesh the gang and see that the pointer goes to mechanical maximum calibration point at low end of band. (Reference mark on dial back plate.)

Fig. 4

## "A" Band Alignment*

Range Switch in BC Position

| Steps | Connect the high side of the test osc. to— | Tune test osc. to— | Turn the radio dial to— | Adjust for max. peak output |
|---|---|---|---|---|
| 1 | AM converter grid, pin 1, 6BE6 in series with .01 mfd. | 455 kc. | "A" Band Quiet point at high freq. end. | †T4—Top core T4—Bottom core |
| 2 | | | | T2—Bottom core T2—Top core |
| 3 | Antenna lead in series with 200 mmf. | 1400 kc. | "A" Band 1400 kc. calibration pt. | C37—Osc. C34—Ant. (Loop) |
| 4 | | 600 kc. | "A" Band 600 kc. calibration pt. | L7—Osc. Rock in. |
| 5 | Repeat steps 3 and 4 until aligned. | | | |
| 6 | When chassis is installed, readjust C34 on the loop for max. output at 1400 kc. | | | |

*Correct alignment of the 455 kc. I.F. requires that the 10.7 mc. FM I.F. be aligned previously.

†Align T4 and T2 by means of alternate loading. Use a 47,000 ohm resistor instead of a 680 ohm resistor. Alternate loading is explained in "FM I.F.-R.F. Alignment."

Fig. 5

B. REGENERATION
1. Improper lead dress.
2. Incorrect alignment.
3. Defective shield or ground straps.
4. Open bypass condenser (r-f or i-f circuits).

C. DISTORTION AND POOR TONE QUALITY
1. Limiter not functioning due to:
   a. Defective limiter tube.
   b. Incorrect limiter voltage.
   c. Limiter circuit not properly aligned.
   d. I-F circuits not properly aligned.
   e. Defective i-f amplifier tube.
   f. Open loading resistor across i-f winding.
   g. Open bypass condenser, i-f circuit.
   h. Incorrect voltages on i-f tubes.
2. Defective resistors or capacitors in deaccentuator network.
3. Insufficient signal for limiter saturation:
   a. Due to r-f circuits out of alignment.
   b. Due to bad r-f tube.
   c. Due to inefficient antenna system.
4. Regeneration in i-f due to open bypass condenser or open loading resistor across i-f transformer.

D. LACK OF HIGHS ON FM STATIONS
1. Check resistance-capacitance values in deaccentuator network.

E. SEVERE AMPLITUDE DISTORTION DURING HIGH AUDIO SIGNAL LEVELS—DUE TO POOR DISCRIMINATOR ALIGNMENT
*Remedy:* This trouble is frequently due to poor discriminator alignment. High level audio signals correspond to wide frequency deviations around the center intermediate frequency. If the discriminator is far out of alignment, the widely deviated signal, which corresponds to a loud noise, will go over the "hump" of the characteristic curve and distortion will result.

The RCA 68R1 does not use a discriminator type detector but many FM sets do. Alignment of the ratio detector, however, is also somewhat critical and must be correct for minimum noise and distortion.

If the discriminator is only slightly out of alignment, the audio quality will be good except on the very loud passages where the response leaves the linear portion of the curve and passes over to the peak. To correct, realign the discriminator transformer primary and secondary trimmers.

Another possibility is that one-half of the discriminator transformer secondary winding may be open; or, the phasing condenser between the primary and secondary windings may be open. Either of these troubles will cause loss of one reference voltage and thereby introduce distortion.

F. DISTORTION IN DISCRIMINATOR A-F OUTPUT—DUE TO IMPROPER LIMITER ACTION
*Remedy:* The same basic operating principle is involved in all present-day limiter circuits. A sharp cut-off pentode is operated so that the grid swing condition between cut-off and zero grid volts is of the order of 3 or 4 volts. The plate and screen voltage is maintained at approximately 63 volts. Under such operating conditions, with a strong signal applied to the limiter grid, plate current saturation is quickly reached. The most frequent trouble in limiter circuits, with the possible exception of tube trouble, is a change in plate voltage due to changes in the value of the plate load resistor or to a partial short-circuit of the plate circuit bypass condenser. If the plate and screen voltages are too high, the "threshold" voltage may change as much as 50 to 150 microvolts or more.

This means that the limiter will function as an i-f amplifier and little or no limiting action will take place. As the signal frequency swings with modulation, it passes over the slope of the i-f characteristic curve generating an AM signal which can be passed on to the discriminator. The discriminator will respond to AM as one-half of the FM detector tube can act as a diode rectifier. Unless the limiter removes the AM response, this condition will occur. The i-f response curve is not linear, so considerable distortion will take place when the FM signal is converted to AM. This is not normal FM reception and the conditions just described are due to a lack of limiter action.

In the RCA 68R1, an ordinary FM discriminator type detector is not used and a limiter stage is not a part of the receiver circuit. The ratio detector used eliminates the need for a limiter stage. Many sets and tuners which do use the conventional detector and limiters have been produced and for this reason the previous data has been presented.

A typical and basic discriminator circuit is shown in Fig. 6. The signal voltage delivered by the limiter is $e_p$ and is applied to $L_2$. This voltage causes a current to flow in $L_2$ and the resulting field of magnetic flux links with $L_3$ and induces a secondary potential that is built up by the resonant circuit action of $L_3 + C_3 +$ stray circuit and tube capacity.

One-half of this voltage, $e_1$, appearing across $L_3$, is applied to diode 1 through $L_1$ and $C_5$. The other half, $e_2$, is applied to diode 2 through $L_1$ and $C_6$. As $L_1$ is an r.f. choke, the voltage drop across it is large.

In addition to the induced voltage and resonant values of $e_1$ and $e_2$, we have the directly applied potential of $e_p$. This voltage, less the drop in $C_1$, which is a small voltage loss, is applied to $L_1$ through $C_6$. The drop across $C_6$ also is small. The voltage across $L_1$ is applied to diode 1 through $C_5$ and the upper part of $L_3$, and to diode 2 through the lower part of $L_3$ and $C_6$. These voltages will add vectorially and the net result is that the discriminator detects the FM signal and develops an audio signal voltage across $R_1 + R_2$. This signal is fed to the input of the audio amplifier through $C_4$ and $R_3$.

From a service standpoint, severe amplitude distortion may be caused by an improper adjustment of $C_2$ and $C_3$ which results in misalignment. The circuit may be aligned correctly by supplying a strong unmodulated r.f. input to the limiter grid. The full output of the generator should be used, at the specified i.f. value. This is 10.7 mc. in most modern sets. A d.c. vacuum tube voltmeter or sensitive d.c. voltmeter is connected across $R_1$ or $R_2$. Usually, it is more convenient to use $R_2$. The trimmer $C_2$ is adjusted for maximum deflection of the meter pointer. The next step is the adjustment of $C_3$. The indicating instrument, d.c. voltmeter or vacuum tube voltmeter, is connected between point g (cathode of diode 1) and ground. As $C_3$ is adjusted, the meter pointer will swing right or left. The adjustment should be for zero voltage between g and ground. Some manufacturers indicate that a micro-ammeter may be used between the cathodes of the discriminator to indicate balance in alignment (point g and ground) but caution is necessary to

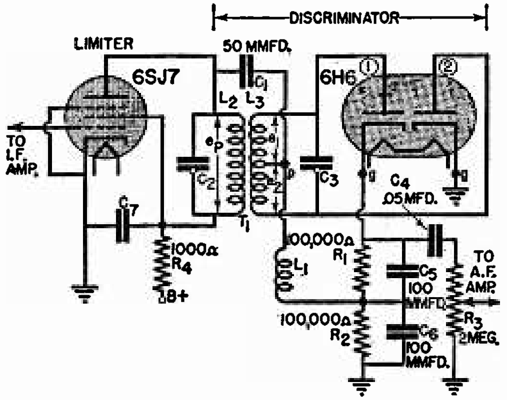



Fig. 6 Typical discriminator circuit for an f.m. receiver. The discriminator load resistors are the 100,000-ohm resistors $R_1$ and $R_2$.

avoid burning out the meter. Use a high range first and then, if necessary, go to a lower range on the current scale of the meter. A vacuum tube voltmeter with a zero center scale calibration is particularly convenient for this type of work.

A lack of balance in the circuit will lead to distortion and possibly excessive noise. This unbalance may be due to misalignment, as previously indicated, or a faulty discriminator tube. Each diode should have approximately the same emission, as indicated by a tube tester. Also, $R_1$ and $R_2$ should be closely alike in ohmic value. $C_5$ and $C_6$ should be alike.

If the set is "dead," and the fault has been localized to the discriminator, $L_2$, $L_3$, $C_1$ or $L_1$ may be "open." The coils can be checked easily with an ohmmeter and the condenser by a replacement method or with an R-C Bridge.

Leakage in $C_1$ would result in distortion and, if bad enough, complete failure of the discriminator. Similarly, an open in $C_5$ or $C_6$ would cause failure or distortion.

The discriminator audio output can be checked with a signal tracer if the input is a frequency modulated signal. If the signal is furnished by an ordinary amplitude modulated generator, the output cannot be judged properly. The standard signal tracer, however, can be used to pick up and demodulate the signal by using slope detection. Although the AM signal tracer is not designed for FM it can be used. If the i.f. is 10.7 mc., set the signal tracer to this frequency and tune in a signal on the receiver. This signal is supplied by a frequency modulated generator or FM station. Now detune the tracer slightly. If the signal can be heard at the grid of the limiter but

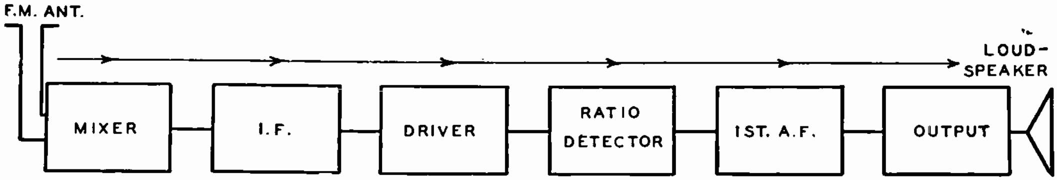



Fig. 7

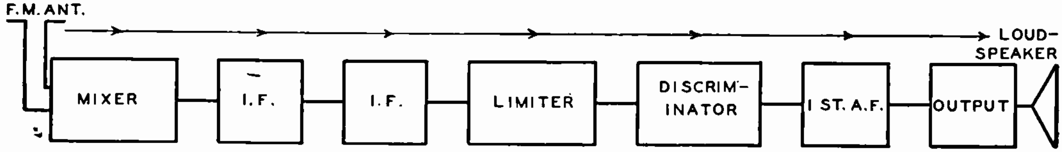



Fig. 8

not at the plate, the fault is localized to the limiter stage.

Assuming the FM signal is detected at each diode plate but no audio output is obtained, the fault is localized to the discriminator. In making these tests, it is helpful to keep in mind a mental picture of the arrangement of stages in an FM set. For the RCA 68R1 we have that of Fig. 7, for other FM sets we may have Fig. 8. The signal passage from the input to the output is shown by the arrows.

The signal may be followed from the output of the mixer (10.7 mc.) to the loudspeaker using a standard signal tracer. The 88 to 108 mc. signal cannot be checked directly except with special, and very expensive equipment.

We are more or less familiar with the functioning of the r.f. mixer and i.f. stages of a receiver, but the limiter action may not be understood or may have been forgotten. A brief review is desirable.

### The Limiter

A typical limiter stage, of a basic kind, is shown in Fig. 9. The frequency modulated r.f. voltage is fed to $L_1$ from the i.f. stage. The function of the limiter is to remove amplitude fluctuations and pass on a purely frequency modulated signal to the FM detector.

The limiter tube is operated at low plate and screen voltage and has no fixed bias except for an automatic bias developed by the tube itself and the grid resistor—condenser combination.

During the part of the r.f. cycle when the input voltage makes the first grid positive with respect to the cathode of the limiter, electrons are attracted to the grid and condenser C in Fig. 9 becomes charged. The ungrounded terminal of C then has a negative potential with respect to ground and the chassis. C requires a certain amount of time for the charge to leak off, even though this time be very short depending on the value of R and C ($t = RC$ seconds, where R = megohms, C = mfds.). Therefore, the condenser will not discharge completely before the next positive half-cycle of r.f. voltage comes along and causes a further attraction of electrons from the grid. Finally, the average grid potential will become negative due to the storage effect of C and its stabilization of the voltage across R. This is the average bias potential and the mean value is dependent on the input signal level, the choice of circuit part values and the tube characteristics.

As the voltage across R and C varies according to signal intensity, in alignment we may adjust $C_1$ and $C_2$ for maximum voltage across C and C using a vacuum tube voltmeter. Or, we can break the grid return circuit, insert a microammeter in series with R, between a and b, and tune for maximum grid current. To keep r.f. out of the meter circuit, the meter is shunted by $C_4$ which can be a .1 mfd. 400 volt condenser. Further, the voltage across R may be used for automatic volume control purposes.

If C develops leakage, the time constant and noise limiting properties of the circuit will be changed. Normal operation will not be obtained. Distortion and excessive noise will result and the automatic bias will be reduced and may be removed entirely if C shorts out. The circuit can be checked quickly and easily with an ohmmeter. An open in $L_1$ or $L_2$ would prevent normal operation.

Up to a grid potential of about 3 volts, the output of the limiter is dependent on the amplitude of the input signal. Above the 3 volt grid level, due to low plate and screen voltages, the tube reaches plate saturation and then does not respond to

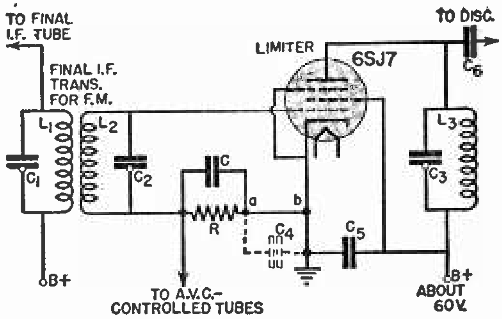



Fig. 9

further amplitude variations. The result is both limiting and a.v.c. action. Notice that there is a definite minimum, or "threshold" voltage below which limiter action does not take place. Some sets may use two limiter stages in cascade to secure even better limiting action.

*n r i*

## Education For Waiting Husbands

A happily married college president concluded a graduation address as follows: "Gentlemen, many of you will marry. Let me entreat you to be kind to your wives. Be patient with them. When you are going out together, do not worry if your wife is not ready at the appointed time. Have a good book nearby. Read it while you wait. And, gentlemen, I assure you that you will be astonished at the amount of information you will acquire."

*n r i*

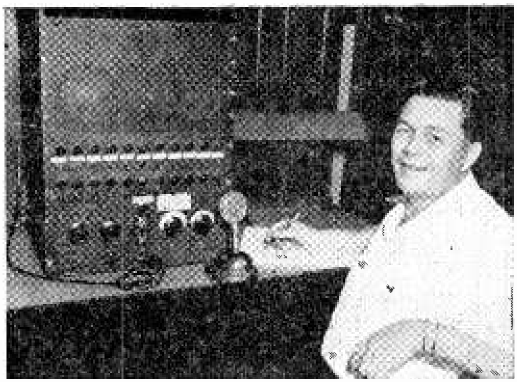
## Our Cover Photo

The Chambers Radio Supply Company, of Cincinnati, Ohio, is one of the most modern and progressive Radio wholesale houses in its area. It is owned by NRI Graduate E. L. Chambers. Mr. Chambers graduated from NRI way back in 1923, and has been continuously engaged in activities of the Radio industry since then. He has been the owner of his own business since 1941.

The Chambers Radio Supply Company has continuously expanded and kept pace with modern trends. Activities now extend into three states and Chambers tells us that approximately one-half of his best Radio technician-dealers are graduates of NRI.

The building shown on our cover is 60 by 75 feet, with a parking lot 25 by 90 feet.

Ten people are employed by Chambers—five in the store and five in the field contacting dealers. A complete line of Radio tubes, parts, and test equipment is handled.



*Dear Mr. Smith*:

"I would like to thank you for your splendid Home Study Radio Course which I have just completed. It has already proved to be a great help to me as it was a large factor in helping me to get my present position as Senior Radio Operator of Police Radio Station WRGP, in Pensacola, Florida, a position which I have held for approximately one year. I have much faith in your course and believe anyone interested in radio will find it well worth their time to investigate your fine radio course."

CHARLES G. LISTER,
P. O. Box 172,
Pensacola, Florida.

*n r i*

*Dear Mr. Dowie*:

"I am certainly grateful to NRI. I never dreamed that I would be servicing radios on my 18th lesson. It is more fun than work.

I am now on my 21st lesson and have serviced six sets. So far I haven't run into much trouble.

On the last set I serviced, I found the trouble in less than two minutes. It pays off to know parts values. The isolating method is excellent. It takes only a few minutes to find the defective stage and the rest is easy—merely locating the defective part.

I will soon earn enough to buy a multi-meter from the school. This sparetime work pays for itself very nicely. Some time next year I hope to have a shop of my own. As I go along, I will buy the three instruments that I need.

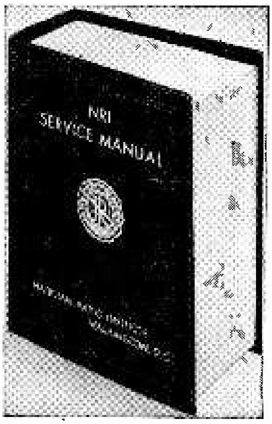
It sure makes a man feel wonderful when a customer meets you on the street and says that his set never sounded any better."

Sincerely yours,
JOHN S. SALI, JR.
Jacksonville, Fla.

# NOW --- RIDER AVAILABLE.

NRI students and graduates who go into Radio servicing as a part or full time business find that they should have diagrams of Radio receivers to expedite servicing and make it more profitable. Practically all Radio servicemen know that such a service is available through John F. Rider, Inc., Publisher.

## NRI SERVICE MANUAL, VOLUME I




Realizing that beginners would find the purchasing of all the service Manuals published by John F. Rider a rather expensive proposition, NRI undertook the task of preparing an abridged Manual covering most of the important Radio receivers up to World War II. This Manual is known as NRI Service Manual, Volume 1 and has been announced to our students and graduates. It is just the thing for the beginner Radio serviceman and has proved very popular.

As time goes on the Radio serviceman realizes the need for additional diagram service. He needs diagrams for all the recent receivers. Such a complete diagram service is offered by John F. Rider. We are pleased to inform our students and graduates that these standard Rider Manuals, beginning with Volume 15, may now be purchased through NRI.

## RIDERS MANUAL, VOLUME 15

Volume 15 of the Rider Manuals is his largest book, encompassing hundreds of post-war and previously unpublished pre-war receivers in its 2,000 pages. More than 1,200 models and 700 chassis of 121 manufacturers of receivers built during 1946, and earlier, are covered in Volume 15, in addition to Rider-prepared and exclusive "clarified schematics" of Multi-band receivers. A Rider-plus service free with Volume 15 is a 181 page index and "How It Works" book. This is a practical guide to the theories of operation of new technical features of latest receivers. The price of Volume 15 is $18.

## RIDERS MANUAL, VOLUME 16

Volume 16 of Rider Manuals is a smaller book. It contains 768 pages. The Cost is proportionately less. This Manual contains diagrams of receivers of 94 manufacturers, including many Rider-developed and Rider-exclusive "clarified schematic" breakdowns of Multi-band receivers. The period of manufacture covered is from late 1946 through early 1947. Included with each copy of Volume 16 is a separate 48-page index and "How It Works" book. The price of Volume 16 is $8.40.

## RIDERS MANUAL, VOLUME 17

Volume 17 takes up where Volume 16 leaves off. It contains 1,648 pages with authorized servicing data on the products of over 100 manufacturers. It contains not only single band but also Multi-band receivers with their Rider-exclusive "clarified schematics." Record players and wire recorders used with receivers are covered. Also with each Volume 17 is a separate "How It

# MANUALS . . .

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We have also arranged, as a special service to our students and graduates, to supply Rider's Manual on "Automatic Record Changers and Recorders." This is a very popular Manual and there is a big demand for it. Mechanics of servicing automatic record changers are covered in this special Manual. It contains ready reference data to speed up trouble shooting and repairs. A plan of analysis is outlined that will apply to any type of changer. Manual contains 744 pages. The price is $9.

The Manuals mentioned in this announcement are now available through NRI. They are listed here in the simplified order blank. Simply check the volume or volumes you wish to purchase, enclose a certified check, money order or bank draft of a sufficient amount to cover your purchase and mail to the National Radio Institute, 16th and U Streets, N. W., Washington 9, D. C. The Manual or Manuals will come to you direct from NRI, postage prepaid. Personal checks should be certified to avoid delay of 10 to 15 days in shipment waiting for checks to clear.

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Important Notice to Students in Canada: These Manuals do not include Canadian diagrams.

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# I Had A Friend

A very successful businessman was interviewed by a reporter for a newspaper. "Mr. Jones," asked the reporter, "to what single influence do you attribute your start toward your business career?" Without hesitation came the answer, "I had a friend."

Back of every outstanding success you will find the influence of some one person who was always close at hand with good counsel, encouragement and moral support. Often it is a mother or father, sometimes a sister, wife or sweetheart, and again it may be just a good friend.

There is a vast distinction between a friend and a companion. One will come to your assistance in an emergency, keep your secrets, speak well of you under all circumstances. The other likes you for your companionship just as long as he can hold you at his own level. Go ahead a little bit and notice the difference. Silently for a while he will envy you, then he will feel he must give you advice and it may not all be for your own good. Because he doesn't have the ambition and determination to get ahead through preparation, he feels he must hold you back too. "Buncombe," he will say when you tell him you have mapped out a training program for yourself, "you are wasting your time—I am going to have some fun." But go to a real friend and say, "I'm not getting anywhere—I am drifting with the tide. Next year, for me, is as uncertain as tomorrow. What shall I do?" He will probably place his hand on your shoulder, look you squarely in the eye and say, "My friend, there is a price tag on you. For a man your age who has no more training than you have, you are earning just about all you are worth. It's all very simple if you will face the facts. To earn more you must know more. It is always crowded at the bottom of the ladder, but there is plenty of room at the top. The trained man has knowledge which will pay him dividends for the rest of his life. No catastrophe can take that knowledge from him. Get out of the rut. You haven't a minute to lose. Not next week or even tomorrow, but today, A. D. 1948, there is work for you to do—work on yourself—absorbing knowledge which is yours for the effort. I'll help you. I am your friend. I see big things for you if only you will do your part. Today, more than ever, you must have specialized training."

In this imaginary conversation I hope you will remember three things which were emphasized. First, there is a price tag on you; second, to earn more you must know more; and third, you haven't a minute to lose. That's about what a real friend will tell you.

L. L. Menne,
*Executive Secretary*

## Chapter Chatter

If it's news about local NRI Alumni Chapters you're interested in, read on brother, 'cause here goes—

**Philadelphia.** Television and F.M. have ceased to be "just around the corner," especially in some of the larger Eastern cities, such as Philadelphia. Norman Kraft and Norman Haffler, who head our committee on demonstrations, have announced plans for a series of discussions centered around the use of modern radio test equipment and its application to F.M. and Television. First will come the use of fundamental instruments such as the signal generator, tube tester, and condenser analyzer. Later on will come the use of the oscilloscope and sweep frequency generator in F.M. and Television alignment. Plenty of demonstrations are to be given, and all members should have ample opportunity for questions and first-hand experience on operating the equipment.

Our Chairman, Harvey Morris, has been absent during recent meetings because of a new contract he has signed with the Television Department of Philco. We expect him to be with us again soon, and are counting on plenty of up-to-the-minute dope on T.V. We also plan on utilizing the wide F.M. and Television experience of our Norman Haffler, who has built his own oscilloscope and several Television receivers.

Norman Kraft, as Vice-Chairman, has been doing a swell job in the absence of Chairman Morris.

Officers were chosen to head our organization for 1948. Harvey Morris was, of course, re-elected as Chairman; Norman Kraft, Vice-Chairman; C. N. Hill was again elected as Recording Secretary; Ray Hamilton, Financial Secretary; Charles Fehn again as Treasurer, and Norman Haffler as Electronic Advisor.

Meetings are permanently scheduled on the second and fourth Mondays at 8:15 P. M., 4510 Frankford Avenue (third floor). We're really looking forward to some enthusiastic meetings.

**Baltimore.** Our new officers for 1948, led by Percy Marsh as Chairman, are doing a fine job in organizing a program for the balance of 1948. Ernie Gosnell, our National NRIAA President, gave a very fine lecture on auto radio vibrators. We're looking forward to some excellent discussions led by Chapter members which will include our Vice Chairman Tom Clark, Mr. Shue, Mr. Whitt, Mr. Klien, Mr. Kelly, our National Vice Chairman Rathbun, Mr. Strupp, and Mr. Ingram.

Subjects of future lectures are too numerous to mention. Each meeting is bound to be full of worthwhile information and we urge all members to attend regularly. We were glad to have Mr. E. Dohner with us as a visitor.

**New York.** Something is always doing here. We are averaging 50 or more members present at each meeting.

Television discussions have become an important part of our Chapter activities. We were very pleasantly surprised by a visit of former Chairman Ralph Baer who delivered a talk on "Video." He is not able to be with us all the time since he is stationed in Chicago. We hope to have him back with us soon.

Our question and answer forum, headed by Alex Remer, has long been an established feature with us. However, Alex always manages to introduce some new twist which keeps interest in this type of discussion very high.

We are getting some real information from lectures given by old standbys such as William Fox, Dick Patten, Joel Robinson, Sidney Fried and others.

We are always striving to plan something new. Members need not stay away in fear of spending a boring evening with us. We hope to have access to facilities for movies before too long. To NRI men in our area who do not attend meetings, we offer a real opportunity to increase your technical ability while enjoying an atmosphere of jovial friendship.

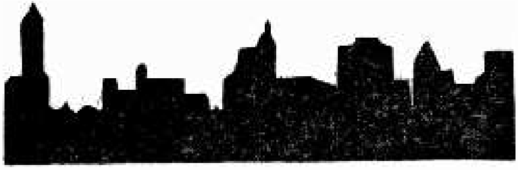
**Chicago.** Our new chairman, Lloyd Immel, is proving to be an enthusiastic leader and organizer. Louis Gold was elected treasurer during 1948. Election of a new secretary, librarian, and sergeant-at-arms has been temporarily postponed.

We have several newer members who are going to be active in future discussions and demonstrations. Fred Korn is making arrangements to provide a radio receiver in kit form for construction at meetings. Another new member, Albert Horvath, led a discussion on servicing power packs. We are looking forward to a demonstration of the Meissner Analyzer by Mr. Robert Frank.

We cordially invite NRI men in our area to visit us, and to become active members of our chapter. Meetings are held on the second Wednesday of each month, 8 P. M., at 2759 South Pulaski Road.

**Detroit.** We have a new idea which is helping to increase member interest and attendance. Mimeographed bulletins are periodically mailed to our membership. They include scheduled discussions for future meetings, and other miscellaneous items of interest to our membership.

We are going after top-flight men for authoritative lectures on F.M. and Television. Expect to have representatives of Sylvania, Philco, and Westinghouse.



Other subjects for past discussions included a demonstration and technical information on the Brush Sound Mirror Wire Recorder. This is something really new. Mr. Ketteman, Service Manager for Philco in the Detroit area, is scheduled to give a talk on record changers and the Beam-O-Lite. Our own member, Floyd Buehler, is making arrangements to have an expert on F.M. and Television antennas with us soon. We are deeply indebted to Buehler, as he is always organizing something interesting and beneficial for the chapter.

We always count on our able Chairman, Earl Oliver, to add something worthwhile to each meeting's activities. Earl conducts a service forum and directs the repair of sets brought in by our members.

We are glad to have W. S. Thomas as a new member. He contributed greatly to the interest of one of our meetings by bringing in a German-made radio which he confiscated during the war.

We invite all men in our area interested in attending meetings to contact our secretary, Harry R. Stevens. We'll be glad to have you with us.

*n r i*

The photo directly below shows New York Chapter members listening to Ralph George and Dick Patten explain the use of the NRI Professional Signal Tracer.

On lower right are four of New York Chapter's recent speakers—from left to right, Alex Remer, Humberto Middleton, Ralph George and Richard Patten.

## Local Chapter Meetings and Officers

NEW YORK—Meet at 8:15 P.M. on 1st and 3rd Thursday of each month at St. Mark's Community Center, 12 St. Mark's Place—between 2nd & 3rd Ave., New York City.

*Chairman*, Bert Wappler, 27 W. 24th St., New York City.

*Secretary*, Louis J. Kunert, 145-20 Ferndale Ave., Jamaica 4, N. Y.

PHILADELPHIA—Meet at 8:15 P.M. on 2nd and 4th Monday of each month at 4510 Frankford Ave. (third floor)

*Chairman*, Harvey Morris, 6216 Charles St., Phila.

*Secretary*, Clifford Hill, 1317 N. Alden St., Phila.

BALTIMORE—Meet at 8:15 P.M. on 2nd and 4th Tuesday of each month at 745 West Baltimore St.

*Chairman*, P. E. Marsh, Box 556 Arlington Station, Baltimore.

*Secretary*, Arthur F. Lutz, 1101 Overbrook Road, Baltimore.

DETROIT—Meet at 8:15 P.M. on 2nd and 4th Friday of each month at Electronics Institute, 21 Henry St., corner Woodward (fourth floor).

*Chairman*, F. Earl Oliver, 3999 Bedford Detroit.
*Secretary*, Harry R. Stephens, 5910 Grayton Rd., Detroit.

CHICAGO—Meet at 8:15 P.M. on 2nd Wednesday of each month at 2759 So. Pulaski Road.

*Chairman*, Lloyd Immel, 2306 W. 51st St., Chicago.

*Secretary*, Louis Brodhage, 4820 N. Kedzie Ave., Chicago.

# Here and There Among Alumni Members

A letter from George R. Stoner, NRI Graduate who is teaching Radio at the Infantry School in Fort Benning, Georgia, thanks us for technical information supplied to him. A recent letter written to him by Chief Instructor Dowie explained the action of the discriminator in the Model BC1000 Signal Corps Radio receiver. Stoner said that this particular circuit had been bothering instructors in their school for the past two years. Now the explanation is clear to all.

—n r i—

*Many new opportunities are opening up in the Communication field. Elhart Nelsen, of Chicago, is now with Highway Radio, Incorporated, as a Radio Operator-Engineer for stations W9XPJ and W9XIP. At present, this firm is promoting the installation of two-way radios in trucks owned by the large trucking firms. All of this work is with F.M.*

—n r i—

Fred L. Stahl, of Valhalla, New York, has his first full-time Radio job with the Gray Research and Development Company, Elmsford, New York. He mentions that his employer was pleased to hear that he is an NRI graduate.

—n r i—

*Ernest S. Lewis, of St. Petersburg, Florida, has his amateur license, call W4MZT, and has also acquired his first-class Radiotelephone license. He plans to study Radio Engineering soon, and hopes to be able to locate near a college where he can work part-time in a broadcast station.*

—n r i—

James Bangley, Jr., who is a broadcast engineer with Station WLPM of Suffolk, Virginia, has been helping complete the installation of WLPM's new F.M. transmitter (107.7 megacycles).

—n r i—

*Earl A. Merryman, of Washington, D. C., has taken a new position as Chief Engineer of Radio Station WBUZ in Bradbury Heights, Maryland.*

—n r i—

Graduate Jerry McCarthy, who owns and operates one of Washington, D. C.'s most progressive Radio and Recording businesses, has recently been appointed as the authorized television service station for DuMont in this district.

—n r i—

*Graduate Maurice Droullard and his partner, G. W. Osborn of Pampa, Texas, have had their new service shop in operation for about two months and are doing very well. They also work as engineers at Radio Station KPDN in Pampa.*

—n r i—

A year ago, Alumnus David S. Hall, of Corona, New York, was in the hospital due to an automobile accident. He was forced to sell his radio servicing business at that time. We are glad to hear from Graduate Hall and to learn that he is beginning to get around again. We hope he will soon be able to become active in Radio work.

*J. W. Essex, of Bridgewater, Nova Scotia, Canada, has been appointed Chief Engineer of Station CKBW. Congratulations!*

—n r i—

Irving Solomon, of Brooklyn, New York, now has his own business handling the sale of Radio, Television, electrical appliances and supplies.

—n r i—

*We were sorry to learn of the death of Alumnus Sabe Bueno, of Trinidad, Colorado. He was a faithful member of our Association, and an excellent Radio serviceman.*

—n r i—

Graduate John H. Schulken, who has been in Radio work since 1925, is now working for the United States Navy Department at Naval Base, South Carolina. He says he runs into a good many NRI men.

—n r i—

*Since his graduation, Max E. Bone has been employed as a radio operator with the Dayton Police Department. In addition, he has his own spare-time Radio service business and hopes to go into full-time service work soon.*

—n r i—

Have an interesting letter from Graduate R. C. Simpson, Jr., of Troy, New York. Simpson became active in radio as a spark coil ham in 1913. He was a radio operator in World War I. Now a retired highway engineer, Graduate Simpson has a small, well equipped shop in his home and all the service work he desires.

—n r i—

*Canadian Graduate W. C. Ducasse, Rainy River, Ont., has owned and operated the Rainy River Radio Electric Shop during the past several years. During World War II he served overseas as a radar instructor. Ducasse graduated from NRI in 1938.*

—n r i—

We enjoyed another letter from a Canadian Graduate, Elroy E. Schizkoske, of Pembroke, Ont., Canada. He is an operator at Station CHOV. We were interested in hearing that Schizkoske hopes to advance himself into the field of Radio research soon.

—n r i—

*Alumnus Elmer Fleischhut, of Mt. Clemens, Mich. is certainly proud of his NRI Professional Signal Tracer. He says a faulty stage is located in no time at all, and he now aligns the R.F., I.F., and OSC. section of every set he repairs.*

—n r i—

Here's proof that radio opportunities are open to young men. Graduate William Lipke, age 18, is now working for KTNM, Tucumcari, New Mexico, as a broadcast engineer. He enrolled with NRI at the age of 15 while still in high school. Now he's making $235 a month.

# NATIONAL RADIO NEWS

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L. L. MENNE, EDITOR
J. B. STRAUGHN, TECHNICAL EDITOR




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