PROVING THE PERFORMANCE

OF YOUR BROADCASTING STATION

Gates Radio Company
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Published by the Gates Radio Company of Quincy, Illinois to assist broadcasters in making proper measurements of their broadcast station equipment, to not only comply with FCC regulations but to improve transmission quality on an everyday basis.

THE FCC SAYS, IN A NUTSHELL....

In reading FCC regulations it, of course, sometimes becomes confusing due to the necessary way that regulations of all kinds must be prepared. As a result our engineering department has read over these regulations and the following points are of particular interest:

(1) The original rule regarding proof of performance was to be established and effective in the year 1949 but was suspended for one year due to the cost and other factors placed on broadcasters.

(2) In the year 1950 all standard AM stations as well as FM broadcasting stations are required to make a complete proof of performance as to frequency response, noise and distortion, at least once annually and preferably the last four months of each calendar year or coincidental with the time that any license renewal is requested.

(3) This information is not posted with FCC unless specifically requested but the renewal forms carry a direct question on whether these measurements have been made and secondly, that they do or do not prove that the equipment is operated in accordance with the Standards Of Good Engineering Practice as set forth in the rules and regulations covering good engineering practice by the Federal Communications Commission.

(4) The measurements must be recorded in writing as a written report and kept at the radio transmitter building for view by the field FCC inspectors at any time requested.

(5) The FCC does not specifically approve or disapprove any particular equipment for making the series of tests as long as there is every evidence that the equipment being used is satisfactory and is functioning properly.

(6) The FCC does not demand that broadcasting stations necessarily own the equipment. This means that those owning the equipment may be engaged to do the work. It is specifically pointed out, however, that the intent of the proof of performance rule is to keep all broadcasting stations operating from the standpoint of top quality transmission and it is the opinion of Gates that top quality transmission cannot be maintained by a once annually check. We feel that checks should be made at least once every month. Therefore owning the equipment, for the conscientious broadcaster, is mandatory.

GENERAL REQUIREMENTS FOR PROOF OF PERFORMANCE....

The FCC and field inspectors will, of course, be principally interested in the overall performance of the complete broadcasting station and not necessarily the performance of any one piece of equipment. As a result proof of performance is generally construed as the performance of the station from microphone input to transmitter output including all of the telephone lines, equalizers, intermediate amplifiers between the microphone and the transmitter and, of course, including the transmitter itself. Needless to say, the ability to measure each of the many equipments in the broadcasting station individually is a necessity as failure to meet frequency response, noise and distortion requirements under the Standards Of Good Engineering Practice could in many instances be the failure of only one small portion of the installation. This portion might not even be the equipment, it could be the telephone line that connects the studios to the transmitter or it could possibly be the method of equalization that would induce high distortion at some frequency or, of course, it could be one single amplifier which was either improperly filtered or shielded that would make the entire station not meet standards. As a result it can be said that proof of performance is classified as having the necessary equipment to measure each item in the broadcasting station individually and then all of these items collectively. The Gates SA-131 proof of performance package has been specifically designed to accomplish this result. It has complete facilities to measure any amplifier or transmitter or any combination of amplifiers with a transmitter. Its design has been the result of considerable consultation with our own test engineers who are testing equipments every working day of the year and know the things that an overall test equipment should have and likewise the things that cause the most trouble. It is the purpose of this booklet to help the engineer about to take proof of performance readings so that he can do it speedily and effectively.

THE TEST SETUP....

The test setup will, of course, vary depending upon what is to be tested and the association of the equipment in respect to the test for overall proof of performance. The test setup will, of course, have the equipment divided where the studios are separate from the transmitter while where the studios and transmitter are all located in one building, the testing will be less complicated as the equipment for testing will be closely associated. Certain fundamental rules are necessary in the testing of equipment in a radio frequency field and likewise audio equipment having quite high gain.

The audio oscillator which is the Type 200 B & W unit is, of course, always the input signal source in the big majority of instances. This operates in conjunction with the MO-3625 gain set for the output of the audio oscillator feeds directly to the gain set and the output of the gain set feeds to the input of the audio amplifier. In this way it is possible to do two things to provide the correct audio input level and to have an input reference meter for the measurement of the audio input over the entire audio range for frequency response measurements. It is particularly pointed out that all wiring between the various units and the amplifier to be tested should be well shielded and these shields tied to a common ground which grounds not only all of the test equipment but the unit to be tested as well. It must be remembered that to obtain proper measurements of all kinds whether it be noise, distortion or response, that nothing must get into the circuit being measured other than that supplied by the audio oscillator. As a result, extreme shielding of all wiring and the use of common grounds is of vital importance. Failure to do this will develop incorrect readings.

The B & W Type 400 noise and distortion meter may also be employed as an output meter which is properly calibrated on one of the scales in decibels. Where measuring an audio amplifier individually it is usually desirable to load the output of the audio amplifier with a carbon or non-inductive resistor having the same resistance value as the output impedance of the amplifier being measured. When measuring an individual amplifier it should never be connected into its normal operating circuit as under certain circumstances the succeeding load such as an equalizer on a telephone line would give incorrect measurements. Therefore the rule should always be followed when measuring an individual amplifier, that it be disconnected from its normal circuit.

When measuring AM transmitting equipment the procedure is quite the same as when measuring an audio amplifier only the Type 400 noise and distortion meter is connected to the transmitter by means of the MO-3626 diode rectifier and pickup coil. This pickup coil is placed in close association with the final tank coil of the broadcast transmitter. Its output is fed to the diode rectifier which in turn provides the proper supply to the Type 400 noise and distortion meter for all response, noise and distortion measurements. Again the use of complete shielding of the audio circuit between the audio oscillator, gain set, and transmitter is vitally necessary; likewise the use of common grounds. For transmitters of higher power than 250 watts it is sometimes desirable to locate the oscillator and gain set several feet from the transmitter so that there will be no danger of stray R.F. fields getting into the oscillator and gain set equipment.

GETTING ACQUAINTED....

Read thoroughly the instruction sheets that accompany the B & W Type 200 audio oscillator and the Type 400 noise and distortion meter. Become thoroughly acquainted with these instruments as to how they operate and the functions that they are capable of performing. You will find by becoming thoroughly acquainted with these instruments that the proof of performance will be very simple.

The MO-3625 Gain Set carries the following instructions:

This unit provides a multiple of functions, such as audio level indication, impedance matching and calibrated loss insertion. The input and output circuit of this unit is balanced. Therefore, it is important to note that it must be used with an audio oscillator that provides a balanced output such as the Barker & Williamson Model 200.

The MO-3625 must likewise be terminated in a balanced load such as provided by the balanced input of an audio amplifier or the balanced audio input of a transmitter.

If the audio oscillator or the equipment under test does not present a balanced circuit such as mentioned in the preceding paragraph, a Gates Type A-3580 repeater transformer must be used for isolation purposes. The MO-3625 has undergone extensive tests in the Gates Laboratories. The accuracy of this instrument cannot be guaranteed if any unauthorized circuit changes or calibration changes are made outside of the Gates Laboratories.

Front Panel Controls — All controls pertaining to the ordinary functions of this unit are located on the front panel.

(a) Noise Key — When in the center position this key connects the external audio oscillator to the VU meter circuit and the attenuation and impedance matching circuits in this MO-3625. When in the up or "NOISE TEST" position, the external oscillator is disconnected from the internal circuits and a load is placed across the unit to simulate the impedance of the audio oscillator. The noise key is placed in the "ON" position for both response and distortion measurements. This key is placed in the "NOISE TEST" position only when noise measurements are being taken.

VU Range Keys — The center key of the set of three keys controls the position of the variable attenuator in the circuit. When this key is in the center position labeled "PAD OUT" the variable attenuator is disconnected from the circuit. This is done in instances where outputs as high as +20 VU are required. When in the up position labeled "PAD IN", the variable attenuator is placed in the attenuation circuit. With this variable attenuator in the circuit, it is possible to read a maximum level of +15 VU.

The VU range key (the key located close to the meter) is a three-position key providing 6 VU ranges. It should be noticed that this key is marked with three ranges on either side. To the left of this key from top to bottom are the ranges +10, +16 and +21. All of these ranges are set off in individual brackets. To the right of this key from top to bottom are the ranges +4, +10 and +15. This key is used in conjunction with the "PAD IN - PAD OUT" key. For example, when the center key is in the "PAD OUT" position, the calibrations on the left of the range key (those enclosed in brackets) are used. When the center key is in the "PAD IN" position, the calibrations on the right side of the range key are used.

Observation of the six ranges will disclose a difference of 6 DB between any two adjacent ranges. This 6 DB difference is necessary in order to compensate for the insertion loss of the variable attenuator which is 6 DB.

VU Meter — The VU meter is used for the purpose of correct input level setting. The range for this meter is selected by the range key located adjacent to the meter as mentioned in the preceding paragraphs. It should be remembered that the VU meter does not indicate the output level of the instrument. It indicates the reference level from which the sum of the values of the fixed plug-in pads and the attenuation of the variable attenuator is subtracted. For example, if the pad key is placed in the "PAD IN" position and the range key in the +4 position, and the audio level is increased until the VU meter indicates "O" VU on the scale, then the reference level is +4. The output level will then be +4 less any losses due to the insertion of any plug-in pads or any losses due to the setting of the variable attenuator.

Variable Attenuator — The variable attenuator is a balanced ladder type providing attenuation in steps of 2 DB. This 10 step control makes possible a maximum attenuation in the control of 20 DB.

Plug-In Pads One, Two and Three — Plug-in pads as used in this unit provide an exceedingly flexible method of loss adjustments and impedance matching. If less than 20 DB loss from the reference level is required then the plug-in pads do not have to be used. The loss from 2 to 20 DB can be adjusted by means of the variable attenuator. When the plug-in pads are not used the shorting plugs must be inserted in the pad sockets. The three sockets labeled "PAD ONE", "PAD TWO" and "PAD THREE" must have either pads or shorting plugs inserted at all times for the proper operation of this unit. The shorting plugs complete the series attenuation circuit when pads are not used. The pad inserted in the "PAD THREE" socket should be used for both attenuation and impedance matching. The pads inserted in sockets marked "PAD ONE" and "PAD TWO" should always be 600/600 ohm pads for this is the internal impedance of the Gain Set. If no pads are required and all three shorting plugs are inserted, the output impedance will be 600 ohms balanced.

The MO-3626 R.F. Rectifier carries the following instructions:

The rectifier proper, together with its pickup coil, forms a complete R.F. demodulation assembly. It may be used for making measurements on any AM transmitter between the radio frequency range of 550 and 1600 Kc. Basically the MO-3626 consists of a Germanium type diode used in a circuit providing the proper R.F. filtering and A.F. loading. The output impedance of the unit is 600 ohms unbalanced. The normal output level is +12 DBM.

Warning —— Although the Germanium diode presents a wide latitude of operating levels, it is possible to burn out the diode by excessive R.F. currents. In order to insure long diode life, the following precautions should always be used:

1. Never use the MO-3626 without some means of checking the audio output level. A VU meter may be used or the Barker & Williamson Distortion Meter may be employed for this purpose. If a VU meter is used the correct output is +12 VU. If the Barker & Williamson Distortion Meter is used, the correct output can be determined in this manner.

    (a) Connect the output shielded lead of the R.F. rectifier to the input of the distortion meter. The inner conductor of this shielded lead should be connected to the upper terminal on the distortion meter. The shield itself should be connected to the lower terminal on the distortion meter.

    (b) Set the main switch to calibrate.

    (c) Set the range switch to the transmitter modulation frequency.

    (d) Advance the calibration control to the half-way point, that is, with the pointer straight up.

    (e) Under these conditions a full scale reading on the distortion meter will indicate the correct operating level.

Procedure at the Studio Site — In order to more clearly explain these procedures, the following assumptions will be made. This is, of course, merely an example.

1. Microphone channel input impedance 250 ohms balanced.

2. All console controls set at "O" with the exception of the control in the microphone channel in use and the master gain control. These two controls should be adjusted to their normal operating settings.

3. An input level of -50 DBM will be used.

Connection Procedure:

1. Turn the Barker & Williamson Audio Oscillator on and allow a five minute warm-up period before making any measurements.

2. Connect the output of the oscillator to the input of the MO-3625 Gain Set by means of a twisted pair shielded cable.

3. Connect the center terminal of the Audio Oscillator to the ground post on the MO-3625. Also connect the ground post of the MO-3625 to the best common ground available. This ground should be common to all of the speech equipment. If the best possible noise and distortion measurements are to be obtained, it is of prime importance that the ground system be well planned.

4. On the MO-3625:

   (a) Place the noise key in the "ON" position.

   (b) Place the pad key in the "PAD IN" position.

   (c) Place the VU range switch in the +10 position.

   (d) Place the variable attenuator in the "O" position.

   (e) Remove the shorting plugs from the "PAD TWO" and "PAD THREE" sockets.

   (f) Insert the 40 DB, 600/600 ohm plug-in pad in the "PAD TWO" socket.

   (g) Insert the 20 DB 600/250 ohm pad in the "PAD THREE" socket.

   (h) Connect the out post on the MO-3625 to the microphone input terminals on the console by means of a shielded twisted pair cable. Ground the shield of this cable to the ground position on the MO-3625 and also to the console ground.

5. Set the Audio Oscillator frequency to 1000 cycles.

6. Advance the output level control on the Audio Oscillator until the VU meter in the MO-3625 indicates "O" VU on the scale.

7. An audio signal of 1000 cycles at a level of -50 DBM, and an impedance of 250 ohms, balanced, is now being fed to the microphone input on the console. The console control should be adjusted so that a normal output into the telephone line is obtained. This normal output is usually +8 DBM.

Connections at the Transmitter Site —

1. Energize the Barker & Williamson Distortion Meter and allow a five minute warm-up period before making any measurements.

2. Connect the shielded output lead of the MO-3626 R.F. rectifier to the input terminals on the distortion meter. This is an unbalanced circuit, therefore, the inner conductor should be connected to the upper terminal of the distortion meter and the shield to the lower terminal. The lower terminal should also be connected to the transmitter ground system. Here again it is of prime importance that a good ground system be established.

3. On the Barker & Williamson Distortion Meter:

   (a) Set the main switch to the "CAL." position.

   (b) Advance the calibration control to the mid position (pointer straight up).

   (c) Set the range switch to the 200-2000 range.

4. If a VU meter is available connect the VU meter to the input terminals on the Barker & Williamson Distortion Meter and set the range to +12 VU.

5. Make the limiting action of the limiting amplifier inactive. On the Gates SA-38 and SA-39 limiters, this can be done by merely removing the 6H6 rectifier.

6. Adjust the modulation level on the transmitter so that the transmitter is modulated 95%.

7. Attach the coaxial cable to the R.F. rectifier and place the pickup loop in the transmitter cabinet. Slowly move the pickup coil into the field of a final tank coil until the meter on the Barker & Williamson Distortion Meter reads full scale deflection, or until the VU meter indicates +12 VU.

   CAUTION: When moving the pickup coil, it must be remembered that the transmitter is on and high voltages are present in the near vicinity of the operator. The usual precaution should be taken so as not to endanger the operator. It is suggested that the transmitter be turned off as the coil is moved and then the transmitter be turned on again while determining the proper position of the coil. The pickup coil should be placed as far along in the R.F. circuit as possible. This will minimize the pickup of harmonics which might be present in the buffer or driver stages. It should be remembered that the least possible coupling necessary in order to obtain a correct output level is the best coupling.

8. If the instructions in the preceding paragraphs have been followed, a correct measuring reference has now been established and the system is ready for distortion, noise and frequency response measurements.

9. When making distortion measurements it is well to experiment with the placement of the pickup coil so that the placement of the coil which results in the lowest possible distortion reading can be obtained.

THE DON'TS OF TESTING....

There are certain simple fundamental rules to follow in the testing of broadcasting equipment that perhaps best classify under the heading of "DON'TS". To assist you these have been listed as follows:

(a) Don't operate any test equipment in an ungrounded condition. The importance of all equipment being grounded usually to a common ground with the item being tested and likewise all audio wiring being properly shielded with the shields grounded is the most important part of good satisfactory proof of performance.

(b) Don't overload input circuits. The MO-3625 Gain Set is provided so that you will not overload input circuits. An overloaded input circuit will provide, of course, excessive distortion, misleading noise measurements and usually poor frequency response.

(c) Don't measure circuits at lower input levels than practically necessary. This is particularly important in respect to noise measurements and also distortion. High noise will usually always show up as high distortion. This is not always the case but will be frequently so. By keeping the input level lower than the practical operating amount you penalize your own noise measurements. As an example, the average microphone used today has an output level between -55 DB and -65 DB. It would therefore be penalizing the measurements to place the input level at -70 DB or lower. This would only make the noise measurements show high and would have no practical value as the equipment would never be operated in such a condition.

(d) Don't operate gain settings on various amplifiers being measured at different positions than the day-to-day normal gain settings. It must always be remembered that the proof of performance of the broadcasting station is the spirit or practical operating condition and not some unusual or fictitious operating condition that would never normally exist. Therefore when making either individual or overall noise, distortion and response measurements, use the practical operating gain settings that you use every day.

(e) Don't operate into impedance mismatches. This will in many instances defeat the entire results desired. Be sure that your impedances are matched both input and output-wise.

(f) Don't expect phenomenal noise results at low percentages of modulation. Again remember that the practical operating broadcasting station modulates on the average up to 90% or slightly more. Noise measurements of 10% or 25% modulation are helpful and necessary but they again are not the practical noise measurements that you want. The same is also true with distortion measurements. Usually better distortion measurements will be obtained at low percentage of modulation. It is always possible in a test setup to easily satisfy yourselves by juggling some particular type of test to the out-of-the-ordinary situation. In making the test remember that you are not just trying to satisfy FCC, you are trying to make your station the finest sounding broadcasting station on the air.

(g) Don't fail to inspect your circuit diagrams of the equipment being measured. This is particularly important as in some extreme circumstances a balanced pad such as in the Gain Set may connect directly to an unbalanced pad that might appear in the input of an audio amplifier or transmitter. Under certain circumstances this will function perfectly satisfactory, however if rising frequency response characteristics are indicated at high frequencies out of all normal proportions or capabilities of the equipment, this is an indication that there is either an impedance mismatch or a combination of the two pads operating in series that effects an impedance mismatch because of buried grounding conditions of the pads. This point is to be considered only in case the measurements are very obviously extremely void of normal. Whenever a measurement is so bad that your own judgment tells you that it does not sound that bad or could not be that bad, it is then an indication of mismatch of the test equipment to the equipment being tested.

LINE TESTING....

Telephone lines usually extending between the studios and the transmitter are the only ones that should come under the proof of performance requirements inasmuch as remote lines which are continually changed from time to time are generally understood to be satisfactory if they meet the normal requirements for good broadcasting. In this discussion of telephone lines we are thus talking about the line from the studio to the transmitter. In some stations as many as four or five lines exist between studio and transmitter. In the average station there are two telephone lines, both of which should be equalized identically and then one of these lines is normally used as a spare and becomes the order telephone line between transmitter and studio. It is well, however, to maintain both telephone lines to have the same measurements so that in case of emergency switchover there will be no change in transmission quality.

Telephone lines are usually measured at the same input level as that level being fed the line under practical operating conditions, as most telephone lines are fed around +10 DBM. If this is the case, then the input measurement to the line should be +10 DBM. The audio oscillator can then be connected at the studio in connection with the Gain Set and the Type 400 noise and distortion meter may be used as an output meter at the point where the transmitter line connects into the audio equipment at the transmitter. This line, of course, should be removed from the audio equipment and a resistor of the same impedance as the audio input, which is usually 500/600 ohms, be inserted in its place. Complete frequency response, noise and distortion measurements should then be made in the usual procedure. It, of course, is well to point out at this point that if the overall proof of performance sags in respect to frequency response, it is quite possible with cooperation of the telephone company to make corrections in the overall frequency response by corrections in the telephone company's line equalizer circuit. There would be nothing wrong with this as long as the corrections required were not too severe. The cost problem usually confronted in the measurement of telephone lines is that of noise, particularly if the transmitter is located some distance from town and the telephone lines are of the open type. However, it is pointed out that the noise measurements of the telephone line should be consistently as good as the rest of the equipment to obtain satisfactory overall measurements, that where high noise is appearing in the telephone lines it is then up to the telephone company to make the necessary corrections as you can do nothing about this. Noise in telephone lines usually ties down to unbalance, crosstalk, and in some instances improper transposition when running in near proximity to high tension power lines. In summary, the measurement of the telephone line is one of the first things that should be done where the overall proof of performance does not meet the engineering requirements from the standpoint of noise.

CORRECTION CIRCUITS....

Provided as part of this booklet is a page on the subject of correction circuits, or Figures 1 thru 4 inclusive. This will be found in the drawing section in the back of the booklet. Figure 1 is equalization in an audio amplifier commonly known as plate to plate equalization between two single ended stages. R1 and R2 are usually a value of 56,000 ohms. These values will change only in rare instances in case the gain between stages was normal. Where the gain between stages was extremely high such as two pentode stages, then the values of R1 and R2 might be greater than 56,000 ohms. Condenser C1 controls the amount of low frequency feedback. This condenser normally would be a value of 0.05 mfd. To increase the low frequency response, decrease the size of capacitor C1. To decrease the low frequency response, increase the value of C1. Capacitor C2 controls the amount of high frequency feedback. To increase the high frequency response, increase the value of C2 which has normally been expressed as 0.001 mfd. To decrease the high frequency response, decrease the value of C2. To further decrease the high frequency response, capacitor C3 may be added which has a normal value of 0.001 mfd. Plate to plate equalization such as expressed in Figure 1 and above is considered a very satisfactory method for making frequency response corrections.

Plate to cathode equalization — This is somewhat similar to plate to plate equalization but sometimes can be done more conveniently, particularly in high gain stages. In this type of circuit R1 has a normal value of 270,000 ohms which will not vary unless the gain between stages is extremely higher than normal. Capacitor C1 has a normal value of 0.05 mfd. and is decreased in value to increase low frequency response, or is increased in value to decrease low frequency response. Capacitor C2, which has a normal value of 0.0025 mfd., is increased in value to increase high frequency response and decreased in value to decrease high frequency response. To further decrease high frequency response, add capacitor C3 which has a normal value of 0.001 mfd. All values shown above are typical values subject, of course, to alteration to obtain the desired practical results.

Equalization in program line — This is accomplished by the use of a line equalizer such as the Gates SA line equalizers described on Page 36 of the

Gates speech input catalog. These line equalizers are available in five different ranges and sell at an average price of about $50.00. By referring to Page 36 of the catalog which is part of this booklet, a full understanding of the equalizers will be had and where in the overall performance there is a deficiency in high frequency response, for example, between 8000 and 10,000 cycles, then a Gates SA-119 equalizer could be paralleled directly across the telephone line to make necessary corrections in a most uncomplicated way. The line equalization is illustrated in Figure 3.

Equalizing the program line by impedance mismatch — This is shown in Figure 4 and is generally considered a temporary expedient and not a recommended method, however it is commonly known that response curves can be changed through the system of impedance mismatching. The caution in following this system is to prevent unbalance in the telephone line and in some instances to prevent increased distortion through impedance mismatching. As most broadcasting stations have a repeater transformer on hand, it is sometimes possible to make a correction of one or several decibels by means of impedance mismatch. Again this gets down to the practical results wherein if the proof of performance is almost in but not quite that a slight impedance mismatch might do the trick and save the cost of a more expensive equalizer. Impedance mismatching is nothing more than, for example, connecting a 500 ohm circuit so that it looks into a different impedance in the succeeding load. As previously stated, this method is considered unorthodox but at times will function quite satisfactorily.

FIXED PADS....

On Page 42 of the Gates catalog, which is part of this booklet, will be found handy reference data in the construction of fixed attenuator pads. Quite frequently both in testing and likewise in corrections it is highly desirable to insert a fixed pad. This table will make it possible to temporarily arrange about any value of fixed pad that might be needed and after the proper value has been obtained it may be desirable to order a calibrated fixed pad such as shown on Page 39 of the Gates catalog.

The use of fixed pads in certain parts of the circuit will at times completely eliminate a perplexing problem of frequency response, noise or distortion depending upon what the problem may be. For example, it is usually considered poor practice to connect the secondary of a transformer such as would be the output of an amplifier directly to the primary of another transformer which would normally be the input of a succeeding amplifier without having a fixed pad between the two units. This pad eliminates the possibility of any reaction between the output and input transformer mentioned above causing error in frequency response and sometimes excess distortion. Likewise the insertion of a proper value fixed pad allows the use of all amplifiers in the circuit at normal gain settings. As most amplifiers regardless of make are designed to perform best at normal gain settings, it should be particularly noted in the overall installation as to whether any amplifier is operating at an extremely low gain setting, which being the case would indicate that improvement probably could be obtained by inserting a fixed pad at the input of this amplifier and allowing it to operate at a normal gain setting. Under certain circumstances abnormal gain settings either low or high will have adverse effect on noise and distortion measurements. Some makes of amplifiers have the attenuator in the second audio stage instead of the first. Thus an abnormally low gain setting of this type of amplifier might indicate that the first audio stage was being overloaded and creating high distortion as well as possible frequency response error. In some instances where it is necessary to use two pads in the same circuit, it is wise to insert a repeater transformer to prevent unbalancing of the circuit. This repeater transformer can be such as the A-3580 described on Page 38 of the Gates catalog.

VOLUME LEVEL TO POWER AND VOLTAGE CONVERSION TABLES....

This handy table will also be found on Page 42 of the Gates catalog which will be helpful in computing output measurements as it is always desirable to know the output capabilities of any particular amplifier so that its limits will be known. When making individual measurements it is recommended that this be calibrated and filed away for reference purposes.

MEASUREMENT SHEET....

Provided as part of this booklet are five measurement sheets for the logging of frequency response, noise and distortion. Additional copies of these sheets will be supplied to any broadcasting station without cost.

GATES COOPERATIVE HELP....

In the preparation of this booklet it has been the desire of the Gates Radio Company to provide broadcast men with helpful hints that have been gathered through the years in the measuring of thousands of instruments that have gone into broadcasting stations. It is recognized that many who will read this booklet are highly skilled in the measurement of broadcast station equipment and the comments herein will be nothing more than repetition. For those who have not had the opportunity of continued measurement of broadcast devices it is hoped that the suggestions made herein will be helpful. The measuring of broadcasting equipment is quite the same as the practical testing of any piece of machinery or electrical instrument. Your automobile has not been tested at a speed of 100 miles per hour. Instead, its design and acceptance is on the basis of the normal driving that you and all others enjoy with your automobile. Again this same word of caution is inserted about broadcasting equipment. There is no more advantage in endeavoring to obtain fine distortion measurements at 125% modulation or excellent noise measurements at abnormal operating conditions of an amplifier than there is endeavoring to obtain fine performance of an automobile at 100 miles per hour. You are interested principally in meeting the Standards Of Good Engineering Practice through operating your equipment normally. The Gates engineering department will, without cost or obligation, in fact will be delighted to correspond with any broadcast engineer regarding any problems that he might have.

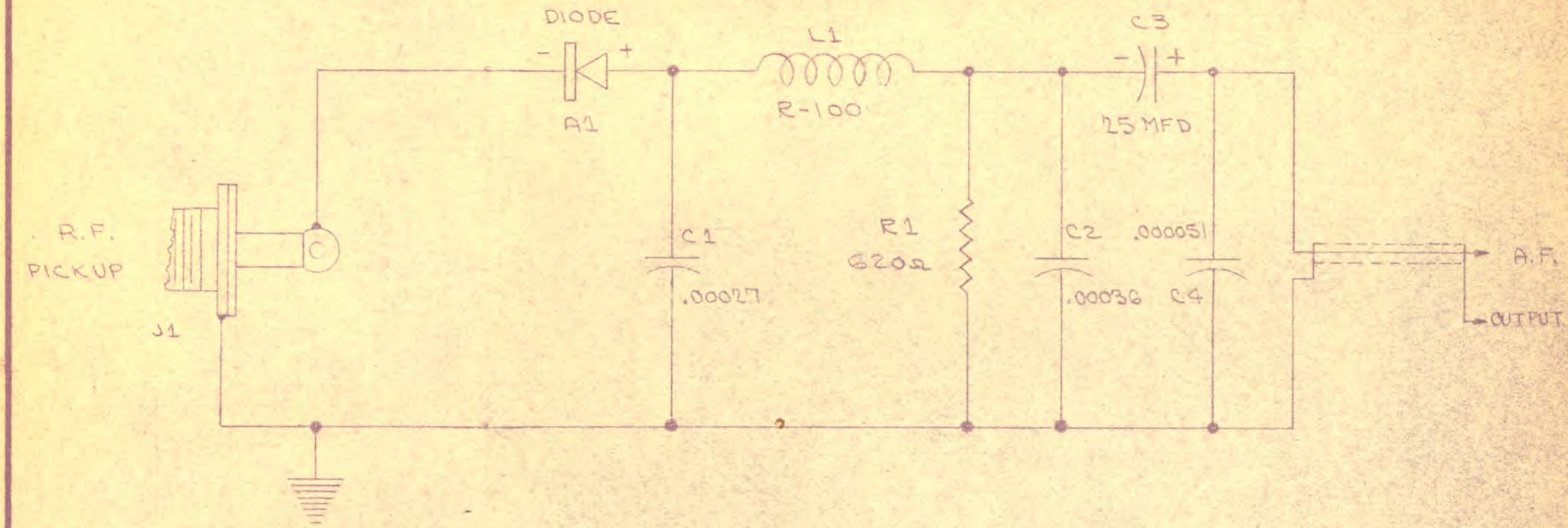
Where field service is required and it does not pertain necessarily to Gates equipment or its guarantee, then we urge that the competent consulting engineering profession at all times be engaged for that work that is out of the normal scope of the broadcast station engineering department. Naturally the Gates Radio Company is interested in selling Gates broadcasting equipment. If after the proof of performance is complete and it is definitely determined that any one part of the equipment will not or cannot meet FCC specifications, then the Gates Radio Company would consider it a pleasure to quote on the needed replacement equipment. At the same time if the need is only for a few cents worth of resistors to take care of your requirements we will consider it a pleasure to supply these. Most important is the fine performance of your broadcasting station. We again reiterate that although the Federal Communications Commission requires proof of performance, this requirement is a truly fine thing for all broadcasting stations as in this day of competition listeners are quick to recognize the difference between good and only fair sounding radio stations. By continual attentiveness to bring about excellent frequency response, noise and distortion readings, your station cannot help but be a fine sounding broadcasting station. Proof of performance could perhaps better be named dollars in the bank because more listeners mean more dollars in the bank and more listeners are automatic when the station is rich and clear in its transmission quality.

Enclosures:

Drawing A-6414
Drawing B-11474
Drawing C-16870
Elec. Parts List 136-PE-101, Gain Set
Elec. Parts List 145-PE-101, R.F. Rectifier
Drawing on Typical Equalizing Systems
5 copies of Measurement Chart
Bulletin on Proof Of Performance Package
Gates Speech Input Catalog with price list

Gates Radio Company
Quincy, Illinois, U.S.A.

DRAWING NUMBER A-6414



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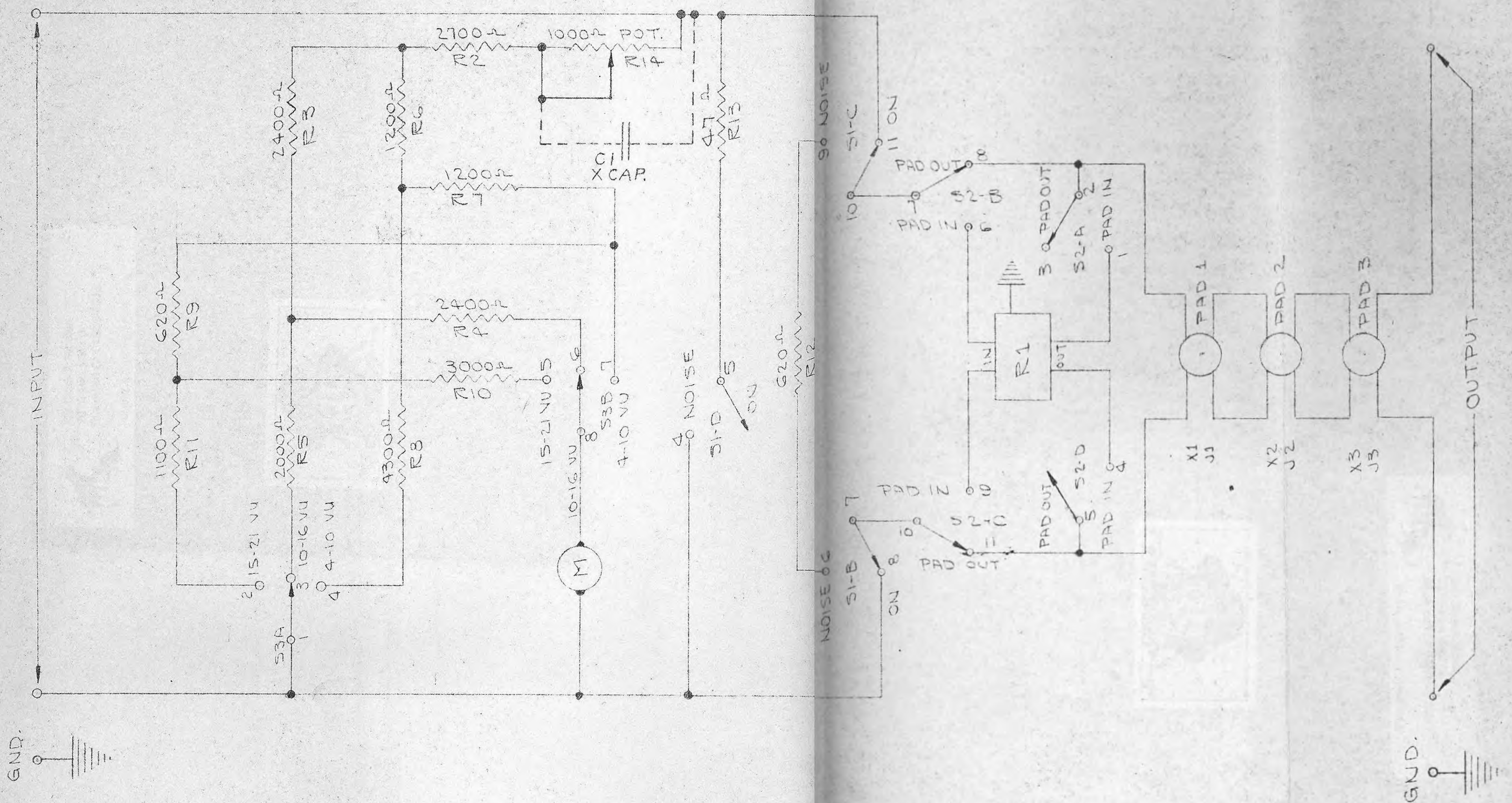
GATES RADIO COMPANY
QUINCY, ILLINOIS

SCHEMATIC FOR DIODE UNIT
MO-3626

MATERIAL		SCALE	
DR. BY R.E.K.	DATE 3-15-50	DRAWING NUMBER	
CH. BY	ENG. N.L.J.	A-6414	

BRUNING No. 309

DRAWING NUMBER B-11474



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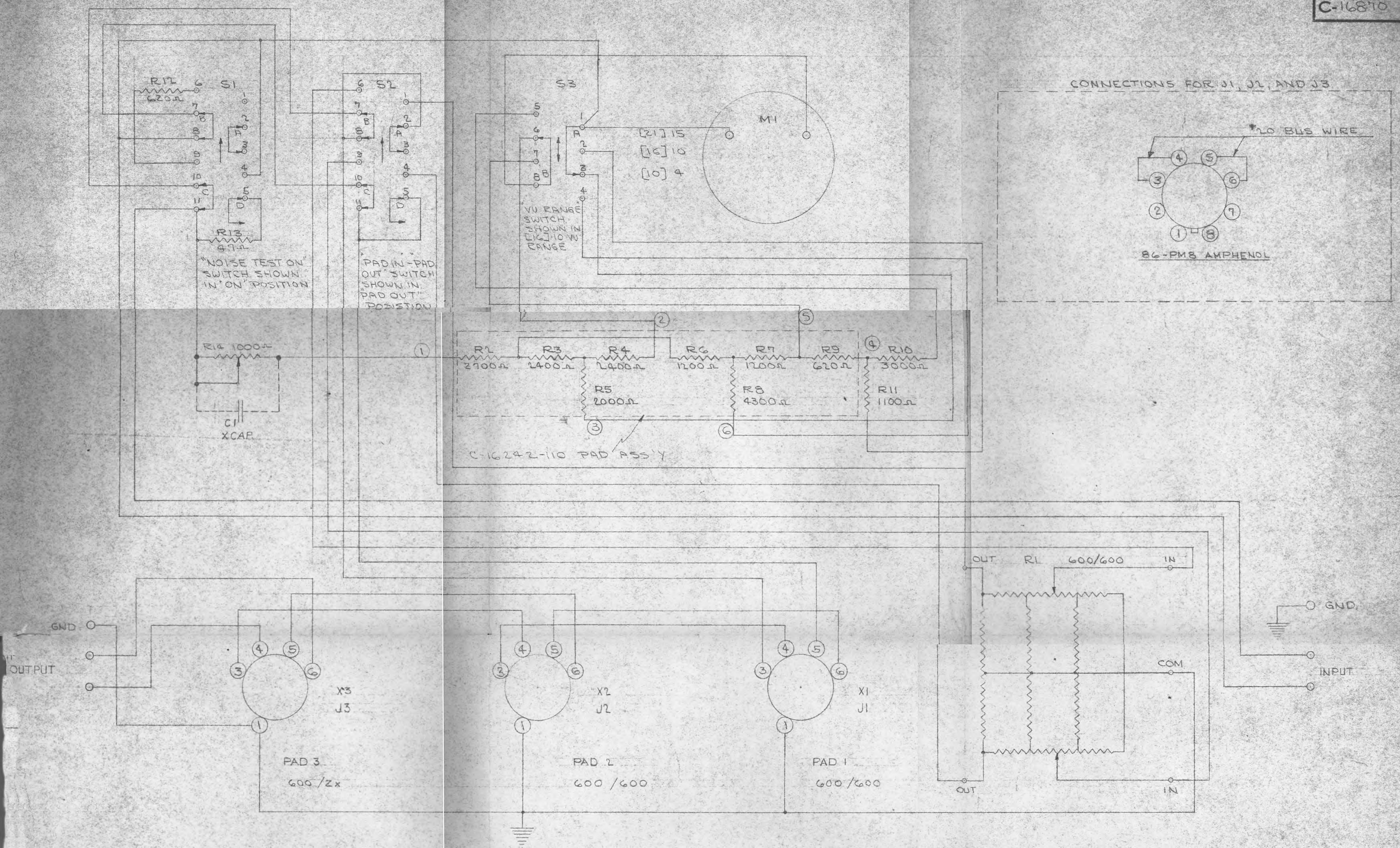
GATES RADIO COMPANY
QUINCY, ILLINOIS

LINE DIAGRAM MO-3625
GAIN SET

MATERIAL		SCALE	
DR. BY HGH	DATE 4-21-50	DRAWING NUMBER	
CH. BY [signature]	ENG. REP	B-11474	

DRAWING NUMBER C-16870



NOTE: PAD 3 IS USED PRIMARILY FOR IMPEDENCE MATCHING WHEN MATCHING FROM 600 TO ANY OTHER IMPEDENCE ITS LOSS IS 20 DB

3	ADDED (C1) PER E.C.N. 2139 6-28-50 D.L.
2	CHANGE PER E.C.N. 2210 6-28-50 D.L.
1	CHG. PER ECN 2098 5-12-50 HGH

GATES RADIO COMPANY
QUINCY, ILLINOIS

SCHEMATIC
GAIN SET — M0-3625

MATERIAL — SCALE

DR. BY RLW — DATE 2-10-50

CH. BY — ENG. NLJ

DRAWING NUMBER C-16870

PARTS LIST MO-3625 GAIN SET

SYMBOL NO.	DESCRIPTION
J1	86 PM8 Connector
J2	86 PM 8 Connector
J3	86 PM 8 Connector
C1	X-Cap. (value det. by Freq. response)
M1	Model 535 VU meter, -20 to +3 DB scale
R1	Type BAL- 251 G Balanced ladder 600/600 ohms
R2	2700 ohms, 1 watt, 5%
R3	2400 ohms, ½ watt, 5 %
R4	2400 ohms, ½ watt, 5%
R5	2000 ohms, ½ watt, 5%
R6	1200 ohms, ½ watt, 5%
R7	1200 ohms, ½ watt, 5%
R8	4300 ohms, ½ watt, 5%
R9	620 ohms, ½watt, 5%
R10	3000 ohms, ½watt, 5%
R11	1100 ohms, ½ watt, 5%
R12	620 ohms, ½ watt, 5%
R13	47 ohms, ½ watt, 5%
R14	A- 3404-8, 1000 ohms, wire wound control
S1	Switch, 9735
S2	Switch, 9735
S3	Switch, N- 10076
X1	Socket, MIP 8 (black)
X2	Socket, MIP 8 (black)
X3	Socket, MIP 8 (black)

PARTS LIST MO-3626 R.F. RECTIFIER UNIT

A1	Germanium crystal diode 1N34
C1	Capacitor, .00027 mfd.
C2	Capacitor, .00036 mfd.
C3	Capacitor, 25 mfd., 25V., MT- 0225
C4	Capacitor, .000051 mfd., Type K
J1	A-6457 Connector
L1	Choke, R100
R1	Resistor, 620 ohms, ½ watt 5%

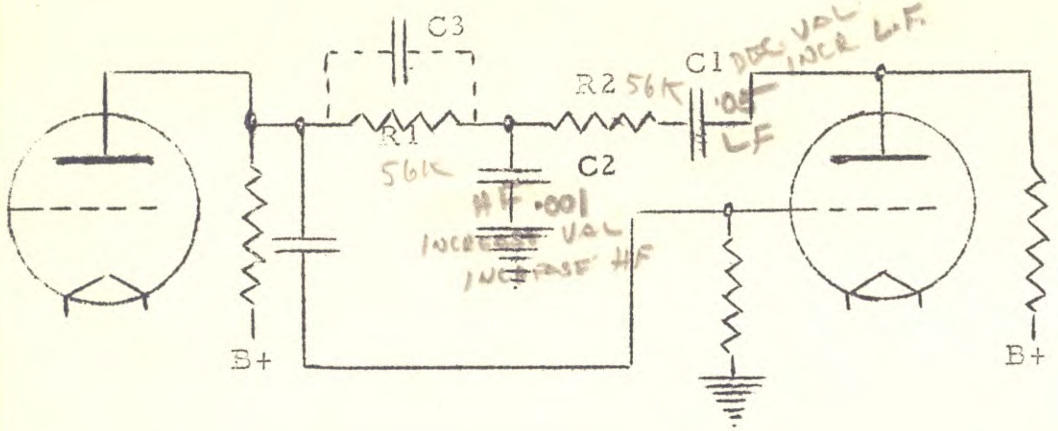


FIG. 1 PLATE TO PLATE EQUALIZING

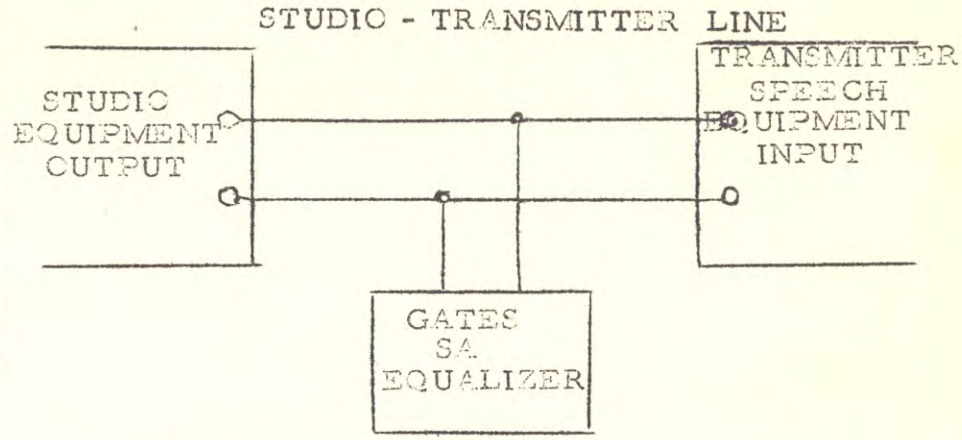


FIG.3 --LINE EQUALIZING

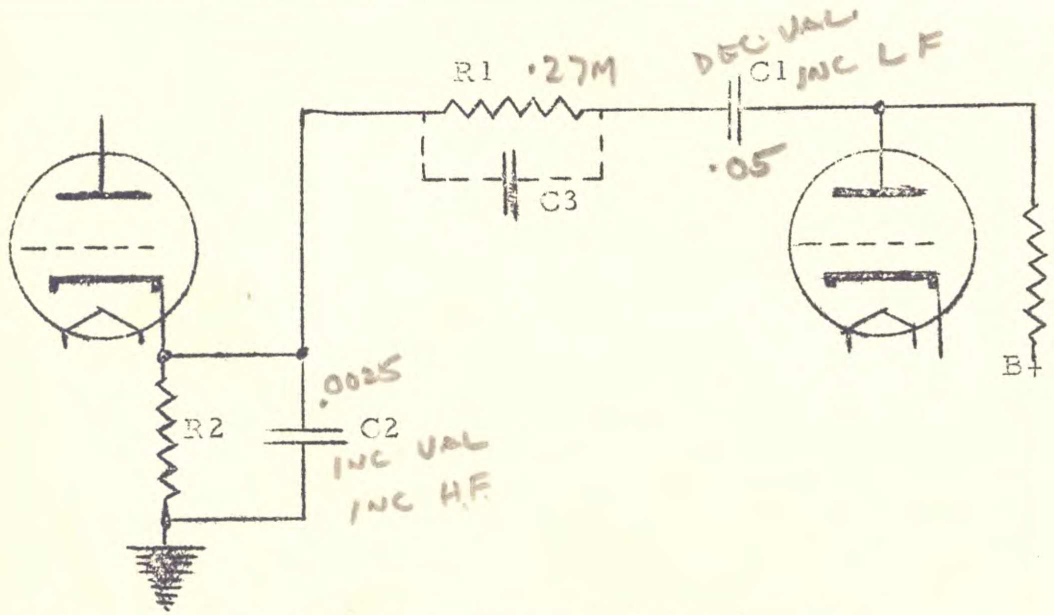


FIG.2 - PLATE TO CATHODE EQUALIZATION

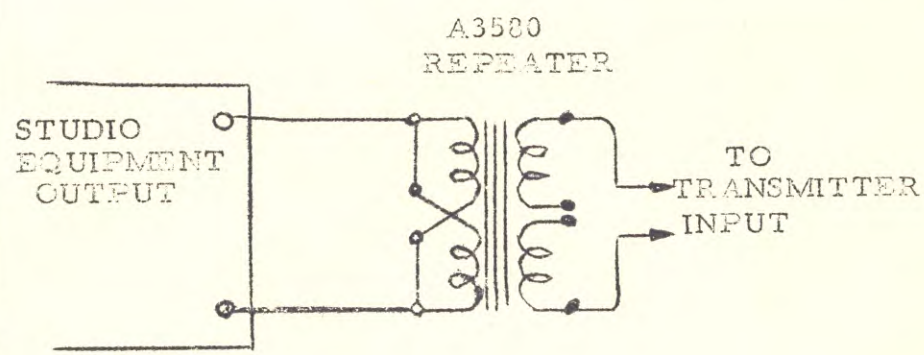


FIG.4 - EQUALIZING THROUGH IMPEDANCE MISMATCH

GATES RADIO COMPANY

TYPICAL EQUALIZING SYSTEMS

SUBJECT CHECKED BY, RADIO STATION DATE

FREQUENCY RESPONSE (CYCLES PER SECOND)	30	50	100	180	360	400	1000	2500	5000	7500	10000	15000
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL												
REMOTE #												

REFERENCE

DISTORTION												
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL -												

	INPUT LEVEL	OUTPUT LEVEL	NOISE REDUCTION
S.P.E.			
T.A.E.			
T.O.			
OVERALL -			

LEGEND

S.P.E. - STUDIO SPEECH EQUIPMENT

S.T.L. - STUDIO TRANSMITTER LINE

T.A.E. - TRANSMITTER AUDIO EQUIPT.

T.O. - TRANSMITTER ONLY

OVERALL - TOTAL OF ABOVE AS IN NORMAL OPERATING CIRCUIT

COMMENTS

MEASUREMENT CHART

GATES RADIO CO.

SUBJECT CHECKED BY, RADIO STATION DATE

CYCLES PER SECOND

FREQUENCY RESPONSE	30	50	100	180	360	400	1000	2500	5000	7500	10000	15000
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL												
REMOTE #												

REFERENCE

DISTORTION												
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL -												

	INPUT LEVEL	OUTPUT LEVEL	NOISE REDUCTION
S.P.E.			
T.A.E.			
T.O.			
OVERALL -			

LEGEND

S.P.E. - STUDIO SPEECH EQUIPMENT

S.T.L. - STUDIO TRANSMITTER LINE

T.A.E. - TRANSMITTER AUDIO EQUIPT.

T.O. - TRANSMITTER ONLY

OVERALL - TOTAL OF ABOVE AS IN NORMAL OPERATING CIRCUIT

COMMENTS

MEASUREMENT CHART

GATES RADIO CO.

SUBJECT CHECKED BY, RADIO STATION DATE

FREQUENCY RESPONSE	30	50	100	180	360	400	1000	2500	5000	7500	10000	15000
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL												
REMOTE #												

(CYCLES PER SECOND)

REFERENCE

DISTORTION												
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL -												

	INPUT LEVEL	OUTPUT LEVEL	NOISE REDUCTION
S.P.E.			
T.A.E.			
T.O.			
OVERALL -			

LEGEND

S.P.E. - STUDIO SPEECH EQUIPMENT

S.T.L. - STUDIO TRANSMITTER LINE

T.A.E. - TRANSMITTER AUDIO EQUIPT.

T.O. - TRANSMITTER ONLY

OVERALL - TOTAL OF ABOVE AS IN NORMAL OPERATING CIRCUIT

COMMENTS

MEASUREMENT CHART

GATES RADIO CO.

SUBJECT CHECKED BY, RADIO STATION DATE

FREQUENCY RESPONSE	30	50	100	180	360	400	1000	2500	5000	7500	10000	15000
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL												
REMOTE #												

CYCLES PER SECOND

REFERENCE

DISTORTION												
S. P. E.												
S. T. L.												
T. A. E.												
T. O.												
OVERALL -												

	INPUT LEVEL	OUTPUT LEVEL	NOISE REDUCTION
S.P.E.			
T.A.E.			
T.O.			
OVERALL -			

LEGEND

S.P.E. - STUDIO SPEECH EQUIPMENT

S.T.L. - STUDIO TRANSMITTER LINE

T.A.E. - TRANSMITTER AUDIO EQUIPT.

T.O. - TRANSMITTER ONLY

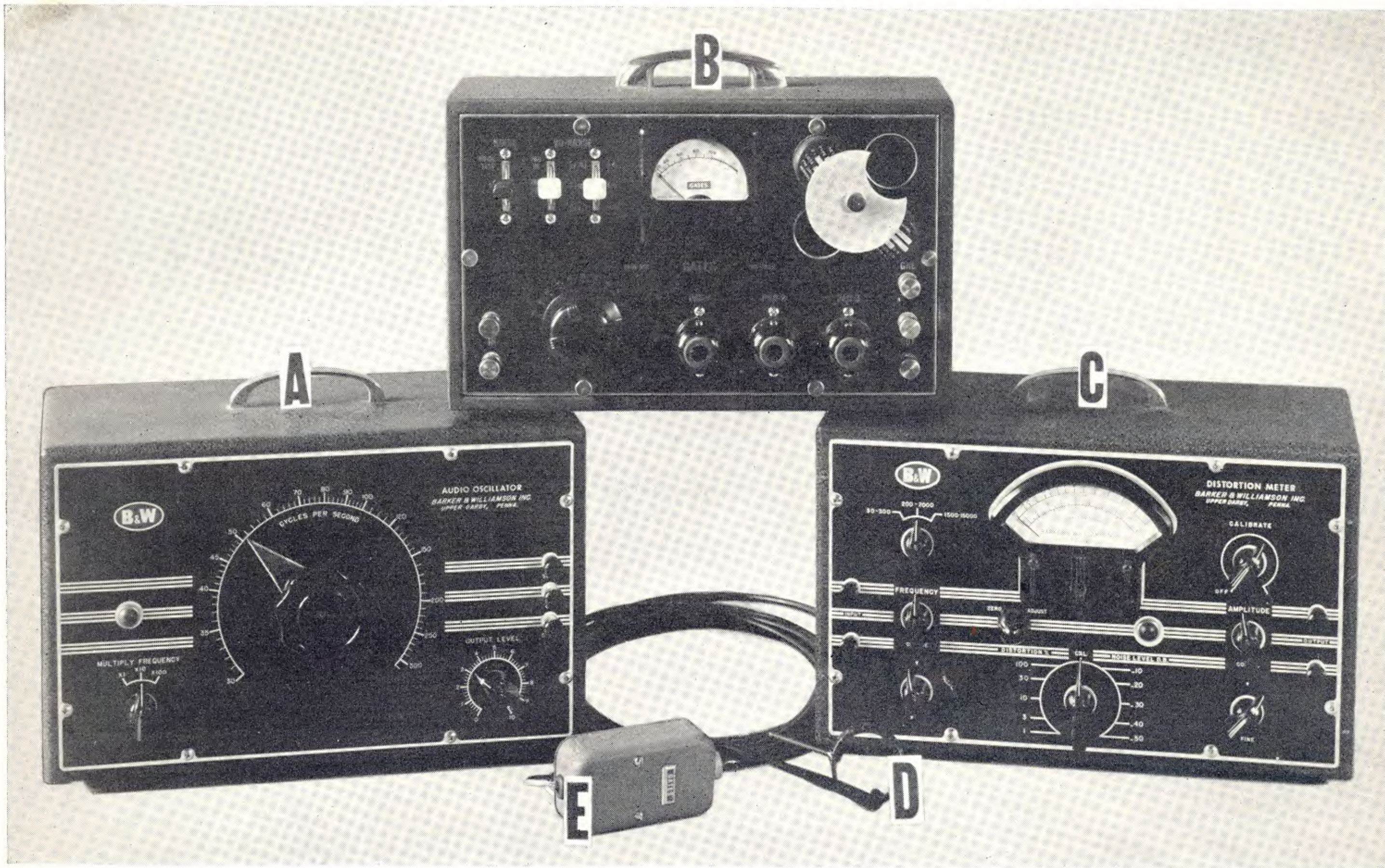
OVERALL - TOTAL OF ABOVE AS IN NORMAL OPERATING CIRCUIT

COMMENTS

MEASUREMENT CHART

GATES RADIO CO.

COMPLETE "PROOF OF PERFORMANCE" PACKAGE



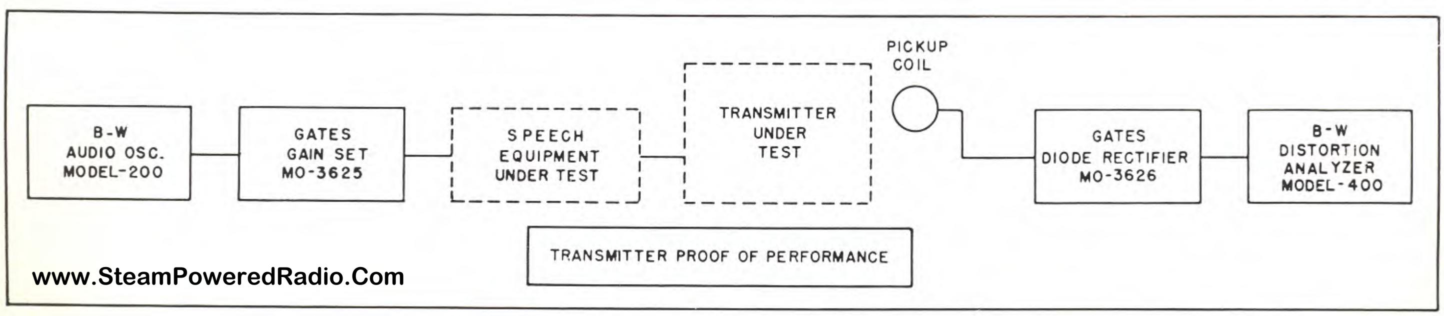
NOW, a complete proof of performance package is available to broadcasting stations in a form that assures accurate results and complete facilities to check audio and radio frequency performance without the need of any additional apparatus. There are five basic units, all described in detail on the opposite page and alphabetically illustrated above as (A) the type 200 audio oscillator, (B) the MO-3625 gain set, (C) the type 400 noise and distortion meter, (D) the R. F. pickup coil for transmitter measurements, and (E) the MO-3626 diode rectifier unit for transmitter measurements in conjunction with the noise and distortion equipment.

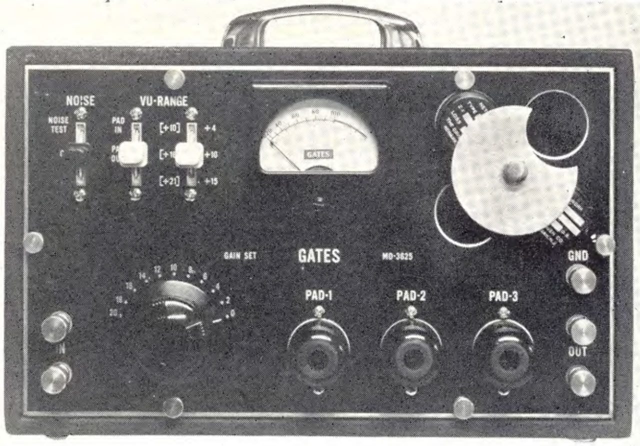
The complete SA-131 proof of performance package has been worked out after weeks of study of broadcast station measurement problems. This package will accurately measure either from low level microphone circuits or high level transmitter input circuits. The diagram below illustrates a typical overall test arrangement. Many other combinations are possible as the experienced radio engineer will quickly recognize. The package is so arranged that it may be used for testing a single amplifier as conveniently as it can be used for testing a complete studio-transmitter installation. Complete instructions for use are supplied with each equipment.

Modesty in the complete package price makes the Gates SA-131 proof of performance kit a necessity even where license renewal is not of immediate consideration. Continued assurance of quality transmission by periodic checking is a vital necessity in present day competitive broadcasting.

Model SA-131 Complete Proof of Performance Package. Code ZEJBE.

Please Turn the Page



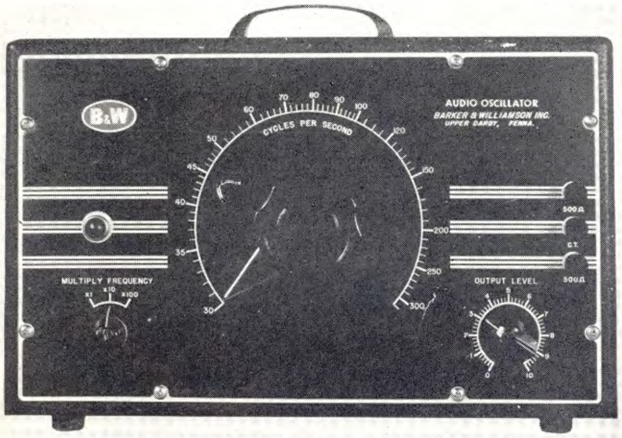


MO-3625 GAIN SET.

Designed basically for use in audio input circuits so that extremely low input levels may be employed and input meter reference provided. It may be successfully used as output meter also. Cabinet, size 12¾" x 8¾" x 4", matches the audio oscillator and distortion meter listed below. Has etched aluminum front panel. Consists of a VU meter provided with associated switches to accommodate all usable ranges for measuring purposes. The attenuation circuit includes a 10 step, 2 Db. per step variable attenuator of the balanced ladder type and fixed plug-in pads which may be used in any number from 1 to 3. These pads are used for both attenuation and impedance matching. Two are supplied, providing 40 Db. attenuation 600/600 ohms and 20 Db. attenuation 600/250 ohms. both balanced H. Additional pads of any desired loss or impedance are obtainable but are not considered necessary for standard proof of performance. Equipment is completely shielded and may be used in the field of a radio transmitter.

SPECIFICATIONS—INPUT IMPEDANCE: 600 ohms, balanced. OUTPUT IMPEDANCE: Variable 30 to 600 ohms, balanced. OUTPUT LEVEL: Variable from plus 21 DBM to minus 136 DBM. RESPONSE: Plus or minus 0.5 Db., 30-15,000 cycles. DISTORTION AND NOISE: Negligible.

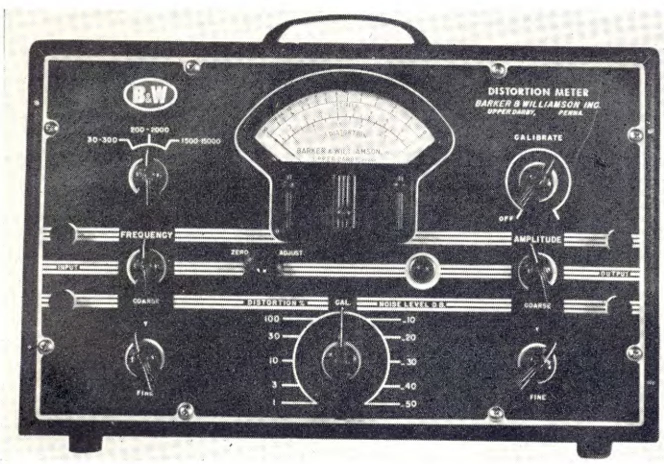
Model MO-3625 Gain Set. Code ZEIRL.



TYPE 200 OSCILLATOR.

Direct reading at stability of better than 1%, this oscillator is ideal for all distortion and frequency response measurements. No zero reset or line calibration required. Power supply self-contained. Completely shielded in steel cabinet 13¾"x7¼"9½". Voltage output, 11 volts into 500 ohm load. R. M. S. harmonics at 5 volts output into 500 ohm load less than 1%, or into open circuit less than 0.5% at all frequencies between 50 and 15,000 cycles. Response plus or minus 1 Db., 30-30,000 cycles. Calibration, plus or minus 2.5%.

Type 200 Oscillator. Code ZEIBT.



TYPE 400 NOISE AND DISTORTION METER.

An excellent quality noise and distortion measuring equipment with variable frequency selector filter providing a single frequency suppression circuit between 50 and 15,000 cycles. Size matches Type 200 oscillator listed above. Frequency range (a) distortion meter; for fundamentals from 50-15,000 cycles measuring harmonics to 45,000 cycles; (b) has voltmeter and Db. meter 30-30,000 cycles. Sensitivity (a) noise and distortion measurements; minimum input 0.3 volts; (b) voltmeter full scale readings of 0.3, 0.1, 0.03, 0.01, and 0.003 volts. Calibration for distortion measurements, plus or minus 10%; for noise measurements, plus or minus 1 Db.; for voltage measurements, plus or minus 5%.

Type 400 Distortion Meter. Code ZEIFY.

MO-3626 RECTIFIER AND PICKUP COIL.

Used in conjunction with the Type 400 distortion meter when measuring AM transmitters. Supplied with pickup coil ready to attach to tank circuit of transmitter with 15 ft. section of coaxial cable. Designed around a germanium diode. Complete R. F. filtering guarantees a pure audio output free from R. F. disturbances.

FREQUENCY RANGE: 550-20,000 Kc. RESPONSE: Plus or minus 1 Db., 30-15,000 cycles. OUTPUT IMPEDANCE: 600 ohms, unbalanced. OUTPUT LEVEL: Plus 12 DBM. NOISE AND DISTORTION: Negligible. SIZE 4" long, 2" wide, 1¼" high.

MO-3626 Rectifier and Pickup Coil. Code ZEJAZ.

Below—Functional diagram of MO-3625 gain set illustrated and described at top of page.