SERVICE

A MONTHLY DIGEST OF RADIO AND ASSOCIATED MAINTENANCE

October
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EDITORIAL

A NUMBER of requests have been received for data pertaining to troubles experienced in connection with Pentode tubes as used in modern receivers. The suggestion was made to present this data in the form of a forum. How about some comment upon the use of two pages in each issue devoted to pro and con discussion by service men and service managers. As to the character of the Pentode tube data desired, refer to the Stewart Warner radio supplement pages in the October supplement. You will find certain definite facts pertaining to the effect of an excessive value of resistance in the grid circuit of Pentode tubes and the manifestations due to excessive grid current in such circuits.

This magazine circulates among the service managers of the various radio receiver manufacturers. We welcome suggestions from these men, for that matter from all interested in radio service relative to the character of the material they would like to see in the subsequent issues of SERVICE.

We are making preparations for a compilation of serial numbers of various models of radio receivers. The idea is to tabulate the range of serial numbers corresponding to a certain model number. Such information would be of value where the serial number of the receiver is known but the model number is not available. Knowing the serial number would permit recognition of the model number and the chassis series in the event that changes had been made. We fully appreciate that serial numbers will not furnish the required information in every case, but the work involved during the preparation would justify itself in it served to furnish information in only 50 percent of the requests. All ideas upon this subject are welcome.

JOHN F. RIDER.

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OCTOBER, 1931

Majestic Cycle of Operation

In the Majestic refrigerator liquid sulphur dioxide is boiled in the evaporator. The sulphur dioxide vapor is then drawn off from the top of the evaporator through a check valve, which prevents the vapor from returning back to the evaporator from the compressor or pump when the machine is stopped. The vapor is drawn into the suction side of the pump and is compressed. After being compressed, it is exhausted into the dome surrounding the compressor and then through copper tubing to the condenser. The condenser consists of a copper coil that has fins placed upon it to obtain the maximum radiation of heat and cool the hot compressed sulphur dioxide vapor as quickly as possible. In addition, there is a small electric fan placed in front of the condenser which helps to circulate cold air through the tubing and around the fins. The sulphur dioxide vapor is condensed into a liquid in the bottom of the condenser from whence it flows into the float chamber of the float valve. The float valve is a device which regulates the amount of liquid that we allow to flow back into the evaporator so that there is a constant evaporation taking place in the evaporator at all times. We have now completed the cycle of operation as far as the sulphur dioxide, that is the refrigerant, is concerned.

Lubrication

The question of selecting the proper oil for lubrication of the Majestic Refrigerator, has called for a long and thorough research. This is because it is well known to us that the subject of oil has been one of the most exacting problems confronting all companies manufacturing mechanical refrigerators. We require an oil to be of such purity and stability as to be able to last continuously for the life of the refrigerator, under conditions of temperature, pressure and acidity (due to presence of SO_2). When you consider that your automobile requires a change of oil every few hundred miles, there is no doubt that the demand placed on your Refrigerator oil requires the best oil obtainable. The Engineering Department has spent much time with the largest refiners in developing this oil. By using the proper crude oil, then going through the refiners' process step by step with the thought ever in mind to make the purest oil chemically, the result is that we have an oil which we feel is as good as can be manufactured, and is so far superior to any oil on the open market that we do not hesitate to say that we will not guarantee our units unless this oil is used.

The Majestic refrigerator also has a continuous and complete cycle of oil. The same pump which compresses the sulphur dioxide is used to pump the oil that is used for cooling, lubricating and sealing the pump sections. The oil is drawn up from a sump in the bottom of the compressor. It is then forced by the pump through the center of the pump rotor to the top of the dome where it is forced out to an oil spinner which spreads the oil against a splash apron and down over the stator of the motor. While the oil is traveling up the shaft of the compressor rotor, part of it is forced out through radial holes to give forced feed lubrication to all moving bearing surfaces. All moving bearing surfaces when in operation continually have a fresh oil film. A certain amount of oil is also pulled up from the oil reservoir and is allowed to enter the sulphur dioxide compression chamber of the pump. This amount of oil is used for sealing the low pressure side of the pump from the high pressure side and positively preventing leakage and loss of efficiency. The oil that has been forced out through the top of the pump rotor shaft and over the stator of the motor, cooling the motor as it flows over it, falls down into the oil reservoir in the base of the compressor. The hot oil passes through a copper tube to the oil cooling coil which is a section of the condenser. The oil is cooled in the condenser and is then returned to the oil sump in the base of the compressor and is ready to go through the cycle again.

Majestic Major Parts

1. A rotary compressor.
2. A motor to operate the compressor.
3. A condenser to liquefy the gas.
4. A small motor fan, to direct a cool blast of air through the condenser.
5. A float valve to regulate the flow of liquid from the condenser to the evaporator.
6. An evaporator to absorb heat from the cabinet.
7. A freezing compartment to make ice cubes and frozen desserts.
8. Check valve to divide the high side from the low side when the compressor is idle.
9. Temperature control to regulate the temperature of the cabinet.
10. Thermal overload relay to protect the entire electrical system.
11. Condenser and transformer to assist in starting the compressor motor. (Capacitor Unit.)

Parts of the Majestic Refrigerator and Their Specific Functions

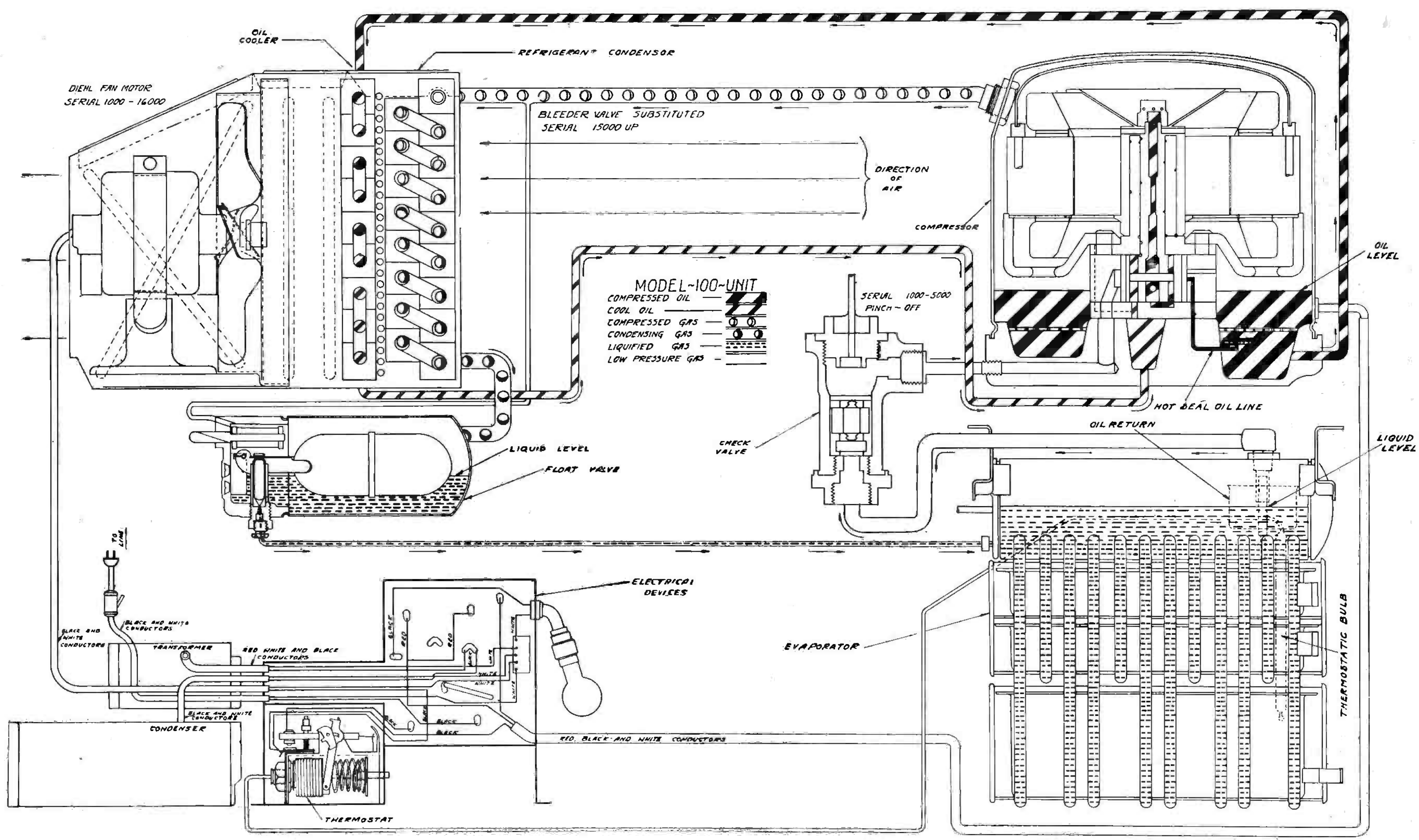
Compressor: The Majestic Compressor is of the rotary type and has a displacement of .608 cu. in. It is of the four vane type. The compressor consists of the following parts: The compressor cap in which are located the oil suction and the oil exhaust ports; the compressor body which is connected to and is directly above the compressor cap and in which are located the suction and exhaust ports. In the compressor body rotates the compressor rotor. The compressor rotor has four grooves in which are placed four vanes and four rockers, one vane and rocker to each groove. The center of the cylinder in which the compressor rotor rotates and the center of the compressor rotor are displaced ⅛ of an inch. In this manner an eccentric rotation is accomplished which gives us compression. The vanes are held in place by spacing pins or vane pins. There are three vane pins, two in one direction and one at right angles to the other two. Directly above and attached to it is the compressor bearing plate. The compressor bearing plate and the compressor cap form the horizontal bearing surfaces for the compressor rotor. The compressor bearing plate also forms a bearing surface for the motor rotor.

In addition, a small amount of gas is introduced from the top of the dome with the oil through the compressor cap, so that when the oil is being pumped, the gas will form a cushion and prevent any "oil knock." The oil that is used to seal the compressor rotor and the pump body at the seal line comes through the compressor body from the oil reservoir through a metering hole whose diameter is 40/1000th of an inch. The clearance between the compressor rotor and the compressor body at the seal line is 7/10,000th of an inch. The metal bearing surface on all parts of the compressor are ground to an accuracy of 1/10,000th of an inch, and the expansion and contraction of the steel through the change of temperature in operation is identical at all parts so that the same clearance is maintained at all times. The compressor is secured by four bolts to the compressor base. There is a metal spider which is secured to the compressor bearing plate which forms a mounting for the motor rotor.

The compressor proper as described above is made of a special low carbon steel that is machined, carbonized, hardened and ground. The bearing surfaces on the compressor cap, the compressor body, the compressor bearing plate, the vanes and the rockers are supplied continually with lubricating oil. The back portion of the vanes when the compressor rotor is rotating from a four cycle pump which pumps the oil. Around the outside of the compressor body in the Model 100 unit is placed a specially designed muffler which muffles any noise of the exhaust of the sulphur dioxide and oil.

Later models of the 100 unit have improved exhausting systems. The muffler is not used and the exhaust travels from the exhaust ports in the body through a vertical hole in the compressor body and cap to an outlet in the compressor base beneath the oil level in the reservoir.

This method of exhausting greatly reduces exhaust noise and simplifies the construction.



Majestic Gas and Oil Cycle Chart
Model 100 Unit

Later Models of the 100 Unit have no return line from the float valve chamber to the top of the condenser. This return line for uncondensed gases being replaced by a bleeder valve placed at the top of the condenser on the high pressure line from the compressor.

Rather than keep a return line on the float valve chamber in all units, the bleeder valve was substituted to simplify the sulphur dioxide circulation and yet have available a means of purging the system of uncondensed gases should it require it.

Resistance Start Capacitor Motor Model 102 Majestic Refrigerator Unit

The Model 102 unit is equipped with an automatic unloader which reduces the starting force formerly required when the compressor was started prior to a period of about 20 seconds allowed for pressure equalization.

The unloader on the model 102 units accomplishes pressure equalization between the low and high pressure side of the compressor within the period of one second. Consequently, it has been possible to use a resistance start motor to replace the auto-transformer starting method previously used.

The efficiency of motor operation remains unchanged with running characteristics of equal value. The resistance start motor has the following characteristics:

Starting Current	15.5 amperes
Stalled Rotor Current	15.5 amperes
Running Current	3 amperes
Running Watts	230 plus or minus 20 watts
Voltage	90-140
Power Factor	.75

The use of the unloader in conjunction with the resistance start motor in the model 102 unit has made it possible to greatly simplify the overload trip construction required. As the compressor will unload immediately the current is turned off, a three cut-off trip is no longer required.

The overload trip used on the model 102 unit has a single trip-off which may be very simply reset from the temperature control escutcheon on the front of the cabinet. In order to place the defrosting switch in a convenient location, it has been incorporated in the temperature control adjustment.

When the temperature control knob is rotated to the maximum left position, the machine is cut off by tripping of the overload trip device. To start the machine after defrosting, it is merely necessary to press the reset button on the escutcheon.

The overload trip characteristics remain unchanged from the model 100 unit type.

Heater unit and bi-metal strip employed are essentially the same as used in the Model 100 unit with regard to current and time required for operation.

Model 103 Majestic Refrigerator Unit

The model 103 Majestic refrigerator unit replaces the model 102 unit employed in Majestic Electric Refrigerator models 150 and 170.

The model 103 unit is an advanced development over the model 102 unit in its increased simplicity and more efficient power plant. The model 103 unit employs the improved condenser start motor instead of the resistance start motor used on the model 102 unit.

Due to the high starting torque of the new motor, the model 103 unit does not employ an unloader for equalizing pressures in order to reduce the force required to start. The control unit employed in the model 103 unit is the electrical equivalent of that employed in the model 102, with the exception of the starting resistance which has been eliminated. The model 103 unit employs a transformer for starting, which is a separate unit mounted on the unit base.

As a consequence, the new model 103 unit has an improved electrical efficiency, simpler construction, and improved operating characteristics.

Model 101 Majestic Refrigerator Unit

The model 101 Majestic refrigerator unit is employed in the Majestic Electric Refrigerator model 140.

The model 101 unit is identical in construction with the model 103, with the exception of the evaporator and assembly arrangement. The evaporator of the model 101 unit has been reduced in size, commensurate with requirements of the four cubic foot food compartment. Instead of the three tray size freezing compartment, the evaporator employed in the model 101 unit, utilizes only two shallow trays that contain a total of forty-two ice cubes.

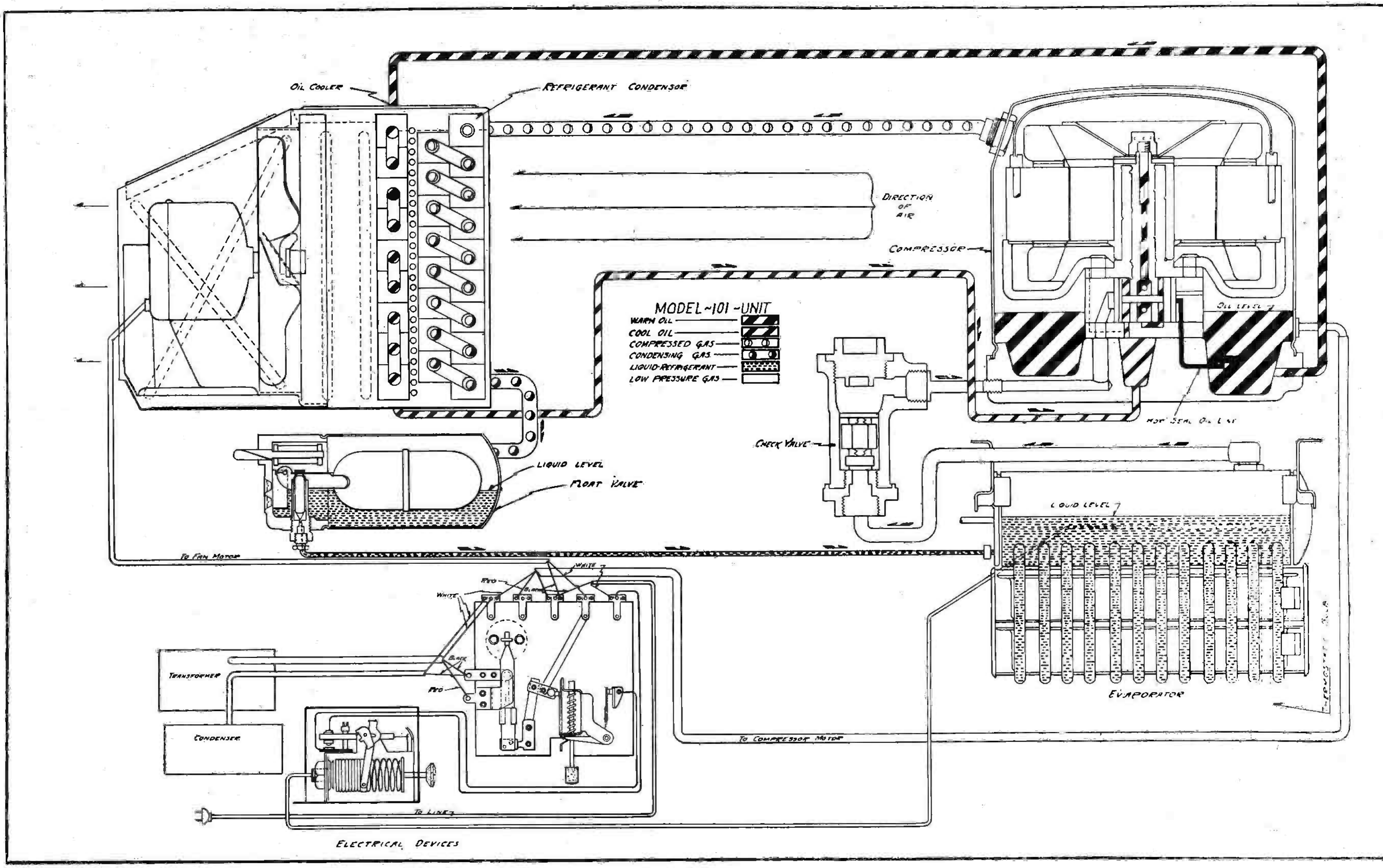
Compressor Motor

The Majestic motor is a squirrel cage induction motor of the capacitor type. It consists of two parts, the stator and the rotor. The stator has two windings which are known as the starting winding and the running winding. The stator is made up of specially annealed steel laminations which are punched to size, riveted together and then ground to absolute dimensions. The stator is wound to form four poles. Each pole winding is made in three sections. The running winding is wound with No. 18 double cotton covered copper wire and the starting winding is wound with No. 22 double cotton covered wire. The two windings are wound 45 mechanical degrees apart from each other and 90 electrical degrees apart from each other. The stator is secured to the spider by four bolts through the laminations. The motor rotor is made up of steel laminations from the same steel as the stator and of copper wires which are placed in the stator in a nearly vertical position and electrically connected by being soldered at their top and bottom. The center of the rotor is fitted with a sleeve, the bottom and inside of which form a bearing surface with the compressor bearing plate. The inside of the sleeve and the outside of the compressor bearing plate are grooved spirally to allow continuous forced feed lubrication. The normal clearance between the motor stator and the motor rotor is 8/1000th of an inch. The motor rotor is fastened to the shaft of the compressor rotor by means of a driving plate at the top of the motor rotor sleeve and at the top of the shaft of the compressor rotor. This driving plate is secured by the rotor nut. This arrangement allows the motor rotor to drive the compressor with only the weight of the compressor rotor itself resting on its bearing surfaces. The Majestic motor operates on single phase alternating current. Majestic has developed at great expense a capacitor motor having all the characteristics that a good motor should have. The reason for the greatly improved characteristics is that the capacity in conjunction with the double winding of the stator accomplishes in effect a two phase operation, thus automatically answering all problems of starting and operating efficiency. There are no brushes or commutators, centrifugal switches, contacts or other internal devices for sources of trouble.

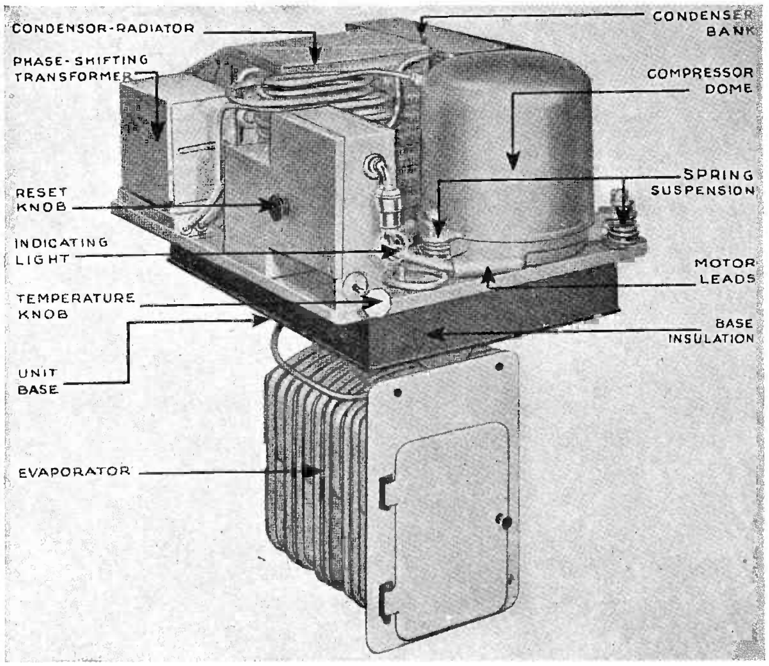
Thermostatic Control

The Thermostatic control is the device which is used to control the temperature of the food compartment of the refrigerator. If we confine a quantity of sulphur dioxide liquid in a tube sealed at one end and with a pressure gauge on the other, we will find that for every temperature of the tube there will be a certain definite pressure of gas. This relation of temperatures and pressure follows the standard saturated vapor temperature pressure table as long as there is any liquid in the tube. When the temperature rises to the point where all the liquid in the tube is changed to a gas, a further rise in temperature causes the pressure to raise. Now, if we replace the gauge with a metal bellows with a spring of the proper tension, for every pressure of the tube there will be a definite change of the position of the bellows head. In our thermostat we place a cross arm between the bellows head and the spring and we utilize this motion due to pressure changes to operate a special form of over center switch. It can readily be seen that if we increase the spring pressure against the bellows a higher pressure and consequently a higher temperature of the tube will be necessary to throw the switch, and conversely, if we decrease the spring pressure we decrease the bellows pressure necessary to throw the switch. The temperature control is merely an external method of decreasing or increasing the spring pressure, and thereby increasing or decreasing the box temperature to a desired point.

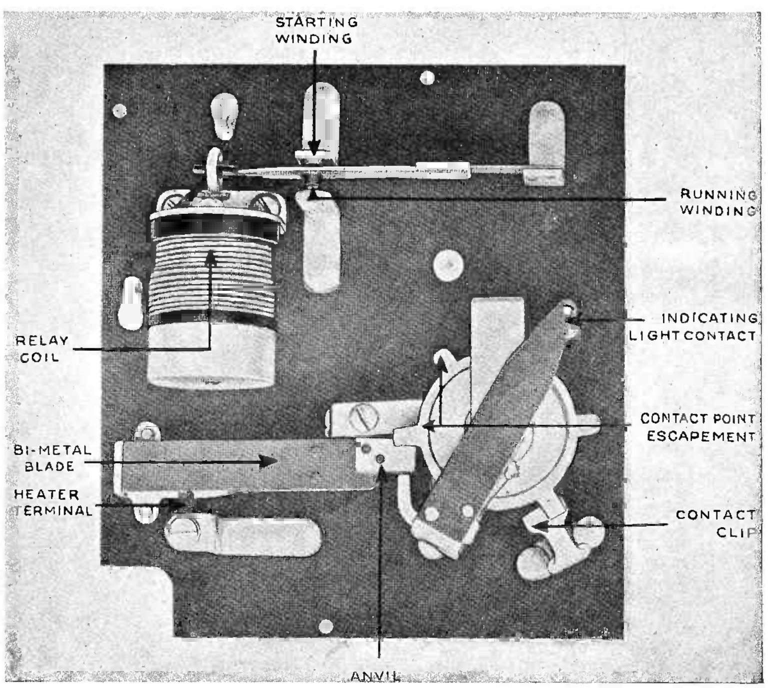
The parts of the thermostatic control consist of the bulb which is clamped to the side of the evaporator, the copper connecting tube from the bulb to a copper bellows, and the over center switch which is connected by the retaining spring to the copper bellows.



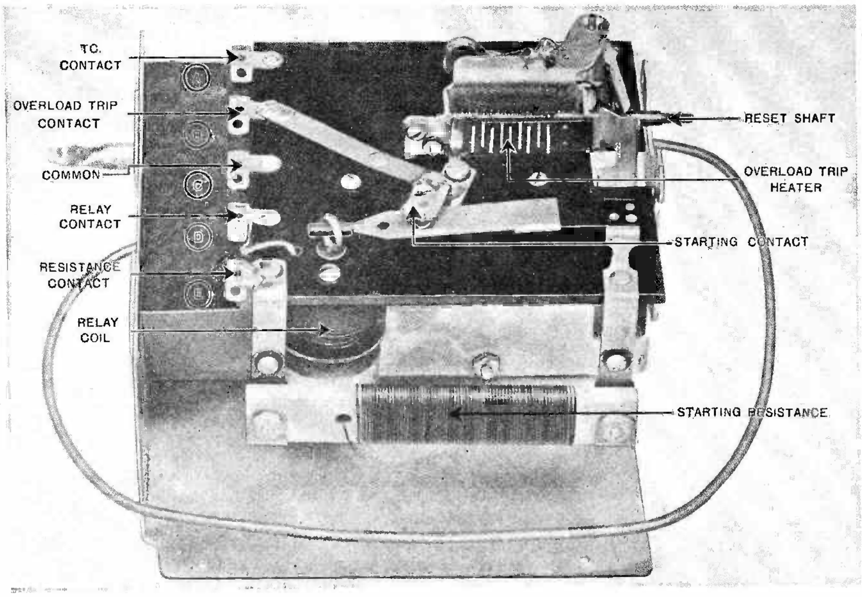
Majestic Gas and Oil Cycle Chart
Model 101 Unit



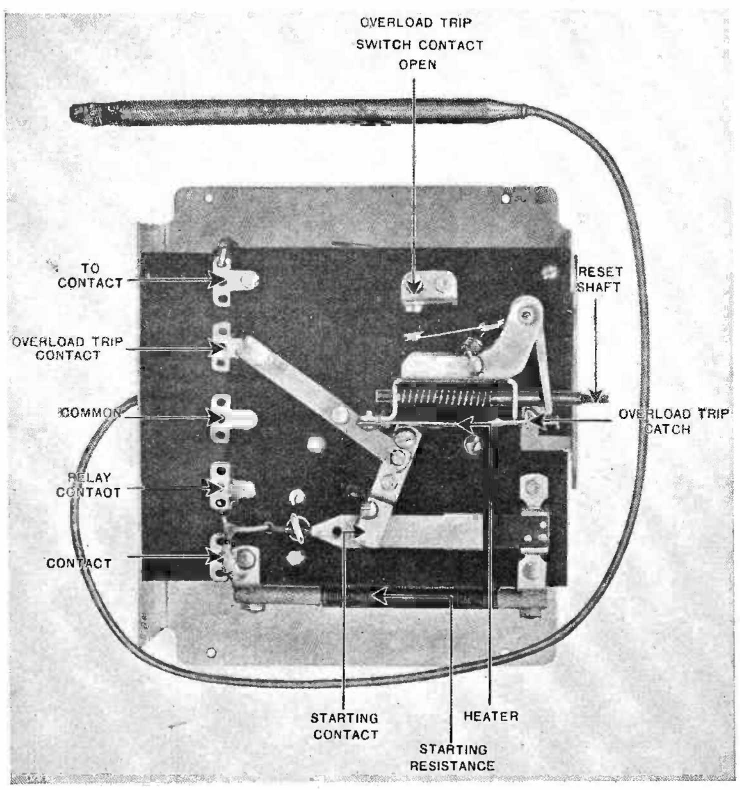
Complete Model 100
Majestic Refrigerating Unit
Part No. 21000



Overload Trip and Starting
Relay Devices
Model 100 Unit
Part No. 20600



Overload Trip Assembly
Model 102
Part No. 21986



Overload Trip Assembly
Models 101 and 103
Part No. 21975

Overload Trip

The function of the overload trip is to protect the motor against damage and inform the user should the machine require service. The overload trip may be called the "watch dog" of the refrigerator. In case of electrical trouble the overload trip promptly stops the motor. After waiting for a period of time, about a minute and a half, it automatically turns on the current again in the hope that the disturbance or trouble of whatever nature had adjusted itself. If this has not occurred, it promptly turns off the motor again. This performance is repeated automatically until it has been tried three times. Then obviously the trouble is of such a nature as to require a service man. Therefore, the overload trip shuts off the current, locks itself in that position and illuminates the green pilot light, informing the user that he has a condition that needs attention before food is spoiled or damage done.

The overload trip in its operation is extremely simple. In case of trouble the first result will be an increase in line current. A small heater grid is placed in series with the line so that any increase of line current above normal will cause sufficient heat to be generated by this grid to cause a bi-metal strip placed directly over it and riveted to it, to bend and trip an escapement device. The escapement is a spring wound device which cuts off or cuts on as the bi-metal strip is straightened after cooling or bent due to heating. After the overload trip has operated three times, and definitely cut off the machine and illuminated the pilot lamp, it may be reset by means of the reset knob placed on the side of the case. Instructions covering the use of the reset knob are printed alongside of the knob.

Fan Motor

The fan motor is used to drive the fan which circulates cooling air through the condenser. The purpose of the fan motor is to obtain the maximum efficiency in the removal of heat from the condenser, and thereby reduce the running time necessary to accomplish a given amount of refrigeration. It therefore is a device that cuts the operating expense of the refrigerator. The fan motor is a squirrel cage induction motor of the shaded pole type. The base of the motor is a casting with a section of the motor casing and also forms an oil well which provides an oil feed to all bearing surfaces of the shaft.

In addition to this the fan motor bearings are made of oilless bronze to assure a perfectly lubricated and vibrationless operation over a period of years without attention. There is sufficient oil in the fan motor so that it should not require any reoiling or attention of any sort for at least a period of five years. Connected to the shaft of the motor is the fan proper. The fan is distinctly a Majestic type of high efficiency and vibrationless and noiseless operation. The pitch of the blades is such that an equal amount of air is pulled by all sections regardless of the fact that the speed is, of course, greater at the outer edge than near the center. In this manner an even flow of air is accomplished and maximum efficiency attained.

Float Valve

The float valve is of the needle valve type and is placed between the condenser and the evaporator. Its function is to control the level of liquid sulphur dioxide in the evaporator so that when evaporation is taking place, it will all take place in the evaporator and not in adjoining connections due to an improper liquid level. The float valve consists of the following parts: The float ball which is made of copper plated steel. The body which is made of drop forged brass cadmium plated. The float chamber which is made of spun brass, the seat which is made of special bronze and the needle which is made of stainless steel. Each part has been so designed and constructed so as to give life-long operation without trouble. The float ball has been constructed of steel so that in case of any particle of foreign matter obstructing the needle on the seat, the valve will not have to be removed in order to clear it. The clearing of the valve may be simply accomplished by the use of a magnet to externally move the float ball in the chamber.

Condenser

The condenser is made of ⅜" copper tubing finned. The fins are placed on the tube to give it the maximum amount of heat radiating surface. The condenser has been automatically designed as to size and area so that the maximum efficiency of heat removal is accomplished in conjunction with the fan and air circulation provided. One section of the condenser is separately connected as an oil cooling coil for the purpose of cooling the oil in its cycle through the compressor. In addition to the condenser there is a small tube connected at the top, in the model 100 unit, which connects to the float chamber of the float valve and allows gases which cannot be condensed to return to the top of the condenser and prevent the float valve from becoming gas bound.

Phase Shifting Transformer and Electrical Condenser

The electrical condenser and the phase shifting transformer are used in conjunction to provide the necessary starting current to the starting winding when the machine is first turned on so that the motor will have an additional starting force. The electrical condenser is continually operating in that it provides the necessary phase displacement between the two windings of the motor to give us, in effect, the operating characteristics of a highly efficient two phase machine. When starting, in order to pass sufficient current to the starting winding and provide additional starting force, the phase shifting transformer is connected by means of the starting relay to provide approximately 500 volts to the terminals of the electrical condenser. Once the machine has started the phase shifting transformer is disconnected by means of the starting relay and the voltage returned to normal. In this manner a high starting force is provided for the motor. The phase shifting transformer and electrical condenser are separately enclosed units mounted on the assembly base. The electrical condenser has a capacity of eight microfarads in two sections of four microfarads each. The condensers utilize a high dielectric and are impregnated against moisture to provide long life and service.

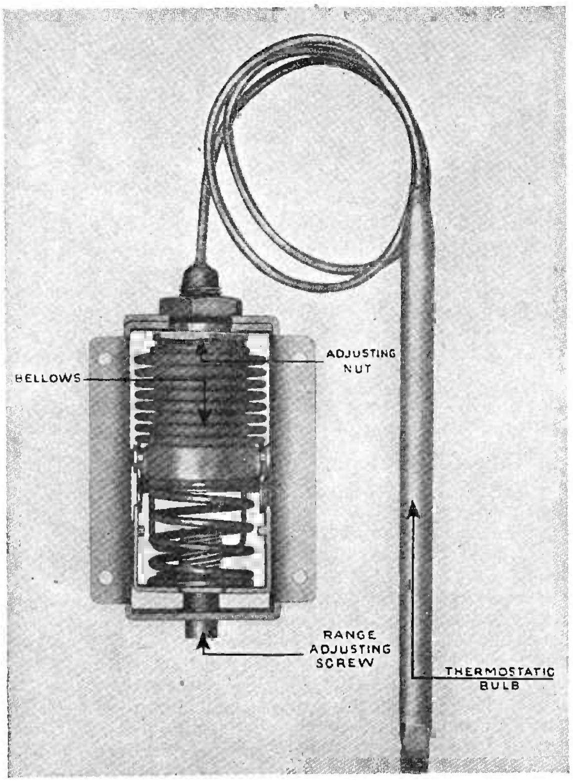
Starting Relay

The starting relay consists of the following parts: solenoid coil and plunger, contact arm and contacts. When starting the starting current which is normally higher than the running current causes the solenoid, which is connected in series with the motor, to pull up the plunger, which in turn causes the contact arm to make contact with the top contact of the relay, and connect the phase shifting transformer to the starting position. After the motor has started to run and the current has dropped down to starting current, the plunger will drop and the contact arm will contact the running contact and connection of the phase shifting transformer.

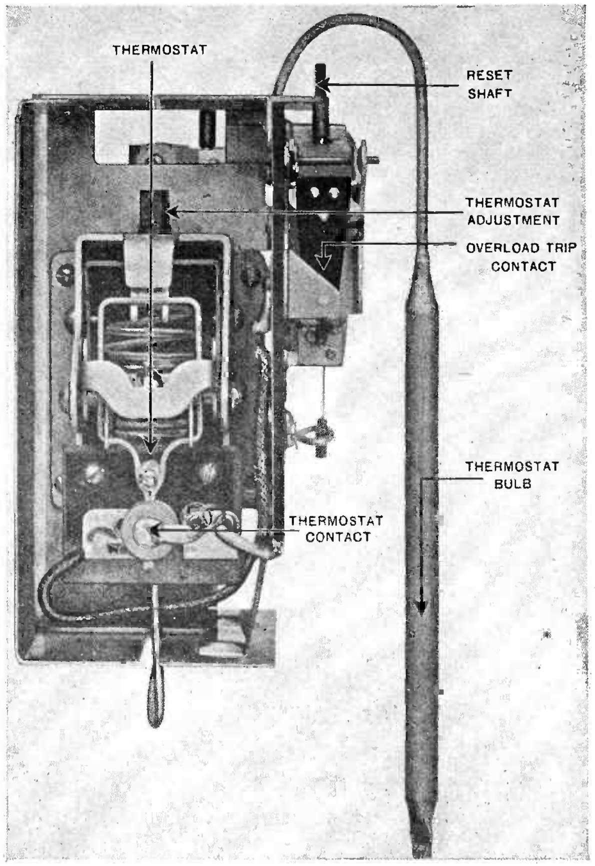
Evaporator

The Majestic evaporator consists of the following parts: the header shell, supporting brackets, cooling tubes, ice compartments, suction and discharge connections. There is also installed inside the shell an oil return cup. The purpose of this cup is to return excessive amounts of oil that might gather in the evaporator over a period of time so that the boiling of the sulphur dioxide will not be affected by the too heavy oil film on its surface. The cooling tubes of the evaporator are made of copper ⅜" in diameter. All tubes and connections of the evaporator are silver soldered. Every other cooling tube is staggered so that there is a refrigerating surface underneath each ice compartment. The ice compartments are made of copper sheet, plated. The evaporator has space provided for three ice trays, two of the conventional size and one tray which allows for double size ice cubes. The use of silver solder on all connections prevents any possibility of leaks in the evaporator due to the expansion and contraction that takes place and that will ordinarily break down other types of solder.

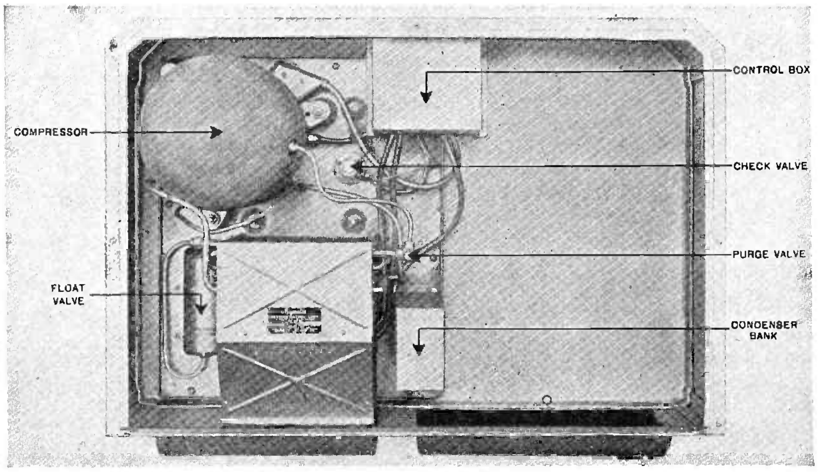
The front of the evaporator is equipped with a spring door which closes the entrance to the ice compartments and prevents unnecessary moisture condensation and ice formation in the ice compartment, thus preventing sticking ice



Thermostat Control
Part No. 21888



Thermostat Assembly
Models 101, 102, 103



Top View
Model 102 Unit

trays. The spring door, in addition, is of white porcelain enamel and improves the general appearance of the interior of the refrigerator.

Check Valve

The check valve consists of the following parts: the body which is constructed of brass, the plunger which is made of special bronze and which has a lapped seat. The bottom seat of the valve is stellite steel, glass finish. The purpose of the check valve is when the machine is stopped to prevent the hot gases in the compressor from flowing back into the evaporator and raising the temperature.

Operating Characteristics of the Majestic Refrigerator

The Majestic refrigerator contains a charge of three pounds, 12 oz. of sulphur dioxide, the moisture content of which is always less than 3/10,000 of 1%. This high grade sulphur dioxide is an exclusive feature of the Majestic refrigerator and insures absolute freedom from any possible corrosive effect due to the presence of moisture in the refrigerant. The Majestic unit contains a charge of 3 pints of Majestic lubricating oil. This oil is a special development of Majestic and constitutes a high grade oil of strong body and lasting qualities that are peculiarly adapted to use in this machine.

The running time of the Majestic refrigerator is between 21% and 25% when used in rooms of normal temperature and under average operating conditions. The starting current of Majestic refrigerators is 13.5 amp. and is sufficiently low to insure against any possible overload of household lighting circuits. The normal operating current is 3 amp. and the normal average power consumption is 230 watts. This power consumption is exceedingly low for the refrigeration accomplished during a 21% to 25% running cycle of time, and of course affords a greater saving in cost of operation to the consumer. The Majestic compressor circulates one qt. of lubricating oil every minute during operation, and one pt. of oil every minute to insure a positive seal within the pump for maintaining its efficiency. Under average operating conditions, the highest pressure attained in the condenser and dome of the compressor is 75 lbs. The average pressure in the evaporator will be between 8 and 10" of vacuum and 5 to 7 lbs. pressure. The motor driving the Majestic compressor is 1/6 H.P. The motor will not stall on 100% overload, and has an average speed of 1725 R.P.M. The Majestic fan motor is a highly efficient motor of fractional horse power that uses but 20 watts. The speed of the fan is approximately 1640 R.P.M.

The fan circulates 80 to 100 cu. ft. of cool air through the condenser every minute. The overloal trip will cut off the machine between 4½ and 5 amp. The time required to cut off the machine with a slight overload such as 4½ amp. is about one minute and a half. With heavier overload the cut off is much quicker and at 13½ amp. is about fifteen seconds.

The starting relay will disconnect or break from the running contacts at about 6 amp. and will have definitely contacted the starting contact at 8 amp. When the temperature control knob is set on No. 3 on the dial the box temperature should be between 40 and 42 degrees. Measurement of temperature should always be made on the middle shelf.

Variable Mu and Pentode Tube Replacement

This subject has been the topic of many inquiries. Whether the change is one requested by the owner of a radio receiver or whether the effort is being made to modernize a receiver or to correct a fault, is not known, but the fact remains that a very great number of inquiries are received relative to such changes. Unfortunately, the answer cannot be a single word, affirmative or negative. There are numerous items to be considered.

Consider the '51 type of tube. The first is that the purpose of the tube is the alleviation of a certain form of difficulty encountered in receivers. This difficulty is cross modulation, or the presence of two stations, when the receiver is tuned only to one. Expressed in the simplest manner, this trouble is not due to imperfect selectivity but to incorrect operation of the amplifier tube being used. By a change in the design of the tube it has been possible to apply a much greater signal voltage, also bias voltage without causing the RF amplifier to act like a detector. The change is of such character that the bend in the lower end of the grid voltage-plate current characteristic curve is much more gradual as the grid bias voltage is made more and more negative.

Accordingly, the first requirement, in order to justify the change, is that some form of cross modulation difficulty be existent when the original '24 type tubes are being used. If the receiver is performing in normal manner as far as local-distant control and selectivity are concerned, there is no definite need for replacing the type '24 RF amplifiers with the type '51 tubes.

Second, is the consideration of the type of volume control. In order that the correct operation of the '51 tube be obtained, it is imperative that the screen voltage be held constant. This means that receivers employing the variable screen voltage form of volume control are not suited for use with the '51. In order to enable the use of the tube, this condition requires a complete revision of the volume control system, at least from variable screen grid voltage to variable control grid bias.

Third, is the fact that in order to enable the use of variable control grid voltage, it is necessary that the receiver be specially designed along such lines. At least the voltage divider system must be designed along such lines, so as to compensate for the variation in the other operating voltages when the control grid bias is increased. We consider the increase only because of the fairly low normal bias requirement.

Fourth, is the increased plate current requirement of the '51 tube. The average difference in plate current for a fixed and constant value of plate and screen potential applied to the '24 and the '51 approximates about 50 percent more in the case of the '51. This means an alteration of the values employed in the voltage divider system in order to allow the application of the required operating voltages with the increased current drain.

Fifth, is the item of automatic volume control equipped receivers. While it is true that the action of the volume control system is a variation of the control grid bias and it would appear as if the system is ideally suited to the variable mu tube, there are very few, if any, cases where the change is recommended.

A sixth consideration is the actual design of the RF transformers. There is a difference in the impedance characteristics of the '24 and the '51. If a receiver has been designed for use with the '24 tube it is best that it be used with that tube. The use of a different tube is apt to disturb the balance of the receiver and while it is possible that the '51 tube may be of the character to afford better sensitivity, the change may also result in a condition which will be troublesome to remedy. At the same time it is possible that a change of this type will result in a loss in sensitivity rather than a gain.

Upon the surface one would be prone to say that a change in the voltage division system of the receiver is a fairly easy task. Such may be true in a few isolated cases, but an investigation of complete voltage divider systems used in the receivers manufactured during 1929 and 1930, shows that the changes are fairly complex. It is the general consensus of engineering opinion, that the change should not be made. What appears to be the major difficulty is the revision of the voltage divider system so as to enable the application of a variable control grid bias of from about 3 to perhaps 45 or 50 volts, with very little change in the screen grid voltage.

Replacing Output Tubes with the Pentode

This topic is a subject of much conversation and much correspondence. The flood of pentodes in modern receivers has created a furor as far as modernization of older receivers is concerned. Whether or not the change is worthwhile is an item worthy of serious consideration.

The basic advantage of the pentode output tube is found in the output power versus the input grid voltage. This tube, by providing greater power output for lower input signal voltage than any other output tube, affords a definite amount of economy as far as cost of operation is concerned. Under the circumstances, when this item is considered to be paramount, there is a definite advantage in the use of the pentode output tube. However, replacing a single '45 or a pair of '45s in a receiver which has been in operation for a period of time is an entirely different item. No longer is it necessary to consider the subject of economical operation. If the original system makes use of 5, 6 or 7 tubes, there is no actual economy achieved by replacing the '45 with the '47. As a matter of fact the actual cost of the units which must be changed when the tubes are changed is of such figure that when broken down for comparison with the actual difference in the cost of operation per hour, day or month, the additional cost to make the change amounts to more than the difference in maintenance for more than a year. Thus there can be no logical reason for making the change other than the effort to "keep up with the Joneses."

It is true that the power output of the pentode power tube is about 50 percent more than that of the '45 type of tube for a constant plate voltage of 250 volts and normal effective signal voltage of about 50 volts in the case of the former and about 16.5 volts in the case of the latter. This appears to be an advantage. However, it is also important to consider several other controlling influences which are introduced because of this wide variation in required input signal voltages. Recognizing that the original receiver is designed to supply the required 50 volts effective signal voltage to the '45 tube, some means must be provided to limit the input voltage to the pentode to the required 16 volts. This means that the sensitivity of the receiver must be greatly reduced when the pentode replaces the '45.

Perhaps it will be well to elaborate upon this statement so as to make certain that it will not be misunderstood. The previously made reference to reduction of general RF sensitivity to accommodate the pentode is true only when the pentode tube replaces the '45 tube in an existing receiver. The statement is not true when the original receiver is designed for use with the pentode power output tube. Recognizing a certain RF sensitivity requirement, the usual change made in the modern receiver design is the omission of the first audio frequency amplifying stage.

Returning again to the instance where the '47 replaces the '45, it is necessary to reduce the value of the signal voltage being fed to the pentode tube. Several methods are possible. One is to arrange a voltage divider across the system connected across the control grid and cathode or filament of the pentode. This is seldom if ever employed. A second arrangement is to reduce the sensitivity of the RF amplifier. The consequences of this change depend upon the exact design of the system. If the circuit utilizes the variable grid bias form of volume control, excessive grid bias may result in distortion in the RF system due to a possible alteration of the operating characteristics of the RF tube by virtue of the greatly increased bias. If the volume control is of the variable screen voltage type, a similar condition may ensue, depending upon the exact design of the system. Each of these conditions have been experienced in actual practice. As far as the tube itself is concerned, the major difference with respect to plate voltage, grid bias and plate current values is the required grid bias. The normal plate voltage of 250 volts is applicable in both cases. The plate currents are practically identical, although, to be exact, that drawn by the pentode is a few mils less. The difference in grid bias is very marked, that required by the pentode being about one-third of that required by the '45. Under the circumstances, one would imagine that the only change required to accommodate the pentode is the change in the value of the grid bias resistance.

Actually such is not the case. While it is true that the aforementioned is the only alteration related to voltage distribution, another change is occasioned by virtue of another constant of the tube. This constant is the plate impedance. That of the pentode is many times that of the '45, perhaps twenty times as great. This means that in order to apply the required load impedance, the output transformer must be changed. That used with the '45 is not suitable for use with the '47, not if a satisfactory amount of power output with minimum distortion is desired.

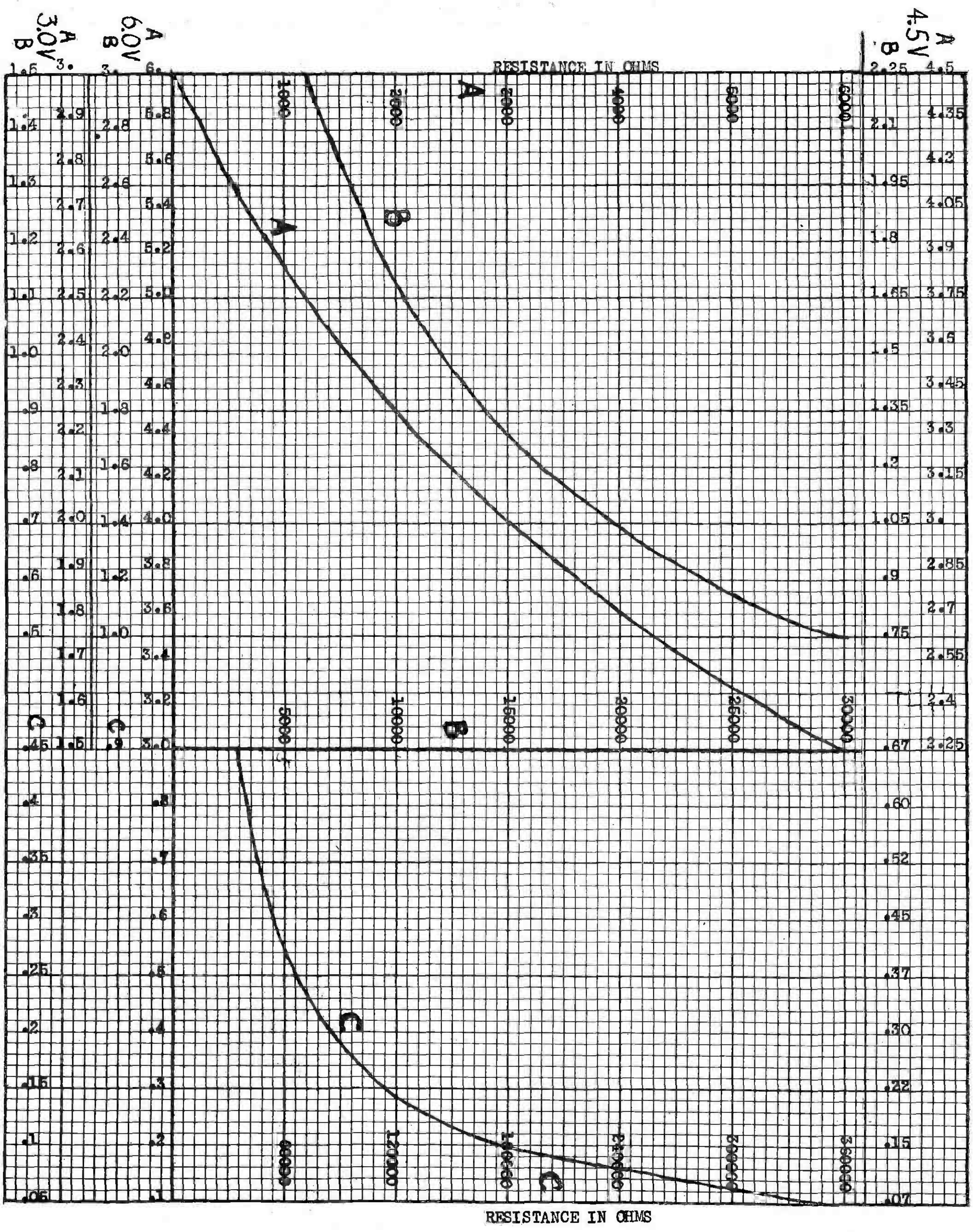
As to the presence of the second and third harmonics in the pentode and the general freedom from such harmonics in the case of the '45, very little need be said in as much as there is a wide variation in the actual harmonic content of the signals passed through the various manufactures of pentodes and the efforts being made to correct this situation.

We can summarize the entire situation by stating that very little is gained by replacing a '45 tube with a pentode in an existing receiver where there is an abundance of RF amplifiers and where the power output is entirely satisfactory.

Voltmeters as Ohmmeters

A large number of voltmeter-battery combinations are employed as continuity testers and ohmmeters. The following curves are resistance calibrations covering a 6-volt 1000 ohms per volt voltmeter when used with three different values of test voltage, namely, 3.0, 4.5 and 6 volts. The curves are divided into three ranges, from 0-6000 ohms, from 6000 to 30,000 ohms and from 30,000 to 360,000 ohms. These three ranges are applicable to these three test voltages. How readily one can check the upper limits of this range depends entirely upon the degree of accuracy employed to determine the meter indication. For that matter it is not imperative that the meter indicate the exact value of resistance when measuring values in excess of 200,000 ohms. The indication of continuity and high resistance is sufficient to show the approximate condition of the unit and such knowledge is sufficient to judge whether or not the circuit is satisfactory.

The single calibration curves for the three values of voltage are made possible by the fact that the multiplying ratio action of any unit is the same irrespective of the test voltage providing that the meter constants remain uniform and the value of the multiplying resistance remains constant. In this case the multiplying resistor is the circuit being tested. The circuit being tested acts like a multiplier because of the division of voltage drops between the external resistance and the meter resistance. Thus if the meter has a resistance of 6000 ohms and the circuit under test likewise has a resistance of 6000 ohms, whatever value of current is forced through the circuit by whatever value of voltage is used, the voltage drop will divide equally between the meter resistance and the external resistor (the circuit being tested). Hence it is possible to develop calibration curves for, say, a test voltage of 6 volts and to employ those curves for the measurement of resistance when



Resistance Calibration Curve

the same meter is used by the test voltage is some decimal value of 6 volts. We have selected 6, 4.5 and 3 volts because they are quite commonly employed. The method of calibration for other meters and other voltages will be shown in a subsequent paragraph.

As evident three curves are shown. Examination of the graphs will also show that 9 sets of figures are used. The figures located along the lower abscissa represent voltage indications. The three sets of figures along the upper abscissa also represent voltage. The numerals along the ordinates represent resistance. The voltage indications have been divided into various ranges associated with resistance ranges. This arrangement is preferable to a single set of figures between zero and maximum because it enables more comprehensive application of the curves and more rapid and accurate determination of the resistance being measured.

Curve A indicates resistances between 0-6000 ohms. These values are read upon the ordinate marked A. This curve is related to the voltage indications classified as A. The exact choice of any one of the three A voltage ranges depends upon the test voltage used. Thus, while the presence of three A voltage indication ranges appears confusing, the exact application is greatly simplified in practice because only three of the nine sets of voltage indications are employed. This choice is governed by the test voltage. Thus, if the test voltage is 6 volts, the range between 6 and 3 volts is A, is coordinated with curve A and shows resistance values as previously stated. If the test voltage is 4.5 volts, the range between 4.5 and 2.25 volts is A and is coordinated with the A curve. In the case of the 3-volt test battery, the range between 3 and 1.5 volts is A.

The B range of resistance is read along the B ordinate and is coordinated with the B voltage ranges. With a 6-volt test battery, this range extends from 3 to 1 volt. With a 4.5 volt battery from 2.25 to .75 volt. With a 3-volt test battery, from 1.5 to .5 volt.

The C range of resistance is read along the ordinate designated as C and along the curve C. This range is coordinated with the C range of voltage indications. With a 6-volt battery, this range extends from .9 to .1 volt. With a 4.5-volt battery from .67 to .07 volt. With a 3-volt battery from .45 to .05 volt. Thus one picks the proper voltage indication range, ordinate and curve according to the voltmeter indication when the circuit or unit is being tested.

Suppose that we show an example. The test voltage is 6 volts. The tester is applied across the terminals of a circuit and the voltmeter indicates 1.8 volts. The 1.8 volt indication with a 6-volt test battery is the B range. This means that curve B must be used and the resistance read along ordinate B. Selecting the 1.8 volt point along the lower abscissa, corresponding to the 6-volt test voltage, we draw an imaginary line upward until it intersects the B curve. Then draw an imaginary line towards the right until it intersects the B ordinate. This line meets the B ordinate at approximately the 14,000 ohm point.

Similar calibration curves can be drawn for other meters. Let us consider a popular and oft recommended unit, the 10-volt DC meter rated at 1,000 ohms per volt. The total resistance of the meter is 10,000 ohms. Let us say that Rm = 10,000. The presence of an external multiplier resistance Rs will result in a division of voltage drops between the meter and the external resistance, when the combination is connected across a battery. The external resistor Rs may take the form of a winding or of a resistor unit. Since the voltage deflection upon the meter is determined by the current flow through the meter and since the total current through the complete circuit is dependent upon the total resistance, the presence of the external series resistance will reduce the current flow through the circuit, therefore the voltage indication upon the meter. The relation between the two resistances determines the relation between the voltage drops present across the resistance of the meter and the external resistance. When the meter resistance and the external resistance are known, it is possible to ascertain the meter deflection with constant test voltage. By the same token, when various voltage indications representative of certain unknown values of external resistance are known, it is possible to determine the value of the unknown external resistance. Either method of calculation can be used.

Suppose that we consider various voltage indications. An indication of 6 volts, that of the test battery, is that registered upon the voltmeter when that instrument free of all external resistors is connected across the battery, or when the test prongs are shorted. The value of the external series resistor is determinable by means of the following equation:

$$Rs = \left(\frac{E}{E^1} - 1\right) \times Rm$$

where E is the value of the test voltage or the voltage of the battery as indicated when the test prongs are shorted. E^1 in turn is the voltage indication when the unknown resistance (circuit or unit being checked for resistance) is in the circuit, being connected in series with the voltmeter and the test battery. Rm as stated is the known internal resistance of the voltmeter. Suppose that E = 6 volts and E^1 = 4 volts. Rm = 10,000 ohms. Then

$$Rs = \left(\frac{6}{4} - 1\right) \times 10{,}000$$
$$= .5 \times 10{,}000$$
$$= 5{,}000 \text{ ohms}$$

If the second voltage indication is .5 volt instead of 4 volts, then

$$Rs = \frac{6}{.5} - 1 \times 10{,}000$$
$$= 11 \times 10{,}000$$
$$= 110{,}000 \text{ ohms}$$

By selecting arbitrary values of voltage for E^1 it is possible to develop a chart or a graph showing the value of the external resistance from short circuit to whatever upper limit is determined by the lowest voltage indication discernible upon the meter. The higher the value of the test voltage for any one circuit, the higher is the upper limit of measurement.

The process of calculation may be reversed by selecting arbitrary values of Rs and determining the multiplying ratio due to the presence of Rs. In this way we can ascertain what will be the voltage indication when a known voltage of resistance is used in the external circuit. The ratio

$$\frac{Rm + Rs}{Rm}$$

is the multiplying factor indicating to what extent the voltage scale has been multiplied. Suppose that we select arbitrary values of Rm = 10,000 ohms and 5,000 ohms respectively. The test voltage is 6 volts and the meter is the 10,000 ohms 6-volt DC instrument. Then with the 10,000 ohms resistor in the circuit the multiplying factor is

$$\frac{10{,}000 + 10{,}000}{10{,}000} = 2$$

or the voltage scale has been multiplied two times, which means that the voltage indication shown upon the meter is one half of the voltage impressed across the circuit. By employing the following equation, it is possible to determine the actual voltage indication to be expected with a known series resistance, when the test voltage is known and fixed. Utilizing 6 volts as the test voltage and a series resistance of 5,000 ohms, the voltage indication should be

$$E^1 = \frac{6}{\dfrac{10{,}000 + 5{,}000}{10{,}000}}$$
$$= \frac{6}{1.5}$$
$$= 4 \text{ volts.}$$

Set Manufacturers and Brand Names

Manufacturer	Address	Brand
Acme Mfg. & Elec. Co.	1440 Hamilton Ave., Cleveland, Ohio	Acme
Advance Elec. Co.	1260 W. 2nd St., Los Angeles, Calif.	Falck
All-American Mohawk Corp.	North Tonawanda, N. Y.	Lyric
Amrad Division	Crosley Radio Corp., Cincinnati, Ohio	Amrad
Andrea, F. A. D., Inc.	Long Island City, N. Y.	Fada
Atchison Radio Mfg. Co.	125 N. 6th St., Atchison, Kans.	Atchison
Atwater-Kent Mfg. Co.	4700 Wissahickon Ave., Philadelphia	Atwater-Kent
Audiola Radio Co.	430 S. Green St., Chicago	Audiola
Automatic Radio Mfg. Co.	332 A St., Boston, Mass.	Tom-Thumb
Brown & Manhart	6219 S. Hoover St., Los Angeles, Calif.	Ranger
Browning-Drake Corp.	224 Calvary, Waltham, Mass.	Browning-Drake
Brunswick Radio Corp.	120 W. 42nd St., New York City	Brunswick
Cardinal Radio Mfg. Co.	2812 S. Main St., Los Angeles, Calif.	Cardinal
Cardon-Phonocraft Corp.	E. Michigan & Horton, Jackson, Mich.	Cardon-Sparks
Carteret Radio Lab.	254 W. 18th St., New York City	Carteret
Champion Radio Mfg. Corp.	1865 W. Gage Ave., Los Angeles, Calif.	Champion
Cleartone Division	Cincinnati Time Recorder Co., 1731 Central Ave., Cincinnati, Ohio	Cleartone
Colonial Radio Corp.	25 Wilbur Ave., Long Island City, N. Y.	Colonial
Columbia Phonograph Co.	1819 Broadway, New York City	Columbia
Continental Radio Corp.	Ft. Wayne, Ind.	Star-Raider
Crosley Radio Corp.	Cincinnati, Ohio	Crosley
Davison-Haynes Mfg. Co.	1012 W. Washington Blvd., Los Angeles	Angelus
De Forest Radio Co.	Passaic, N. J.	DeForest
Delco Radio Corp.	Dayton, Ohio	Delco
Echophone Radio Mfg. Co.	104 Lake View Ave., Waukegan, Ill.	Echophone
Edison, Thos. A., Inc.	Orange, N. J.	Edison
Electrical Research Lab.	1731 W. 22nd St., Chicago	Erla
Elmore-Lambing Radio Co.	1205 S. Olive St., Los Angeles, Calif.	Singer
Find-All Radio Co.	285 Madison Ave., New York City	Find-All
Flint Radio Co., Inc.	3446 S. Hill St., Los Angeles, Calif.	Flint
French, Jesse, & Sons Co.	New Castle, Ind.	Jesse-French
General Electric Co.	Bridgeport, Conn.	General Electric
General Motors Radio Corp.	Dayton, Ohio	General Motors
Gilbert, R. W.	2357 W. Washington Blvd., Los Angeles	Gilbert
Gilfillan Bros., Inc.	1815 Venice Blvd., Los Angeles, Calif.	Gilfillan
Gray & Danielson Mfg. Co.	2101 Bryant St., San Francisco, Calif.	Remler
Graybar Elec. Co.	Graybar Bldg., New York City	Graybar
Grebe, A. H., & Co., Inc.	70 Van Wyck Blvd., Richmond Hill, N. Y.	Grebe
Griffin Smith Mfg. Co.	1224 Wall St., Los Angeles, Calif.	Royale
Grigsby-Grunow Co.	5801 Dickens Ave., Chicago	Majestic
Gulbransen Co.	3232 W. Chicago Ave., Chicago	Gulbransen
Herbert H. Horn	1629 S. Hill St., Los Angeles, Calif.	Tiffany Tone
High Frequency Laboratories	3900 N. Claremont Ave., Chicago	Minuet
Howard Radio Co.	South Haven, Mich.	Howard
Howard, Austin A., Corp.	1725 Diversey Pkwy., Chicago	Austin
Hyatt Elec. Corp.	406 N. Madison St., Woodstock, Ill.	Hyatt
Jackson-Bell Co.	1682 W. Washington St., Los Angeles, Calif.	Jackson-Bell
Jewel Mfg. Co.	222 S. West Temple St., Salt Lake City	Jewel
Keller-Fuller Mfg. Co.	1573 W. Jefferson, Los Angeles, Calif.	Radiette
Kellogg Switchboard & Supply Co.	1066 W. Adams St., Chicago	Kellogg
Kemper Radio Corp., Ltd.	1236 Santee St., Los Angeles, Calif.	Kemper-Kompak
Kennedy, Colin B., Corp.	South Bend, Ind.	Kennedy
King Mfg. Co.	254 R St., Buffalo, N. Y.	King
Kolster Radio Corp.	200 Mt. Pleasant Ave., Newark, N. J.	Kolster
Long Radio Co.	2810-12 S. Main St., Los Angeles	Cardinal
Marti Radio Corp.	Ampere, N. J.	Marti
Master Radio Mfg. Co.	1682 W. 35th Pl., Los Angeles, Calif.	Master
Mid West Radio Corp.	Cincinnati, Ohio (410 E. 8th St.)	Miraco
Mission Bell Radio Mfg. & Distr. Co.	1125 Wall St., Los Angeles, Calif.	Mission
National Transformer Mfg. Co.	5100 Ravenswood Ave., Chicago	Balkeit
National Transformer Mfg. Co.	5100 Ravenswood Ave., Chicago	National
Patterson Radio Corp.	239 S. Los Angeles St., Los Angeles	Patterson
Philadelphia Storage Battery Co.	Ontario & C Sts., Philadelphia, Pa.	Philco
Pierce-Airo, Inc.	113—4th Ave., New York City	Pierce-Airo
Pierce-Airo, Inc.	113—4th Ave., New York City	De Wald
Pilot Radio & Tube Co.	Lawrence, Mass.	Pilot
Pioneer Radio Co.	Plano, Ill.	Pioneer
Plymouth Radio Corp.	2625 N. Main St., Los Angeles, Calif.	Plymouth
Powell Mfg. Co.	6121 S. Western Ave., Los Angeles, Calif.	Powell
Premier Elec. Co.	Grace & Ravenswood Ave., Chicago	Premier
RCA Victor Co., Inc.	233 Broadway, New York City	Radiola
RCA Victor Co., Inc.	233 Broadway, New York City	Victor
Republic Radio Co.	3940-46 Grand Ave., Chicago	Republic
Roth-Downs Mfg. Co.	2512 University Ave., St. Paul, Minn.	Orpheus
Seeley Elec. Co.	1818 West 9th St., Los Angeles, Calif.	Lark
Silver-Marshall, Inc.	6401 W. 65th St., Chicago	Silver
Simplex Radio Co.	Monroe & King Sts., Sandusky, Ohio	Simplex
Sparks-Withington Co.	Jackson, Mich.	Sparton
Stein, Fred W.	1200 Main St., Atchison, Kans.	Aztec
Steinite Mfg. Co.	Ft. Wayne, Ind.	Steinite
Sterling Mfg. Co.	2831 Prospect Ave., Cleveland, Ohio	Sterling
Stewart-Warner Corp.	1826 Diversey Pkwy., Chicago	Stewart-Warner
Story & Clark Radio Corp.	173 N. Michigan Ave., Chicago	Story & Clark
Stromberg-Carlson Tel. Mfg. Co.	Rochester, N. Y.	Stromberg-Carlson
Transformer Corp. of America	Keeler & Ogden Ave., Chicago	Clarion
Trav-Ler Mfg. Co.	1818 Washington Blvd., St. Louis	Trav-Ler
United Air Cleaner Corp.	9705 Cottage Grove Ave., Chicago	Sentinel
United American Bosch Corp.	Springfield, Mass.	Bosch
United Engine Co.	Lansing, Mich.	———
U. S. Radio & Television Co.	Marion, Ind.	Apex
Vaga Mfg. Corp.	718 Atlantic Ave., Brooklyn, N. Y.	Vagabond
Waltham Radio Corp., Ltd.	4228 S. Vermont Ave., Los Angeles	Waltham
Ware Mfg. Corp.	Trenton, N. J.	Ware
Westinghouse Elec. & Mfg.	150 Broadway, New York City	Westinghouse
Zenith Radio Corp.	3620 Iron St., Chicago	Zenith

Compiled by Radio Call Book Magazine and Technical Review

GENERAL						DETECTION			AMPLIFICATION										
Type	Base	Use	Filament Heater Supply	Filament Terminal Voltage	Filament Current Amperes	Detector Plate Voltage	Grid Return Lead to	Detector Plate Current Milli Amperes	Amplifier Plate Voltage	Grid Bias Voltage— D.C. On Fil.	Grid Bias Voltage— A.C. On Fil.	Amplifier Plate Current Milli-Amperes	Screen Grid Volts +	Screen Current Milliamperes	Plate Impedance Ohms	Mutual Conductance Micromhos	Voltage Amplification Factor	Ohms Load for Maximum Undistorted Output	Maximum Undistorted Output Milli-watts
181	Side Pin, 4-Prong	Power Amplifier	A.C. or D.C.	3.0	1.35	....	....	....	180	30.0	30.0	16	....	....	2,850	1050	3.0	....	....
401	Side Pin, 4-Prong	Detector or Amplifier	A.C. or D.C.	3.0	1.35	45	Cath.	2	90 180	3.0 13.5	3.0 13.5	5 6	....	....	9,500 7,000	1000 1200	9.5 8.7	....	....
401-A	Standard, 4-Prong	Detector or Amplifier	D.C.	5.0	.25	45	+F	1.5	90 135	4.5 9.0	......	2.5 3.0	....	....	11,000 10,000	725 800	8.0 8.0	11,000 20,000	15 55
410	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	7.5	1.25	....	....	....	250 350 425	18.0 27.0 35.0	22.0 31.0 39.0	10 16 18	....	....	6,000 5,150 5,000	1330 1550 1600	8.0 8.0 8.0	13,000 11,000 10,000	400 900 1600
412-A	Standard, 4-Prong	Detector or Amplifier	D.C.	5.0	.25	45	+F	1.5	90 135	4.5 9.0	....	5.2 6.2	....	....	5,600 5,300	1500 1600	8.5 8.5	5,600 7,800	30 120
412-A	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	5.0	.25	....	....	....	135 157.5 180	9.0 10.5 13.5	11.5 13.0 16.0	6.2 9.5 7.6	....	....	5,800 4,700 5,000	1600 1700 1700	8.5 8.5 8.5	3,700 3,700 10,800	120 195 275
424	Standard, 5-Prong	R.F. Amp. or Detector	A.C. or D.C.	2.5	1.75	90—180	Cath.	1.0	180 180	1.5 3.0	1.5 3.0	4.0 4.0	75 90	Not Over One-Third of Plate Current	400,000 400,000	1050 1000	420 400	....	....
424	Standard, 5-Prong	Audio Freq. Amplifier	A.C. or D.C.	2.5	1.75	....	....	....	250	1.0	1.0	0.5	25	....	200,000	500	1000	....	....
426	Standard, 4-Prong	Amplifier	A.C. or D.C.	1.5	1.05	....	....	....	90 135 180	5.0 8.0 12.5	6.0 9.0 13.5	3.8 6.3 7.4	....	....	8,600 7,200 7,000	955 1135 1170	8.2 8.2 8.2	9,800 8,800 10,500	30 80 160
427	Standard, 5-Prong	Detector or Amplifier	A.C. or D.C.	2.5	1.75	180	Cath.	.8	90 180	6.0 13.5	6.0 13.5	2.7 5.0	....	....	10,800 9,300	850 1150	12.5 12.5	....	....
430	Standard, 4-Prong	Detector or Amplifier	D.C.	2.0	.06	45	+F	1.5	90	4.5	......	2.0	....	....	12,500	700	8.8	....	....
431	Standard, 4-Prong	Power Amplifier	D.C.	2.0	.13	....	....	....	135	22.5	......	8.0	....	....	4,000	875	3.5	....	170
432	Standard, 4-Prong	Radio Freq. Amplifier	D.C.	2.0	.06	....	....	....	135	3.0	......	1.5	67.5	Not Over One-Third of Plate Current	800,000	550	400	....	....
433	Standard, 5-Prong	Pentode Power Amplifier	D.C.	2.0	.26	....	....	....	135	13.5	......	14.0	135	3	45,000	1400	65	7,500	650
435	Standard, 5-Prong	Detector Amplifier	A.C. or D.C.	2.5	1.75	250	Cath.	1.0—3.0	250	3.0	3.0	7.0	90	2.5 Maximum	350,000	1050	Controlled	....	....
436	Standard, 5-Prong	Radio Freq. Amplifier	D.C.	6.3	.3	....	....	....	90† 135* 135	1.5† 1.5* 1.5	......	1.8 3.0 3.5	55† 67.5* 75	Not Over One-Third of Plate Current	200,000 300,000 250,000	850 1050 1100	170 350 275	....	....
437	Standard, 5-Prong	Detector or Amplifier	D.C.	6.3	.3	45	Cath.	.5—10	90† 135	6† 9	......	2.7 4.5	....	....	11,500 10,000	780 900	9.0 9.0	14,000 12,500	30 75
438	Standard, 5-Prong	Pentode Power Amplifier	D.C.	6.3	.3	....	....	....	135	13.5	......	8.0	135	2.5	110,000	900	100	15,000	375
445	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	2.5	1.5	....	....	....	180 250	33.0 48.5	34.5 50.0	25 34	....	....	1,900 1,750	1850 2000	3.5 3.5	3,500 3,900	780 1600
447	Standard, 5-Prong	Pentode Power Amplifier	A.C. or D.C.	2.5	1.5	....	....	....	250	15.0	16.5	32	250	2.5	38,000	2500	100	7000	2500
450	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	7.5	1.25	....	....	....	250 350 400 450	41.0 59.0 66.0 80.0	45.0 63.0 70.0 84.0	28 45 55 55	....	....	2,100 1,900 1,800 1,800	1800 2000 2100 2100	3.8 3.8 3.8 3.8	4,300 4,100 3,670 4,350	1000 2400 3400 4600
480	Standard, 4-Prong	Full Wave Rectifier	A.C.	5.0	2.0	....	....	....	Maximum A.C. Voltage Per Plate 350 Volts R.M.S. Maximum Rectified Current 125 M.A.										
481	Standard, 4-Prong	Half Wave Rectifier	A.C.	7.5	1.25	....	....	....	Maximum A.C. Voltage Per Plate 700 Volts R.M.S. Maximum Rectified Current 85 M.A.										
482-A	Standard, 4-Prong	Power Amplifier	D.C.	5.0	.8	....	....	....	200	45	......	18	....	....	2,000	1500	3.0	4500	1500
482-B	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	5.0	1.25	....	....	....	250	32.5	35	18	....	....	3,330	1500	5.0	4500	1750
483	Standard, 4-Prong	Power Amplifier	A.C. or D.C.	5.0	1.25	....	....	....	250 250	65.5 63.5	58.0 65.0	20 36	....	....	2,000 1,500	1500 2000	3.0 3.0	4500	2000
484-A	Standard, 5-Prong	Detector or Amplifier	D.C.	3.0	1.6	100	Cath.	0.5	90 180	3 9	3 9	5 6	....	....	10,800 9,300	1150 1350	12.5 12.5	....	....
485	Standard, 5-Prong	Detector or Amplifier	A.C. or D.C.	3.0	1.3	135	Cath.	0.8	90 180	3 9	3 9	5 6	....	....	10,800 9,300	1150 1350	12.5 12.5	....	....
486	Standard, 5-Prong	Radio Freq. Amplifier	D.C.	3.0	.25	....	....	....	90	3.0	......	3.0	....	....	28,000	450	12.5	....	....

*Recommended values for use in Auotmobile Receivers.
†Recommended values for use in Receivers designed for 110 volts D.C. operation.

Characteristics of Sparton Tubes