SERVICE

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EDITORIAL

AN examination of the wiring diagrams published in the last three Monthly supplements, particularly the superheterodyne drawings, shows that receiver design has not yet approached its limits. We find screen grid autodyne mixer-oscillator circuits, push-pull demodulators, etc. The development of the screen grid autodyne mixer-oscillator is a definite advancement over the conventional three electrode tube autodyne system because the input circuit of the screen grid autodyne tube can be tuned accurately to resonance with the incoming carrier. An unusual mixer-oscillator arrangement of the autodyne type is shown in the U. S. Radio and Television series 7 and 99 receivers listed in the December supplement. The more we examine these diagrams the more do we realize the tremendous need for complete circuit data. The modern service man who attempts to check a modern superhet without knowing the structure of that circuit is lost.

For several years past there has been a definite stand relative to the use of manuals during the servicing of a radio receiver in the home. The attitude taken has been that checking a wiring diagram in front of a customer is a reflection upon ability. The sooner this idea is changed, the better will it be for all concerned. No one service man who may be called upon to service any one of a number of radio receivers of different manufacture can hope to remember the circuit peculiarities of each of the various receivers. Knowledge of these peculiarities is essential even if the trouble is minor. Propaganda acquainting the public with the fact that good service men should be expected to refer to diagrammatic information is in order. In this respect the radio service problem differs from service work in other fields. Telephone men have no compunction about referring to schematic diagrams during a repair call. If all receivers were alike there would be no need for wiring diagrams. However, since different series of chassis with like model numbers incorporate changes, nothing can replace the wiring diagram.

JOHN F. RIDER.

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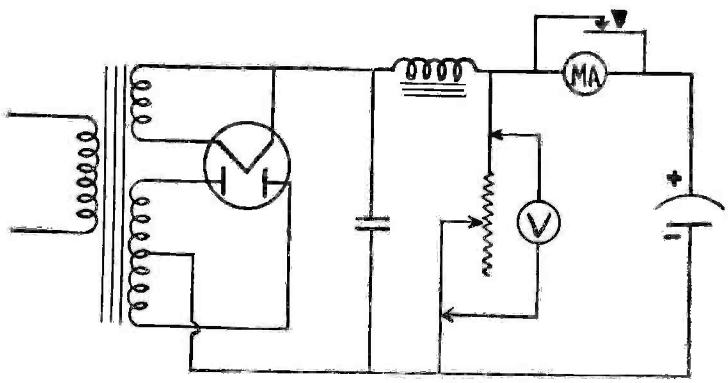
Testing Electrolytic Condensers

The recent advent of the electrolytic condenser for filter and bypass work in radio receivers has created interest in the testing details surrounding this unit. Investigation discloses some very interesting facts, information of general and specific value.

It might be well because of conditions which may arise to briefly mention some of the pertinent differences between the electrolytic and the conventional solid dielectric type of condenser. The man who will be called upon to work with electrolytic condensers should be aware of the following:



1. Condensers which have been inoperative for a period of time will require reforming. Expressed in another manner, these condensers will not operate in the normal manner until after a few hours of ordinary use. This means that a receiver several months old and now being placed into operation and utilizing electrolytic type filter condensers may hum badly for several hours. As the period of use increases, and the structure of the receiver is perfect in every respect, this hum will gradually decrease and finally reach the normal level accepted according to the design of the receiver.

2. The condenser is polarized and when associated with operating voltage circuits which includes testing must be used with correct polarity of the operating voltage.

3. The condenser by virtue of its design does not possess the dielectric resistance to be experienced with solid dielectric condensers. A certain amount of leakage current is present and this means that the routine form of voltage test is not satisfactory.

4. Because of the design of the condenser, the application of the testing voltage is accompanied by a sudden surge of current which definitely determines test procedure.

As far as testing of electrolytic condensers is concerned, there is one routine test of greatest favor. This is for leakage current. There is of course a capacity test but the equipment involved is such as not to lend itself to general work. With respect to leakage current, we are forced to recognize certain qualifications. One of these is the time limit. The leakage current to be encountered when checking an electrolytic condenser is governed by the length of time during which the testing voltage is applied. While it is impossible to definitely state the degree of leakage current reduction per minute of test voltage application, let it be stated that the normal leakage current should be expected after about 8 or 10 minutes of test voltage application. In this respect, testing of electrolytic condensers is more tedious than the testing of solid dielectric condensers. Furthermore, the greater the period of test voltage application for each condenser, the less will be the leakage current. In other words, there is a gradual decrease of leakage current as the period of test voltage application is increased.

It has been customary to quote leakage current of electrolytic condensers in fractions of a milliampere per microfarad. While this method of stipulating test information is satisfactory in certain cases, it is not satisfactory in other cases, which means that the actual quotation relative to general application is subject to revision. However, it is safely applicable when associated with any one value of total capacity, perhaps even over a range of capacities. An example of this statement is as follows: We are familiar with the fact that a rating of .5 milliampere (maximum) per microfarad of capacity for electrolytic filter condensers up to about 10 or 20 microfarads is satisfactory. In some instances, the maximum leakage per microfarad is set at .1 to .25 milliampere. Yet this value is extremely high in capacities rated at from 500 to 4000 microfarads. If we allow .25 or .5 milliampere per microfarad, the leakage current for a 1000 microfarad section would be from 250 to 500 milliamperes, a value of current entirely out of proportion.

Actual investigation shows that the leakage current ratings decrease with increase in capacity, so much so, that a good 1000 microfarad condenser when tested at the rated value of voltage (determined by the operating voltage of the condenser) does not show more than perhaps 20 microamperes per microfarad or about 20 milliamperes for a 1000 microfarad unit. Units rated in excess of 1000 microfarads show even lower leakage per microfarad capacity.

There exists a difference of opinion relative to the time which should elapse between the application of the testing voltage and the time when the leakage current is read as an indicator of the condition of the condenser. Various periods are recommended, ranging from 1 to about 10 minutes. Strange as it may seem, the leakage currents quoted in connection with such tests range from about 1 milliampere per microfarad to down as low as .1 milliampere per microfarad; the former maximum being stated in connection with the shortest period and the latter with the longest period. Accordingly, it is possible to come to a compromise as to time and leakage, bearing in mind that a preliminary observation of the leakage current will determine the necessity of increasing the test period. If after one or two minutes of test the leakage current is greater than normal, the test should be continued for a longer period, say 10 minutes for condensers which have been in constant use, but have been removed for test. If the condenser has been inactive for several days, weeks or months, a much longer period of test is required, otherwise judgment cannot be rendered. As to the compromise of time and leakage current we are in favor of the 8 to 10 minute test with 1 milliampere per microfarad as the absolute limit for electrolytic type filter condensers up to 8 microfarads and used in "B" eliminators. Bypass condensers higher than 8 microfarads and up to about 20 microfarads should not show more than about .1 to perhaps .3 milliampere per microfarad.

It might be well to bear in mind the location of the condenser. Naturally, a condenser used across the filter system or in the filter system of a "B" power pack will have very little effect upon the output voltage if its leakage current reaches 1 milliampere per microfarad, whereas a bypass condenser with like leakage when connected across a bias resistor will not be satisfactory.

Electrolytic condensers intended for filter work should be tested for leakage current at voltages between 400 and 450 volts DC. Some of the early Mershon units (wet electrolytic) were tests at 350 volts DC. The numerous manufactures of dry electrolytic condensers intended for filter work are rated at about 450 volts peak and may be tested at the aforementioned values. A test circuit is shown in figure 1.

The source of the testing voltage is a conventional eliminator, wherein the power transformer is of the modern type intended for use at the recent anode voltage ratings. In other words the anode voltage per plate upon the rectifier which is of the '80 type is between 350 and 375 volts AC. Such a rectifier with a simple single section filter will provide the required output, in as much as the current load is very small. As a matter of fact, such a rectifier will furnish about 450 volts DC at about 10 mils and 400 volts DC at about 20 mils load. The input filter condenser is of 1 or 2 microfarads. The choke is a 30 henry unit capable of passing about 100 mils. This high value of current carrying capacity is selected to safeguard in the event of a defective electrolytic placed on test. The voltmeter is a 0-500 volt DC instrument. The milliammeter is a 0-10 DC meter. A permanent switch controlled shorting shunt is connected across the current meter. This short is always connected across the meter. It is disconnected by means of a push button. The normal position of this button keeps the shorting link across the meter, thus protecting the meter against injury in the event of excessive leakage in the condenser under test or in the event of a short circuit. The variable resistance across the filter output is used to adjust the output voltage to the required 400 volts. It is of the tubular type with a sliding contact. Its maximum resistance is about 25,000 ohms and it is rated at 75 watts. The voltmeter is connected across the resistor and the latter is adjusted until the required 400 volts DC is obtained. This method is preferable to filament control because the output voltage is variable with very good precision. Of course the adjustment of the load resistance is not made with the power "on". The voltage is checked with the power "on" and about three-quarters of the resistance in the circuit. Then the input AC circuit is opened and the resistance increased or decreased according to the previously observed voltage. A few moments of experimenting will enable the correct adjustment.

The voltmeter remains connected across the load resistance and serves to indicate the condition of the electrolytic condenser being tested. In this operation advantage is taken of the operating characteristic of an AC type eliminator. If the condenser is defective it increases the current load and the output voltage indication is low. If on the other hand the condenser is satisfactory, a change in voltage output will occur only during the first few minutes (if that long) after the condenser has been connected into the circuit. The indication upon the voltmeter governs the use of the current meter protecting switch. If the output voltage returns to normal after a few minutes of operation, the current meter protecting link is open circuited and the leakage current is read upon this meter. **Under no circumstances should you open the shorting link to check the current when the voltmeter shows an appreciable drop in voltage with the condenser under test connected across the system. If you do the current meter will be damaged.**

The polarity indication associated with the condenser under test refers to the polarity of the condenser. A satisfactory method of connecting the condenser under test to the voltage source is to use a metal plate for the eliminator negative lead and a rubber insulated clip is attached to the positive lead. The condenser is placed atop the metal plate and the positive lead clip is fastened to the terminals of the condenser sections.

The correct values of leakage current have been previously mentioned.

Notes on Superheterodyne Receivers

There are certain items related to superheterodyne receivers which have been the subject of numerous questions and discussion. One of these is the presence of certain beat notes in practically every superheterodyne receiver. It seems as if every superhet, no matter how perfect the alignment and how satisfactory the general performance, is afflicted in this manner. Such is actually the case and while it is true that there is a variation in the intensity of these beats, that is, they are stronger in some cases than in others, the fact remains that they are present. Although no definite information is available upon the subject, it is imagined that the present design of superhets is such that the conditions which produce these beats are ever present, although in varying degree. It should of course be understood that the normal status of this condition is not the equivalent of a defect subject to repair. The condition may be aggravated in some one of several ways, but when this occurs, the receiver is defective and manifest by a very pronounced increase in the intensity of the beats as made audible through the loud speaker.

It might be well to mention that the service man called in to repair a superheterodyne which is not functioning in normal manner, and the actual fault is something other than undesired heterodyning should expect to find such beats after having repaired the receiver.

The points at which these beats will be heard are governed by various factors. One of these, the major one, is the peak frequency of the intermediate amplifier. The second is a matter of receiver design, operating voltages, the efficacy of shielding, etc. The reason for the beat note is the reaction between the harmonics of the intermediate frequency and the original carrier frequency. This reaction occurs between the demodulator or second detector tube plate circuit and some part of the receiver wherein flow the broadcast carrier currents.

The frequencies at which one may expect to encounter beats in broadcast receivers are within the broadcast band, with about 1400 KC as the upper frequency limit and about 650 KC as the lower frequency limit. This range of frequencies covers the harmonic band from about the second to the eighth harmonic of the various intermediate peaks. The presence of the second harmonic as a beating frequency is found in but few cases, namely in connection with the few receivers which employ 480 KC peaks. In all of the rest, the third harmonic is the lowest which will fall within the broadcast band.

Based upon pure theory and without regard to the intensity of the respective harmonics and the likelihood of such beating action a beat note is possible upon every harmonic of the intermediate frequency which falls within the broadcast band. Actually such is not the case. Whereas perhaps five harmonics of a peak frequency will fall within the broadcast band, only one or two may be audible. It might be well to mention that the harmonics heard most frequently cannot be classified according to numerical values because what may be the third harmonic of one frequency and which will fall within the broadcast band, may approximate the fifth harmonic of another peak frequency. Thus the range of from the second to the eighth harmonics is the only satisfactory means of presentation. Then again, it is of interest to note that in cases where the fourth, fifth and sixth harmonics fall within the broadcast band, the seventh and eighth harmonics cause very little trouble, whereas in cases where the second and third fall within the broadcast band, the fourth, fifth and sixth cause very little trouble. As it happens, the harmonic beats when present will be found to be most prevalent around the middle of the tuning dial, i.e., between about 650 KC and 1200 KC.

To determine the approximate frequencies of the beats to be expected, consider first the peak frequency of the receiver. If it lies between 170 and 180 KC, these harmonics will be the fourth, fifth and sixth of whatever peak between these limits is used. If the intermediate peak is between 260 and 262 KC, the prevalent beats will be the third and fourth and fifth harmonics, with greatest strength at the two lower values.

The tracking of the oscillator condenser with respect to the RF condenser and the tuning of these systems has much to do with the frequency of the beats. Thus if the beat note produced by heterodyning the received carrier by some value which is not the rated intermediate peak frequency, the heterodyne beats will occur at values other than the rated harmonics of the rated intermediate frequency. Thus if the rated intermediate peak is 175 KC, in which case the pronounced beats would be heard at 700 KC, 875 KC and 1050 KC and the tracking of the oscillator is such that the intermediate frequency produced is 173 KC, the points at which the harmonics would be heard would be 692 KC, 865 KC and 1038 KC. Now with the allocation of the broadcasting frequencies, the 865 KC beat would be audible only upon a loud station which would spread over more than five KC each side of the 860 KC setting, but the 692 KC and the 1038 KC signals would be heard during the tuning adjustments at 690 and 1040 KC. Now it is possible to approximate the fact that the intermediate frequency is higher or lower than the rated value by noting the tuning adjustment for those points where the zero beat condition is produced. Thus in the case of the 692 KC signal, the beat would be audible at 690 KC, but would be tuned to zero beat at 692 KC, which deviation from the rated frequency tuning can be noted upon an accurately calibrated receiver.

Generally speaking, the heterodyne signals will be audible upon those broadcast frequency adjustments which are even multiples of 10. However, in the case of loud signals they may be heard at other frequency adjustments within the broadcast band.

The following is a tabulation of intermediate frequencies as used by a number of prominent manufacturers. These are on record as of this date of issue.

130 KC Intermediate
Atwater-Kent
172.5 KC Intermediate
Sparks-Withington (Sparton)
175 KC Intermediate
All American Mohawk
American Bosch
Andrea, F. A. D. (Fada)
Brunswick
Bulova Watch Co.
Colonial
Columbia Phonograph
Crosley
Echophone
Erla
General Electric (Flat top in some cases)
Graybar (Flat top in some cases)
Grebe
Grigsby-Grunow
Gulbransen
Howard
Jesse French
Kennedy
Kolster
Montgomery Ward
RCA-Victor (Flat top in some cases)
Silver Marshall
Stromberg Carlson
Transformer Corp. of America
United Air Cleaner
Sears Roebuck
Wells Gardner
Westinghouse (Flat top in some cases)
Wholesale Radio
Zenith
177.5 KC Intermediate
Audiola
Stewart-Warner
260 KC Intermediate
Philco
262 KC Intermediate
U. S. Radio and Television

By flat top tuning is meant band pass tuning. In some of the console models one or two of the transformers are arranged to have a flat top over a band width of 8 KC, four kilocycles each side of the peak frequency.

Referring to the presence of the undesired heterodyne notes, the greatest care must be exercised to see that the plate circuit of the second detector or demodulator tube is intact in every respect. The radio frequency choke and filter circuit in this system is of such importance relative to freedom from undesired beats that some receivers mount this choke within a metal shield. The structure of the RF filter system in the demodulator plate circuit is of the utmost importance. Its isolation likewise is of importance. With respect to the former, the connections to the bypass capacities and the condensers themselves must be perfect. These units must function to keep the rectified IF currents out of the system preceding the demodulator system, essentially out of the RF and mixer systems.

Relative to second requirement, the demodulator plate circuit must be far removed, inductively speaking, from any and all parts of the RF and mixer circuits. Whatever input leads to the receiver enter the receiver must be kept at a distance from the RF choke in the demodulator plate circuit and from the connections to the grid or plate leads to that tube. Expressed in a single sentence all coupling between the demodulator tube grid or plate circuit and the RF system must be avoided like the plague. This applies particularly to the aerial lead. Keep it far from any part of the demodulator tube circuit. The better the isolation of this tube, the greater the freedom from undesired beats.

Tuning Peculiarities

There are certain peculiarities inherent to the superheterodyne receiver which are in a way contrary to general conception. One of these relates to tuning. What is to be said in the next few lines is valuable information to be conveyed to salesmen by service men.

Although the intermediate frequency transformers used in modern superhets are peaked at a certain intermediate frequency, they nevertheless are responsive over a band of frequencies, perhaps about 5 KC either side of the peak. This means that any frequency within the upper or lower limits of the IF transformer band pass will find its way through the intermediate amplifying system. Supplementary to this is the consideration that no matter what the frequency difference between the incoming broadcast carrier and the frequency of the oscillator, that signal, the beat note, will be modulated. This means that if the beat note is of some frequency within the limits of the band pass of the intermediate frequency transformers, that signal modulated will pass through the IF amplifier, and will be heard through the speaker.

Accordingly, we are confronted with the problem of tuning the receiver. If we assume proper tracking of the oscillator tuning system, say in a 175 KC peaked superhet, the beat will always be 175 KC, no matter what the frequency adjustment of the tuning system. If the receiver is incorrectly tuned, that is to some frequency other than exact resonance, say a deviation of two kilocycles, the signal will be passed through the system and will be audible but the quality of reproduction will be very poor. Some men attempt to reduce volume in this fashion. Detuning a superheterodyne as a means of reducing volume or controlling volume is very poor practice and is productive of a great deal of distortion. Then again operating in this fashion is courting troubles related to adjacent channel selectivity. By tuning midway between two fairly strong stations operating upon adjacent channels, the presence of both stations is a hazard.

Determining the Intermediate Frequency Used in the Receiver

There are times when the intermediate frequency used in the intermediate amplifier of a superheterodyne is unknown. Yet a service call may require a test upon the IF amplifier. Accordingly, it might be advantageous to know the means of determining the peak adjustment. Experiments have shown that the method to be outlined is satisfactory irrespective of the incorrect alignment of one of the two IF tuning condensers associated with each of the transformers. The only time when trouble may be encountered is when the intermediate transformers have been deliberately tuned and peaked at some frequency other than the required peak. Since such a case is not frequent, we can consider the method of checking as being applicable in the majority of instances. The equipment required consists of an IF oscillator, modulated by one of several means and capable of covering a 125 to 270 KC range. Also an output meter, although it is possible to dispense with the output meter by using the speaker sound output as the indication of signal transfer. The operation consists of feeding a modulated IF signal into the intermediate frequency amplifier and noting the output response by sound intensity or the indication upon the output meter, as the oscillator is tuned over the intermediate frequency band.

The output circuit of the oscillator is connected across the control grid lead of the first detector or mixer tube and the chassis. The "A" lead of the oscillator is connected to the control grid and the "G" lead to the chassis. If the mixer tube is of the '27 type, the "A" terminal of the oscillator is connected to the grid contact upon the tube socket, the regular lead to this terminal being temporarily disconnected. The lead to the chassis remains as before.

Starting with a frequency adjustment of 270 KC upon the test oscillator, the oscillator tuning control is slowly decreased in frequency. The point where the signal is loudest through the receiver speaker or the output meter indication is greatest is noted. The frequency adjustment of the oscillator at this point is an approximation of the peak frequency adjustment of the receiver. The reason for not stipulating that this point is the peak frequency is due to the possibility of incorrect alignment of the two tuning condensers associated with each transformer. Knowing the usual peak frequencies, one can very readily recognize that if the maximum signal is noted at a peak frequency of say 258 KC, that the correct peak is 260 KC inasmuch as the latter is a rated peak whereas the former has never been quoted as being used.

There is a definite advantage gained by starting the oscillator tuning at the upper rather than the lower end of the frequency scale. This is found in the fact that difficulties due to the generation of harmonics, particularly the second, do not interfere with the response of the IF system. If the tuning were started at the low frequency end of the scale, the IF system actually peaked at 260 KC would show response at two settings of the oscillator dial, namely at 130 and 260 KC. The first response would be due to the second harmonic of the 130 KC fundamental and the second response would be due to the 260 KC fundamental. By starting at the upper end, we consider but one response, namely the first. If after the point of first response has been noted, the test is carried further and the oscillator is tuned to approximately 130 KC, a point of second response will of course be observed, but there is no need for continuance of testing, after the first point of response has been observed.

Automatic Volume Control

There are certain characteristics which accompany the operation of receivers equipped with automatic volume control which enable recognition of the fact that the receiver employs such a tube. In view of the fact that there is no external means of distinguishing this tube from the others, it might be well to know how to recognize the symptoms which are present when an AVC tube is used. The design of the tube and its operation is such that it becomes operative when a signal is being passed through the receiver. Upon such an occasion the tube levels the gain or sensitivity of the receiver. Normally without any signal input, the AVC tube is inoperative, which means that during this period the sensitivity of the receiver is greatest. Accordingly, the noise level of the receiver is also greatest. When a signal is fed into the receiver, its sensitivity is lowered and the noise level is decreased. Thus if you come in contact with a receiver which shows a marked increase in noise level between stations or the moment a station carrier goes off the air, that receiver more than likely is equipped with an automatic volume control.

Image Frequency and the Atwater-Kent Double Spot Circuit

The term "image frequency" is oftentimes referred to in text related to superheterodyne receivers. This term refers to an interfering signal which may find its way into the receiver and be present in the output of the receiver without any defect on the part of the receiver. There is an exception to this statement, this being the presence of the signal when the receiver employs a special circuit for the elimination or minimization of this signal.

Expressed in the simplest language, the "image frequency" is that frequency which differs from the frequency of the desired carrier by a value equal to twice the peak frequency of the intermediate amplifier but is always higher than the desired carrier. An example of this is the following. Suppose that the desired carrier is of 1000 KC. If the intermediate is tuned to 130 KC, the frequency adjustment of the oscillator will be 1000 KC plus 130 KC or 1130 KC. Now there is a frequency which may differ from the 1130 KC adjustment of the receiver oscillator by 130 KC, yet not be the desired carrier. This frequency would be 1130 plus 130 or 1260 KC. Thus 1260 KC is the image frequency for the 1000 KC carrier when the intermediate is tuned to 130 KC. If the intermediate system is tuned to 175 KC, then for a desired carrier of 1000 KC, the oscillator adjustment would be 1175 KC and the image frequency would be 1175 KC plus 175 KC or 1350 KC.

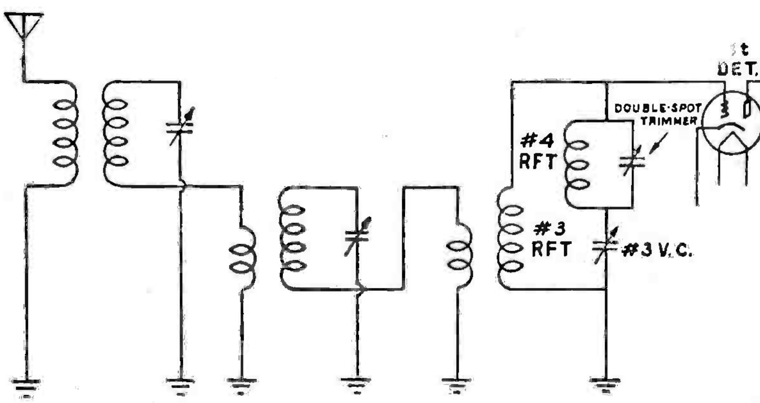
The aforementioned statement relative to the condition that the "image frequency" must be higher than the desired carrier is true only in the case of the modern single control superhet wherein the oscillator or "beating" frequency is higher than the desired carrier. If the oscillator tuning control is independent and may be adjusted to produce a beating frequency lower than the carrier, then the image frequency is lower than the carrier frequency by twice the value of the intermediate frequency.

The elimination of the image frequency is a function of the tuned circuits preceding the mixer or first detector tube. These circuits would be the RF amplifier. It evolves upon these circuits to keep the image frequency out of the mixer tube and it is equally important to see that the aerial lead or the aerial circuit is not in such position as to allow the entry of a strong image frequency signal into the mixer circuit. In the case of the Atwater-Kent receivers, the image frequency suppression is accomplished through the use of what is known as a "double spot" circuit, located in the mixer tube grid circuit.

The Atwater-Kent Double Spot Circuit

The double spot circuit used in the Atwater-Kent superheterodynes can be seen in the schematics shown upon pages 114-M, 114-P and others in this same series. A rearranged diagram of just this part of the circuit is shown in figure 1. This schematic shows the complete pre-selector circuit preceding the mixer tube. The "double spot" suppression circuit consists of the No. 4 RFT winding and its associated double spot trimmer. However, associated with this circuit are the No. 3 RFT winding and the No. 3 tuning condenser.

A discussion of the adjustment of this system is justified because it is native to none other than the Atwater-Kent series of receivers and because its use requires a special adjustment of the RF test oscillator during the alignment procedure. All of the circuit ahead of the secondary of the No. 3 RFT



are used to provide a high order of selectivity of the carrier frequencies. The combination of No. 3 RFT and its condenser and No. 4 RFT and its condenser constitute a double tuned circuit, that is a circuit simultaneously tuned to two different frequencies. The complete circuit is tuned to the carrier frequency desired and the No. 4 RFT and the double spot trimmer condenser are tuned to the image frequency to be suppressed. The function of the double spot circuit is to short circuit all currents of the image frequency.

To accomplish this the double spot circuit is tuned to 260 KC higher than the adjustment of the pre-selector circuit. The 260 KC tuning adjustment is based upon the use of a 130 KC peak. If this peak were 175 KC, the adjustment of the double spot circuit would be 350 KC higher than the frequency adjustment of the pre-selector system. By properly tracking the double spot trimmer and the main tuning condensers the frequency difference between the pre-selector circuit and the double spot circuit is always maintained at 260 KC, the double spot system being higher than the pre-selector system.

The following information applies solely to the alignment of the double spot system in the Atwater-Kent receivers, since only this organization utilizes this system. The adjustment of the double spot circuit requires a modulated test oscillator with variable output so that a normal and extra strong 1500 KC signal is available at will. An output indicating device is connected into the receiver output circuit so as to indicate the correct adjustment. The output of the test oscillator is connected across the aerial and ground posts of the receiver. With the test oscillator adjusted to a normal 1500 KC modulated signal, the pre-selector trimmers (the double spot excluded) are adjusted for maximum output response, with particular attention being paid to No. 3 VC. Then the oscillator output is switched to the extra strong signal. Now tune the receiver to 1240 KC and adjust the double spot circuit trimmer for minimum output response. It is possible that total elimination of the signal will not be attained, but this is quite normal during such an adjustment. When it occurs, care must be taken to adjust for the absolute minimum output response.

Then change the test oscillator adjustment at 1500 KC to normal output and retune the receiver to 1500 KC and readjust trimmer No. 3 for maximum output indication. Then repeat the adjustment of the double spot trimmer by tuning the receiver to 1240 KC and switching the test oscillator at 1500 KC to the extra strong signal. Repeat these adjustments until further manipulation of trimmer No. 3 does not increase the output of the receiver at 1500 KC and the adjustment of the double spot trimmer at 1240 KC is productive of a state of minimum output.

The Majestic Refrigerator (Part 2)

Dealer Repair

At no time will the dealer have any occasion to break into the SO_2 lines. Repairs on the compressor, condenser, float valve, evaporator, check valve and the SO_2 and oil lines will be taken care of by your Distributor. Should any difficulty be experienced with the above parts, the dealer should endeavor to diagnose and report his findings along with the customer's complaint on the report form furnished by his distributor. The unit should be removed and replaced with another unit. The original unit when returned from the distributor after being repaired, must be replaced in the original cabinet. Necessary repairs the dealer will perform are limited to the electrical equipment listed below.

1. Test and repair or adjust overload trip device.
2. Test and replace electrical condenser.
3. Test and replace phase shifting transformers.
4. Test and repair condenser cooling fan.
5. Test, adjust and repair thermostat control.
6. Test and replace starting relay.
7. Replace bi-metallic strip.

Electrical System—Model 100

The control device and motors form the electrical system of the unit. The control box is on the front left hand corner of the mounting plate, and the Compressor motor is inside the dome. The capacitor unit is in two parts; namely, the electrical condenser, on rear right hand corner, above float valve and the auto-transformer on rear left hand corner. The fan motor is inside the fan housing.

Control Box

The control box contains the following apparatus:

(a) Thermostatic switch or temperature control.

(b) Motor starting relay.

(c) Overload or electrical system protective device.

The thermostatic switch consists of a patented, positive action snap switch operated by gas pressure within a metallic bellows. To this bellows is attached a length of ⅛" copper tubing ending in a six inch bulb, which is clamped to the cooling unit. This entire assembly contains a certain amount of SO_2. A difference in temperature in the bulb causes a difference in gas pressure in the bellows which, in turn, operates the switch between predetermined limits. A mechanical means of varying this spring pressure is brought out to a knob on the front of the box, thereby giving the customer an opportunity to vary the temperature of the box.

Replacing the Bellows Assembly

Should the thermostatic switch not function properly, it is probable that the bellows assembly has lost its charge of SO_2. To replace the assembly, proceed as follows:

(a) Remove four screws holding switch to control box, and unsolder three wires from lugs.

(b) Release bulb from cooling unit clamp.

(c) Remove switch from unit entirely.

(d) Release lock nut and slip out old bellows assembly.

(e) BEFORE attempting to remove bellows from shipping clamp, cool bulb of new bellows assembly to 10° F. by inserting bulb in tall glass of crushed ice and salt.

(f) Transfer bellows immediately to switch with retaining nut on inside of body and lock nut on the outside.

(g) Set switch with range shaft turned in one full turn, setting switch so it cuts off at 22° F. and cuts in at 34° F. These temperatures are actual bulb temperatures. All adjusting to be done with threaded collar.

(h) Tighten clamp nut and replace switch.

Overload Trip Device—Model 100 Unit

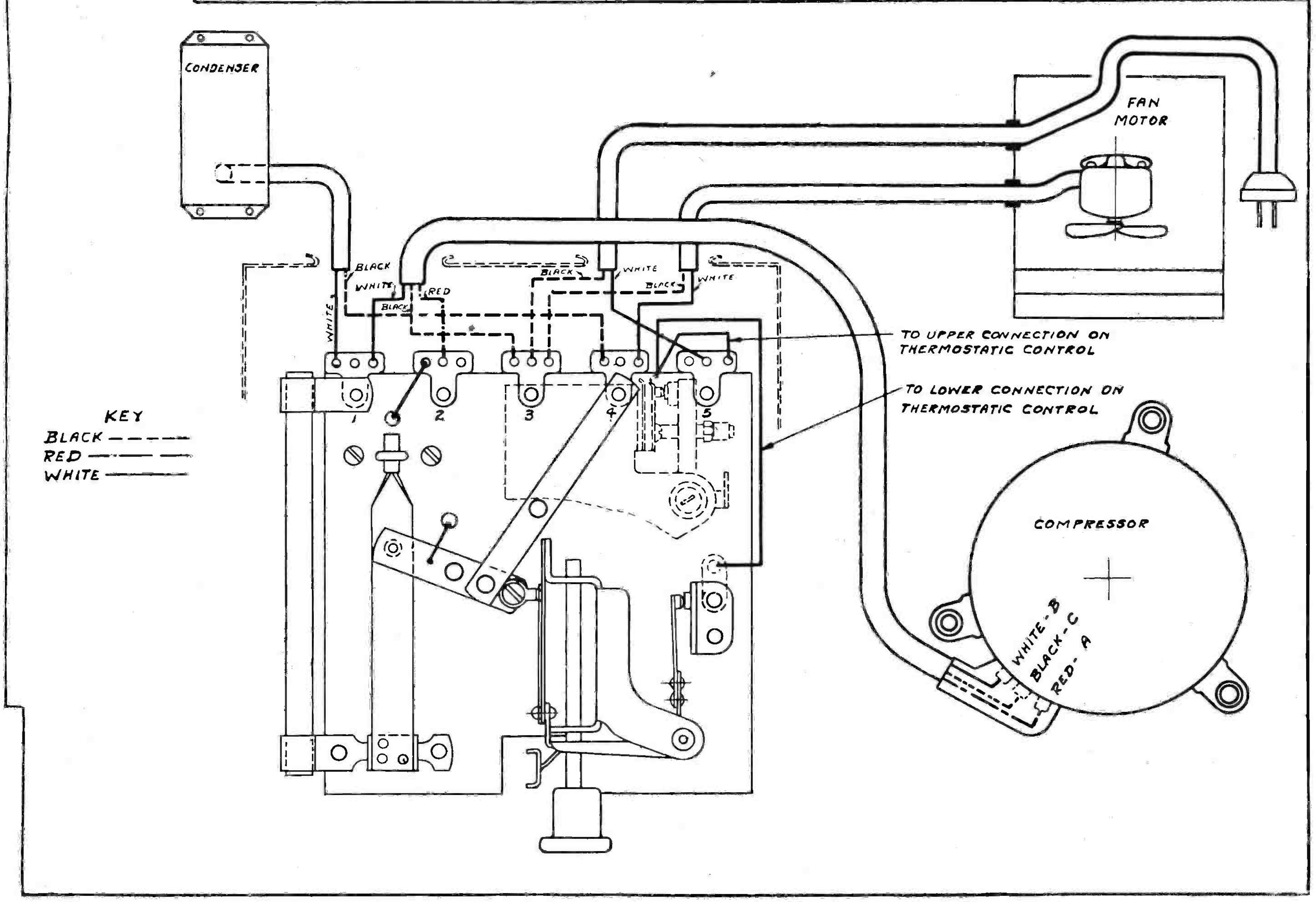
The overload trip is a thermal time limit device that automatically shuts off the current. After cutting out it waits approximately one minute and a half and then automatically turns the current on. This cycle repeats three times, whereupon the device locks itself in an off position and lights the indicator light. This light remains lighted until the device is manually reset, or the defrosting switch shut off.

Setting and Repairing Overload Trip

Should the unit kick out at 4½ amperes within 12 minutes, it will be necessary to increase the pressure with which the bi-metal strip bears on the stop. This may be done by bending the bracket. Never bend the bi-metal strip. Be very careful not to bend the bracket too much, because the unit may not then cut out at seven amperes. Should the heater be burned out, it will be necessary to replace the entire heater bi-metal assembly, which can be done by removing the 2 screws that hold it in place.

PART NAME

WIRING DIAGRAM MODEL 102 REFRIGERATOR UNIT 50-60 CY. 115 VOLTS



The overload trip should always be tested after adjusting or replacing the bi-metal strip. The movable contact should be checked for contact with the stationary contact, and if they are badly burned the entire panel should be returned to the distributor for replacement.

Setting and Repairing Relay

In order to eliminate electrical contacts within the sealed dome, an external motor starting relay is provided to shift the motor contact from starting to running.

The relay contact arm or armature may be adjusted by bending the bracket. With the armature in the down position, the contact should clear the upper contact by at least one thirty-second of an inch and with the solenoid or weight up against the spool, there should be the same clearance between the armature and the inside top of the ring. These may be adjusted by bending the contact brackets or the armature slightly.

Uncrating and Preparing Cabinet for Delivery

A great deal of care should be taken when cabinets are removed from the crate. Under no circumstances should a pinch bar be used, as you are liable to mar the finish. The only part to remove is the front panel of the crate. After this is off, the cabinet can be pulled out of the crate. After the cabinet has been uncrated, it should be placed in a level position.

(a) The cabinet cover should next be removed and carefully laid aside so it will not be scratched or marred.

(b) The interior of the cabinet should next be inspected to see that the sponge rubber gasket is evenly compressed in the proper position.

(c) The nine unit mounting screws should next be inspected to see that they are all tightened. These screws are used to hold the unit in proper position and to compress the sponge rubber gasket. It is important that this gasket be evenly compressed to prevent air leakage.

(d) The three hold down insert cups with lock nuts, located above the suspension springs, are used to hold the compressor dome from vibrating during shipment. These should be removed so that the compressor will float freely on the suspension springs. If the compressor touches the mounting plate, adjustment of the springs should be made. In order to do this the three cotter keys and nuts should be removed. Next the compressor should be carefully lifted off and the cone shape coil spring slightly elongated. Replace the three cone shape spring spacers and small recoil springs with lock nuts and cotter keys.

(e) The four fan housing cover screws must be removed and the cover taken off. This will allow access to the fan oil reservoir. Remove the reservoir cover and pour contents of oil container which you will find tied to the control housing, into the reservoir. See that the oil reservoir cover is properly replaced and fan housing cover replaced and tightened securely.

(f) See that the temperature control is properly centered and that it sets at position one.

(g) Ice cube trays and food shelves should never be placed in cabinet until installed in customer's home.

(h) The unit is now ready to start and put on test for two hours, in your "Service Station." All necessary checks, such as vibration, etcetera, should be made during this test. The unit should be delivered cold, to the customer.

Delivery

(a) In delivering the refrigerator to the customer, a padded cover should be placed over it to prevent scratching.

(b) The cabinet should never be placed outdoors on a porch or other locations where it will be exposed to the elements.

(c) The cabinet should be leveled up by placing a small level in the ice cube tray compartment.

(d) The back of the cabinet should never be placed directly against the wall as it will cause vibration. Also, all legs must touch the floor.

(e) The cabinet, both interior and exterior, should be cleaned before foods are placed in it.

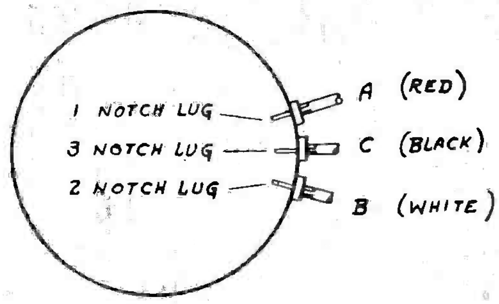
(f) The customer should now be instructed how to defrost the unit, how to empty the defrosting pan, how to fill and remove the ice cube trays, how often the fan motor should be oiled and the method of cleaning the cabinet and hardware. The Dealer's service man should endeavor to call the following day to see if his instructions are thoroughly understood and the unit is operating properly.

Cleaning Refrigerator and Food Compartments

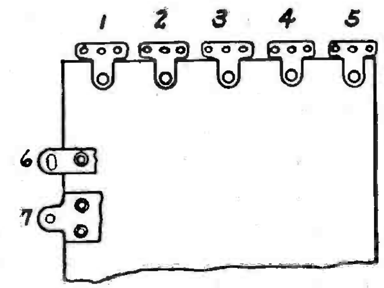
It is recommended that the food compartment be thoroughly cleaned once a month.

In cleaning this compartment, it is advisable to use lukewarm water in which either borax or baking soda has been dissolved, and wipe dry at once. Do not use hot water.

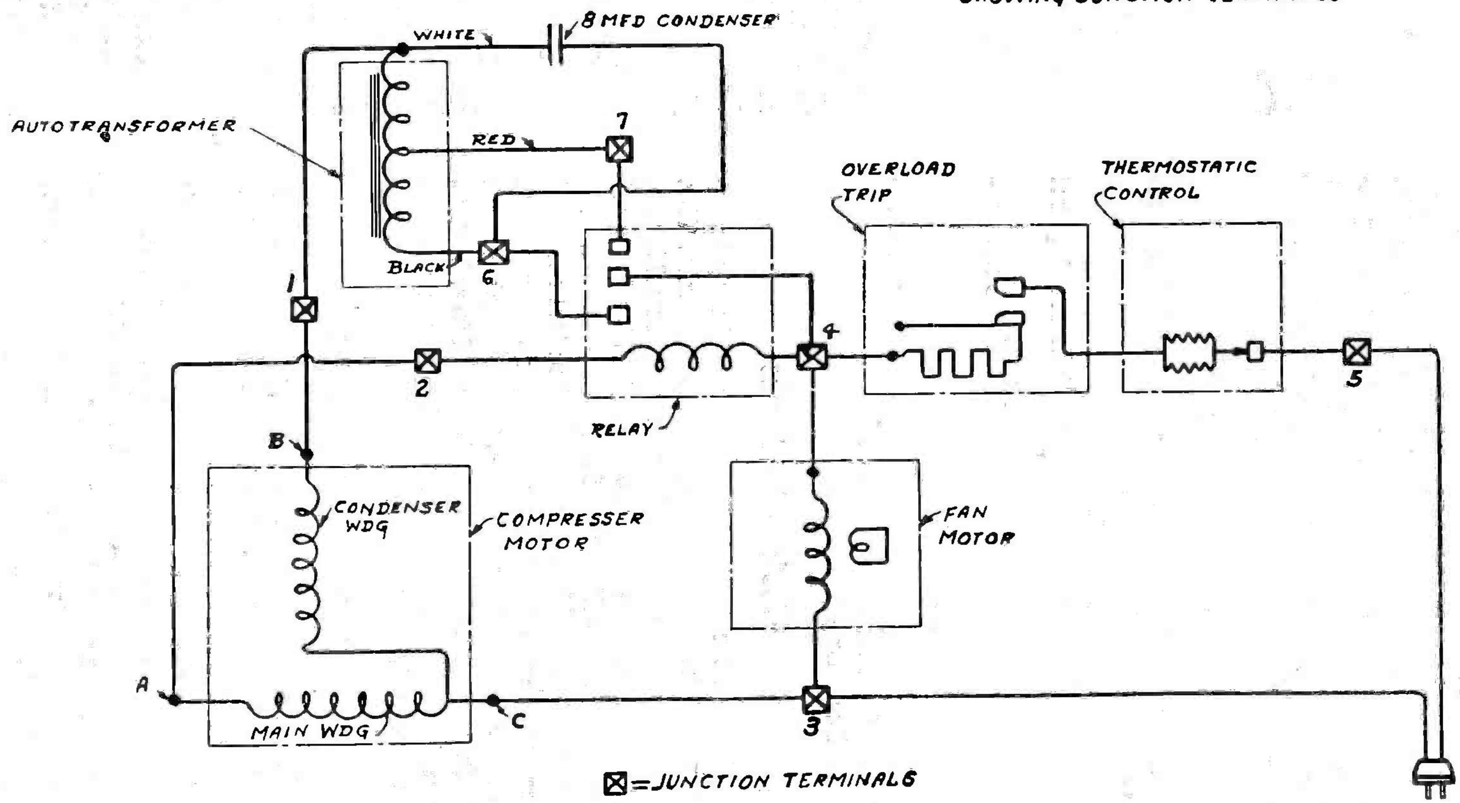
SCHEMATIC DIAGRAM OF ELECTRICAL CIRCUIT OF MODEL 101 & 103 REFRIGERATING UNIT (CONDENSER TYPE) 50-60 CY 115 VOLTS



PLAN VIEW OF COMPRESSER
SHOWING TERMINALS



PLAN VIEW OF PANEL
SHOWING JUNCTION TERMINALS



Cleaning Exterior of Refrigerator

To remove dust and any ordinary stain use a damp cloth. In case of a more permanent stain or grease, use pure soap and lukewarm water, or Majestic Cabinet Cleaner. This is an especially prepared cleaner, and is obtainable from your distributor in either pint or gallon bottles. Scouring soap or lye solutions should never be used.

Cabinet Repairs

1. Placing Hardware on the door, including temperature control escutcheon.
2. Replacing inside liner.
3. Replacing evaporator porcelain front panel and door.
4. Evaporator trays and shelves. Ice Cube Separators.
5. Replacing food shelves.
6. Lacquering outside cabinet or any other repairs which might be needed.
7. Repairing porcelain.

Testing for Leaks

If a leak occurs in a Majestic unit, it may be detected by using a solution of 28% ammonia. This can be purchased in any drug store. A small brush, or cotton swab, with a few drops on it, when held near the leak, will form a dense white smoke. This smoke is formed because of the chemical action of ammonia and SO_2. This method of detecting leaks is known as the "smoke test." Leaks that are not ordinarily noted by smell can be found in this manner. If in doubt about any leak, always use the "smoke test."

Unit Leaks SO_2 or Oil

In case of a leak in the system, remove the unit from the customer's home and determine the position of the leak with ammonia, as stated above.

No attempt should be made to repair the leak with soldering iron or gas torch. Before the unit is sent back to your distributor, the leak must be stopped. In most cases the leak can be stopped by peining with a small flat punch and light hammer, or by pinching the line.

If it cannot be stopped in the above manner, it will be necessary to discharge the unit. This may be accomplished by removing the cap from the purge valve with a soldering iron. (Caution—**Never use a Torch.**) After cap has been removed, loosen small screw to allow gas to escape.

The unit may then be purged by discharging the gas through a rubber hose into a caustic soda or lye solution. About three to four gallons will be required, using one pound of lye for each gallon of water.

Diagnosis of Trouble

In order to help you diagnose internal trouble, we list below several paragraphs pertaining to certain conditions which you may encounter.

Leaking Check Valve

When the idle (off) period is shorter than normal, the unit should be checked for leaking check valve. Open the cabinet door for several minutes after the unit has stopped and feel the suction line below the check valve. If the suction line at this point is warm it will be an indication that the check valve is not seating properly. This allows hot oil and gas to leak back to the evaporator from the pump. This leak is probably due to a deposit of foreign matter on the check valve seat. This foreign matter may be dislodged by striking the check valve housing several sharp blows or may be removed by flushing with surge of liquid SO_2 and oil from the evaporator. This surge may be accomplished by tipping the cabinet forward to an angle of about 30° several times. The surges of liquid may be noted by the difference in the sound of the compressor.

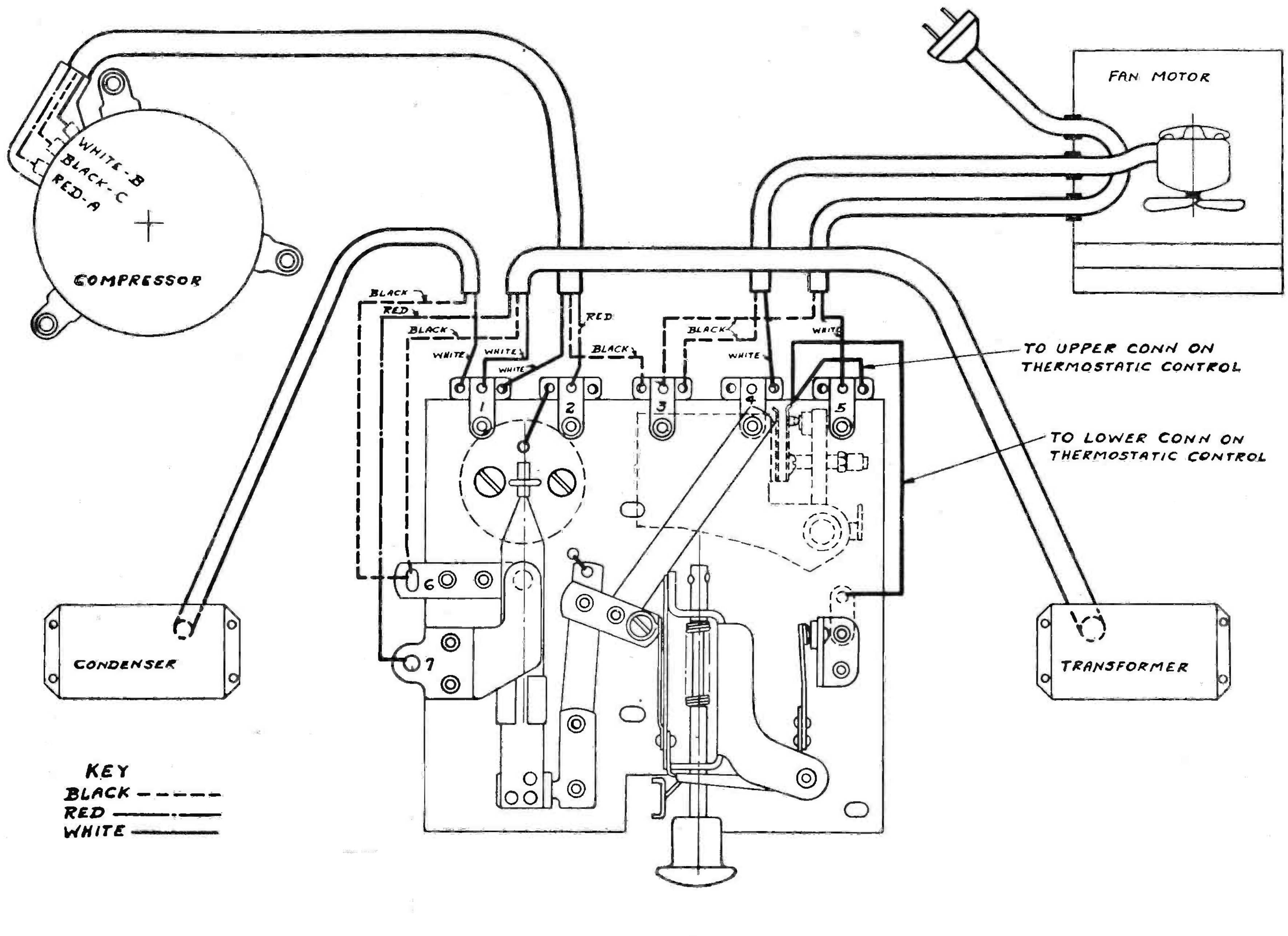
No Refrigeration Tapping Check Valve

The condition of no refrigeration with a tapping check valve during operation is usually caused by shipping or storing refrigerators under temperatures sufficiently low enough and of long enough duration to condense the sulphur dioxide in the compressor dome.

The presence of sulphur dioxide liquid in the dome will raise the oil level, and in those cases where sufficient condensation has taken place to raise the oil level above the seal intake, the compressor will run without an oil seal and no compression will result. A low wattage consumption will accompany this condition as no work is being accomplished in the compression of the refrigerant. When this condition exists, the liquid sulphur dioxide enters the chambers of the oil pump and is circulated through the oil cooling coil in the place of the lubricating oil.

Operation of the unit in a warm room will not remedy this condition as there is not sufficient heat generated in the dome with no load on the compressor to cause vaporization of the liquid sulphur dioxide.

PART NAME WIRING DIAGRAM - MODEL 101 REFRIGERATOR UNIT (CONDENSER TYPE) 50-60 CY. 115 VOLTS



To remedy the above condition, heat the oil line to vaporize the liquid sulphur dioxide circulating through the oil cooling coil and at the same time keep the float valve open with a magnet to allow the expanded vapor to go into the evaporator. The oil line should be heated until sufficient liquid sulphur dioxide is vaporized to lower the level of the oil in the dome so that an oil seal is supplied to the compressor. This will be indicated by the wattage consumption increasing to normal.

Stuck Shut Check Valve or Restricted Suction Line

In the event that either of the above conditions existed the unit would run continuously with little or no refrigeration. If the check valve is stuck shut, it may be dislodged by striking the check valve housing several sharp blows. If the blows have dislodged the check valve, it should be flushed out by tipping the cabinet forward. If this has no effect on the operation of the unit, check the suction line for a restriction which may be indicated by a sweating line at the point of restriction. This condition will only be found where the line is partially closed.

Leaky Float Valve

In the event that the unit operates with a longer than normal running period, or continuous operation, and has little or no refrigeration, the unit should be checked for a leaky float valve which will be indicated by a sweating or frosted check valve or suction line. This also may be an indication of an overcharge of SO_2.

The leaking float valve may be caused by a small piece of foreign matter lodging on the valve seat or by a defective needle or seat. The foreign matter can be removed by repeated operation of the float valve by means of an electro magnet. If this operation of the float valve does not remedy the fault the float valve should be changed. This change of valves should not be attempted by the dealer.

Stuck Shut Float Valve

In the event that a unit cuts out on the overload trip after operating normally for a considerable length of time, the unit should be checked for stuck shut float valve. This condition may be also determined by the use of the electric magnet. If the float valve is stuck shut, the float chamber and a portion of the SO_2, condenser will be filled with liquid SO_2. When the float is raised by the magnet under these conditions, the valve will remain open until the liquid level drops. The sound of liquid SO_2 rushing to the evaporator may be easily heard.

Restriction in Liquid Line

If the unit has cut out due to the overload trip, and the magnet has been applied to the float valve without result, the service man should determine whether the float is actually being raised by the magnet. If a loud click is not heard when the power is turned on the magnet, the float may either be stuck tightly shut so it cannot be moved, or it may be floating at the top of the float chamber. This would indicate the chamber is full of liquid SO_2. Several sharp blows will usually dislodge the float valve if it is stuck shut. If no liquid is heard entering the evaporator, the cause may be a restricted ⅛" liquid line leading to the evaporator.

Air in System

The electro magnet may also be used to check for air or non-condensable gases in the system. If when the magnet circuit is closed the float valve lifts freely against the top of the float housing and drops back again when the power is shut off, but, there is a rush of liquid to the evaporator only when the float is raised and none when the float is lowered, the system may have air in it. The unit should be checked for other causes which might make it kick out on the overload trip while running such as: short in electrical system, high wattage due to stuck or sluggish pump, stuck fan or improper air circulation around the cabinet. If there is air in the system, the pressure will raise rapidly after the float is again reseated and the overload trip will open as before—Units which have restricted lines, or air, or non-condensable gas in the system, must be returned to your Distributor for repair.

Food Compartment Temperature Too Cold

A. Check running time to determine whether thermostat or temperature control is properly adjusted.

B. Check thermostat bulb for proper position.

Box Temperature Not Cold Enough

In the event that the food compartment is not cold enough, the following features should be checked in the order given:

A. Check frost coating on evaporator. If the frost is allowed to accumulate, the efficiency of the evaporator will be greatly reduced. Caution customer to defrost regularly, when frost is ¼ to ½" thick.

B. Check the percentage of running time. The thermostat may be set too warm, or the gas may have leaked out of the thermostat bulb. (See paragraph covering thermostat adjustment.)

C. Check position of thermostat bulb and bracket.

D. Check for leaking float valve.

E. Check for loss of refrigerant charge. This may be detected by noting the frost level on the evaporator.

F. Check for stuck shut check valve or restricted suction line as explained previously.

G. Check door gaskets for leakage, with sheet of thin paper.

Unit Runs Too Much

A. Check thermostat or temperature control for proper setting.

B. Refer to paragraph entitled food compartment temperature not cold enough.

Compressor Will Not Start

A. Check Line voltage.

B. Check wiring diagram for shorts or open circuits.

C. Check overload trip for proper adjustment.

D. Stuck pump (send unit to Distributor).

Unit Noisy

A. Check suspension of compressor for broken springs or riding on stud of bracket.

B. Check tubing for vibration and contact with other tubes or parts of unit.

C. Check fan for loose bearings, etc.

Caution—Model 100 Unit

If unit is shut off, either by removing plug from wall, or by turning switch to "Defrost" position, it is necessary to wait about 5 minutes before turning it on again. If an attempt is made to start the unit sooner than this, the overload trip will cut out, because the unit has not had a chance to unload. Owners should be cautioned about this, for their failure to know about it may mean an unnecessary service call.

Methods of Testing Overload Trip Device, Starting Relay, Condenser Bank, Phase-Shifting Transformer, Continuity, Etc.

A Special Test Instrument has been designed to enable you to accurately test these circuits. This instrument is obtainable from your Distributor. For those dealers who are already equipped with this test panel, we print below complete instructions of operation, together with a diagram of the control panel.

Test on the Overload Trip Device

Place test clips on the two bottom lugs marked (A) and (B). Throw switch marked 4 to the "on position." Allow 15 minutes to elapse (check by watch) and if the overload trip has not kicked off, this particular test is completed. Next, throw switch marked 4 to "off position" and throw switch marked 7 to "on position." The trip should now kick over in from 45 seconds to three minutes. Check also, the amount of time necessary for the tin metal strip to cool off and return to its original position. This time should be approximately one and one-half minutes.

Test for Pilot Light Contacts

With the test clips on lugs (A) and (B) throw switch marked 13 to "on position." The overload trip will now go thru a complete cycle, and will lock itself in an "off position," whereupon the pilot light should glow when unit is plugged into receptacle. **CAUTION**—When testing pilot light, be certain that test panel is disconnected from A. C. line when you plug in refrigerator. Serious damage can result to device if it is allowed to remain connected to A. C. current supply.

Procedure for Checking Control Unit Model 102

Referring to photographic sketch the following checks are to be made for correctness of operation of the Model 102 Control Unit:

1. Overload Trip.
2. Relay.
3. Condenser and Resistor.

To Check the Overload Trip

1. Place test clips on contacts A and B.
2. With a current of 4½ amperes flowing through the heater the cut off time should be approximately 12 minutes.
3. With a current of 7 amperes the cut off time will be between 30 seconds and 1½ minutes.
4. Deviations from the above operating characteristics may be corrected by properly bending the bi-metal strip into place.

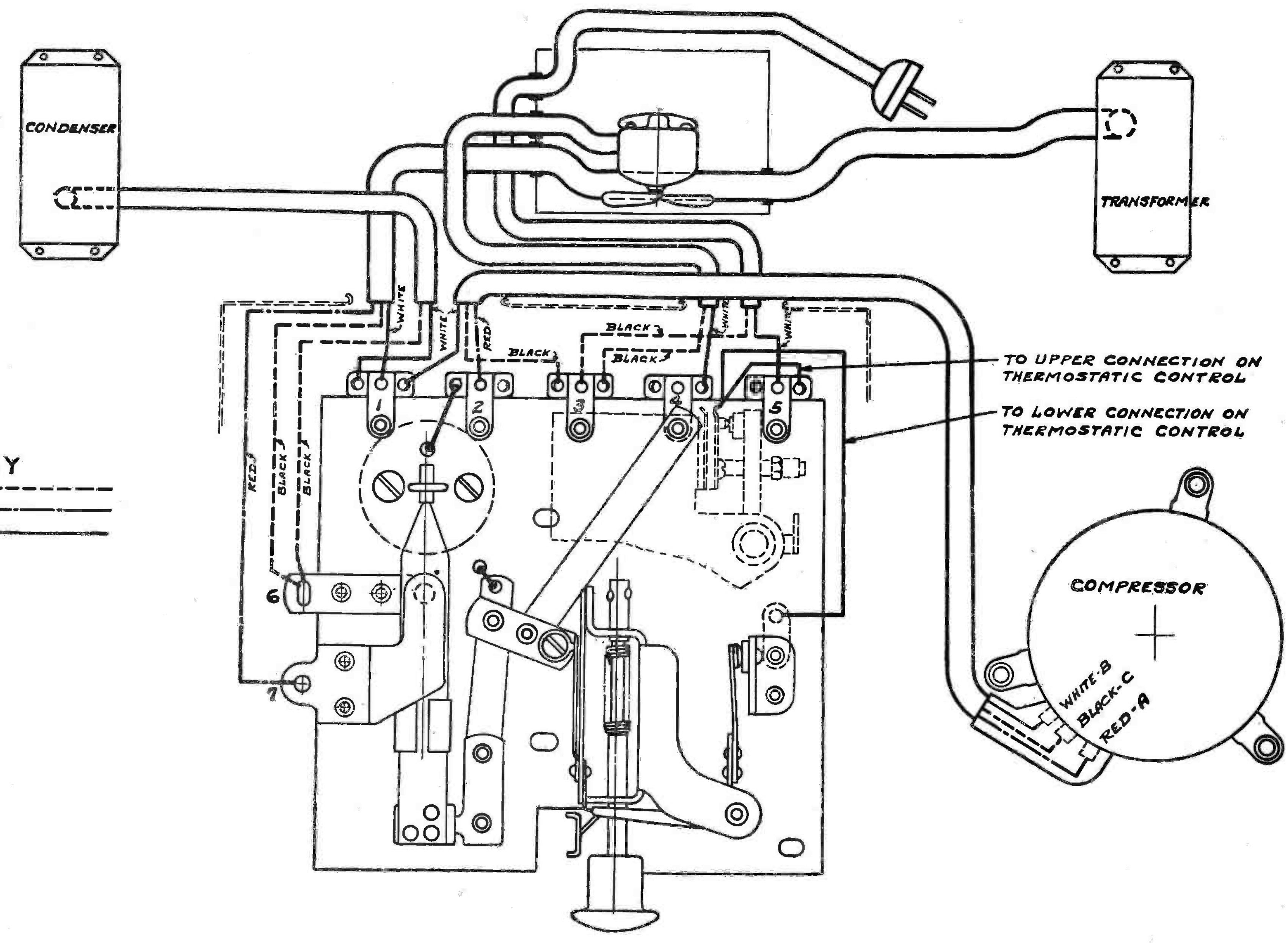
Model 102 Resistance Start

To Check the Starting Relay

1. Place test clips on contacts B and D.
2. With a current of between 6.1 and 6.8 amperes flowing through the relay coil the contact will make.

PART NAME

WIRING DIAGRAM - MODEL 103 REFRIGERATOR UNIT (CONDENSER TYPE) 50-60 CY. 115V.



KEY
BLACK - - - - - -
RED ——————
WHITE ——————

Model 102 and 103 Condenser Start

1. Place test clips on contacts B and D.
2. At 6 amperes or less lower contact should be made.
3. At 8½ amperes or more lower contact should be broken and upper contact made.

Test on Relay

Connect test clips to 5 hole lug (C) and lug (D). Throw switches 4.5 and 7.5 to "on position." Now, test continuity between lugs (F) and (E) with continuity leads. Next throw switch marked 7.5 to "off position," and leave switch marked 4.5 on "on position." Now, contact between lugs (F) and (G) with continuity leads. Continuity should be obtained on both of these tests.

Test on Condenser Bank

Disconnect either set of two wires from one lug on terminal strip in condenser bank. Now, place continuity leads on both wires of one block. Throw switch directly below pilot light on panel, to "on position." If pilot light does not light, condenser block is open. If light is at full brilliancy, condenser block is shorted. If light glows at about half brilliancy, condenser block is O. K. After one block is tested, repeat test on other block.

Test on Phase-Shifting Transformer

The phase-shifting transformer is an auto-transformer and has three leads from it. Throw switch directly below panel light to "on position." Make contact with any two of the transformer leads. The pilot light on the panel should light when contact is made, but should not light when contact is made with any one of the wires and the control housing on transformer can.

Motor Continuity Test

The same test is employed on the three leads coming from the motor, as on the transformer.

Caution

The refrigerator unit must be disconnected from the wall receptacle before the test panel is connected. Operator may receive serious burns if this is not done.