RADIO - TELEVISION

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LESSON NO. 21

Common Receiver Troubles

Even though the modern radio receiver has been carefully built and has delivered excellent service during the early part of its life, yet troubles are bound to set in after it has remained in active service for some time. This is especially true when the receiver has been abused by some carless owner and has been forced to operate under conditions which offer sufficient strain to break down the best of receivers.

Besides only the older sets developing troubles, it is of course also true that a comparatively new or even a brand new receiver may refuse to operate properly. So taking all these possibilities of trouble together, you can see that the Radio Service Man is indeed a BUSY man, for there are not only thousands of receivers in operation throughout the world but MILLIONS. However, to do his work efficiently, he must KNOW Radio. By having the radio background, which you built up during the preceding lessons, you are familiar with how the different parts of the receiver SHOULD work and therefore when confronted by some defective receiver, you will be in a position to think and act intelligently.

Naturally, a good analyzer will enable one to locate receiver troubles quickly and with a minimum of effort but all of the fellows who are just starting out don't have such a valuable testing outfit. Therefore, to meet the requirements of all, we have made a special effort in the preparation of this lesson to offer you many practical suggestions whereby you can locate the most common receiver troubles with the least possible equipment. This means that we will in this case depend mostly upon audible symptoms and visual inspection to trace the defects.

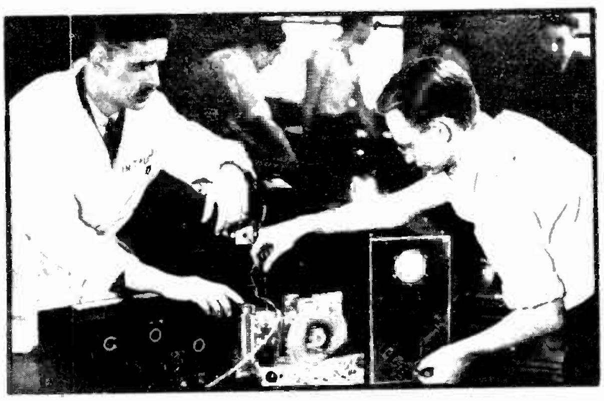

Fig. 1
National Student Receiving Instruction In Using An Oscilloscope.

In later lessons, of course,

YOU WILL BE MADE FAMILIAR WITH MORE EFFICIENT METHODS FOR LOCATING TROUBLES BY USING LABORATORY INSTRUMENTS.

LET US SUPPOSE THAT A CERTAIN SET OWNER HAS ASKED YOU TO COME TO HIS HOME TO SEE WHAT IS WRONG WITH HIS RECEIVER. THE FOLLOWING SUGGESTION'S OUTLINE THE STEPS YOU WOULD TAKE TO DETERMINE THE TROUBLE.

A DEAD RECEIVER

FIRST, LET US ASSUME THAT WHEN WE TURN ON THE SET BY CLOSING THE SWITCH, WE HEAR NO SOUND WHATEVER FROM THE SPEAKER. THAT IS, WE DON'T HEAR ANY MUSIC, SPEECH, NOR EVEN THAT FAMILIAR RUSHING SOUND, WHICH INDICATES THAT A RECEIVER IS AT LEAST ALIVE, ALTHOUGH NO SIGNALS ARE HEARD. SO IF THE RUSHING SOUND IS NOT HEARD WHEN THE SWITCH IS TURNED ON AND NEITHER A "CLICK" WHEN THE SWITCH IS TURNED OFF, THEN THE RECEIVER IS COMPLETELY DEAD.

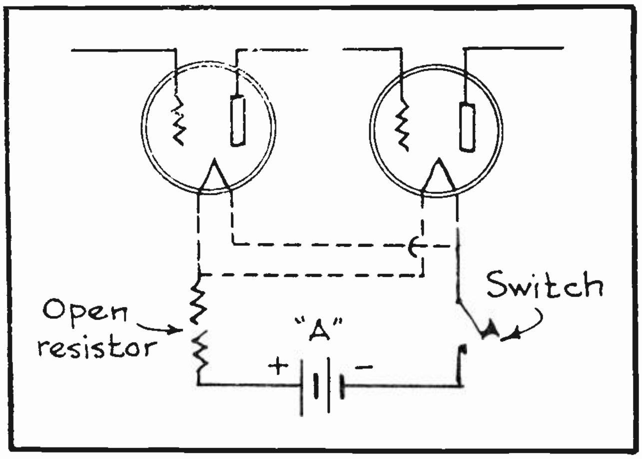

FIG. 2
Effect of Open Filament Circuit.

CHECKING THE TUBES

IF THE ABOVE TEST SHOWS THE RECEIVER TO BE DEAD, THE FIRST THING TO DO IS TO LOOK AT THE TUBES AND SEE IF THEY ARE "LIGHTED." IN CASE THAT ALL THE TUBES BUT ONE OR TWO ARE BURNING, THEN REMOVE THOSE WHICH AREN'T AND REPLACE THEM WITH TUBES WHICH YOU KNOW ARE GOOD. TO DO THIS, YOU CAN USE AN EXTRA GOOD TUBE WHICH YOU HAVE ON HAND OR ELSE YOU CAN REMOVE THE DEAD TUBE AND ALSO ANOTHER TUBE OF THE SAME TYPE WHICH IS BURNING AND INTERCHANGE THESE TWO. THEN IF THE GOOD TUBE BURNS IN THE SOCKET IN WHICH YOU FOUND THE DEAD TUBE, WHILE THE DEAD TUBE DOES NOT BURN IN THE SOCKET FROM WHICH THE GOOD TUBE WAS REMOVED, YOU WILL KNOW THAT THE FILAMENT OF THE DEAD TUBE IS BURNED OUT AND THEREFORE THIS TUBE WILL HAVE TO BE REPLACED WITH A NEW ONE.

HOWEVER, IF BOTH TUBES BURN WHEN INTERCHANGED, THEN THE TROUBLE WAS DUE TO A FAULTY CONNECTION BETWEEN THE PRONGS AND SOCKET CONNECTIONS OF THE TUBE WHICH WAS FIRST FOUND DEAD. SO ALWAYS BE SURE THAT THESE CONNECTIONS ARE MADE PROPERLY BEFORE COMING TO HASTY CONCLUSIONS.

CHECKING THE FILAMENT CIRCUITS

IN CASE THAT A TUBE, WHICH IS KNOWN TO BE GOOD, IS PLACED IN THE SOCKET WHERE THE DEAD TUBE WAS FOUND AND THIS GOOD TUBE DOESN'T LIGHT EITHER, THEN CHECK THE WIRES OF THE FILAMENT CIRCUIT, WHICH ARE CONNECTED TO THE FILAMENT TERMINALS OF THE SOCKET, FOR AN OPEN OR SHORT CIRCUIT.

TO ILLUSTRATE THIS POINT, WE SHALL USE FIG. 2. HERE WE HAVE THE FILAMENT CIRCUIT OF TWO BATTERY TYPE TUBES CONNECTED IN PARALLEL. BY AN "OPEN" WE MEAN THAT THE CIRCUIT IS INTERRUPTED DUE TO A BREAK SOMEWHERES IN THE CIRCUIT SO THAT THE CURRENT CANNOT FLOW OVER ITS INTENDED PATH.

This may mean that the circuit wire itself may be broken, a connection becoming unsoldered, a resistor or other component of the circuit being burned out etc.

In Fig. 2, for instance the filament circuit is open due to the fixed resistor being burned out and this condition will prevent current from flowing through all of the tube filaments. In fact, by studying this circuit carefully, you will note that an open in that part of the circuit which is drawn with solid lines will cause the failure of ALL tube filaments to function, whereas an open at any point of the circuit ed indicated with dotted lines in Fig. 2 will only put the filament of a single tube out of commission—the other can still continue its normal operation.

From this explanation you can readily see that if only one tube filament fails to function even though the tube is known to be in perfect condition, then it is only necessary to check the particular branch of the filament circuit which conveys the current from the main filament circuit wires to the tube in question. Start at the tube socket and work toward the main or feeder wires of the circuit. (Be sure that the socket clips make good contact with the filament prongs of the tube.)

A "short circuit" is illustrated for you in Fig. 3. In this case the insulation has been chafed off the filament circuit wires so that the bare conductors contact eachother. Under such conditions, the resistance through the point of shorting will be less than that thru the remainder of the normal circuit. Consequently, current will circulate from the source of E.M.F. through the point of shorting without ever reaching the filaments of the tubes.

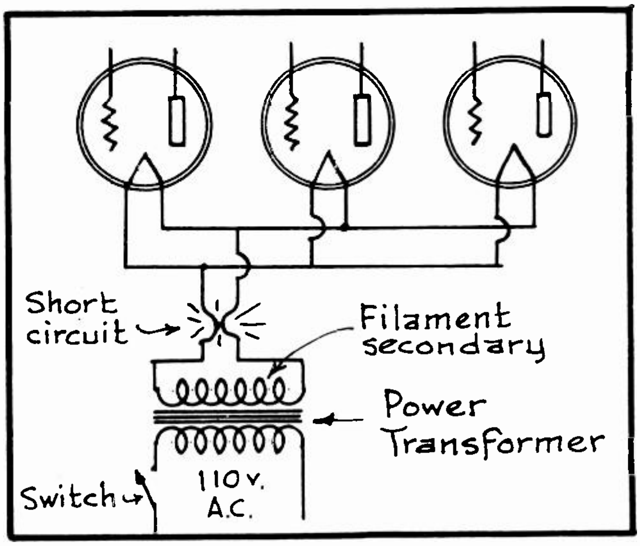

FIG. 3
Effect of a "Short" in Filament Circuit

It is important to note that the current flow through that portion of the circuit included between the source of E.M.F. and the point of shorting will be much greater than normal and will therefore cause this portion of the circuit to become hot.

Although Fig. 3 happens to correspond to an A.C. receiver circuit, yet the short in the filament circuit of a battery operated receiver would affect the receiver in the same way.

If in a battery operated receiver none of the tube filaments burn or only burn dimly, then there is also a possibility of the "A" battery being discharged or its terminals corroded.

A grounded filament circuit will in some cases cause a failure of current to reach the tube filaments in either A.C. or battery operated receivers. This depends upon the particular circuit design. For example,

IN FIG. 4 YOU ARE SHOWN A DIAGRAM IN WHICH ONE SIDE OF THE FILAMENT CIRCUIT IS NORMALLY GROUNDED. NOW IF THE INSULATION SHOULD BE WORN OFF THE CIRCUIT WIRING SO THAT THE BARE CONDUCTOR TOUCHES THE METAL RECEIVER CHASSIS AT SOME SUCH POINT AS INDICATED IN FIG. 4, THEN THE FILAMENT CIRCUIT WOULD BE ACCIDENTALLY GROUNDED WITH THE RESULT THAT THE "A" BATTERY WOULD SOON DISCHARGE ITSELF WITHOUT EVEN FLOWING THROUGH THE TUBE FILAMENTS. THE REASON FOR THIS, OF COURSE, IS THAT THE RESISTANCE OF THE TUBE FILAMENTS IS MUCH GREATER THAN THE RESISTANCE FROM THE ACCIDENTAL GROUND BACK TO THE "A" SUPPLY BY WAY OF THE METALLIC CHASSIS —ELECTRIC CURRENT HAS A NATURAL TENDENCY TO FOLLOW THE PATH OF LEAST RESISTANCE.

SHOULD YOU FAIL TO FIND A DEFECT IN THE FILAMENT CIRCUIT WIRING OF AN A.C. RECEIVER IN WHICH ALL OF THE TUBE FILAMENTS OF ANY ONE FILAMENT CIRCUIT DO NOT "LIGHT", THEN LOOK FOR AN OPEN LOW VOLTAGE SECONDARY WINDING AT THE POWER TRANSFORMER. IF ALL TUBE FILAMENTS ARE INOPERATIVE, IT IS ALSO POSSIBLE THAT THE PRIMARY WINDING OF THE POWER TRANSFORMER OR FUSE IN THIS CIRCUIT IS OPEN (BURNED OUT) OR ELSE THERE MAY BE AN OPEN LEAD IN THE RECEIVER'S A.C. PLUG CORD OR EVEN A POOR CONNECTION BETWEEN THE CORD'S PLUG AND THE OUTLET OF THE HOUSELIGHTING CIRCUIT.

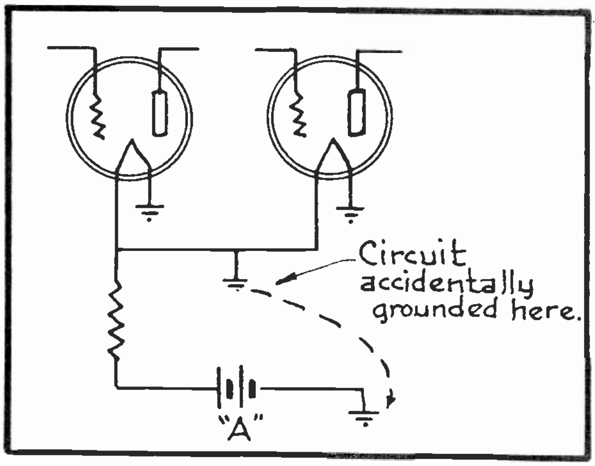

FIG. 4
A Grounded Filament Circuit.

TUBES LIGHT BUT RECEIVER IS DEAD

IN RESPECT TO THE LIGHT EMITTED BY THE FILAMENT OF VACUUM TUBES, ALWAYS REMEMBER THAT THE FILAMENTS OF SOME TUBES ONLY PRODUCE A DULL RED GLOW EVEN WITH EVERYTHING IN PERFECT WORKING ORDER.

IF YOU SHOULD FIND ALL OF THE TUBE FILAMENTS TO LIGHT BUT NOT HEAR ANY SOUNDS FROM THE SPEAKER—THAT IS, NOT EVEN THE A.C. HUM, ANY RUSHING SOUND NOR CLICKING SOUND UPON ACTUATING THE SWITCH, THEN LOOK FOR TROUBLE IN THE PLATE CIRCUIT OF THE LAST AUDIO AMPLIFYING OR POWER TUBE, IN THE SPEAKER COUPLING UNIT AND IN THE SPEAKER ITSELF. IN A.C. RECEIVERS, ALSO LOOK FOR A DEFECTIVE "B" POWER UNIT AND IN BATTERY OPERATED RECEIVERS FOR DISCHARGED "B" BATTERIES.

QUITE OFTEN, THE PRIMARY WINDING OF THE OUTPUT TRANSFORMER OR SPEAKER FIELD COIL IS FOUND TO BE BURNED OUT WHEN THE RECEIVER ACTS IN THIS WAY. TO DETERMINE DEFINITELY IF SUCH IS THE CASE, YOU CAN DISCONNECT THE SUSPECTED WINDING FROM THE RECEIVER CIRCUIT AND THEN TEST IT FOR CONTINUITY AS ILLUSTRATED IN FIG. 5.

IN FIG. 5, FOR EXAMPLE, YOU ARE SHOWN HOW THE PRIMARY WINDING OF THE OUTPUT TRANSFORMER MAY BE TESTED FOR CONTINUITY BY MEANS OF A LOW RANGE D.C. VOLTMETER CONNECTED IN SERIES WITH A 4½ VOLT "C" BATTERY. IF THE TWO TEST POINTS ARE TOUCHED TOGETHER, THE VOLTMETER WILL INDICATE THE BATTERY VOLTAGE OR 4½ VOLTS. THEN IF THE TEST POINTS SHOULD BE TOUCHED TO THE TWO TERMINALS OF THE WINDING BEING TESTED, AS ILLUSTRATED IN FIG. 5, THE VOLTMETER WILL INDICATE VERY NEARLY THE FULL BATTERY VOLTAGE, PROVIDED THAT THE WINDING UNDER TEST IS IN PERFECT CONDITION. ON THE OTHER

HAND, IF THE WINDING IS BURNED OUT OR OPEN CIRCUITED, THE VOLTMETER NEEDLE WILL REMAIN AT ITS ZERO POSITION AS THE TEST THROUGH THE WINDING IS MADE.

THIS TEST CAN BE APPLIED IN THE SAME MANNER TO ANY ORDINARY WINDING USED IN RADIO RECEIVERS. RESISTORS CAN ALSO BE TESTED FOR CONTINUITY BY THIS METHOD BUT WHEN DOING SO, ONE MUST TAKE INTO CONSIDERATION THE FACT THAT THE NORMAL VOLTMETER READING OBTAINED DURING THE TEST WILL BECOME LESS AS THE RESISTANCE VALUE OF THE RESISTOR IN QUESTION BECOMES GREATER. CONSEQUENTLY, THIS TEST IS NOT PRACTICAL FOR TESTING RESISTORS OF VERY HIGH OHMIC VALUE.

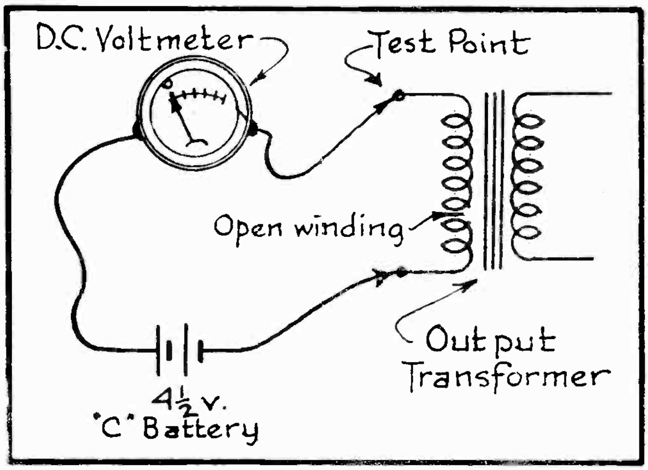

FIG. 5

Testing for an Open Transformer Winding.

AS TO THE MOST POSSIBLE CAUSES FOR A "B" POWER UNIT "KILLING" THE RECEIVER COMPLETELY, YOU CAN SUSPECT THE FILTER CONDENSERS FIRST AND THEN THE FILTER CHOKE COILS. BROKEN DOWN OR SHORT CIRCUITED FILTER CONDENSERS ARE A RATHER FREQUENT OCCURRENCE AND IN MOST CASES THIS DEFECT WILL CAUSE THE PLATES OF THE RECTIFIER TUBE TO BECOME RED HOT.

FIG. 6 SHOWS YOU HOW TO TEST THE FILTER SYSTEM, USING ONLY A LOW RANGE D.C. VOLTMETER AND A PAIR OF SERIES CONNECTED DRY CELLS OR ELSE A $4\frac{1}{2}$ VOLT "C" BATTERY. TO TEST A FILTER CONDENSER IN THIS MANNER, SIMPLY DISCONNECT ONE SIDE OF IT FROM THE CIRCUIT WITH THE RECEIVER SWITCH TURNED OFF AND CONNECT THE TEST POINTS ACROSS THE CONDENSER AS SHOWN AT THE LEFT OF FIG. 6.

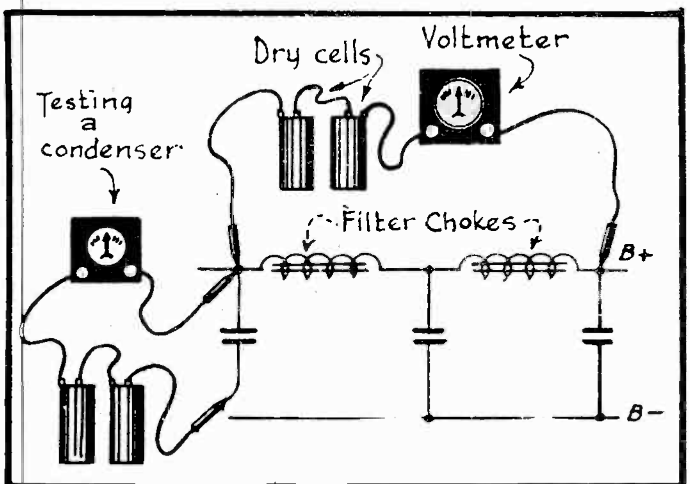

FIG. 6

Testing the Filter System.

IF THE CONDENSER IS GOOD, YOU WILL NOTICE THAT UPON FIRST MAKING CONTACT WITH THE TEST POINTS, THE VOLTMETER NEEDLE WILL DEFLECT SLIGHTLY FROM ITS ZERO POSITION AND THEN IMMEDIATELY RETURN TO ITS ZERO MARK TO REMAIN. ON THE OTHER HAND, IF THIS CONDENSER IS SHORT CIRCUITED, THEN THE VOLTMETER WILL INDICATE FULL BATTERY VOLTAGE AS THE TEST IS MADE. (BE SURE, HOWEVER, THAT THE CONDENSER IS DISCONNECTED FROM THE RECEIVER CIRCUITS AS YOU CONDUCT THIS TEST, FOR IF IT ISN'T, YOU MAY ACTUALLY BE TESTING THROUGH SOME OTHER BRANCH CIRCUIT WHICH MAY BE CONNECTED IN PARALLEL WITH THE CONDENSER BEING TESTED). YOU CAN APPLY THIS TEST IN THE SAME MANNER TO TEST ANY TYPE OF CONDENSER FOR A SHORT.

TO TEST THE FILTER CHOKE COILS FOR CONTINUITY, YOU CAN APPLY THIS

SAME TEST BY CONNECTING ONE TEST POINT TO THE INPUT END OF THE FIRST CHOKE AND THE OTHER TEST POINT TO THE OUTPUT END OF THE SECOND CHOKE.

IF A METER READING IS OBTAINED, THEN NEITHER OF THE CHOKE WINDINGS IS OPEN CIRCUITED BUT IF THE METER NEEDLE READS ZERO, ONE OF THE CHOKE COILS IS OPEN CIRCUITED AND THE TWO COILS WILL THEN HAVE TO BE TESTED SEPARATELY SO AS TO DETERMINE WHICH OF THE TWO IS DEFECTIVE.

IF THE "B" POWER SUPPLY IS DEAD EVEN THOUGH THE FILTER SYSTEM IS IN PERFECT CONDITION, THEN CHECK THE RECTIFIER TUBE, ITS CONNECTIONS AND THE HIGH VOLTAGE WINDING OF THE POWER TRANSFORMER. THIS TRANSFORMER WINDING CAN ALSO BE CHECKED FOR CONTINUITY WITH THE D.C. VOLTMETER AND BATTERY BY TESTING ACROSS ITS TERMINALS.

THE RECEIVER ALIVE BUT NO SIGNALS HEARD

NOW WE COME TO THE POINT WHERE NO SIGNALS ARE HEARD COMING FROM THE LOUD SPEAKER BUT THE FAMILIAR RUSHING SOUND AND NORMAL A.C. HUM, WHICH INDICATES THAT THE RECEIVER IS ALIVE, CAN BE HEARD IN THE SPEAKER. THE FIRST THING THAT WE DO IN THIS CASE IS TO CHECK UP ON THE ANTENNA AND GROUND CIRCUITS AND SEE THAT GOOD SOLID ELECTRICAL CONNECTIONS ARE MADE AT THEIR ENDS AND THAT NO OPENS OR PARTIAL OPENS EXIST ANYWHERES THROUGHOUT THEIR ENTIRE LENGTH.

TO MAKE SURE THAT THE ANTENNA IS O.K., YOU CAN DISCONNECT THE ANTENNA LEAD-IN WIRE AT THE RECEIVER AND THEN CONNECT A SCRAPED END OF A 30 FT. PIECE OF INSULATED HOOK-UP WIRE TO THE ANTENNA TERMINAL OF THE SET AND JUST LAY THIS WIRE OUT ALONG THE FLOOR AND USE IT IN THIS WAY AS A TEMPORARY ANTENNA.

IF THE SET WORKS PROPERLY WITH THIS TEMPORARY ANTENNA, THEN THERE IS TROUBLE IN SOME PART OF THE REGULAR ANTENNA. IF A LIGHTNING ARRESTER IS BEING USED IN THE ANTENNA CIRCUIT, THEN DISCONNECT IT SO THAT THE ANTENNA LEAD-IN AND THE GROUND WIRES WILL NOT HAVE ANY LIGHTNING ARRESTER BETWEEN THEM. IF THE SET THEN OPERATES PROPERLY, THE LIGHTNING ARRESTER IS SHORTED AND SHOULD BE REPLACED WITH A NEW ONE.

A PRELIMINARY CHECK OF PLATE CIRCUITS

SHOULD NO TROUBLE BE FOUND WITH THE ANTENNA AND GROUNDING CIRCUITS, THEN MAKE A ROUGH CHECK OF THE PLATE CIRCUITS IN THE FOLLOWING MANNER: WITH THE SWITCH OF THE RECEIVER TURNED ON, REMOVE THE LAST AUDIO OR POWER TUBE FROM ITS SOCKET FOR JUST AN INSTANT AND THEN REPLACE IT. A FAIRLY LOUD CLICK SHOULD BE HEARD IN THE SPEAKER AS THIS TUBE IS REMOVED. NOW REMOVE AND REPLACE ONE TUBE AT A TIME, WORKING FROM THE LAST AUDIO STAGE TOWARD THE ANTENNA STAGE AND AS EACH OF THE TUBES IS REMOVED, THIS CLICK SHOULD BE HEARD.

IF SUCH A CLICK IS PRODUCED AS EACH TUBE IS PULLED OUT OF ITS SOCKET, IT INDICATES THAT THE PLATE CIRCUIT OF THAT PARTICULAR TUBE IS ALRIGHT. SHOULD YOU, HOWEVER, BE ABLE TO WITHDRAW ONE OR MORE TUBES FROM THEIR SOCKETS WITHOUT HEARING THIS CLICK, THEN THERE IS TROUBLE IN THE PLATE CIRCUIT OF THAT PARTICULAR TUBE. NATURALLY, THE PLATE CIRCUIT WILL THEN HAVE TO BE CHECKED FROM THE TUBE BACK TO EITHER THE "B" BATTERIES OR TO THE VOLTAGE DIVIDER, DEPENDING OF COURSE WHETHER THE SET IS AN A.C. OR BATTERY OPERATED RECEIVER.

IF THE PLATE CIRCUIT OF ANY ONE TUBE OR ONLY OF SEVERAL BUT NOT ALL TUBES IS FOUND TO BE DEFECTIVE, THEN IT IS VERY LIKELY THAT A BY-PASS CONDENSER WHICH IS CONNECTED BETWEEN THIS PLATE CIRCUIT AND THE B- SIDE OF THE CIRCUIT HAS BECOME SHORTED. TO ILLUSTRATE THIS, LET US LOOK AT FIG. 7 WHERE A BY-PASS CONDENSER IS CONNECTED BETWEEN THE TUBE'S PLATE AND ONE SIDE OF ITS FILAMENT OR B-. OBVIOUSLY, IF THIS CONDENSER SHOULD DEVELOPE AN INTERNAL SHORT DUE TO ITS DIELECTRIC BREAKING DOWN, IT WILL BE IMPOSSIBLE FOR THE B VOLTAGE TO REACH THE TUBE'S PLATE. THE REASON FOR THIS BEING THAT THE RESISTANCE OFFERED THROUGH THE SHORTED CONDENSER IS MUCH LESS THAN THE RESISTANCE BETWEEN THE PLATE AND FILAMENT WITHIN THE TUBE. THE "B" CURRENT, THEREFORE, WILL DISCHARGE THROUGH THE SHORTED CONDENSER INSTEAD OF PASSING THROUGH THE TUBE IN THE NORMAL MANNER AND IN TIME WILL COMPLETELY DISCHARGE THE "B" BATTERY.

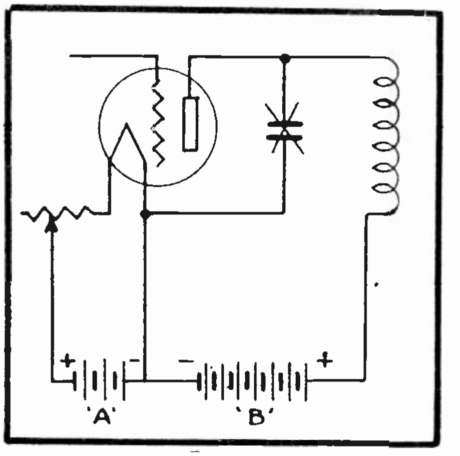

FIG. 7
A Shorted by-Pass Condenser.

IN THE CASE OF AN A.C. RECEIVER, SUCH A SHORTED BY-PASS CONDENSER WOULD MAKE THIS PARTICULAR PLATE CIRCUIT INOPERATIVE BUT THE CIRCUIT WILL COME BACK TO LIFE THE INSTANT THAT THIS DEFECTIVE CONDENSER IS DISCONNECTED FROM THE CIRCUIT. CONSEQUENTLY, IF YOU SUSPECT SUCH A BY-PASS CONDENSER AS BEING THE CAUSE FOR THE TROUBLE, SIMPLY DISCONNECT IT FROM THE CIRCUIT AND TEST THE PERFORMANCE OF THE RECEIVER, REMEMBERING OF COURSE THAT IN THE CASE OF A BATTERY OPERATED RECEIVER, THIS CONDITION WILL HAVE DISCHARGED THE "B" BATTERY BY THIS TIME AND THIS IN TURN WOULD STILL MAKE THE RECEIVER INOPERATIVE EVEN THOUGH THE DEFECTIVE CONDENSER BE REMOVED.

IF THE PLATE VOLTAGE IS FOUND TO REACH THE POWER STAGE SATISFACTORILY BUT NO PLATE VOLTAGE TEST IS OBTAINED AT ONE OR MORE OF THE REMAINING TUBE SOCKETS AS DETERMINED BY THE TUBE REMOVAL TEST, THEN THERE IS A POSSIBILITY OF THE TROUBLE BEING LOCATED IN THE VOLTAGE DIVIDER SYSTEM.

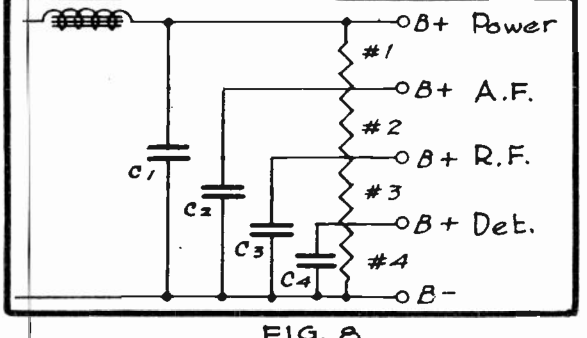

FIG. 8
Voltage Divider defects.

FOR INSTANCE IF IN THE VOLTAGE DIVIDER SYSTEM OF FIG. 8 RESISTOR SECTION #2 IS OPEN, NO VOLTAGE WOULD BE AVAILABLE ACROSS THE B+R.F. AND B- TERMINALS AND THIS IN TURN WOULD MEAN THAT THE R.F. TUBES WOULD BE DEPRIVED OF THEIR PLATE VOLTAGE. SHOULD THE BY-PASS CONDENSER C_2 BECOME SHORT CIRCUITED, THEN NO VOLTAGE WOULD BE AVAILABLE BETWEEN THE B-, B+DET, B+R.F. OR B+A.F. TERMINALS BUT THE POWER TUBE WOULD STILL GET SOME PLATE VOLTAGE ALTHOUGH SOMEWHAT BELOW ITS NORMAL VALUE. BY SIMPLY REASONING IN THIS MANNER, YOU CAN READILY DETERMINE WHICH "B" VOLTAGES IN THE SYSTEM OF FIG. 8 WOULD BE LACKING IF ANY ONE RESISTOR SECTION SHOULD BECOME OPEN OR ANY BY-PASS CONDENSER SHORTED.

TO VERIFY THE FACT AS TO WHETHER OR NOT A GIVEN BY-PASS CONDENSER IS SHORT CIRCUITED, YOU CAN MAKE THE SAME VOLTMETER--BATTERY TEST AS ALREADY

DESCRIBED TO YOU RELATIVE TO FILTER CONDENSERS.

CHECKING THE GRID CIRCUITS

IF THE PLATE CIRCUITS SHOULD ALL BE FOUND IN PROPER CONDITION, THE NEXT TEST SHOULD BE MADE IN THE GRID CIRCUITS. A SIMPLE TEST TO MAKE IS TO TAKE YOUR MOISTENED FINGER OR THE TIP OF A METAL SCREW DRIVER AND TOUCH AN EXPOSED PART OF THE GRID CIRCUIT SUCH AS THE GRID TERMINAL AT A SOCKET, THE CONTROL GRID CAP OF A SCREEN GRID TUBE, OR ANY OTHER CONVENIENT POINT IN THIS CIRCUIT AND THE INSTANT YOU DO THIS, A CLICK SHOULD BE HEARD IN THE SPEAKER: THIS WILL MEAN EITHER OF TWO THINGS, NAMELY, AN OPEN OR A GOOD GRID CIRCUIT BUT THIS CAN READILY BE CHECKED BY MEANS OF A VOLTMETER-BATTERY TESTING OUTFIT.

THAT IS TO SAY, BY KNOWING HOW THE CIRCUIT SHOULD NORMALLY BE WIRED, YOU CAN TEST THE VARIOUS COMPONENTS OF THE QUESTIONABLE GRID CIRCUIT SUCH AS THE TRANSFORMER WINDINGS ETC. FOR CONTINUITY AND IN THIS WAY LOCATE THE POINT AT WHICH THE CIRCUIT IS INTERRUPTED.

SHOULD NO CLICK BE OBTAINED WHEN THE GRID CIRCUIT IS TOUCHED, THEN THE GRID CIRCUIT IS EITHER GROUNDED OR SHORTED SOMEPLACE AND YOU CAN AGAIN MAKE USE OF THE SAME TESTER IN ORDER TO LOCATE THE POINT OF GROUNDING OR SHORTING. THAT IS, BY TESTING BETWEEN GROUND (CHASSIS) AND THE CIRCUIT, YOU CAN TELL WHETHER THE CIRCUIT IS GROUNDED OR NOT.

WEAK SIGNALS

ANOTHER COMMON RADIO AILMENT IS THAT THE STATIONS ONLY COME IN WEAK, SO THAT WE CANNOT GET SUFFICIENT VOLUME FROM THE SPEAKER IN ORDER TO GET COMFORTABLE RECEPTION. IN THIS CASE, CHECK THE "A" AND "B" VOLTAGES SO AS TO BE SURE THAT THEY ARE UP TO THE REQUIRED VALUE. WITH THESE VOLTAGES CORRECT, TRY REMOVING ONE TUBE AT A TIME AND REPLACING IT WITH A NEW ONE AND IF YOU NOTICE AN IMPROVEMENT WITH THE NEW TUBE, LEAVE IT IN PLACE AND DO THE SAME TO THE OTHER TUBES. MANY A RECEIVER HAS BEEN BRINGING IN WEAK SIGNALS BECAUSE OF OLD WORN OUT TUBES AND A TREMENDOUS GAIN IN PERFORMANCE IS OFTEN OBTAINED WHEN THE SET IS EQUIPPED WITH NEW TUBES, PROVIDED OF COURSE, THAT ALL OTHER PARTS OF THE RECEIVER ARE IN PROPER OPERATING CONDITION.

CHECK THE "A" BATTERY LEADS TO SEE THAT THEY ARE NOT REVERSED AND SEE TO IT THAT THE GRID BIAS VOLTAGE IS ALSO OF THE PROPER VALUE FOR THE TYPE TUBE AND PLATE VOLTAGE USED. THEN DON'T FORGET TO CHECK UP FOR ANY HIGH RESISTANCE POINTS IN THE ANTENNA OR GROUND CIRCUITS BECAUSE NEITHER OF THESE PATHS SHOULD OFFER THE SLIGHTEST UNNECESSARY OBSTRUCTION TO THE RADIO FREQUENCY CURRENTS.

ADDITIONAL TROUBLES WHICH MAY CAUSE WEAK SIGNALS ARE AS FOLLOWS: LOW LINE VOLTAGE, IMPROPER TRIMMER ADJUSTMENT ON GANG TUNING CONDENSER, DEFECTIVE RECTIFIER TUBE, RECEIVER NOT PROPERLY NEUTRALIZED IF NEUTRODYNE CIRCUIT, DEFECTIVE VOLUME CONTROL, SCREEN GRID VOLTAGE LACKING AT ONE OR MORE TUBES, LEAKY BY-PASS CONDENSER, DEFECTIVE RESISTOR, DEFECTIVE R.F. TRANSFORMER, DEFECTIVE SPEAKER, DEFECTIVE A.F. TRANSFORMER OR AN OPEN GRID CIRCUIT.

FADING SIGNALS

SOMETIMES, YOU WILL COME ACROSS A RECEIVER FROM WHICH THE SOUNDS BE

COME LOUDER AND THEN NEARLY DISAPPEAR AND THEN ALL OF A SUDDEN THEY ARE LOUD AGAIN. THIS ACTION IS CALLED "FADING" AND IS OFTEN DUE TO METEOROLOGICAL CONDITIONS BECAUSE RADIO WAVES, ESPECIALLY FROM DISTANT STATIONS, ARE AFFECTED BY DIFFERENT WEATHER CONDITIONS AND THESE EFFECTS ARE MOST NOTICEABLE AT NIGHT. NATURALLY, A RECEIVER NOT PROVIDED WITH AUTOMATIC VOLUME CONTROL IS NOT CAPABLE OF OVERCOMING CONDITIONS SUCH AS THESE, WHICH ARE REALLY CAUSED OUTSIDE OF THE RECEIVING EQUIPMENT.

IN ORDER TO CHECK THE SET TO BE SURE THAT THESE WAVERING SIGNALS ARE CAUSED BY FADING DUE TO ATMOSPHERIC CONDITIONS, JUST TUNE IN A LOCAL STATION. IF NONE OF THIS FADING CONDITION IS NOTICED AT THIS TIME, THEN YOU KNOW THAT THE FADING ACTION WAS CAUSED OUTSIDE THE RECEIVER. HOWEVER, IF YOU STILL GET WAVERING SIGNALS FROM THE LOCAL STATION ALSO, THEN CHECK UP ON THE RECEIVER.

IF THE RECEIVER IS AT FAULT, YOU WILL OFTEN FIND FLUCTUATING (CHANGEABLE) VOLTAGES AS CAUSING THIS CONDITION, CHECK UP FOR RUN DOWN BATTERIES IF IT IS A BATTERY SET, ALSO SEE THAT ALL TUBES AND THEIR CONNECTIONS ARE IN THE PROPER CONDITION. IN A.C. SETS, TRY A NEW RECTIFYING TUBE IN PLACE OF THE ONE IN USE AND SEE TO IT THAT ALL CONNECTIONS ARE MADE SATISFACTORILY. SOMETIMES, YOU WILL FIND ANTENNA AND GROUND WIRES WHICH ARE INSTALLED SO THAT THEY ARE SUBJECT TO SWAYING IN WINDY WEATHER AND CONSEQUENTLY IF THERE ARE ANY DEFECTIVE POINTS OR JOINTS ANYWHERES IN THIS SWINGING PORTION, THE STRENGTH OF THE SIGNALS WILL BE CAUSED TO WAVER WITH THIS SWINGING MOTION. LEAKY CONDENSERS AND POOR RESISTORS ALSO SOMETIMES CAUSE FADING RECEPTION.

BODY CAPACITY

THERE ARE ALSO TIMES WHEN THE VOLUME OF THE SET IS AFFECTED DURING THE TIME ONE BRINGS HIS HANDS NEAR THE CONTROL DIALS, AND THIS IS FREQUENTLY DUE TO "BODY CAPACITY" IN POORLY DESIGNED RECEIVERS AND CAN GENERALLY BE OVERCOME BY A GOOD JOB OF SHIELDING THE PARTS--ENCLOSING THEM IN GROUNDED METAL CONTAINERS OF ALUMINUM, BRASS, OR COPPER.

INTERFERENCE OF STATIONS

AT TIMES, YOU WILL BE FACE TO FACE WITH A RECEIVER WHICH WILL NOT PERMIT A CERTAIN STATION TO COME IN WITHOUT HAVING SOME OTHER STATION BUTTING IN AT THE SAME TIME AND THIS TYPE OF RECEPTION IS ENOUGH TO GET ON ANY MAN'S NERVES. THE FIRST THING TO TRY IN SUCH A CASE IS TO TUNE THE SET AS CAREFULLY AS YOU CAN AND ATTEMPT TO GET THE GREATEST VOLUME POSSIBLE, WITHOUT HAVING TO TURN ON THE VOLUME CONTROL MORE THAN IS ABSOLUTELY NECESSARY. THIS WILL MEAN THAT YOU ARE TUNING TO THE SHARPEST DEGREE POSSIBLE AND YOU WILL FIND MANY COMPLAINTS SIMPLY DUE TO FAULTY TUNING.

IN OTHER WORDS, MANY UNSKILLED SET OWNERS WILL TUNE IN SOME STATION AND AS SOON AS THEY JUST BARELY HEAR IT COMING IN, THEY WILL INCREASE THE VOLUME BY MEANS OF THE VOLUME CONTROL, INSTEAD OF FIRST INCREASING THE VOLUME AUTOMATICALLY WITH SHARPER TUNING.

IN CASE THAT THE SET IN QUESTION IS EQUIPPED WITH SMALL TRIMMER CON CONDENSERS, WHICH ARE USED TO COMPENSATE FOR THE DIFFERENT CAPACITIES OF THE CIRCUIT WIRING IN SINGLE DIAL RECEIVERS, TUNE AS SHARPLY AS YOU CAN WITH THE REGULAR CONTROL DIAL AND THEN ADJUST EACH OF THE TRIMMER CONDEN

SERS TO THE POINT WHERE THE GREATEST VOLUME IS OBTAINED, WITHOUT FURTHER MOVEMENT OF THE REGULAR CONTROL DIAL.

ALSO SEE TO IT THAT THE TUBES ARE NOT TOO OLD AS OLD TUBES WILL DESTROY THE SELECTIVITY OF AN OTHERWISE GOOD RECEIVER. A HIGH RESISTANCE OR PARTIALLY OPENED GRID CIRCUIT WILL ALSO CAUSE BROAD TUNING. ANOTHER THING WHICH AFFECTS SELECTIVITY IS THE SIZE OF THE ANTENNA, FOR THE LONGER THE ANTENNA, THE LESS SELECTIVE WILL BE THE RECEPTION AND FOR GENERAL PURPOSES, AN OUTDOOR ANTENNA WHICH IS NOT MORE THAN ABOUT FIFTY FEET LONG AND TWENTY FEET HIGH IS MORE SELECTIVE THAN A LONGER ONE AND AN INDOOR ANTENNA IS STILL MORE SELECTIVE THAN AN OUTDOOR ONE, BUT THE SIGNAL STRENGTH WILL BE REDUCED.

HAVING MADE SOMEWHAT OF A GENERAL CHECK OF THE SET, THERE IS NOTHING MORE ONE CAN DO, OTHER THAN TO ACTUALLY REDESIGN AND REBUILD THE SET, OR ELSE INSTALL AN ADDITIONAL TUNING CIRCUIT IN THE FORM OF A WAVE TRAP.

VARIOUS OTHER TYPES OF INTERFERENCE

SOMETIMES WE RUN INTO ANOTHER TYPE OF INTERFERENCE BESIDES THAT OF A MIXUP OF RECEIVED STATIONS AND THESE ARE FREQUENTLY CAUSED BY NEARBY ELECTRICALLY OPERATED DEVICES SUCH AS VACUUM CLEANERS, FANS, ELECTRIC MOTORS, ETC. THESE NOISES HAVE REGULAR CLICKING BUZZING OR CRACKLING SOUNDS.

THE FIRST THING TO DO IN SUCH A CASE IS TO DISCONNECT THE ANTENNA LEAD-IN WIRE FROM THE SET AND IF YOU STILL HEAR THE SAME NOISE, DISCONNECT THE GROUND WIRE. IF THE REMOVAL OF EITHER OF THESE WIRES STOPS THE NOISE, THEN FIRST CHECK UP THESE ENTIRE CIRCUITS TO SEE THAT THEY ARE O.K. IF THEY ARE, THEN THE CHANCES ARE THAT THIS DISTURBANCE IS CAUSED BY A DEFECTIVE ELECTRICALLY OPERATED APPLIANCE OF SOME KIND, WHICH IS LOCATED NEARBY.

THE ELIMINATION OF INTERFERENCE IS A MIGHTY BIG SUBJECT AND THEREFORE WE HAVE PREPARED A SEPARATE LESSON ON HOW TO DEAL WITH THIS PROBLEM. FOR THIS REASON, WE SHALL NOT CONSIDER THIS SOURCE OF TROUBLE IN GREATER DETAIL AT THE PRESENT TIME.

UNDESIRABLE NOISES

WE MUST NOT OVERLOOK THE FACT THAT MANY UNDESIRABLE NOISES SUCH AS SCRATCHING, RASPING AND CRACKLING SOUNDS ARE ALSO OFTEN DUE TO DEFECTS WITHIN THE RECEIVER ITSELF. THE MOST COMMON CAUSES FOR SUCH NOISES ARE FAULTY CONNECTIONS, SUCH AS THE TUBES MAKING POOR CONTACT IN THEIR SOCKETS, LOOSE SOLDERING JOBS ETC.

TO FIND THESE BAD CONNECTIONS YOU CAN AGGRAVATE THEM BY JIGGLING THEM A LITTLE WITH A WOODEN STICK AND IF YOU SHOULD MOVE A LOOSE CONTACT, THE INCREASED SCRATCHING NOISES IN THE SPEAKER WILL IMMEDIATELY INDICATE IT. IF YOU SHOULD FIND SOME OF THE PRONGS ON THE BASE OF THE TUBES TO BE CORRODED AND DIRTY, BRIGHTEN THEM UP WITH A PIECE OF FINE SANDPAPER.

SHOULD YOU HEAR SCRATCHING NOISES AS YOU OPERATE THE CONTROL KNOB OF A RHEOSTAT OR POTENTIOMETER, IT MEANS THAT THE BLADE IS NOT MAKING GOOD CONTACT WITH THE RESISTANCE WIRE AND THIS IS OFTEN DUE TO ACCUMULATION OF DUST ON THE TRACK UPON WHICH THE BLADE SLIDES. ANCTHER CHECK TO MAKE IS TO SNAP THE SWITCH "OFF" AN "ON" SEVERAL TIMES SO AS TO MAKE SURE THAT ITS CONTACTS ARE FIRM.

CHECK ALL FUSE AND RESISTOR CLIPS CAREFULLY AND MAKE SURE THAT THE UNIT, WHICH THEY HOLD IN PLACE, IS CLAMPED TIGHTLY BY THEM. IN OTHER WORDS, WHEN YOU HEAR SUCH SCRATCHING SOUNDS, CHECK ALL CONNECTIONS INCLUDING BATTERIES, CONDENSERS BOTH FIXED AND VARIABLE ETC. AND KEEP IN MIND THAT RADIO PARTS CANNOT STAND DIRT. THE SPEAKER SHOULD ALSO BE INSPECTED FOR DIRTY OR LOOSE PARTS IF NECESSARY.

DEFECTIVE R.F. AND A.F. TRANSFORMERS, TUBES AND RESISTORS MAY ALSO BE RESPONSIBLE FOR SUCH RASPING NOISES.

POOR TONE QUALITY OR DISTORTION

THE NEXT TROUBLE WHICH WE ARE GOING TO CONSIDER IS DISTORTION OR POOR TONE QUALITY. OF COURSE, SOME SETS ARE NATURALLY BETTER TONE PRODUCERS THAN OTHERS BECAUSE OF BETTER DESIGN, HIGHER PRICED PARTS ETC. WE ARE NOT DISCUSSING TONE QUALITY FROM THIS STANDPOINT BUT RATHER THE TROUBLES WHICH AFFECT AN OTHERWISE GOOD RECEIVER IN THIS WAY.

ONE CANNOT EXPECT THE TUBES TO FUNCTION PROPERLY IF THEY ARE NOT OPERATING UNDER THE CONDITIONS FOR WHICH THE MANUFACTURER BUILT THEM, SO IT BECOMES NECESSARY TO MAKE AN ACCURATE TEST OF THE A,B, AND C VOLTAGES. SHOULD ANY ONE OF THESE VALUES BE INCORRECT, THEN A BAD CASE OF DISTORTION WILL EXIST.

ALSO BEAR IN MIND THAT YOU CANNOT SUBSTITUTE A TUBE OF ONE TYPE IN PLACE OF A TUBE OF ANOTHER TYPE WHICH REQUIRES DIFFERENT OPERATING CONDITIONS, AND EXPECT GOOD RESULTS. OLD WORN OUT TUBES ALSO ADD THEIR CAUSES OF DISTORTION AND IN SUCH CASES SHOULD BE REPLACED WITH NEW ONES OF THE PROPER TYPE.

IMPROPER TUNING CAN ALSO CAUSE DISAGREEABLE TONE QUALITY AND ESPECIALLY IF THE VOLUME CONTROL IS TURNED TOO HIGH WITH A CARELESSLY TUNED CIRCUIT. OTHER COMMON CAUSES FOR DISTORTION ARE BY-PASS OR COUPLING CONDENSERS, DEFECTIVE AUDIO TRANSFORMERS, OPEN GRID CIRCUITS, TRIMMER CONDENSERS IMPROPERLY ADJUSTED; DEFECTIVE SPEAKER, RESISTOR, OR VOLUME CONTROL.

HOWLING

NOW FOR A FEW WORDS ABOUT HOWLING. BY HOWLING WE DO NOT MEAN A HIGH PITCHED SQUEALING OR WHISTLING BUT ONE WHICH GENERALLY STARTS ALL OF A SUDDEN AFTER THE SET HAS BEEN OPERATING FOR A WHILE AND THEN COMMENCES WEAKLY AND GRADUALLY BUILDS UP IN STRENGTH, EVEN THOUGH THE CONTROLS ARE NOT TOUCHED. WE CALL THIS AN AUDIO HOWL AND IT IS USUALLY CAUSED BY WHAT IS KNOWN AS A MICROPHONIC TUBE.

A MICROPHONIC TUBE IS ONE WHICH VIBRATES AT SUCH A RATE AS TO CAUSE PLATE CURRENT CHANGES WHICH ARE OF AUDIO FREQUENCY AND THUS PRODUCE THIS HOWLING EFFECT. AS A RULE, YOU WILL FIND IT TO BE EITHER THE DETECTOR OR AN AUDIO AMPLIFYING TUBE AND IT IS BEST FOUND BY PUTTING A LITTLE PRESSURE ON ONE TUBE AT A TIME WITH YOUR FINGERS. IN CASE YOU ARE ABLE TO STOP THE HOWL BY APPLYING THIS PRESSURE TO A TUBE, THEN THE TUBE, WHICH YOU ARE HOLDING, IS THE ONE CAUSING THE TROUBLE.

SOMETIMES YOU CAN STOP THIS BY SWITCHING THE MICHROPHONIC TUBE WITH ANOTHER OF THE SAME TYPE. VERY OFTEN THE VIBRATIONS OF AN IMPROPERLY CUSHIONED SPEAKER WHICH IS IN CONTACT WITH THE CABINET OF THE RECEIVER WILL

TRANSFER ITS VIBRATIONS TO THE PARTICULAR TUBE AND THUS CAUSE THE TUBE TO VIBRATE IN STEP WITH IT. TO REMEDY THIS, YOU CAN CUSHION THE SPEAKER WITH FELT, OR IF IT IS OF THE PORTABLE TYPE, REMOVE IT FROM DIRECT CONTACT WITH THE RECEIVER CABINET.

A CHANGE IN FILAMENT OR HEATER VOLTAGE WILL ALSO FREQUENTLY HELP MATTERS IN THIS CASE BUT THE VOLTAGE SHOULD BE LOWERED RATHER THAN INCREASED ABOVE NORMAL, AS EXCESSIVE FILAMENT VOLTAGES WILL JUST NATURALLY SHORTEN THE LIFE OF THE TUBES.

SQUEALING AND WHISTLING

AT TIMES, ONE IS CONFRONTED WITH A RECEIVER WHICH PRODUCES A WHISTLING OR SQUEALING SOUND AS THE VOLUME IS BEING INCREASED AND THIS MEANS THAT EXCESSIVE REGENERATION HAS TAKEN PLACE AND IS CAUSING OSCILLATIONS. IT IS AT THIS TIME THAT THE SET IS RADIATING ENERGY AND IS ACTING AS A SMALL TRANSMITTER AND THUS INTERFERES WITH A NEIGHBOR'S RECEPTION.

IN CONSIDERING THIS TYPE OF TROUBLE, WE MUST ALSO CONSIDER THE TYPE OF RECEIVER IN USE. FOR EXAMPLE, SOME SETS PREVENT OSCILLATION BY MEANS OF RESISTORS IN THE GRID CIRCUITS OF THE RADIO FREQUENCY AMPLIFYING STAGES AND SHOULD ANY OF THESE BECOME SHORTED, THEN THERE WILL BE A GOOD CHANCE FOR OSCILLATIONS TO SET UP. SHOULD THE RECEIVER BE DESIGNED TO MAKE USE OF NEUTRALIZING CONDENSERS TO FEED BACK ENERGY OF OPPOSITE PHASE FROM THE PLATE TO GRID CIRCUITS, SUCH AS IN THE NEUTRODYNE CIRCUITS, THEN THERE IS A POSSIBILITY THAT THE NEUTRALIZING CONDENSERS REQUIRE ADJUSTMENT.

IF THE GRID LEAK IS OF TOO HIGH A RESISTANCE, SQUEALING IS SOMETIMES CAUSED OR IF SOME OF THE BY-PASS CONDENSERS ARE OPEN CIRCUITED. BESIDES ALL THESE CAUSES OF SQUEALING, YOU WILL FIND THAT IMPROPER GROUND CONNECTIONS AND UNGROUNDED SHIELDS CAN ALSO BRING ABOUT THIS UNDESIRABLE CONDITION.

A VERY IMPORTANT POINT, WHICH WE SHOULD NOT OVERLOOK IN RESPECT TO SQUEALING IS TO CHECK THE PLATE IN THE R.F. STAGES AND ALSO THE FILAMENT VOLTAGES. IF EITHER OF THESE IS EXCESSIVELY HIGH, THE SET IS APT TO SQUEAL AND BY LOWERING THEM SOMEWHAT, THE SQUEALING IS OFTEN ELIMINATED.

SOMETIMES, INSTEAD OF HEARING A HIGH PITCHED SQUEAL, ITS NATURE IS MORE LIKE THAT OF A LOW PITCHED GROWL AND THIS TROUBLE IS OFTEN CAUSED IN A.C. SETS IN WHICH ONE OF THE BY-PASS CONDENSERS AT THE VOLTAGE DIVIDER OF THE POWER UNIT HAVE BECOME OPEN CIRCUITED. THIS WILL ALSO HAPPEN IF ONE OR MORE OF THEM ARE OF TOO LOW A CAPACITY.

HUMMING

AT TIMES, WE HEAR FAIRLY LOUD HUMMING NOISES BEING EMITTED FROM THE SPEAKER AND AS A GENERAL RULE, HUMS OF THIS TYPE ARE PRODUCED BY ALTERNATING CURRENTS. IN BATTERY TYPE RECEIVERS, THIS HUMMING IS NOT QUITE SO COMMON AS IN A.C. SETS BUT YET THERE ARE OCCASSIONS WHEN THEY TOO ARE SUBJECTED TO THIS TROUBLE. IT OFTEN HAPPENS THAT THE ANTENNA OR GROUNDING WIRES HAVE BEEN INSTALLED CARELESSLY, SO THAT THEY RUN NEAR TO AND PARALLEL TO SOME HIGH VOLTAGE POWER LINES. IN SUCH A CASE, THE RECEIVER WILL BE CONTINUALLY BOTHERED WITH THIS ANNOYING HUMMING SOUND. TO REMEDY THIS, IT IS ADVISABLE TO ERECT YOUR ANTENNA AND MAKE YOUR GROUND CONNECTION IN the manner outlined for you in the lesson dealing with the installation of antennas.

If it is an A.C. set on which you are trying to eliminate the hum, also be sure about the antenna and ground installations as was already mentioned and if these are O.K., regulate the hum adjustment on the receiver in the manner prescribed in one of your earlier lessons.

Do not permit the A.C. power supply cord to come too close to the receiver circuits and don't run the speaker wires parallel to or close to an A.C. line. In some instances, the hum can even be reduced materially by reversing the plug contacts of the power unit in the light socket.

Insufficient or ungrounded shielding is also a common cause for hum in A.C. sets and it is also advisable to check up on the detector tube and its plate voltage and should these items not be as they belong, make them so and if this should be the cause of the trouble, the hum will be eliminated quickly.

If a bias resistor is open circuited, the set may also develope a bad hum or even if a by-pass condenser at the biasing resistor or at the voltage divider should become open circuited, we may also hear humming sounds.

Hums in A. C. sets are also often produced in the power units. For example, if the hum is still heard if the speaker is disconnected or temporarily shorted out, it is very likely that the power transformer may be at fault or that the trouble lies in the filtering system. Cases also arise where hum is found to be due to a defective rectifier tube.

MOTOR BOATING

At some time, you may have occasion to come across a receiver in which the speaker produces sounds similar to that emitted by the exhaust of a motorboat engine--in other words, a "putt-putt" sound effect. If a receiver acts in this way, we usually say that it is "Motorboating."

This disturbance is more apt to happen in receivers employing resistance or impedance coupling in the A.F. amplifier and is usually caused by coupling between the stages. What it really amounts to is a low frequency audio oscillation.

Some of the most common defects which are likely to cause motorboating are incorrect "C" bias voltage, lack of "C" bias resistor by-pass condenser or one of too small capacity, excessive "B" potential, open by-pass condenser in voltage divider system or condenser of too small capacity rating being used for this purpose.

COMMON DEFECTS IN "B" POWER UNITS

Now let us consider some of the most common troubles encountered in "B" power units whether they be used in the form of a "B" eliminator for battery-type receivers or as a part of the conventional A.C. receivers. We can divide the most probable troubles of these "B" power units into four general classifications as follows: (1) "B" supply unit completely dead with no output whatever being supplied. (2) Insufficient voltage and

CURRENT OUTPUT. (3) LACK OF VOLTAGE AT ONLY SOME BUT NOT ALL OF THE OUTPUT TERMINALS. (4) EXCESSIVE HUM IN THE OUTPUT.

THE FOLLOWING OUTLINE TELLS YOU WHAT TO LOOK FOR IF CONFRONTED WITH ANY ONE OF THE FOUR CONDITIONS JUST MENTIONED.

I - NO OUTPUT FROM "B" SUPPLY UNIT.

1.- A.C. LINE VOLTAGE NOT REACHING PRIMARY WINDING OF POWER TRANSFORMER.
2.- DEFECTIVE POWER TRANSFORMER.
3.- DEFECTIVE RECTIFIER TUBE.
4.- OPEN FILTER CHOKE COIL.
5.- SHORTED FILTER CONDENSER.

II - INSUFFICIENT VOLTAGE AND CURRENT OUTPUT.

1.- LOW LINE VOLTAGE.
2.- DEFECTIVE RECTIFIER.
3.- HIGH RESISTANCE IN FILTER CIRCUIT.
4.- EXCESSIVE LOAD BEING APPLIED TO THE UNIT.

III - LACK OF VOLTAGE AT SOME BUT NOT ALL OUTPUT TERMINALS.

1.- OPEN RESISTOR IN VOLTAGE DIVIDER SYSTEM.
2.- SHORTED BYPASS CONDENSER IN VOLTAGE DIVIDER SYSTEM.

IV - EXCESSIVE HUM IN OUTPUT.

1.- DEFECTIVE RECTIFIER TUBE.
2.- SHORTED FILTER CHOKE.
3.- DEFECTIVE FILTER CONDENSER OR POORLY CONNECTED TO CIRCUIT.
4.- LACK OF ADEQUATE BY-PASS CONDENSERS OR NONE USED AT ALL.

IF NO OUTPUT IS OBTAINED FROM THE "B" SUPPLY, A QUICK CHECK CAN BE MADE BY TURNING THE POWER SWITCH TO THE "ON" POSITION AND NOTING IF THE FILAMENT OF THE RECTIFIER TUBE LIGHTS (PROVIDED, OF COURSE, THAT A FILAMENT TYPE TUBE IS BEING USED FOR THIS PURPOSE.) SHOULD THE FILAMENT FAIL TO LIGHT, THEN IT IS POSSIBLE THAT THE TUBE FILAMENT IS BURNED OUT, ITS FILAMENT CIRCUIT OPEN OR SHORTED, A DEFECTIVE POWER TRANSFORMER, OR THE PRIMARY CIRCUIT OF THE POWER TRANSFORMER INCOMPLETE.

IF THE FILAMENT OF THE TUBE LIGHTS AT NORMAL BRILLIANCE, THEN EVERYTHING FROM THE A.C. LINE TO THE TUBE IS O.K. THE RAYTHEON GASEOUS RECTIFIER TUBE HAS NO FILAMENT BUT WHEN IN OPERATION, IT SHOULD BECOME QUITE HOT.

IN EITHER CASE, IF THE RECTIFIER IS FOUND TO BE OPERATING SATISFACTORILY, THEN THE FILTER CIRCUIT IS AT FAULT AND WILL HAVE TO BE CHECKED AS ALREADY EXPLAINED EARLIER IN THIS LESSON. THEN IN THE EVENT THAT THE VOLTAGE DIVIDER PERMITS ONLY SOME OF THE VOLTAGES TO BE OBTAINED AT THE OUTPUT, IT WILL HAVE TO BE CHECKED FOR DEFECTIVE RESISTORS AND BY-PASS CONDENSERS AS ALSO ALREADY EXPLAINED.

A SIMPLE AND QUICK METHOD FOR CHECKING THE SECONDARY WINDING OF

THE TRANSFORMER OR ONE OF THE BUFFER CONDENSERS FOR A POSSIBLE SHORT CIRCUIT IN A "B" POWER UNIT, IN WHICH A RAYTHEON GASEOUS TYPE RECTIFYING TUBE IS USED, IS ILLUSTRATED FOR YOU IN FIG. 9.

ALL THAT IS NECESSARY IS TO CONNECT A 110 VOLT, 25 WATT INCANDESCENT LAMP IN SERIES WITH THE PRIMARY CIRCUIT OF THE TRANSFORMER AS HERE SHOWN.

WITH THE SYSTEM IN OPERATION, REMOVE THE RECTIFIER TUBE FROM ITS SOCKET. UPON DOING SO, THE INCANDESCENT LAMP SHOULD ONLY BURN VERY DIM IF EVERYTHING IS O.K. HOWEVER, IF THE LAMP BURNS AT FULL BRILLIANCE, THEN EITHER THE SECONDARY WINDING OF THE TRANSFORMER OR ONE OR BOTH OF THE BUFFER CONDENSERS ARE SHORTED. THEY CAN THEN BE TESTED INDIVIDUALLY TO DETERMINE THE EXACT DEFECT.

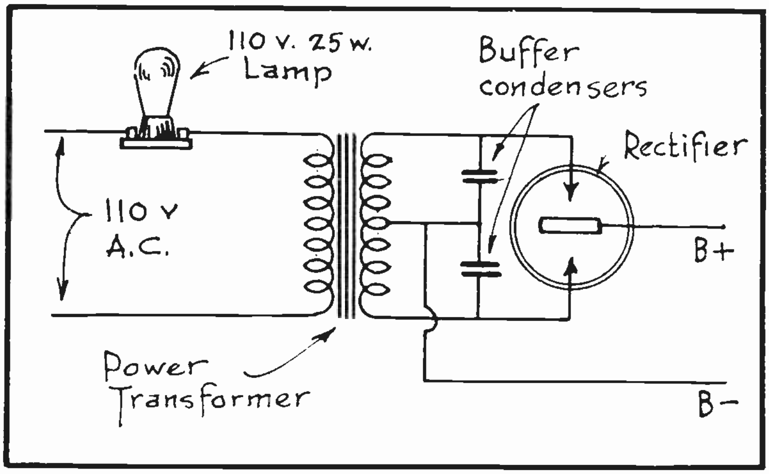

FIG. 9
Checking the Secondary Circuit of the Transformer.

AS THE RECTIFIER TUBE IS REPLACED IN ITS SOCKET, THE BRILLIANCE OF THE INCANDESCENT LAMP SHOULD GRADUALLY INCREASE IF THE SECONDARY CIRCUIT IS IN SATISFACTORY CONDITION.

THE MOST COMMON TROUBLES OF RADIO RECEIVERS HAVE BEEN DISCUSSED IN THIS LESSON AND BY STUDYING THIS LESSON VERY CAREFULLY, YOU SHOULD FIND YOURSELF IN THE POSSESSION OF SUFFICIENT KNOWLEDGE CONCERNING THIS SUBJECT SO THAT YOU CAN APPLY IT TO IMMEDIATE PRACTICAL USE.

IN THE FOLLOWING LESSON, YOU ARE GOING TO CONTINUE THE STUDY OF TROUBLE-SHOOTING IN RECEIVERS, ONLY THAT WE ARE GOING TO EMPLOY STILL MORE SYSTEMATIC AND EFFICIENT METHODS WITH THE AID OF TESTING INSTRUMENTS.

EXAMINATION QUESTIONS

LESSON NO. 21

1. - WHAT POSSIBLE DEFECTS WOULD YOU LOOK FOR IF A RECEIVER IS COMPLETELY DEAD?

2. - WHAT DO WE MEAN BY AN OPEN CIRCUIT?

3. - WHAT DO WE MEAN BY A SHORT CI CUIT?

4. - IF A RECEIVER IS FOUND TO BE "ALIVE" BUT DOES NOT PROVIDE A REPRODUCTION OF SIGNALS, THEN WHAT MAY BE THE MOST PROBABLE CAUSE FOR THE TROUBLE?

5. - WHAT MAY CAUSE WEAK SIGNAL REPRODUCTION?

6. - WHAT CONDITIONS ARE FREQUENTLY RESPONSIBLE FOR RASPING AND CRACKLING NOISES COMING FROM THE SPEAKER?

7. - WHAT ARE SOME OF THE MOST PROBABLE CAUSES FOR SQUEALING AND WHISTLING?

8. - WHAT DO WE MEAN BY "MOTORBOATING" AND WHAT MAY CAUSE SUCH A CONDITION?

9. - IF SOME BUT NOT ALL "B" VOLTAGES ARE AVAILABLE AT THE TERMINALS OF A "B" SUPPLY UNIT, WHAT ARE THE MOST LIKELY CAUSES FOR THE TROUBLE?

10. - DESCRIBE A QUICK AND SIMPLE METHOD FOR CHECKING THE CONTINUITY OF PLATE CIRCUITS IN A RECEIVER.

DEAR STUDENT

IN ORDER TO ACHIEVE SUCCESS IN LIFE WE MUST HAVE HIGH IDEALS, AIMS AND AMBITIONS.

WE MUST BE WILLING TO WORK HARD, SACRIFICE FREELY, BE UNSELFISH, CO-OPERATIVE, ENTHUSIASTIC AND DETERMINED.

LET'S SINCERELY TRY, AND WE WILL SURELY ACHIEVE.

RADIO - TELEVISION

Practical • J. A. ROSENKRANZ, Pres. • Training

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LESSON NO. 22

◦ RECEIVER TROUBLE-SHOOTING ◦

Here is another lesson on RADIO SERVICING and in it, you will find many valuable suggestions dealing with the proper testing procedures and repairing of receivers. Your object, when confronted with a faulty receiver should not only be to FIND the trouble but to find it in as SHORT A TIME as possible. The radio service man's time, you know, is worth money and he cannot afford to waste it by spending an unnecessary amount of it in looking for troubles, which when handled correctly, can be located with little difficulty.

IMPORTANCE OF SYSTEMATIC TESTING

In any line of work, where efficiency is an important factor, we automatically associate the word SYSTEM with it and this certainly applies to radio service work. For example, to do efficient service work, the radio expert must attack his problems in a SYSTEMATIC way and not attempt to solve them by the use of hit and miss methods.

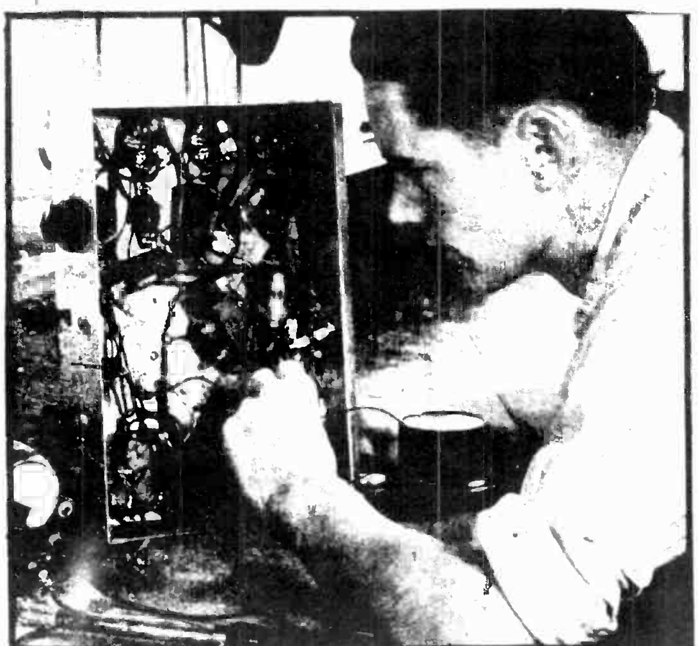

FIG.1
Testing a Radio Receiver.

This entire course in Radio has been built up in a way, which we feel will train you to think clearly along the lines of radio, so that you can successfully apply your TECHNICAL KNOWLEDGE to PRACTICAL PROBLEMS and this in a final analysis is really the key note to Radio Success.

WHEN ON THE JOB, BY ALL MEANS USE THE BASIC RADIO PRINCIPLES WHICH YOU HAVE BEEN LEARNING RIGHT ALONG. VISUALIZE THE CIRCUIT CONNECTIONS AS YOU WORK WITH YOUR HANDS AND APPLY THE SYSTEMATIC METHODS OF TROUBLE SHOOTING IN THE MANNER SHOWN YOU IN THIS AND IN OTHER SERVICE LESSONS.

NOW TO GO ON WITH OUR DISCUSSION OF TESTING RADIO RECEIVERS.

LET US FIRST SUPPOSE THAT WITH THE RECEIVER TURNED ON, THE TUBES ARE ALL BURNING BUT NO MUSIC OR VOICE CAN BE MADE TO COME FROM THE SPEAKER. A QUICK CHECK OF THE ANTENNA AND GROUND CONNECTIONS HAS PROVED THESE TO BE O.K. AND WE ARE LEAD TO BELIEVE BY THE ACCOMPANYING SYMPTOMS, THAT THE TROUBLE IS WITHIN THE RECEIVER ITSELF.

CONFRONTED WITH THE PRESENT PROBLEM, IT WOULDN'T BE A SENSIBLE THING FOR US TO CONSIDER THE RECEIVER AS A WHOLE AND TO CHECK EACH AND EVERY WIRING CIRCUIT ONE AFTER THE OTHER. ROUGHLY, WE MIGHT SAY THAT A HUNDRED DIFFERENT DEFECTS COULD CAUSE A SIMILAR TROUBLE AND YET PROBABLY ONLY ONE OF THEM IS CAUSING THE FAILURE OF THE RECEIVER AT THIS PARTICULAR TIME. LOOKING FOR THIS ONE LONE DEFECT AMONG A POSSIBLE HUNDRED DEFECTS, WHICH MIGHT BE SCATTERED ANYWHERE UPON THE RECEIVER CHASSIS, WOULD BE LIKE LOOKING FOR A NEEDLE IN A HAY STACK, PROVIDED THAT ONE DOES NOT FOLLOW A SYSTEMATIC ROUTINE OF TESTING.

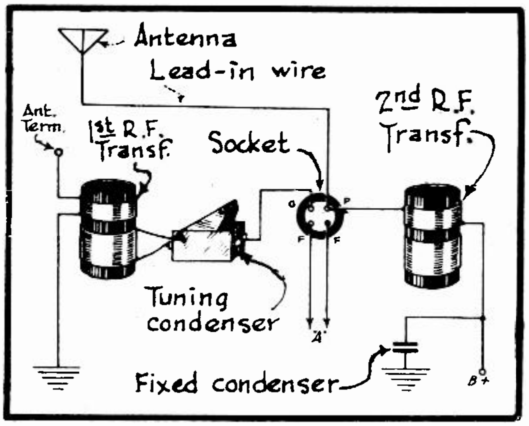

FIG. 2
Eliminating an R.F. Stage.

LOCATING A DEFECTIVE R.F. STAGE

THE FIRST THING THAT WE WANT TO DO HERE IS TO NARROW DOWN THE AREA IN WHICH THE DEFECT IS LOCATED AND ONCE HAVING DONE THIS, LESS TROUBLE WILL BE EXPERIENCED IN LOCATING THE EXACT CAUSE FOR THE RECEIVER'S FAILURE TO OPERATE. WE COMMENCE OUR TESTS BY DETERMINING FIRST, THE DEFECTIVE STAGE OF THE RECEIVER AND WE DO THIS BY BEGINNING IN THE R.F. STAGES, ELIMINATING ONE STAGE AT A TIME.

TO ELIMINATE THE FIRST R.F. STAGE, WE DISCONNECT THE ANTENNA LEAD-IN WIRE FROM THE ANTENNA POST OF THE RECEIVER, REMOVE THE FIRST R.F. TUBE FROM ITS SOCKET AND INSERT THE ANTENNA LEAD-IN WIRE INTO THE PLATE HOLE OF THIS R.F. SOCKET AS SHOWN IN FIG. 2. IN THIS WAY, THE ANTENNA WILL NOW BE CONNECTED IN THE PLATE CIRCUIT OF THE FIRST R.F. TUBE AND THE PRIMARY WINDING OF THE SECOND R.F. TRANSFORMER WILL NOW BE SERVING AS THE ANTENNA COIL. IF THESE CONNECTIONS ENABLE THE RECEIVER TO OPERATE AGAIN, THEN THE TEST PROVES THAT THE DEFECT IS LOCATED WITHIN THE CIRCUITS OF THE 1ST R.F. STAGE.

TO MAKE SURE THAT YOU WILL SEE WHY THE TEST CAN BE MADE IN THIS WAY, WE ARE PRESENTING FIGS. 3 AND 4. IN FIG. 3, A BATTERY OPERATED RECEIVER CIRCUIT IS SHOWN, WHEREAS AN A.C. CIRCUIT IS PICTURED IN FIG. 4. UPON CAREFUL INSPECTION OF FIG. 3, YOU WILL OBSERVE THAT THE PLATE CIRCUITS OF ALL THREE R.F. TUBES ARE CONNECTED TO GROUND THROUGH THE BY-PASS CONDENSER WHICH IS INDICATED ON THE DIAGRAM. THUS IT CAN BE SEEN THAT IF THE ANTENNA LEAD-IN WIRE IS CONNECTED TO THE PLATE END OF THE PRIMARY WINDING OF ANY

OF THE R.F. TRANSFORMERS, THE RESULTING CIRCUIT WILL BE THE SAME AS THAT IN THE REGULAR ANTENNA STAGE AND THE R.F. CURRENTS FROM THE ANTENNA HAVE NO DIFFICULTY AT ALL IN PASSING THROUGH THE BY-PASS CONDENSER AND INTO GROUND.

IN THE A.C. CIRCUIT OF FIG. 4, THE PRIMARIES OF THE R.F. TRANSFORM-

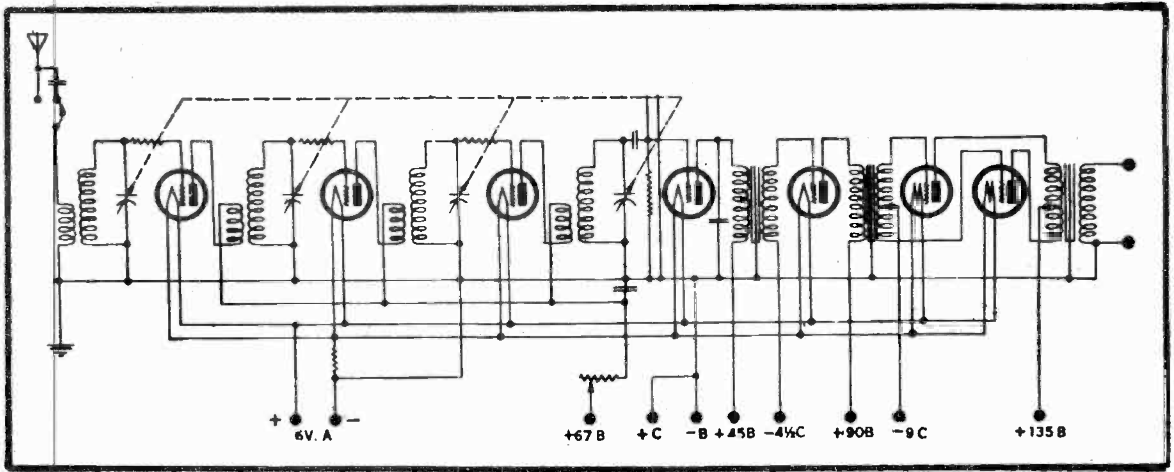

FIG. 3
Battery Type Receiver Circuit.

ERS ARE ALL CONNECTED TO GROUND THROUGH A .1 MFD. BY-PASS CONDENSER AND SO HERE TOO, EITHER OF THESE WINDINGS CAN BE MADE TO SERVE AS THE ANTENNA COIL, WHILE MAKING THE PRESENT TEST.

NOW THAT YOU ARE ABLE TO SEE WHY THIS CAN BE DONE, LET US CONTINUE WITH THE ACTUAL TESTING. IF AFTER THUS ELIMINATING THE 1ST R.F. STAGE AND STILL NOT OBTAINING ANY RESPONSE FROM THE RECEIVER, WE KNOW THAT THE TROUBLE IS NOT LOCALIZED WITHIN THE 1ST. R.F. STAGE AND SO OUR NEXT STEP IS TO REPLACE THE 1ST. R.F. TUBE IN ITS SOCKET, REMOVE THE SECOND R.F. TUBE AND INSERT THE ANTENNA LEAD-IN WIRE INTO THE PLATE HOLE OF THIS LATTER SOCKET. THIS WOULD SERVE TO CUT-OUT THE 1ST. TWO R.F. STAGES AND IN THE CASE OF FIG. 3, WE WOULD NOW HAVE A CONVENTIONAL FIVE-TUBE RECEIVER, WITH AN R.F. STAGE PRECEDING THE DETECTOR. SHOULD THE RECEIVER NOW OPERATE, THEN THE TEST INDICATES THAT THE SECOND R.F. STAGE IS THE ONE

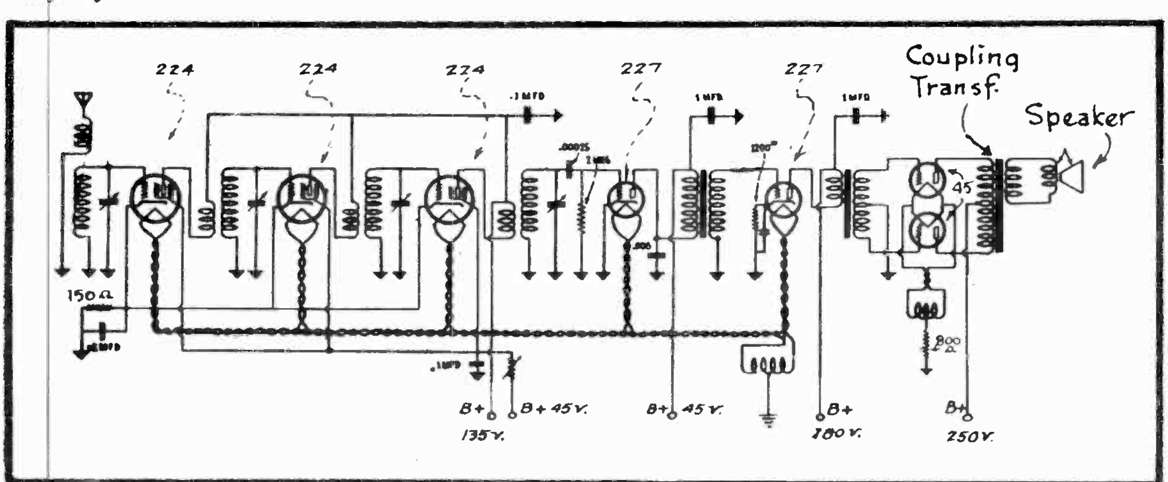

FIG. 4
An A.C. Receiver Circuit.

CAUSING THE TROUBLE.

WE CONTINUE IN THIS WAY, GRADUALLY WORKING CLOSER TOWARD THE DETECTOR STAGE. IT MUST BE UNDERSTOOD, HOWEVER, THAT BY TEMPORARILY OPERATING THE RECEIVER MINUS SOME OF ITS R.F. STAGES, THE SIGNALS, IF THEY COME IN AT ALL, WILL NATURALLY BE WEAKER THAN WITH ALL STAGES IN OPERATION AND ALLOWANCE MUST BE MADE FOR THIS.

WHILE MAKING THIS TEST, A STRONG LOCAL STATION SHOULD BE TUNED IN AND IF FOUND NECESSARY. HEAD-PHONES CAN BE SUBSTITUTED FOR THE SPEAKER, SO AS TO BE ABLE TO DETECT WEAKER SIGNALS. IT IS NOT ADVISABLE TO OPERATE THE RECEIVER WITH MORE THAN ONE OF THE TUBES REMOVED FROM THEIR SOCKET AT THE SAME TIME BECAUSE THIS WILL TEND TO OVERLOAD THE REMAINING TUBES AND IS ESPECIALLY BAD PRACTICE IN A.C. RECEIVERS, WHERE A POWER TRANSFORMER IS USED.

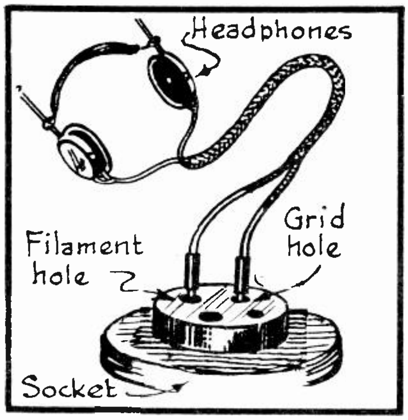

FIG.5
Testing the Power Stage.

THE FINAL R.F. SOCKET, TO WHICH THIS TEST CAN BE APPLIED, IS THE ONE PRECEDING THE DETECTOR AND IF NONE OF THE TESTS HAVE SO FAR INDICATED A DEFECTIVE R.F. STAGE, THEN THE TROUBLE IS LIKELY TO BE LOCATED IN THE DETECTOR, A.F., POWER STAGE OR SPEAKER.

BEING CONVINCED BY THESE TESTS THAT THE TROUBLE IS NOT WITHIN ANY OF THE R.F. STAGES, THEN WE AGAIN CONNECT THE ANTENNA LEAD-IN WIRE TO THE ANTENNA POST OF THE RECEIVER AND SEE TO IT THAT ALL R.F. TUBES ARE PROPERLY REPLACED IN THEIR RESPECTIVE SOCKETS.

LOCATING A DEFECTIVE A.F. STAGE

TO TEST THE AUDIO AND DETECTOR STAGES, WE COMMENCE BY REMOVING THE POWER TUBE FROM ITS SOCKET AND THEN INSERT ONE OF THE CONTACT PINS OF A PAIR OF HEADPHONES INTO THE FILAMENT HOLE OF THE TUBE SOCKET AND THE OTHER PHONE PIN IS INSERTED IN THE GRID HOLE OF THE TUBE SOCKET, AS SHOWN IN FIG. 5. IF THE SIGNALS COME IN QUITE STRONG THROUGH THE PHONES, THE TEST INDICATES THAT EITHER THE SPEAKER OR ELSE THE COUPLING BETWEEN THE SPEAKER AND POWER STAGE IS DEFECTIVE.

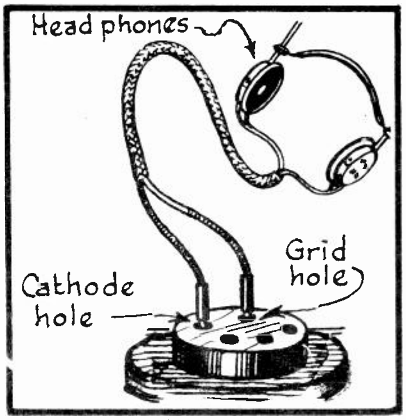

FIG. 6
Testing at a "UY" Socket.

THIS TEST, YOU WILL NOTE IN BOTH FIGS. 3 AND 4 OF THIS LESSON, WILL SERVE TO CONNECT THE PHONES ACROSS THE SECONDARY WINDING OF THE POWER STAGE INPUT TRANSFORMER, OR IN THE CASE OF THE PUSH-PULL AMPLIFIER, IT WILL CONNECT THE PHONES ACROSS HALF THE SECONDARY OF THE INPUT TRANSFORMER.

IF THIS TEST GIVES A VERY WEAK, OR NO SIGNAL RESPONSE AT ALL, THEN THE POWER TUBE IS REPLACED AND THE TUBE OF THE PRECEDING AUDIO STAGE IS REMOVED. IF THIS AUDIO TUBE IS OF THE THREE-ELEMENT TYPE, THEN ONE PHONE TIP IS INSERTED IN THE GRID HOLE OF THE SOCKET AND THE OTHER IN THE FILAMENT HOLE OF THE SOCKET. IF, HOWEVER, THE TUBE BE OF THE HEATER TYPE,

THEN ONE PHONE TIP IS INSERTED IN THE GRID HOLE OF THE SOCKET AND THE OTHER IN THE CATHODE HOLE, AS ILLUSTRATED IN FIG. 6. EITHER OF THESE CONNECTIONS. WILL CONNECT THE PHONES ACROSS THE SECONDARY WINDING OF THE PRECEDING A.F. TRANSFORMER, DEPENDING UPON WHETHER THE SOCKET IS OF THE 4 OR 5 HOLE TYPE.

STRONG SIGNALS PRODUCED IN THE PHONES WITH THIS CONNECTION, INDICATES THAT THE TROUBLE IS IN THE OUTPUT SIDE OF THIS A.F. TUBE AND NOT PRECEDING IT. IN THIS WAY, WE WORK OUR WAY TOWARDS THE DETECTOR UNTIL THE 1ST. A.F. TUBE SOCKET IS REACHED. THEN IF NO RESULTS ARE OBTAINED AT THIS POINT AND CONSIDERING OUR A.F. AND R.F. TESTS TOGETHER, WHICH WE HAVE SO FAR MADE, WE KNOW THAT THE TROUBLE MUST EITHER BE IN THE DETECTOR ITSELF, THE R.F. TRANSFORMER PRECEDING THE DETECTOR, OR ELSE IN THE A.F. COUPLING UNIT IN THE OUTPUT SIDE OF THE DETECTOR TUBE.

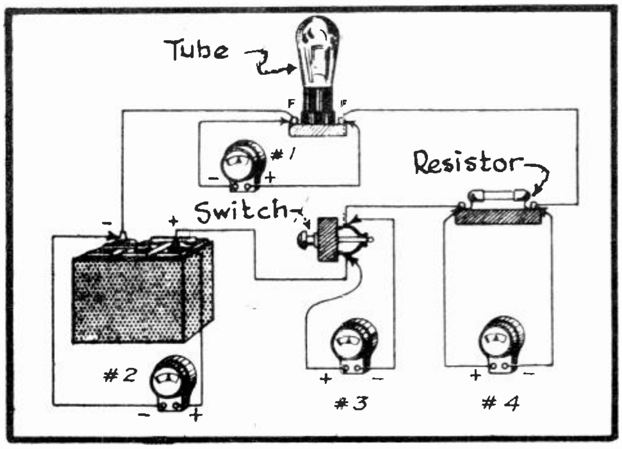

FIG. 7
Testing a Filament Circuit With a Voltmeter.

ALTHOUGH THIS PROCESS SOUNDS RATHER DRAWN OUT, WHEN EXPLAINED IN DETAILED FORM, YET YOU WILL FIND THAT IN ACTUAL PRACTICE, THESE SIMPLE TESTS ARE QUICKLY MADE AND A DEFECTIVE STAGE CAN READILY BE SINGLED OUT FROM THOSE, WHICH ARE IN PROPER WORKING ORDER. ONCE HAVING DETERMINED THE TROUBLED STAGE, ONLY A RELATIVELY SMALL PORTION OF THE RECEIVER'S COMBINED CIRCUITS REMAIN TO BE SEARCHED FOR THE SEAT OF THE TROUBLE AND THIS OFFERS A GREAT SAVING IN TIME.

TESTING IN THE FILAMENT CIRCUIT WITH A VOLTMETER

HAVING MADE THESE PRELIMINARY STAGE TESTS, LET US NOW SEE HOW WE WILL "RUN-DOWN" CIRCUIT TROUBLE, AFTER HAVING A GENERAL IDEA OF WHERE TO LOOK FOR IT. THE FIRST METHOD, WHICH WE SHALL USE IS THE ORDINARY VOLTMETER TEST.

IN FIG. 7, WE HAVE A SIMPLE FILAMENT CIRCUIT FOR A BATTERY OPERATED TUBE AND WE FIND THAT WHEN THE FILAMENT SWITCH IS CLOSED, THE TUBE DOES NOT LIGHT UP. OUR FIRST CHECK IS TO TRY ANOTHER TUBE OF THE SAME TYPE IN THIS SOCKET AND FINDING THAT THIS TOO FAILS TO LIGHT-UP, WE ARE CONVINCED THAT SOMETHING IS RADICALLY WRONG IN THE FILAMENT CIRCUIT AND NOT IN THE TUBE.

THE NEXT THING IS TO LOCATE THE CAUSE OF THE TROUBLE AND WE COMMENCE BY TESTING ACROSS THE FILAMENT TERMINALS OF THE TUBE WITH A D.C. VOLTMETER OF THE PROPER RANGE AS SHOWN AT POSITION #1. WE WILL ASSUME THAT THE VOLTMETER DOES NOT REGISTER ANYTHING HERE, SHOWING US THAT THE TROUBLE IS CLOSER TO THE SOURCE OF THE FILAMENT SUPPLY. THIS BEING THE CASE, IT IS EASIER TO START AT THE SOURCE OR BATTERY AND TO GRADUALLY WORK TOWARDS THE TUBE AS THE SUCCESSIVE TESTS ARE MADE BUT BE SURE THAT THE TUBE IS IN THE SOCKET AND THAT THE SWITCH IS TURNED ON WHILE MAKING THESE TESTS.

NOW THEN, CONNECT YOUR VOLTMETER ACROSS THE BATTERY TERMINALS AS SHOWN AT POSITION #2 AND WE FIND THAT HERE THE VOLTMETER READS FULL BATTERY VOLTAGE. THIS MEANS THAT THE BATTERY IS O.K. SO WE MAKE OUR FOLLOWING VOLTMETER TEST AT POSITION #3, WHERE THE METER IS CONNECTED ACROSS THE SWITCH TERMINALS. WITH THE SWITCH TURNED ON, AND IN GOOD CONDITION, IT WILL OFFER PRACTICALLY NO RESISTANCE TO THE FILAMENT CURRENT AND THEREFORE, NO VOLTMETER READING SHOULD BE OBTAINED HERE.

FINDING THIS TO BE THE CASE, WE CONTINUE OUR TEST BY NEXT CONNECTING OUR VOLTMETER ACROSS THE TERMINALS OF THE FILAMENT RESISTOR AS SHOWN AT POSITION #4. HERE LET US SAY THAT THE METER READS BATTERY VOLTAGE. THIS WOULD INDICATE THAT THE RESISTOR IS OPEN CIRCUITED AND THE DIAGRAM IN FIG. 8 WILL SHOW YOU CLEARLY JUST WHY AN OPEN RESISTOR WILL PRODUCE A VOLTMETER READING EQUIVALENT TO BATTERY VOLTAGE.

NOTICE IN FIG. 8 THAT ON ACCOUNT OF THE OPEN RESISTOR, CONDITIONS ARE SUCH THAT THE VOLTMETER IS ACTUALLY CONNECTED ACROSS THE TWO BATTERY TERMINALS WITH ONLY THE TUBE AND SWITCH IN SERIES WITH THE CIRCUIT.

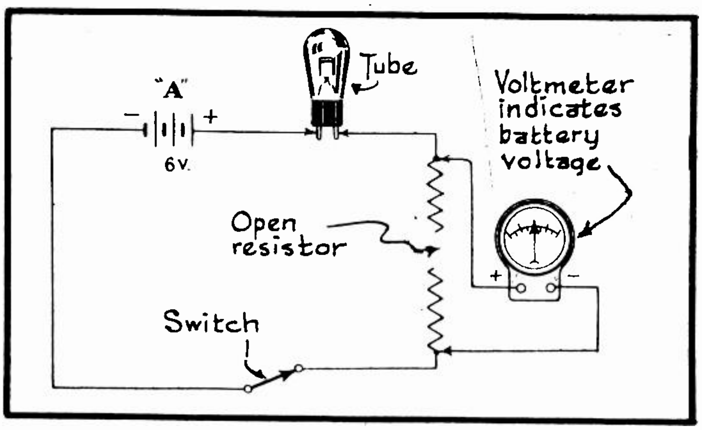

FIG. 8
Test Obtained at Open Circuit.

TO REMEDY THE CONDITION JUST FOUND, WE WOULD REPLACE THE OPEN RESISTOR WITH A NEW ONE OF THE SAME RATING.

WITH THE CIRCUIT OF FIG. 7 AND 8 IN PERFECT CONDITION AND WITH A TUBE USED, HAVING A RATING OF OF 5 VOLTS FILAMENT VOLTAGE, WHILE A 6 VOLT BATTERY IS BEING USED, WE WOULD FIND THAT THE VOLTMETER READING ACROSS THE FILAMENT TERMINALS OF THE TUBE WOULD BE 5 VOLTS. THE NORMAL VOLTMETER READING ACROSS THE FILAMENT RESISTOR IN THIS CASE WOULD BE 1 VOLT, WHICH WOULD ACCOUNT FOR THE 1 VOLT DROP FURNISHED BY THE RESISTOR. WHEN TESTING, ONE MUST TAKE THESE DIFFERENT CONDITIONS INTO CONSIDERATION.

THE METER USED FOR THE TESTS JUST DESCRIBED SHOULD HAVE A MAXIMUM SCALE READING ABOVE 6 VOLTS BUT YET NOT HIGH ENOUGH, SO THAT 6 VOLTS CAN HARDLY BE READ. WE WOULD OF COURSE USE A D.C. VOLTMETER IN THIS D.C. CIRCUIT AND IF UPON TEST, WE FIND THAT THE NEEDLE MOVES ACROSS THE SCALE IN THE WRONG DIRECTION, ALL THAT MUST BE DONE IS TO REVERSE THE TEST CONNECTIONS. TO TEST AN A.C. FILAMENT CIRCUIT, WE WOULD FOLLOW THE SAME SYSTEM AS JUST DESCRIBED, ONLY THAT AN A.C. VOLTMETER OF THE PROPER SCALE CALIBRATION WOULD BE USED. OTHERWISE, THE TESTS ARE MADE EXACTLY ALIKE AND BE SURE TO HAVE THE RADIO SWITCH TURNED ON WHEN MAKING TESTS OF THIS KIND.

CHECKING A PLATE CIRCUIT WITH A VOLTMETER

NOW IN FIG. 9, YOU WILL OBSERVE A SIMPLE PLATE CIRCUIT OF AN A.C. RECEIVER, SO LET US SEE HOW WE COULD TEST THIS CIRCUIT WITH A VOLTMETER.

FIRST OF ALL, TAKE NOTE THAT A D.C. VOLTMETER IS USED AND THAT ITS RANGE IS SUFFICIENTLY GREAT FOR THE HIGH "B" VOLTAGES BEING USED. FURTHERMORE, THIS VOLTMETER SHOULD HAVE A HIGH INTERNAL RESISTANCE.

TO MAKE A PRACTICAL PROBLEM OF THE CIRCUIT ILLUSTRATED IN FIG. 9, WE WILL ASSUME THAT WE HAVE SO FAR TRACED THE TROUBLE SUFFICIENTLY TO KNOW THAT IT IS SOMEWHERES IN THE PLATE CIRCUIT HERE SHOWN. THE VOLTMETER CONNECTION AT POSITION #1 SHOULD GIVE US THE ACTUAL PLATE VOLTAGE, WHICH IS APPLIED TO THIS TUBE BUT WE WILL ASSUME THAT THE VOLTMETER AT #1 DOES NOT READ ANYTHING. IN OTHER WORDS, THIS SHOWS US THAT THE PLATE OR "B" VOLTAGE IS NOT GETTING UP TO THE TUBE FROM THE VOLTAGE DIVIDER OR "B" SUPPLY.

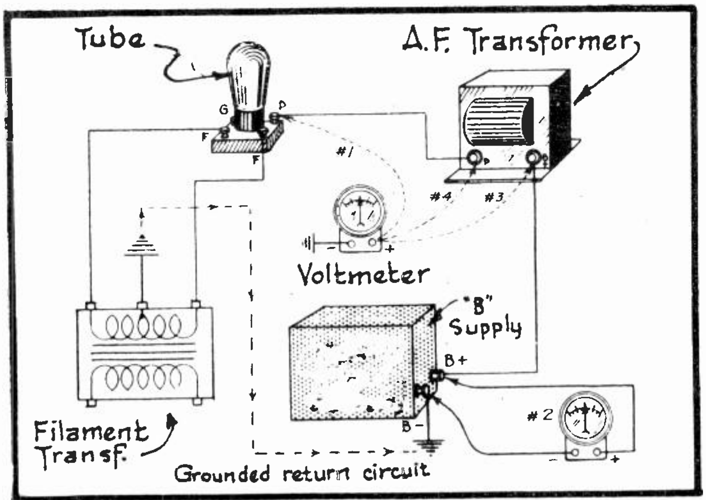

FIG. 9
Voltmeter Tests In Plate Circuit

KNOWING THIS, OUR NEXT STEP IS TO CHECK OUR VOLTAGE AT THE "B" OUTPUT FOR THIS PARTICULAR PLATE CIRCUIT AND WITH THE VOLTMETER CONNECTED ACROSS THE PROPER "B"+ TERMINAL AND B- (GROUND IN THIS CASE) WE FIND THAT HERE THE VOLTAGE IS CORRECT. THIS METER CONNECTION IS ILLUSTRATED AT #2 IN FIG. 9.

SO FAR, WE HAVE FOUND THAT THE PLATE VOLTAGE IS PRESENT AT THE "B" SUPPLY OR DIVIDER BUT IS NOT GETTING UP TO THE PLATE OF THE TUBE, SO IT IS NO MORE THAN NATURAL THAT WE ARE LOSING IT SOMEWHERE ALONG THE LINE BETWEEN THESE TWO POINTS. THEREFORE, WE GRADUALLY WORK OUR WAY FROM THE VOLTAGE DIVIDER UP TO THE TUBE SOCKET IN QUESTION, TESTING AT EACH UNIT AS WE GO ALONG.

IN FIG. 9, OUR FIRST CHECKING POINT ALONG THE LINE WILL BE THE A.F. TRANSFORMER TERMINAL LABELED B+. MAKING OUR VOLTMETER CONNECTIONS AS SHOWN AT POSITION #3, WE WILL ASSUME THAT HERE AGAIN FULL "B" VOLTAGE IS REGESTERED (NOTE THAT THE VOLTMETER IS AT THIS TIME STILL CONNECTED ACROSS THE B+ AND B- TERMINALS BECAUSE THE B- LINE IS GROUNDED TO THE METAL CHASSIS.) FULL VOLTAGE AT THIS POINT INDICATES THAT THE CIRCUIT FROM THE "B" SUPPLY TO THIS POINT IS O.K.

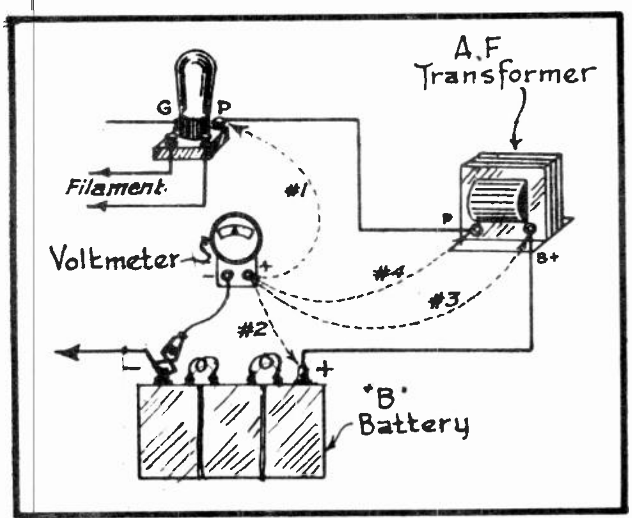

FIG. 10
Voltmeter Test In Plate Circuit Without Ground Return System.

HAVING OBTAINED A SATISFACTORY TEST HERE, WE NEXT MOVE TO THE PLATE TERMINAL OF THE TRANSFORMER (P), MAKING OUR METER CONNECTIONS AS SHOWN AT POS-

ITION #4. HERE LET US SAY THAT THE VOLTMETER GIVES US NO READING. NOW SINCE A SATISFACTORY READING IS OBTAINED AT POSITION #3 AND NONE AT #4, THE TEST SHOWS THAT THE PRIMARY WINDING OF THIS A.F. TRANSFORMER IS OPEN CIRCUITED AND FOR THIS REASON, THE "B" VOLTAGE CANNOT BE IMPRESSED UPON THE PLATE OF THE TUBE. THE REMEDY, IN THIS CASE IS TO REPLACE THE DEFECTIVE TRANSFORMER WITH A GOOD ONE.

IN CASE THE PLATE CIRCUIT IN QUESTION DOES NOT EMPLOY A GROUND RETURN SYSTEM, SUCH AS THE BATTERY CIRCUIT IN FIG. 10, THEN THE SAME METER CONNECTIONS AS DESCRIBED IN RELATION TO FIG. 9 ARE MADE AS ILLUSTRATED IN FIG. 10. THE ONLY DIFFERENCE BETWEEN THE PLATE CIRCUITS OF THESE TWO ILLUSTRATIONS IS THAT ONE USES A WIRE RETURN PATH FOR THE "B" SUPPLY, WHEREAS THE OTHER USES THE METAL CHASSIS FOR THIS PURPOSE. CONSEQUENTLY, IN FIG. 10, WE CONNECT THE NEGATIVE SIDE OF THE VOLTMETER TO THE MINUS "B" TERMINAL, WHILE THE POSITIVE SIDE OF THE METER IS IN TURN MOVED TO THE DIFFERENT POSITIONS INDICATED.

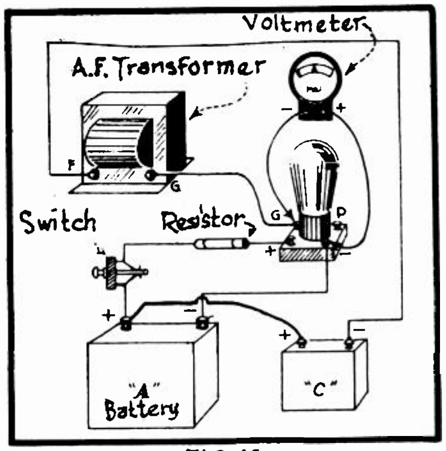

FIG. 11
Checking Bias Voltage at Tube in D.C. Set.

TO FASCILITATE MATTERS OF THIS NATURE IN ACTUAL PRACTICE, IT IS ADVISABLE TO LEAVE THE NEGATIVE METER TEST LEAD FASTENED TO THE NEGATIVE SIDE OF THE CIRCUIT BEING CHECKED, BY MEANS OF A SNAP CLIP, WHILE THE POSITIVE TEST LEAD IS PROVIDED WITH THE CUSTOMARY SHARPENED TEST POINT.

ALSO REMEMBER THAT WHEN CHECKING THE PLATE VOLTAGE AT A TUBE IN A D.C. RECEIVER CIRCUIT, THE POSITIVE SIDE OF THE METER IS CONNECTED TO THE PLATE TERMINAL OF THE TUBE SOCKET AND THE NEGATIVE METER TERMINAL IS CONNECTED TO THE NEGATIVE FILAMENT TERMINAL. THIS CONNECTION GIVES THE TRUE AND EFFECTIVE PLATE VOLTAGE AT THE TUBE.

TO CHECK THE SCREEN GRID VOLTAGE AT ANY SOCKET, CONNECT THE (+) TERMINAL OF THE D.C. VOLTMETER TERMINAL TO THE SCREEN GRID TERMINAL OF THE TUBE AND THE (-) TERMINAL OF THE METER TO THE CATHODE TERMINAL OF THE TUBE SOCKET, TO THE NEGATIVE FILAMENT TERMINAL IN THE CASE OF BATTERY OPERATED RECEIVERS, OR TO THE CENTER TAP OF THE FILAMENT TRANSFORMER WINDING IN THE CASE OF FILAMENT TYPE A.C. TUBES.

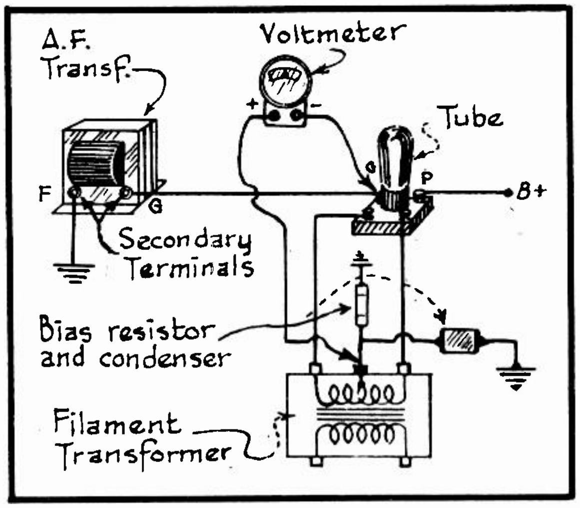

FIG. 12
Checking Bias Voltage at Tube in A.C. Set.

CHECKING A GRID CIRCUIT WITH A VOLTMETER

SO FAR, WE HAVE SEARCHED FOR OPENS BOTH IN THE FILAMENT AND PLATE CIRCUITS WITH THE AID OF A VOLTMETER, AS WELL AS TO CHECK OUR VOLTAGES AT THESE POINTS, SO LET US NEXT SEE HOW WE WOULD CHECK FOR THE GRID BIAS VOL-

TAGE OF A TUBE. REFERRING TO FIG. 11, YOU WILL SEE THE METER CONNECTION FOR CHECKING THE BIAS VOLTAGE IN THE TUBE CIRCUIT, IN WHICH THE VOLTAGES ARE FURNISHED BY BATTERIES.

NOTICE THAT THE VOLTMETER IS CONNECTED ACROSS THE GRID AND NEGATIVE FILAMENT TERMINAL OF THE TUBE SOCKET. THE METER READING SHOULD BE THAT REQUIRED FOR THE TYPE OF TUBE IN USE AND IN PREVIOUS LESSONS ON RECEIVER TUBES, YOU WERE GIVEN THE REQUIRED "C" VOLTAGES FOR THE POPULAR TUBES OF BOTH THE A.C. AND D.C. TYPES.

SHOULD NO "C" VOLTAGE BE AVAILABLE AT THE TUBE SOCKET UPON MAKING THIS TEST, THEN CHECK AT THE "C" BATTERY TERMINALS AND GRADUALLY WORK YOUR WAY ALONG THE "C" CIRCUIT TOWARDS THE TUBE, JUST AS DESCRIBED RELATIVE TO THE "B" CIRCUIT AND THE FIRST POINT OF NO READING WILL TELL YOU WHERE THE TROUBLE IS, AS FAR AS OPEN CIRCUITS ARE CONCERNED.

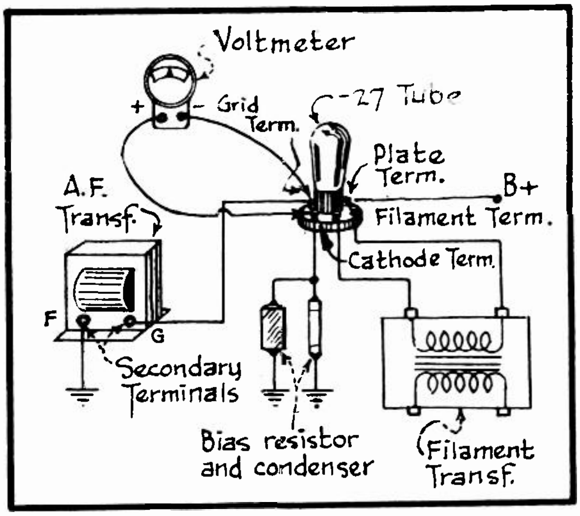

FIG. 13
Checking Bias Voltage In Circuit Using -27 Tube.

THE METHOD OF MAKING THIS BIAS VOLTAGE CHECK, WHEN A -26 A.C. TUBE IS USED, IS ILLUSTRATED IN FIG. 12. HERE THE BIAS VOLTAGE IS OBTAINED BY MEANS OF THE RESISTOR, WHICH IS CONNECTED TO THE CENTER TAP OF THE TUBE'S FILAMENT WINDING AND WHOSE OTHER END IS GROUNDED. IN THIS CASE, WE CONNECT ONE TEST LEAD TO THE GRID TERMINAL OF THE SOCKET, WHEREAS THE OTHER TEST POINT IS CONNECTED TO THE CENTER TAP OF THE FILAMENT TRANSFORMER WINDING. THIS LATTER POINT, YOU WILL REMEMBER AS BEING THE ELECTRICAL CENTER OR "ZERO" POINT OF THE FILAMENT.

IN CASE A HUM ADJUSTER SHOULD BE CONNECTED ACROSS THIS FILAMENT LINE, WITH THE CENTER POINT OF THE RESISTOR GROUNDED, THEN WE WOULD CONNECT ONE SIDE OF THE VOLTMETER TO THE GRID TERMINAL OF THE TUBE SOCKET AND THE OTHER SIDE TO THE CENTER OF THE HUM RESISTOR, BUT TO THE UN-GROUNDED END OF THE BIAS RESISTOR. THE VOLTAGE CHECK MADE IN THIS WAY WILL BE ACCURATE BECAUSE THE BIAS IS BEING MEASURED BETWEEN THE GRID AND NEUTRAL POINT OF THE A.C. FILAMENT.

FIG. 13 SHOWS YOU HOW THE BIAS VOLTAGE IS MEASURED AT A HEATER TYPE TUBE, THE -27 IN THIS CASE. NOTICE THAT HERE ONE END OF THE VOLTMETER IS CONNECTED TO THE GRID TERMINAL OF THE TUBE SOCKET AND THE OTHER METER CONNECTION IS MADE AT THE CATHODE TERMINAL OF THE TUBE SOCKET. ALSO BEAR IN MIND THAT THE GRID BIAS VOLTAGE MUST BE NEGATIVE AND NOT POSITIVE. IN OTHER WORDS, THE GRID MUST BE MORE NEGATIVE THAN THE ELECTRON EMITTER (CATHODE OR FILAMENT).

WHEN SEARCHING FOR AN OPEN IN THE BIAS VOLTAGE CIRCUIT IN AN A.C. RECEIVER, DISCONNECT THE VOLTMETER FROM THE TUBE SOCKET'S GRID TERMINAL ONLY, LEAVING THE OTHER VOLTMETER LEAD IN ITS FORMER POSITION. NOW TOUCH THE FREE LEAD OF THE VOLTMETER TO THE GRID TERMINAL OF THE PRECEDING TRANSFORMER, THEN TO THE -F TRANSFORMER TERMINAL ETC., GRADUALLY WORK

ING AWAY FROM THE TUBE WITH THIS TEST LEAD. BETWEEN THE POINTS OF FULL BIAS VOLTAGE READING AND NO READING WILL BE FOUND THE OPEN.

SHORTS AND GROUNDS

SO FAR, WE HAVE LOCATED OPEN CIRCUITS BUT HAVE NOT AS YET CONCERNED OURSELVES WITH SHORT CIRCUITS AND GROUNDS. THIS THEN, IS GOING TO BE OUR NEXT JOB.

NOW AN ACCIDENTAL GROUND, OPEN, OR SHORT WILL ALL PREVENT THE CIRCUIT IN WHICH THEY EXIST, FROM OPERATING PROPERLY. THE OPEN ACTS AS THOUGH THE CIRCUIT WERE BEING INTERRUPTED, THE SAME AS THOUGH A SWITCH WERE OPENED AND NO CURRENT IS THEREFORE BEING DRAWN FROM THE SOURCE OF POWER. THE SHORT AND GROUND, HOWEVER, OFFER AN ELECTRIC PATH OTHER THAN THAT ORIGINALLY INTENDED FOR THE CIRCUIT AND FIG. 14 WILL NO DOUBT SERVE TO CLEAR THIS UP IN YOUR MIND.

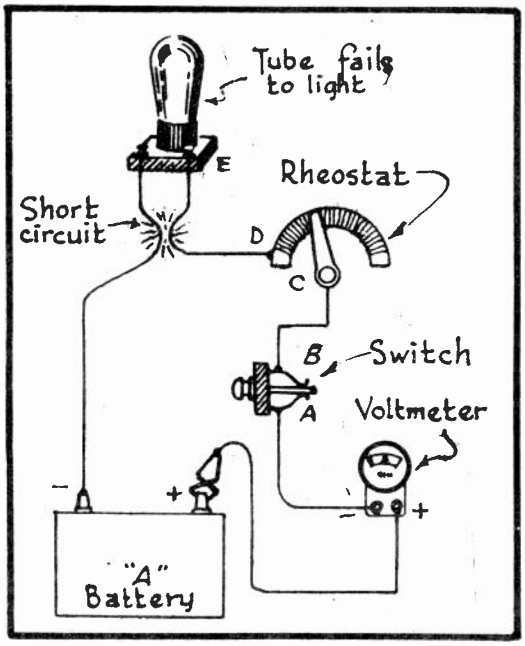

FIG. 14
Locating a Short Circuit.

LOCATING A SHORT

IN FIG. 14, WE ARE REPRESENTING A FILAMENT CIRCUIT FOR A SINGLE TUBE AND AT THE POINT LABELED "SHORT CIRCUIT" THE TWO FILAMENT WIRES HAVE ACCIDENTALLY COME IN CONTACT WITH EACHOTHER. IT MUST BE UNDERSTOOD AT THIS POINT THAT TWO THOROUGHLY INSULATED WIRES, WHEN BROUGHT INTO CONTACT WITH EACHOTHER, WILL NOT PRODUCE A SHORT BECAUSE THE INSULATION WILL SERVE TO KEEP THE TWO COPPER WIRES FROM TOUCHING EACHOTHER. SHOULD, HOWEVER, THE INSULATION BECOME CHAFED OR SCRAPED OFF THESE WIRES, SO THAT THE COPPER STRANDS MAKE CONTACT WITH EACHOTHER, THEN WE HAVE A DIRECT ELECTRICAL CONNECTION BETWEEN THE TWO SIDES OF THE CIRCUIT AT THIS POINT, SO THAT CURRENT CAN FLOW THROUGH THIS CONTACT.

THIS BEING THE CASE IN FIG. 14, IT IS OBVIOUS THAT THE FILAMENT CURRENT FROM THE BATTERY HAS ITS CHOICE OF FLOWING EITHER THROUGH THE TUBE'S FILAMENT OR ELSE THROUGH THE POINT OF SHORTING IN THE LINEWIRES. THE FILAMENT, HOWEVER, OFFERS CONSIDERABLE RESISTANCE OR OPPOSITION TO THE FLOW OF CURRENT, WHEREAS THE SHORT OFFERS PRACTICALLY NONE. THE RESULT IS, THAT THE CURRENT FLOWS THROUGH THE PATH OF LEAST RESISTANCE, WHICH IN THIS CASE HAPPENS TO BE THROUGH THE SHORT AND THE TUBE'S FILAMENT IS DEPRIVED OF ITS CURRENT ALTOGETHER AND THEREFORE CANNOT "LIGHT."

FURTHERMORE, DUE TO THE LOW RESISTANCE OF THIS SHORT, A HEAVY CURRENT WILL BE DRAWN WHICH WILL CAUSE THIS CIRCUIT TO BECOME OVERLOADED AND THEREFORE HEAT UP. THIS WILL GENERALLY PRODUCE AN ODOR FROM BURNING INSULATION AND IF A BATTERY IS FURNISHING THE CURRENT, THEN IT WILL BECOME DISCHARGED IN A SHORT TIME.

IF THIS POINT OF SHORTING CANNOT BE SEEN OFF-HAND, WE CANLOCATE IT

QUITE EASILY BY OPEN CIRCUITING THE LINE AT THE SOURCE OF THE CURRENT AND INSERTING A VOLTMETER IN SERIES WITH THE LINE, AS SHOWN IN FIG. 14. THIS VOLTMETER SHOULD BE CAPABLE OF READING FULL FILAMENT VOLTAGE AND DUE TO ITS HIGH INTERNAL RESISTANCE, IT WILL REDUCE THE FLOW OF THIS EXCESSIVE FILAMENT CURRENT ENOUGH SO THAT THE SHORTED CIRCUIT CAN NO LONGER BECOME HOT, WHEN WE TURN ON THE SWITCH.

THE VOLTMETER, AS CONNECTED TO THE CIRCUIT IN FIG. 14, WILL GIVE A DEFINITE READING, WHOSE AMOUNT WILL DEPEND UPON THE RESISTANCE OF THE CIRCUIT. NOW TO LOCATE THIS SHORT, WE OPEN ONE PORTION OF THE FILAMENT CIRCUIT AT A TIME, WORKING OUR WAY FROM THE VOLTMETER TOWARDS THE TUBE. FOR EXAMPLE, WE WOULD START BY DISCONNECTING THE CIRCUIT AT POINT "A" OF THE SWITCH. THIS OPENING OF THE CIRCUIT WOULD CAUSE THE VOLTMETER NEEDLE TO DROP TO A ZERO READING, SHOWING US THAT THE SHORT IS STILL FARTHER UP THE LINE.

WE NOW RECONNECT CONNECTION "A" AND OPEN THE LINE AT "B". THIS DONE, THE VOLTMETER NEEDLE WILL AGAIN DROP TO ZERO THE SAME AS BEFORE, SO WE RECONNECT THIS POINT AND CONTINUE THIS ROUTINE IN THE SAME WAY AT POINTS "C" AND "D" OF THE RHEOSTAT. ANY OF THESE POINTS, WHEN DISCONNECTED, WILL CAUSE THE VOLTMETER NEEDLE TO DROP TO ZERO AND HAVING COMPLETED OUR TEST AT "D", WE RECONNECT THIS POINT AND THEN DISCONNECT POINT "E" AT THE TUBE SOCKET. UPON DOING THIS, WE WILL FIND THAT THE VOLTMETER DOES NOT DROP TO ZERO BUT REMAINS AT ITS FORMER READING AND THIS INDICATES THAT THE VOLTMETER CIRCUIT IS COMPLETED THROUGH THE SHORT, EVEN THOUGH "E" BE DISCONNECTED.

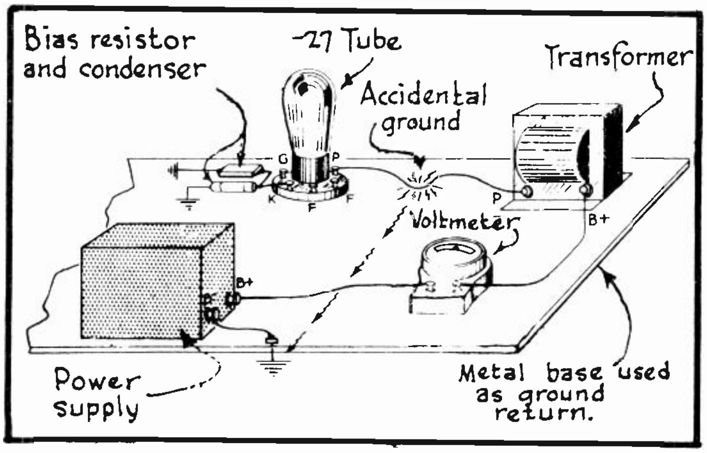

FIG. 15
Accidental ground in Plate Circuit.

THE RULE THEN, FOR LOCATING SUCH A SHORT IS THAT THE SHORT IS LOCATED BETWEEN THE FIRST PLACE AT WHICH THE METER CONTINUES TO READ VOLTAGE AND THE LAST PLACE AT WHICH THE METER DROPPED BACK TO ZERO. IN OTHER WORDS, IN THE CASE ILLUSTRATED IN FIG. 14, THE SHORT IS SOMEWHERES BETWEEN POINTS "D" AND "E".

THIS PORTION OF THE CIRCUIT CAN THEN BE CAREFULLY INSPECTED UNTIL THE EXACT POINT OF SHORTING IS LOCATED. THE WIRES CAN THEN BE SEPARATED FROM EACHOTHER AND EACH OF THEM CAREFULLY INSULATED AT THIS POINT WITH FRICTION TAPE, OR ELSE THE LINES CAN BE REPLACED WITH NEW WIRE, IF THIS SHOULD BE FOUND NECESSARY.

A SHORT IN THE PLATE CIRCUIT ETC. CAN BE LOCATED BY MEANS OF THIS SAME SYSTEM OF TESTING, ONLY THAT ONE MUST BE CAREFUL TO USE A VOLTMETER SCALE SUITABLE FOR THE VOLTAGE NORMALLY HANDLED BY THE CIRCUIT IN QUESTION.

LOCATING A GROUND

TO SHOW YOU HOW AN ACCIDENTAL GROUND WILL ACT, WE ARE USING FIG. 15,

WHICH ILLUSTRATES AN ACCIDENTALLY GROUNDED PLATE CIRCUIT. THE CIRCUIT WHEN IN OPERATING CONDITION, HAS THE B+ OF THE VOLTAGE DIVIDER CONNECTED TO THE B+ TERMINAL OF THE TRANSFORMER. THE "P" (PLATE) TERMINAL OF THE TRANSFORMER WAS ORIGINALLY DIRECTLY CONNECTED TO THE PLATE TERMINAL OF THE TUBE SOCKET BY MEANS OF AN INSULATED WIRE. THE PLATE CURRENT, AFTER HAVING PASSED THROUGH THE TUBE, WOULD FLOW FROM THE CATHODE THROUGH THE BIAS RESISTOR AND BY WAY OF THE METAL CHASSIS (GROUND) BACK TO THE GROUNDED B- TERMINAL OF THE "B" POWER UNIT.

SHOULD THE PLATE CIRCUIT BECOME ACCIDENTALY GROUNDED AT THE POINT INDICATED IN FIG. 15 BECAUSE OF THE INSULATION BEING SCRAPED OFF THE CONNECTING WIRE, THEN THE PLATE CURRENT WOULD RETURN DIRECTLY FROM THE TRANSFORMER BACK TO THE POWER UNIT BY WAY OF THE METAL CHASSIS, WITHOUT EVER REACHING THE TUBE. NATURALLY, THE TUBE WOULD BE INOPERATIVE.

TO LOCATE THE GROUND, DISCONNECT THE PLATE CIRCUIT FROM THE CORRECT B+ TERMINAL OF THE VOLTAGE DIVIDER AND CONNECT A VOLTMETER, OF THE PROPER CALIBRATION, IN SERIES WITH THE PLATE CIRCUIT AS SHOWN IN FIG. 15. THEN PROCEED BY DISCONNECTING THE CIRCUIT AT THE B+ TERMINAL OF THE TRANSFORMER AND NOTE THE ACTION OF THE METER. IN THIS CASE, THE NEEDLE WILL DROP TO A ZERO READING. RECONNECT THIS POINT, AND THE METER WILL AGAIN READ "B" VOLTAGE BUT IT WILL ONCE MORE DROP TO ZERO WHEN INTERRUPTING THE CIRCUIT AT THE "P" TERMINAL OF THE TRANSFORMER.

DISCONNECTING THE CIRCUIT AT THE PLATE TERMINAL OF THE TUBE SOCKET HAS NO EFFECT UPON THE METER AND IT CONTINUES TO READ "B" VOLTAGE, THEREBY INDICATING THAT THE GROUND EXISTS SOMEWHERES BETWEEN THE LAST TWO POINTS CHECKED, OR BETWEEN THE PLATE TERMINAL OF THE TUBE SOCKET AND TRANSFORMER IN THIS PARTICULAR CASE.

THE ACCIDENTAL GROUND ACTS THE SAME AS A SHORT, ONLY THAT THE GROUND MEANS ELECTRICAL CONTACT BETWEEN A WIRE AND THE METAL CHASSIS, WHICH ACTS AS THE OTHER SIDE OF THE CIRCUIT, WHEREAS A SHORT MEANS AN ELECTRICAL CONTACT BETWEEN TWO WIRES, BOTH OF WHICH SERVE AS A SIDE OF THE SAME CIRCUIT. DON'T BY ANY MEANS BECOME CONFUSED BETWEEN THE ACCIDENTAL GROUND AND THE GROUNDING METHODS, WHICH ARE INTENTIONALLY USED ON RECEIVERS.

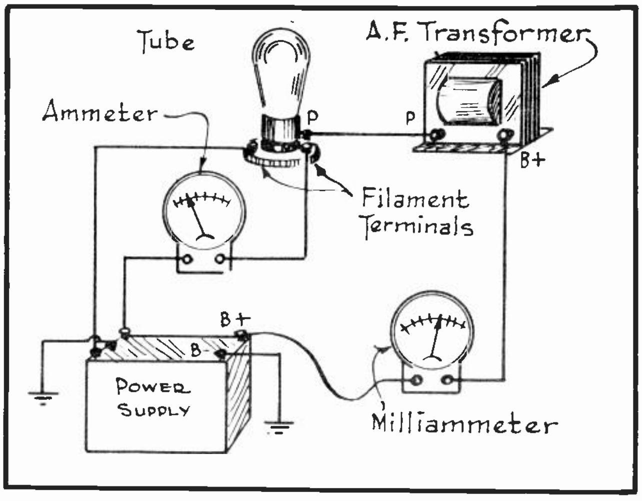

FIG. 16
Measuring Filament and Plate Current.

TO REPAIR A GROUND, THE DEFECTIVE WIRE CAN BE TAPED OR ELSE REPLACED WITH A NEW ONE. AT ANY RATE THE WIRE MUST BE REMOVED FROM ANY FURTHER ELECTRICAL CONTACT WITH THE METAL CHASSIS.

QUITE OFTEN, YOU WILL FIND "B" CIRCUITS TO BECOME GROUNDED DUE TO THE SHORT CIRCUITING OF BY-PASS CONDENSERS, WHICH ARE CONNECTED BETWEEN THE "B" CIRCUIT AND GROUND. SUCH BROKEN DOWN CONDENSERS CAN BE READILY LOCATED BY APPLYING the same series of tests as already described relative to Fig.15. Having thus located the point of grounding, the suspected condenser can be disconnected from the circuit and then checked by means of the voltmeter-battery type continuity tester as already described in your previous lesson.

MEASURING PLATE AND FILAMENT CURRENTS

Having familiarized yourself with various uses of voltmeters, you are now ready to measure the filament and plate currents, which are drawn by tubes. The meter connections for determining these currents are shown in Fig. 16.

Here you will see how the plate circuit is temporarily disconnected, so that a milliammeter can be connected in SERIES with the plate circuit. All plate current for this tube must therefore flow through the milliammeter and be registered by it.

This milliammeter does not necessarily have to be connected at the particular point shown in Fig. 16 but may be connected in the line between the plate terminal of the tube socket and the plate terminal of the transformer. The important thing is to connect it in SERIES with the plate circuit.

In Fig. 16, you are also shown how an AMMETER is connected in the filament circuit, so as to measure the current drawn by the filament of the tube. Here again, the circuit must be OPENED in order to make the meter connections but either side of the filament circuit can be used because the same filament current flows through all parts of the filament circuit.

Again we want to remind you that if your meter reads backwards (goes off the scale on the zero end) then it just means that you have the meter connections reversed. A reversal of your connections will then enable your meter to read in the correct direction. This holds good in all D.C. circuits but in A.C. circuits, you don't have to worry about polarity when making meter tests; for the meter reads correctly with either of the two possible polarity connections.

INDICATIONS OF METER READINGS

Up to this point, we have centered our testing operations upon the use of meters, both for checking values, as well as to run down circuit troubles. The next thing then, is to learn what IMPROPER meter readings at the tubes are likely to indicate and this will help you a great deal in running down circuit trouble that much quicker. The best way to do this, no doubt, is to give you these possible troubles in outline form as follows:

VOLTMETER READS ZERO WHEN CONNECTED ACROSS THE FILAMENT TERMINALS OF THE TUBE SOCKET.

1. - Discharged "A" battery in battery sets.
2. - An open or else complete short in this circuit.
3. - Defective tupe socket.
4. - Defective filament circuit switch.

5. - DEFECTIVE POWER TRANSFORMER.
6. - PRIMARY CIRCUIT OF POWER TRANSFORMER INCOMPLETE.

FILAMENT OR HEATER VOLTAGE TOO HIGH.

1. - HIGH LINE VOLTAGE, OR WRONG CONNECTION OF LINE VOLTAGE TAP.
2. - HEATER OR FILAMENT BURNED OUT.
3. - ONE OR MORE TUBES IN SAME CIRCUIT BURNED OUT, THEREBY DECREASING LOAD ON CIRCUIT.
4. - TUBE OF WRONG TYPE FOR SOCKET.
5. - PRIMARY WINDING OF POWER TRANSFORMER PARTIALLY SHORTED.

PLATE VOLTAGE LACKING AT ALL TUBES.

1. - SHORTED FILTER CONDENSER.
2. - OPEN FILTER CHOKE.
3. - DEFECTIVE RECTIFIER TUBE.
4. - DEFECTIVE POWER TRANSFORMER.
5. - PLATE CIRCUIT OF POWER TUBE GROUNDED.
6. - OPEN IN MAIN "B" CIRCUIT FEEDING ALL OTHER "B" CIRCUITS.

NO PLATE VOLTAGE ON ONE TUBE AND LOW PLATE VOLTAGE ON OTHER TUBES.

1. - SHORTED BY-PASS OR COUPLING CONDENSER.
2. - OPEN R.F. CHOKE.
3. - DEFECTIVE TUBE.
4. - GROUNDED PLATE CIRCUIT.
5. - OPEN RESISTOR.

NO PLATE VOLTAGE ON POWER TUBES BUT PRESENT AT OTHER TUBES.

1. - OPEN IN OUTPUT OR SPEAKER COUPLING UNIT.
2. - OPEN IN POWER TUBE PLATE CIRCUIT.

LOW PLATE VOLTAGE ON ALL TUBES.

1. - DEFECTIVE RECTIFIER TUBE.
2. - DEFECTIVE FILTER CONDENSER.
3. - SHORTED BIAS RESISTOR BY-PASS CONDENSER.
4. - SHORTED GRID BIAS RESISTOR.
5. - DEFECTIVE BY-PASS CONDENSER.
6. - LOW LINE VOLTAGE.
7. - DEFECTIVE VOLTAGE DIVIDER.
8. - DEFECTIVE FILTER CHOKE.
9. - DEFECTIVE POWER TRANSFORMER.

HIGH PLATE VOLTAGE.

1. - HIGH LINE VOLTAGE.
2. - SHORTED FILTER CHOKE.
3. - SHORT CIRCUITED RESISTOR.
4. - WORN OUT TUBES PLACING INSUFFICIENT "B" LOAD UPON POWER SUPPLY. (OPEN IN "B" CIRCUIT OF POWER STAGE WILL INCREASE THE "B" VOLTAGE AT TUBES IN THE OTHER STAGES.)
5. - EXCESSIVE GRID BIAS RESISTANCE IN POWER STAGE.

EXCESSIVE PLATE CURRENT.

1. - Excessive plate voltage.
2. - Excessive screen grid voltage.
3. - Open grid circuit.
4. - Not enough grid bias.
5. - Gaseous tube.

LOW PLATE CURRENT WITH NORMAL PLATE VOLTAGE.

1. - Defective tube.
2. - Too much bias resistance.
3. - Low filament voltage.
4. - Low screen grid voltage.

NO SCREEN GRID VOLTAGE.

1. - Shorted screen-grid by-pass condenser.
2. - Defective tube.
3. - Defective resistor.
4. - Open screen grid circuit.

NO GRID BIAS.

1. - Open grid circuit.
2. - Grounded cathode.
3. - Grounded filament.
4. - Shorted grid by-pass condenser.

LOW GRID BIAS.

1. - Low plate current.
2. - Old tubes.
3. - Defective bias resistance or one of incorrect value.
4. - Defective bias resistor by-pass condenser.

HIGH GRID BIAS.

1. - Excessive plate current.
2. - Bias resistor of too high value.
3. - Defective bias resistor.

You are making excellent progress in your studies and each lesson is doing its part towards qualifying you as a radio expert.

This and the preceding lesson supplied you with some exceptionally important information concerning receiver troubles and tests. We, therefore, suggest that you review these lessons with special care so that all of the information and suggestions offered therein will become thoroughly fixed in your mind for future use. You will soon be called upon to apply this knowledge to practical problems out in the industry and it thus becomes essential for you to REMEMBER THE FACTS.

In the following lesson, you are going to study about RADIO INTERFERENCE--how to locate it and how to eliminate it. You are going to find this study especially interesting, as well as highly instructive.

Examination Questions

LESSON NO. 22

There is no substitute for common sense. No man can do all your thinking for you. Your brains are better for hard use. You can't be a fool and handle a worthwhile job successfully.

1. – Describe a simple method whereby you can determine whether or not an R.F. stage of a receiver is inoperative.

2. – Describe a simple method whereby you can determine whether or not an A.F. stage of a receiver is inoperative.

3. – If in the circuit of Fig. 7 in this lesson, the switch fails to close the circuit when turned to the "on" position, then what indication will be offered by the voltmeter when connected at position #3?

4. – If in the circuit of Fig. 9 in this lesson, the primary winding of the A.F. transformer is burned out, how will the meter test indicate this fact?

5. – How will the grid bias voltage in the circuit of Fig. 11 be affected if a connection at one of the secondary winding terminals of the A.F. transformer should become disconnected?

6. – How would you locate an accidental ground with the aid of a voltmeter?

7. – Describe how you would measure the plate current which is drawn by a tube.

8. – If the plate voltage is lacking at all tubes, what would be the likely cause for this condition?

9. – If no screen grid voltage should be obtained at a certain tube, what would you look for?

10. – If no plate voltage is available at a receiver's power tubes but is present at all of the other tubes, then what would you look for?

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LESSON NO. 23

• RADIO INTERFERENCE •

IN THIS LESSON, YOU ARE GOING TO STUDY ABOUT A CONDITION, WHICH HAS RUINED MANY AN OTHERWISE ENJOYABLE PROGRAM FOR THOUSANDS OF RADIO LISTENERS. WE REFER TO THIS CONDITION AS RADIO INTERFERENCE AND IT MAKES ITSELF KNOWN BY CAUSING ALL KINDS OF CRASHING, CRACKLING, AND RASPING NOISES TO BE EMITTED FROM THE LOUD SPEAKER.

THIS KIND OF RECEPTION IS ENOUGH TO GET ON ANYONE'S NERVES AND THE RADIO MAN, WHO KNOWS HOW TO GET RID OF THESE NOISES, IS CERTAINLY A WELCOME VISITOR TO THE HOME OF SUCH A TROUBLED OWNER. SINCE THIS TYPE OF TROUBLE IS SO COMMON AND ANNOYING, YOU SHOULD TAKE ADVANTAGE OF IT AND LEARN ALL ABOUT RADIO INTERFERENCE BECAUSE IT OFFERS YOU A LARGE FIELD OF OPPORTUNITIES IN WHICH TO EARN A LOT OF MONEY.

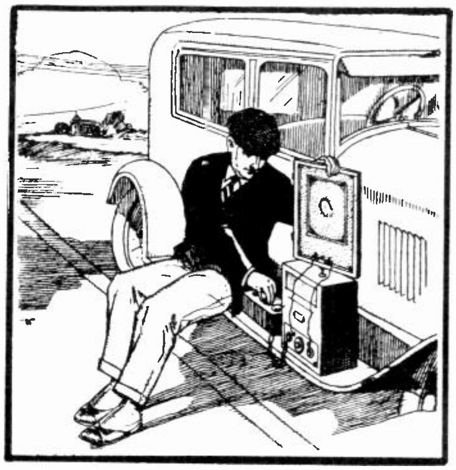

FIG. 1
Tracing the Source of Interference.

THE MEANING OF "RADIO INTERFERENCE"

THE TERM "RADIO INTERFERENCE" IS USED RATHER FREELY AND IN A BROAD WAY. FOR EXAMPLE, WHEN TWO STATIONS ARE HEARD SIMULTANEOUSLY FROM A RECEIVER, WE SAY THAT THEY ARE INTERFERING WITH EACHOTHER OR THAT THE RECEIVER IS TROUBLED BY INTERFERENCE. THIS TYPE OF INTERFERENCE HOWEVER, IS DUE TO A LACK OF SELECTIVITY IN THE RECEIVER AND IN THIS LESSON, WE ARE NOT PARTICULARLY INTERESTED IN THIS KIND OF INTERFERENCE. AT THIS TIME, OUR INTEREST IS MAINLY CENTERED UPON THAT TYPE OF INTERFERENCE, WHICH CAUSES NOISY RECEPTION.

THE INTERFERENCE, WHICH WE ARE STUDYING ABOUT NOW, IS CAUSED BY ELECTRICAL DISTURBANCES, ORGINATING EITHER NEAR OR AT SOME DISTANCE FROM THE RECEIVER'S LOCATION BUT REGARDLESS OF WHERE IT COMES FROM, THE SET OWNER EXPECTS THE RADIO MAN TO GET RID OF IT. THERE IS, HOWEVER, ONE TYPE

OF INTERFERENCE OVER WHICH WE HUMANS HAVE NO CONTROL AND THESE ARE THE ELECTRICAL DISTURBANCES, WHICH HAVE THEIR ORIGIN WITHIN THE ATMOSPHERE. THIS ATMOSPHERIC ELECTRICITY IS GENERALLY REFERRED TO AS STATIC AND SOMETIMES THESE STATIC CHARGES PILE UP AND SUDDENLY DISCHARGE THEMSELVES WITH A TREMENDOUS FLASH, WHICH WE KNOW AS LIGHTNING. "STATIC" IS ONE OF NATURE'S ENEMIES AGAINST PERFECT RADIO RECEPTION AND ALTHOUGH ITS EFFECTS CAN BE REDUCED, YET IT CANNOT BE ELIMINATED ENTIRELY.

STATIC DISCHARGES CAUSE A CRASHING SOUND TO BE EMITTED FROM THE RECEIVER AND IN SOME LOCALITIES AND AT CERTAIN SEASONS OF THE YEAR, THESE STATIC DISTURBANCES ARE VERY BOTHERSOME. SOMETIMES, ONE WILL BE LISTENING TO A BEAUTIFUL SELECTION BEING PLAYED BY SOME FAMOUS SYMPHONY ORCHESTRA, WHEN ALL OF A SUDDEN AND WITHOUT ANY WARNING WHATEVER, A LOUD CRASHING NOISE WILL COME OUT OF THE RECEIVER, WHICH SOUNDS AS THOUGH THE WHOLE ROOF HAD CAVED DOWN UPON THE ORCHESTRA. THIS NOISE, HOWEVER, IS SIMPLY DUE TO ONE OF NATURE'S TRICKS WITH STATIC SOMEWHERES UP IN THE ATMOSPHERE, PROBABLY MILES AWAY FROM THE POINT WHERE YOU ARE "LISTENING-IN."

MAN-MADE INTERFERENCE

NOT ONLY DO WE HAVE NATURE'S INTERFERENCE TO DEAL WITH BUT WE HAVE TO FIGHT "MAN-MADE" INTERFERENCE AS WELL. YOU SEE, ANY ELECTRICAL DISCHARGE, SUCH AS A SPARK IN THE AIR, WILL SEND RADIO WAVES OUTWARD IN ALL DIRECTIONS. FORTUNATELY, THESE EMITTED WAVES ARE SOMETIMES SO FEEBLE THAT THEY ARE NOT RADIATED VERY FAR AND FOR THIS REASON ARE NOT VERY BOTHERSOME. AT OTHER TIMES, HOWEVER, SUCH A SPARK WILL RADIATE WAVES WITH SUFFICIENT FORCE TO CAUSE THEM TO TRAVEL FOR MILES AND MILES, THEREBY NOT LOCALIZING THE DISTURBANCE BUT PROBABLY RUINING RADIO RECEPTION FOR A WHOLE COMMUNITY.

THE WAVES RADIATED BY SUCH SPARK DISCHARGES EFFECT THE RECEIVER IN MUCH THE SAME WAY AS A REGULAR RADIO WAVE BUT THEY ARE UNTUNED AND CONSEQUENTLY CANNOT AS A RULE BE ELIMINATED BY TUNING IN SOME OTHER STATION.

EVEN WHEN AN ALTERNATING CURRENT IS FLOWING THROUGH A CONDUCTOR, ELECTRIC WAVES WILL BE RADIATED FROM THE CONDUCTOR, WHICH MAY AFFECT SOME NEARBY RECEIVER AND THE HIGHER THE FREQUENCY OF THIS ALTERNATING CURRENT, THE MORE PRONOUNCED WILL BE THE INTERFERENCE EFFECT UPON A RADIO RECEIVER. A GREAT MANY OF THE PRODUCERS OF THIS RADIO INTERFERENCE MAY BE LOCATED WITHIN THE SAME BUILDING IN WHICH THE RECEIVER IS BEING OPERATED AND IN FIG. 2, YOU WILL SEE SOME COMMON ELECTRICALLY OPERATED HOUSEHOLD APPLIANCES, WHICH CERTAINLY DO THEIR PART IN CAUSING INTERFERENCE.

BY ADDING THESE EVERY DAY HOUSEHOLD APPLIANCES TO THE MANY OTHER POSSIBLE CAUSES OF INTERFERENCE, WHICH MAY BE LOCATED ELSEWHERE OUTSIDE OF THE HOME, IT IS OBVIOUS THAT OUR LIST OF INTERFERENCE PRODUCERS WILL BE QUITE LARGE.

BEAR IN MIND, THAT ANY APPLIANCE, WHICH USES AN ELECTRIC MOTOR, OR VIBRATING INTERRUPTER POINTS IS A GOOD INTERFERENCE PRODUCER. IN FACT, EVEN A LOOSE ELECTRICAL CONNECTION INSIDE A LAMP IS APT TO ARC AND THEREBY PRODUCE INTERFERENCE.

THE FOLLOWING LIST GIVES YOU AN IDEA OF THE MANY THINGS WHICH ARE LIKELY TO CAUSE INTERFERENCE NOISES:

DOOR BELLS OR BUZZERS
ELECTRIC SEWING MACHINES
ELECTRIC VACUUM CLEANERS
ELECTRIC FANS
ELECTRIC WASHING MACHINES
ELECTRIC VIBRATOR OR MASSAGING MACHINES
ELECTRIC TOASTERS
ELECTRIC IRONS
ELECTRIC CURLING IRONS
ELECTRIC SOLDERING IRONS
ELECTRIC RANGES
ELECTRIC WAFFLE IRONS
DEFECTIVE INSULATORS ON POWER LINES
DEFECTIVE POWER TRANSFORMERS
ELECTRIC PERCOLATORS
ELECTRIC HAIR CLIPPERS
ELECTRIC REFRIGERATORS
ELECTRIC SIGNS
ELECTRIC ELEVATORS
ELECTRIC RAILWAYS
X-RAY MACHINES
MOTION PICTURE EQUIPMENT
ARC LAMPS
FLASHER SIGNS
ELECTRIC MOTORS
ELECTRIC GENERATORS
DEFECTIVE ELECTRIC SWITCHES OF ALL TYPES ETC.

WE COULD GO ON PRACTICALLY INDEFINITELY, NAMING ALL KINDS OF POSSIBLE SOURCES OF INTERFERENCE BUT THOSE MENTIONED WILL AT LEAST GIVE YOU AN IDEA OF WHAT TO LOOK FOR.

NOW THAT YOU KNOW WHERE VARIOUS INTERFERENCE NOISES ORIGINATE, THE NEXT STEP IS TO FIND THEIR CAUSE AND LOCATION AND THIS, OF COURSE, IS THE HARDEST PART OF THE JOB. HOWEVER, WHEN TRACING SUCH NOISES IN A SYSTEMATIC

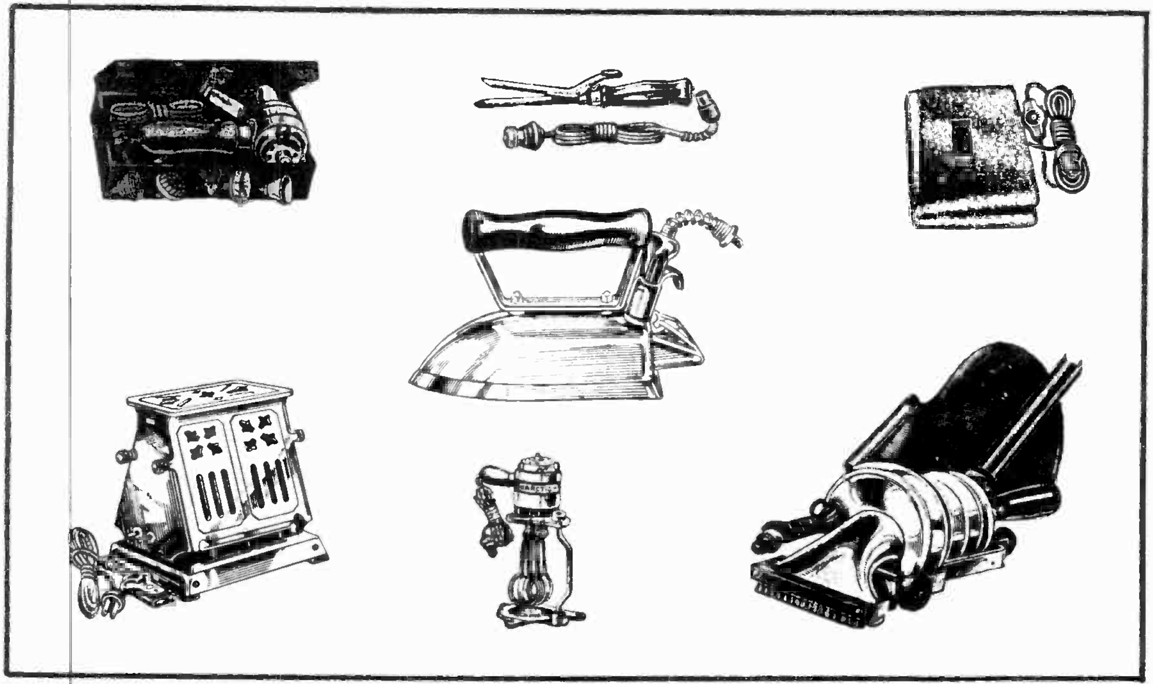

FIG. 2
Some Common Causes for Interference in the Home.

WAY, IT REALLY ISN'T AS DIFFICULT AN UNDERTAKING AS ONE MIGHT FIRST EXPECT.

LOCATING INTERFERENCE

SINCE TROUBLE WITHIN THE RECEIVER ITSELF MAY ALSO CAUSE VARIOUS TYPES OF SCRATCHING AND CRACKING SOUNDS, ONE MUST NOT JUMP TO HASTY CONCLUSIONS AND BLAME IT UPON INTERFERENCE THE FIRST THING, BEFORE EVEN STOPPING FOR A MOMENT TO CONSIDER THE SITUATION IN A MORE THOROUGH AND SEN-

SIBLE MANNER. TO DETERMINE IN A GENERAL WAY WHERE THESE UNDESIRABLE NOISES ARE COMING FROM IT IS BEST TO FIRST DISCONNECT THE ANTENNA LEAD-IN WIRE FROM THE RECEIVER WHILE THE RECEIVER IS IN OPERATION AND BRINGING IN A STATION, AS WELL AS THE NOISE YOU ARE LOOKING FOR.

SHOULD THE NOISE DISAPPEAR THE INSTANT YOU DISCONNECT THE ANTENNA LEAD-IN WIRE, THEN YOU KNOW THAT THE DISTURBING NOISES WERE ENTERING YOUR RECEIVER BY WAY OF THE ANTENNA. HOWEVER, IF THE NOISES ARE STILL HEARD, EVEN WITH THE ANTENNA DISCONNECTED, THEN CONTINUE YOUR INVESTIGATION BY NEXT DISCONNECTING THE GROUND WIRE FROM THE RECEIVER. IN CASE THE NOISE DISAPPEARS WITH ITS REMOVAL, THEN THE TEST INDICATES THAT THESE NOISES WERE EITHER PICKED UP AND DELIVERED TO THE RECEIVER BY THE GROUND WIRE, OR ELSE A POOR GROUND CONNECTION WAS BEING USED.

IF THE SAME NOISE STILL PERSISTS WITHIN THE RECEIVER WITH THE ANTENNA AND GROUND BOTH DISCONNECTED, THEN THE TROUBLE IS WITHIN THE RECEIVER ITSELF--PROVIDED IT IS A BATTERY OPERATED SET. HOWEVER, IF THE RECEIVER IS BEING OPERATED FROM AN A.C. LIGHTING SUPPLY, THEN THE SOURCE OF NOISE MAY EITHER BE WITHIN THE RECEIVER OR ELSE SOMEWHERES IN THE LIGHTING OR POWER LINE, WHICH IS SUPPLYING THE RECEIVER WITH ITS OPERATING POWER.

SINCE IT IS NOT AN UNCOMMON OCCURRENCE FOR A FAULTY CONNECTION WITHIN THE RECEIVER TO PRODUCE SCRATCHING SOUNDS, IT IS ADVISABLE TO CHECK THE RECEIVER IN A GENERAL WAY BEFORE LOOKING FOR LINE TROUBLE. TO DO THIS, LEAVE THE RECEIVER IN OPERATION AND TUNED TO A STATION. THEN TAKE A STRIP OF BAKELITE OR HARD RUBBER AND PROD THE DIFFERENT CIRCUIT CONNECTIONS WHILE THE RECEIVER IS IN OPERATION. SHOULD A POORLY SOLDERED JOINT BE MOVED IN THIS WAY, THE EFFECT WILL BE NOTICEABLE AT THE SPEAKER IMMEDIATELY.

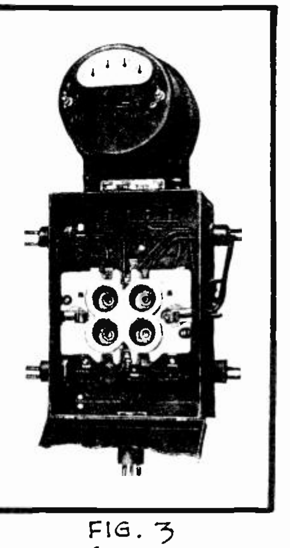

FIG. 3
Service Cabinet

ALSO MAKE SURE THAT THE TUBE PRONGS ARE ALL CLEAN AND THAT THEY MAKE A GOOD FIRM CONTACT WITH THE SPRINGS IN THEIR RESPECTIVE SOCKETS. SEE TO IT THAT SUCH PARTS AS THE VARIABLE CONDENSERS ARE FREE FROM DUST AND DON'T FORGET THAT A POOR SWITCH CONTACT OR DIRTY VOLUME CONTROL IS FREQUENTLY RESPONSIBLE FOR SCRATCHING NOISES. WORKING THESE PARTS BACK AND FORTH WILL READILY INDICATE THEIR CONDITION.

HAVING MADE THIS GENERAL INSPECTION OF THE A.C. RECEIVER AND BEING CONVINCED THAT THE NOISES ARE COMING IN OVER THE POWER LINES, THEN YOU ARE READY TO SET ABOUT THE TASK OF TRACING THEM TO THEIR SOURCE. TO DO THIS, GO TO THE ENTRANCE OR SERVICE SWITCH OF THE LIGHT SUPPLY IN THE BUILDING, IN WHICH THE RECEIVER IS BEING OPERATED. ONE OF THESE SWITCHES IS SHOWN IN FIG. 3 AND NO DOUBT YOU WILL IMMEDIATELY RECOGNIZE IT AS BEING THAT FAMILIAR LOOKING SWITCH BOX, WHICH IS MOUNTED EITHER NEAR OR TOGETHER WITH THE METER. IN A GREAT MANY CASES, YOU WILL FIND IT ON THE BACK PORCH OF THE HOME.

ALL THE LIGHTING CURRENT, WHICH COMES INTO A BUILDING, MUST PASS THROUGH SUCH A MAIN SWITCH AND IF THIS SWITCH IS OPENED, ALL OF THE CIR-

CUITS WITHIN THE BUILDING ARE PUT OUT OF OPERATION. THE LIGHTING CIRCUITS IN MOST BUILDINGS ARE DIVIDED INTO GROUPS WHICH ARE KNOWN AS BRANCH CIRCUITS AND ALL OF THESE BRANCH CIRCUITS ARE FED BY THE MAIN SUPPLY LINE, WITH THE BRANCHES HAVING THEIR ORIGIN EITHER IN THIS SERVICE SWITCH CABINET OR ELSE IN A SEPARATE CABINET. EACH CIRCUIT IS PROTECTED WITH A SEPARATE SET OF FUSES, WHICH MAY BE EITHER OF THE PLUG OR CARTRIDGE TYPE, BOTH OF WHICH ARE SHOWN IN FIG. 4. A PLUG FUSE IS SHOWN AT THE TOP OF FIG. 4 AND A FERRULE TYPE CARTRIDGE FUSE IS SHOWN AT THE BOTTOM OF THIS ILLUSTRATION. NOW WITH THE RADIO RECEIVER IN OPERATION, REMOVE THE BRANCH CIRCUIT FUSES ONE AT A TIME UNTIL YOU FIND ONE, WHICH WHEN REMOVED, CAUSES THE RECEIVER TO STOP OPERATING. THIS THEN, IS THE FUSE WHICH PROTECTS THE BRANCH CIRCUIT TO WHICH THE RECEIVER IS CONNECTED. KNOWING THIS, REPLACE THIS FUSE SO THAT THE RECEIVER CAN OPERATE AGAIN AND WITH A PROGRAM COMING IN, TOGETHER WITH THE UNDESIRABLE NOISE YOU ARE LOOKING FOR, REMOVE THE OTHER BRANCH CIRCUIT FUSES ONE AT A TIME AND LISTEN FOR THE EFFECT UPON THE RECEIVER.

SHOULD THE INTERFERING NOISE DISAPPEAR WHEN A CERTAIN FUSE IS REMOVED, THEN THE NOISE HAS ITS ORIGIN IN THIS PARTICULAR BRANCH CIRCUIT. THE THING TO DO THEN IS TO DISCONNECT ALL OF THE APPLIANCES FROM THIS ONE TROUBLESOME BRANCH CIRCUIT BUT DO THIS IN A ROUTINE WAY. THAT IS, TURN OFF THE DIFFERENT APPLIANCES SUCH AS LAMPS, THE VACUUM CLEANER, THE ELECTRIC FAN, THE ELECTRIC HEATER ETC. ONE AT A TIME AND IF THE NOISE DISAPPEARS, THEN THE DISCONNECTION OF THE UNIT CAUSING ITS DISAPPEARANCE IS RESPONSIBLE FOR THE INTERFERENCE. YOU CAN READILY DETERMINE WHICH APPLIANCES ARE OPERATED FROM A SINGLE BRANCH CIRCUIT, BY SIMPLY TURNING ON ALL THE LIGHTS ETC. IN THE ENTIRE BUILDING AND NOTING WHICH GROUP GOES OUT WHEN ONE PARTICULAR BRANCH CIRCUIT FUSE IS REMOVED. THOSE APPLIANCES, WHICH ARE PUT OUT OF COMMISSION BY REMOVING A SINGLE FUSE ARE ALL CONNECTED TO THE SAME BRANCH CIRCUIT. SHOULD, HOWEVER, ALL OF THE CIRCUITS BE "KILLED" WHEN YOU REMOVE A FUSE, THEN IT SIMPLY MEANS THAT YOU HAVE REMOVED A MAIN CIRCUIT FUSE INSTEAD OF A BRANCH CIRCUIT FUSE, SO WATCH FOR THIS.

FIG. 4
Fuses.

IF YOU HAVE REMOVED A BRANCH CIRCUIT FUSE WITHOUT ELIMINATING THE INTERFERING NOISE, THEN REMOVE THE BALANCE OF THE BRANCH FUSES, ONE AT A TIME. SHOULD NONE OF THESE TESTS REMOVE THE INTERFERENCE, IT IS VERY LIKELY THAT THE TROUBLE MAY BE IN THE BRANCH CIRCUIT TO WHICH THE RECEIVER IS CONNECTED AND TO CHECK UP ON THIS POSSIBILITY, SIMPLY CONNECT THE RECEIVER TO ANOTHER BRANCH CIRCUIT AND NOTE HOW IT PERFORMS. IF THE INTERFERENCE HAS DISAPPEARED, IT INDICATES THAT THE SOURCE OF THE NOISE IS IN THAT PARTICULAR BRANCH CIRCUIT FROM WHICH THE RECEIVER WAS ORIGINALLY BEING OPERATED. SO CHECK THE TROUBLESOME BRANCH CIRCUIT CAREFULLY AND THIS MEANS FOR DEFECTIVE CIRCUIT CONNECTIONS, AS WELL AS FOR DEFECTIVE APPLIANCES WHICH MAY BE CONNECTED TO THE CIRCUIT. FREQUENTLY, YOU WILL FIND THIS INTERFERENCE BEING CAUSED BY LOOSE WIRES AT LAMP SOCKETS, WALL SWITCHES, OUTLET SOCKETS, ETC. AND EVEN A LOOSE LAMP BULB MAY BE RESPONSIBLE FOR THE INTERFERING NOISE.

INTERFERENCE VIA THE POWER LINES

NOW IF NONE OF THESE FUSE REMOVAL TESTS STOP THE INTERFERENCE, THEN YOU KNOW THAT THE NOISES ARE ENTERING THE BUILDING BY WAY OF THE MAIN SUPPLY LINES. IT MAY BE DUE TO FAULTY LINE INSULATORS ON THE POLES, A DEFECTIVE LINE TRANSFORMER ETC. AND IN SUCH CASES, IT IS ADVISABLE TO NOTIFY THE POWER COMPANY AND THEY WILL SEE TO IT THAT THEIR EQUIPMENT IS ALL CHECKED AND PUT BACK IN PROPER WORKING ORDER. IN FACT, YOU WILL FIND MOST POWER COMPANIES VERY ACCOMODATING, WHEN IT COMES TO RUNNING DOWN LINE TROUBLE AND VERY OFTEN THEY WILL FIND CONDITIONS IN WHICH THE INTERFERENCE SOURCE IS LOCATED IN A DIFFERENT BUILDING, WHICH HAPPENS TO BE CONNECTED TO THE SAME POWER DISTRIBUTING LINES.

BEFORE BRINGING YOUR TROUBLES BEFORE THE POWER COMPANY, HOWEVER, MAKE SURE THAT THE TROUBLE IS NOT LOCALIZED AROUND OR WITHIN THE BOTHERED RECEIVER. THAT IS, ASK DIFFERENT PEOPLE IN THE NEIGHBORHOOD IF THEY TOO ARE TROUBLED WITH THIS INTERFERENCE AND ALSO TRY TO DETERMINE THE TIME OF DAY OR NIGHT WHEN THESE NOISES ARE MOST PRONOUNCED. IN THIS WAY IT MAKES IT MUCH EASIER TO FIND WHETHER THE POSSIBLE CAUSE IS IN SOME FACTORY, WHICH ONLY OPERATES DURING CERTAIN HOURS OF THE DAY, OR IN A THEATER OR FLASHER ELECTRIC SIGN, WHICH ONLY OPERATE AT NIGHT ETC. ALL OF THIS INFORMATION IS OF A GREAT HELP TO YOU, AS WELL AS TO THE POWER COMPANY AND OFFERS A SYSTEMATIC METHOD OF ATTACKING THE PROBLEM IN LOCATING THE SOURCE OF THE INTERFERENCE.

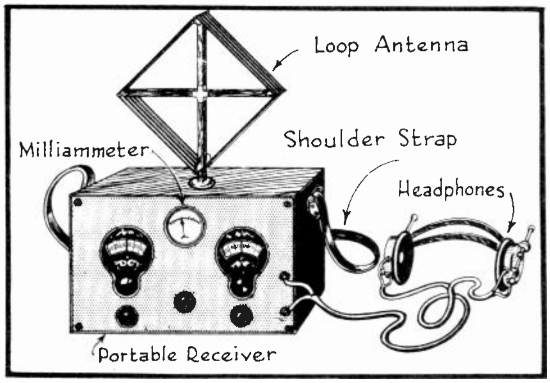

FIG. 5
Interference Locator

SEARCHING A DISTRICT FOR INTERFERENCE PRODUCER

SOMETIMES YOU MAY BE CALLED UPON TO LOCATE INTERFERENCE WHICH IS BOTHERING A WHOLE DISTRICT OF RADIO FANS AND WHICH MIGHT BE ACTING UPON THEIR RECEIVERS THROUGH EITHER THE ANTENNA, GROUND CONNECTION OR LIGHTING LINES. THIS OFFERS A CONSIDERABLY LARGE TERRITORY IN WHICH TO LOOK FOR THIS TROUBLE AND THE EASIEST WAY TO LOCATE THE SOURCE OF SUCH INTERFERENCE IS BY MEANS OF THE APPARATUS SHOWN IN FIG. 5.

THIS OUTFIT CONSISTS OF A SENSITIVE LOOP OPERATED RECEIVER, EQUIPPED WITH A SHOULDER STRAP SO THAT IT CAN BE CARRIED ABOUT WITH EASE AND COMFORT. IN ADDITION TO HAVING THE CONVENTIONAL RADIO RECEIVING CIRCUITS WITHIN THIS CABINET, AN EXTRA VISUAL INDICATING DEVICE IS ALSO USED AND IT IS FOR THIS REASON THAT THE MILLIAMMETER IS MOUNTED ON THE PANEL OF THE INTERFERENCE LOCATER.

THE CIRCUIT DIAGRAM FOR THE VISUAL INDICATING DEVICE IS SHOWN IN FIG. 6 AND THIS PORTION OF THE TESTER IS COUPLED TO THE OUTPUT OF THE REGULAR RECEIVER CIRCUIT BY MEANS OF THE 1 TO 1 RATIO IRON CORE TRANSFORMER. A PAIR OF PHONES ARE ALSO CONNECTED TO THE OUTPUT OF THE RECEIVER CIRCUIT SO THAT THE INTERFERENCE AND BROADCAST SOUNDS CAN BE HEARD. THAT PORTION OF THE CIRCUIT, WHICH IS SHOWN IN FIG. 6 IS WHAT IS KNOWN AS A SIMPLE TYPE VACUUM TUBE VOLTMETER.

BY STUDYING FIG. 6, YOU WILL NOTE THAT THE SECONDARY OF THE COUP-

LING TRANSFORMER IS CONNECTED ACROSS THE GRID CIRCUIT OF AN -01 A RADIO TUBE AND A POTENTIOMETER IS USED WITH WHICH THE GRID BIAS ON THIS TUBE CAN BE CONTROLLED. A SEPARATE SET OF BATTERIES SHOULD BE USED IN THE INDICATOR CIRCUIT FROM THOSE USED IN THE RECEIVER CIRCUIT, IN ORDER TO PROVIDE CORRECT METER READINGS. THE MILLIAMMETER, YOU WILL NOTE, IS CONNECTED IN THE PLATE CIRCUIT OF THE -01 A TUBE AND IT HAS A RANGE OF FROM 0 TO 25 MILLIAMPERES.

THE BIAS VOLTAGE OF THE -01 A TUBE IS SO ADJUSTED THAT WITH THE LEAST AMOUNT OF INTERFERENCE RECEIVED, THE DEFLECTION OF THE MILLIAMMETER NEEDLE SHOULD BE AT A MINIMUM. WITH THE ADJUSTMENT THUS MADE, IT WILL BE FOUND THAT THE METER READING WILL INCREASE AS THE RECEIVER IS BROUGHT CLOSER TO THE SOURCE OF THE INTERFERENCE AND IT WILL DECREASE WHEN MOVED FARTHER FROM THE SOURCE OF INTERFERENCE.

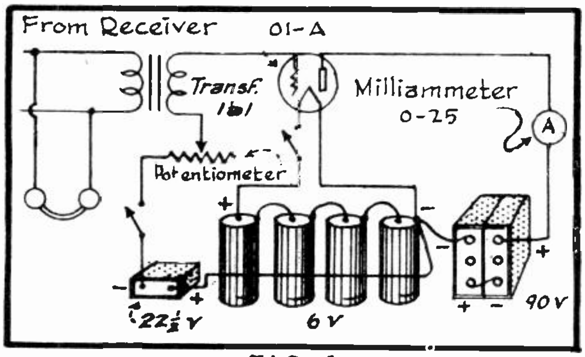

FIG. 6
Circuit Diagram of the Visual Indicator

THUS BY HAVING THE PHONES ALSO CONNECTED IN THE CIRCUIT, ONE CAN COMPARE THE RESULTS OF THE METER INDICATIONS WITH THE AUDIBLE INDICATIONS, FOR THE INTERFERENCE WILL ALSO INCREASE IN LOUDNESS AS ONE BRINGS THE RECEIVER CLOSER TO THE SOURCE.

IN ORDER TO HAVE AN IDEA IN WHICH DIRECTION TO TRAVEL WHEN RUNNING DOWN INTERFERENCE, A GREAT DEAL OF TIME CAN BE SAVED THROUGH THE USE OF AN ADJUSTABLE LOOP AERIAL. THIS CAN BE ACCOMPLISHED BY MOUNTING THE LOOP IN A BEARING AS SHOWN IN FIG. 5 OR ELSE THE LOOP CAN BE CARRIED BY HAND.

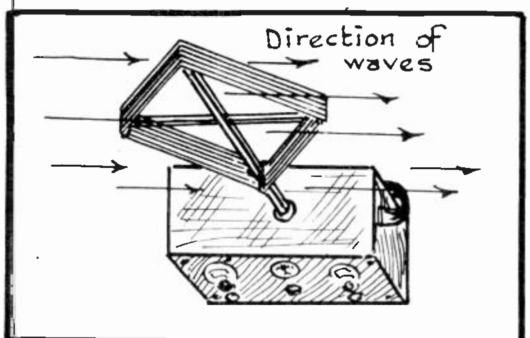

FIG. 7
Position of Loop for Strongest Signal.

THE LOOP ANTENNA HAS DIRECTIONAL QUALITIES AND THE SOUNDS FROM A STATION WILL BE LOUDEST WHEN THE WAVES THEREFROM PASS OVER THE LOOP WIRES AS SHOWN IN FIG. 7. THE SAME CONDITION HOLDS GOOD WHEN LOOKING FOR INTERFERENCE BECAUSE WHEN THE INTERFERENCE WAVES PASS ACROSS THE LOOP IN THE DIRECTION SHOWN IN FIG. 7, THEY TOO WILL COME IN WITH MAXIMUM FORCE.

DUE TO THIS QUALITY OF THE LOOP ANTENNA, IT BECOMES QUITE A SIMPLE PROBLEM TO CENTRALIZE THE LOCATION OF THE INTERFERENCE DOWN TO AN APPROXIMATE POINT AND WE DO THIS IN THE MANNER ILLUSTRATED IN FIG. 8.

HERE YOU WILL SEE A PORTION OF A STREET MAP IN A DISTRICT TROUBLED WITH RADIO INTERFERENCE. THE SEAT OF THE TROUBLE IS AT ONE SPOT BUT IT SPREADS OUT THROUGHOUT THIS ENTIRE SECTION AND BECOMES A NUISANCE TO THE WHOLE NEIGHBORHOOD. YOU ARE THE MAN CHOSEN TO FIND WHERE THIS INTERFERENCE IS COMING FROM AND THE FIRST THING YOU DO IS TO SET UP YOUR INTERFERENCE LOCATING EQUIPMENT AT SOME SUCH POINT AS #1 IN FIG. 8.

NOW YOU TUNE YOUR PORTABLE RECEIVER UNTIL THE INTERFERENCE BECOMES BARELY AUDIBLE IN YOUR PHONES. SET YOUR POTENTIOMETER SO THE MILLIAMMETER READS MINIMUM AND THEN WITHOUT MOVING YOUR POSITION, SLOWLY ROTATE YOUR LOOP ANTENNA UNTIL YOU FIND A POINT WHERE THE INTERFERENCE NOISE COMES IN LOUDEST AND WHERE THE MILLIAMMETER SHOWS THE GREATEST DEFLECTION.

IT IS A GOOD PLAN TO DRAW A ROUGH SKETCH OF THE SURROUNDING TERRITORY, SOMEWHAT LIKE THAT SHOWN IN FIG. 8 AND ALSO MARK UPON IT THE POSITION YOU JUST OCCUPIED (STATION #1) AND ALSO DRAW IN THE POSITION OF THE LOOP ANTENNA WHERE THE LOUDEST RESPONSE FROM THE INTERFERENCE WAS OBTAINED FROM THIS FIRST SET UP.

THIS DONE, YOU NOW MOVE TO SOME OTHER LOCATION, A FEW BLOCKS AWAY FROM THE FIRST AND HERE YOU AGAIN SET UP YOUR APPARATUS. THIS IS STATION #2 IN FIG. 8 AND WITH THE SAME CONTROL SETTINGS AS AT STATION #1, NOTE THE RESPONSE OF YOUR APPARATUS WITH THIS NEW SET UP AT #2. (YOU MIGHT HAVE TO READJUST THE VOLUME CONTROL BIAS POTENTIOMETER.) NOW ROTATE THE LOOP SLOWLY UNTIL THE INTERFERENCE NOISE COMES IN LOUDEST AND THE MILLIAMMETER READING MAXIMUM. MARK THIS NEW POSITION ON YOUR MAP AND ALSO THE DIRECTION IN WHICH THE LOOP WAS POINTING.

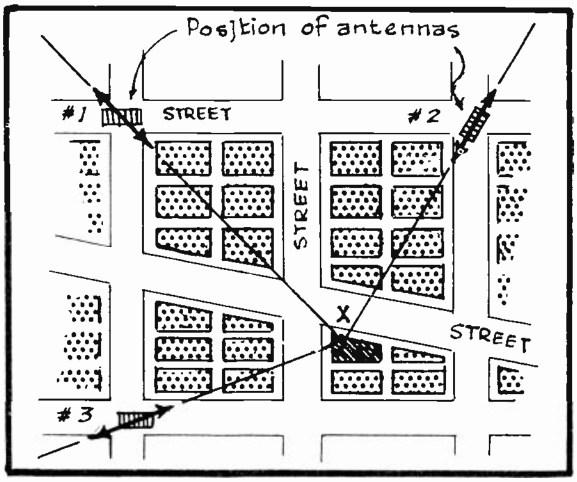

FIG. 8
Locating Interference

NOW MOVE TO SOME OTHER POSITION A FEW BLOCKS AWAY, SUCH AS SET UP #3 IN FIG. 8. DO THE SAME THING HERE AS AT THE PREVIOUS TWO SET UPS, AGAIN MARKING THE POSITION OF THE LOOP AND LOCATION OF THE SET UP. MAKE SEVERAL OF THESE TESTS, WORKING EITHER AROUND A LARGE SQUARE OR CIRCLE AND THEN BY DRAWING DOTTED LINES THRU ALL THE LOOP DIRECTION ARROWS ON YOUR MAP AS IN FIG. 8, YOU WILL FIND SOME POINT WHERE THESE PROJECTED LINES WILL VERY NEARLY ALL INTERSECT OR CROSS EACHOTHER. THIS IS THE POINT FROM WHERE THE INTERFERENCE IS COMING AND IT IS MARKED WITH AN "X" IN FIG. 8.

THIS GIVES YOU THE APPROXIMATE POSITION OF THE INTERFERENCE SOURCE AND WILL GIVE YOU A GOOD IDEA OF THE DIRECTION IN WHICH YOU SHOULD MOVE IN ORDER TO FIND IT. THEN AS YOU COME CLOSER AND CLOSER TO IT, THE INTERFERENCE NOISE WILL CONTINUALLY INCREASE IN YOUR HEADPHONES AND THE MILLIAMMETER WILL ALSO CONTINUE TO REGISTER AN INCREASED READING. GRADUALLY, YOU WILL HAVE WORKED YOUR WAY RIGHT TO THE SEAT OF THE TROUBLE WHERE YOUR MILLIAMMETER READING AND RESPONSE FROM THE PHONES WILL BE AT THEIR MAXIMUM.

GOOD, SENSITIVE AUTOMOBILE RECEIVERS HAVE ALSO BEEN USED TO ADVANTAGE IN RUNNING DOWN INTERFERENCE. IN THIS CASE, THE INTERFERENCE NOISE INCREASES IN INTENSITY AS THE CAR IS DRIVEN CLOSER TO THE SOURCE. TO ENSURE STILL GREATER EFFICIENCY, AN OUTPUT METER CAN BE CONNECTED TO THE AUTOMOBILE RECEIVER AND IT WILL OFFER AN INCREASED READING AS THE INTERFERENCE SOURCE IS APPROACHED.

THE ELIMINATION OF INTERFERENCE

HAVING GONE INTO THE DISCUSSION OF THE METHODS USED TO LOCATE THE CAUSE OF INTERFERENCE, OUR NEXT PROBLEM WILL BE TO ELIMINATE THE INTERFERENCE AFTER WE HAVE FOUND IT. IN A GREAT MANY CASES, YOU WILL FIND THAT THE DISTURBANCE IS CAUSED BY SOME FAULTY ELECTRICAL APPARATUS, WHICH WOULD NOT ORDINARILY CAUSE THIS TROUBLE WERE IT IN PROPER OPERATING CONDITION. THE THING TO DO HERE, OF COURSE, IS NOT TO DOCTOR UP THE APPARATUS BY ATTEMPTING TO REDUCE THE EFFECTS OF THE DISTURBANCES BUT IT IS MUCH WISER TO REMEDY THE CAUSE OF THE DISTURBANCE.

FOR EXAMPLE, YOU MIGHT TRACE THE INTERFERENCE TO EXCESSIVELY SPARKING BRUSHES ON A GENERATOR. SO THE LOGICAL THING TO DO HERE IS TO STOP THE SPARKING AT THE BRUSHES BY EITHER REPLACING THE WORN BRUSHES WITH NEW ONES, CLEANING THE COMMUTATOR OF THE ARMATURE WITH SAND PAPER OR ANY OTHER REPAIR, WHICH MAY BE REQUIRED TO OVERCOME THE TROUBLE. MAJOR REPAIRS ON ELECTRICAL MACHINERY ARE GENERALLY OUT OF THE RADIO MAN'S LINE AND CONSEQUENTLY SHOULD BE TURNED OVER TO AN ELECTRICIAN, WHO IS SPECIALLY TRAINED ALONG THIS LINE OF WORK.

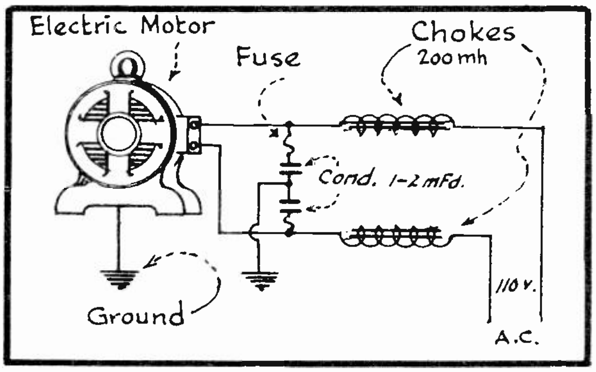

FIG. 9
Filter Connections for an Electric Motor.

THERE ARE, HOWEVER, CASES WHERE ELECTRICAL EQUIPMENT WILL PRODUCE A GREAT DEAL OF INTERFERENCE, EVEN THOUGH IT BE IN A NORMAL OPERATING CONDITION AND SINCE NO EFFECTIVE REPAIRS CAN BE MADE IN THIS INSTANCE, WE HAVE TO DO THE NEXT BEST THING, WHICH IS TO REMOVE THE EFFECTS RATHER THAN THE CAUSE OF THE INTERFERENCE AND IN THIS WAY PREVENT THE INTERFERENCE NOISES FROM BEING TRANSMITTED TO NEARBY RADIO RECEIVERS.

TO REDUCE INTERFERENCE NOISES, WE USE FILTERS, CONSISTING OF CHOKES AND CONDENSERS, WHICH ARE SIMILAR IN OPERATION TO THOSE YOU USED IN A.C. POWER PACKS. FIG. 9 SHOWS YOU HOW SUCH A FILTER SYSTEM WOULD BE CONNECTED UP TO AN ELECTRIC MOTOR, WHICH IS CAUSING INTERFERENCE.

NOTICE THAT WE FIRST MAKE SURE THAT THE METAL HOUSING OF THE MOTOR IS WELL GROUNDED. THEN WE INSTALL A 200 MILLI-HENRY CHOKE IN EACH OF THE SUPPLY LINES. TWO 1 OR 2 MFD. CONDENSERS ARE CONNECTED IN SERIES AND SHUNTED ACROSS THE LINES AS SHOWN AND THEIR CENTER CONNECTION IS GROUNDED. THIS GROUND CONNECTION CAN BE MADE EITHER AT A COLD WATER PIPE OR ELSE TO THE CONDUIT CARRYING THE POWER LINES. (CONDUIT IS THE IRON PIPING IN WHICH ALL MODERN POWER WIRING IS CARRIED AND THIS CONDUIT IS ALWAYS GROUNDED SOMEWHERE ALONG ITS RUN, SO BY MAKING YOUR GROUND CONNECTION TO THE GROUNDED CONDUIT, YOU WILL AT THE SAME TIME HAVE AN EFFECTIVE GROUND CONNECTION FOR YOUR FILTER. BE SURE, HOWEVER, TO SCRAPE OFF ALL DIRT OR PAINT FROM THE POINT ON THE CONDUIT AT WHICH YOU MAKE YOUR GROUND CONNECTION AND USE AN APPROVED GROUND CLAMP.)

IF THE POWER LINES, WHICH SUPPLY THE MOTOR, ARE WORKING AT AN A.C. VOLTAGE OF 110 OR 220 VOLTS, AS IS GENERALLY THE CASE, THEN EACH OF THE FILTER CONDENSERS SHOULD HAVE A RATED D.C. WORKING VOLTAGE OF 500 VOLTS

AND IT IS PREFERABLE THAT THEY BE OF THE MICA DIELECTRIC TYPE RATHER THAN PAPER. SHOULD THE LINE VOLTAGE BE 550 VOLTS A.C. THEN EACH OF THE CONDENSERS IN FIG. 9 WOULD BE REPLACED BY TWO SERIES CONNECTED CONDENSERS, EACH HAVING A RATED D.C. WORKING VOLTAGE OF 500 VOLTS AND THE CONNECTIONS WOULD THEN BE MADE AS ILLUSTRATED IN FIG. 10.

ALSO NOTICE IN FIG. 9 THAT A FUSE IS CONNECTED IN SERIES WITH EACH OF THE FILTER CONDENSERS. THESE FUSES OFFER AN ADDITIONAL PROTECTION IN CASE THE CONDENSERS SHOULD BECOME SHORT CIRCUITED. IF THIS WERE TO HAPPEN, THE MOTOR CIRCUIT WOULD ALSO BE SHORTED AND THEREBY DRAW AN EXCESSIVE CURRENT OF DANGEROUS PROPORTIONS. HOWEVER, BY INCLUDING FUSES IN THE CONDENSER CIRCUIT, THE FUSES WILL BLOW OUT AND THUS INTERRUPT THE CIRCUIT, THE INSTANT THAT THE DAMAGING CURRENT COMMENCES TO FLOW AT THE TIME OF A CONDENSER'S BREAKING DOWN.

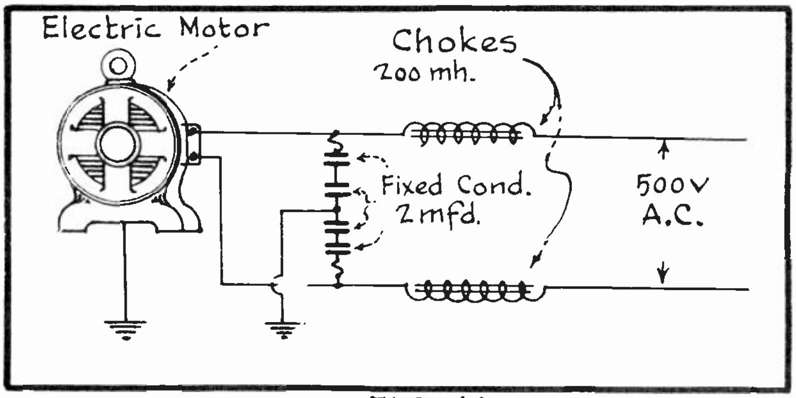

FIG. 10
Filter for 550 Volt A.C. Circuit.

THE ELECTRICAL DISTURBANCE OF THE MOTOR, WHICH IS CAUSING THE INTERFERENCE IS OF A HIGH FREQUENCY AS YOU WERE ALREADY TOLD. THEREFORE, BY HAVING THE CHOKES CONNECTED IN SERIES WITH THE LINES, THEY WILL OFFER A GREAT DEAL OF OPPOSITION TO THE FLOW OF THE HIGH FREQUENCY INTERFERENCE CURRENT BUT NOT TO THE LOW FREQUENCY A.C. CURRENT, WHICH OPERATES THE MOTOR.

THE CONDENSERS, ON THE OTHER HAND OFFER FREE PASSAGE TO THE HIGH FREQUENCY INTERFERENCE CURRENT BUT A TREMENDOUS OPPOSITION TO THE LOW FREQUENCY A.C. MOTOR OPERATING CURRENT. CONSEQUENTLY, THE CHOKE COILS FORCE ALL OF THE HIGH FREQUENCY INTERFERENCE CURRENT INTO GROUND BY WAY OF THE CONDENSERS AND IN THIS WAY PREVENT THEM FROM GETTING INTO THE POWER LINES WHERE THEY COULD BE RADIATED OVER WHOLE DISTRICTS.

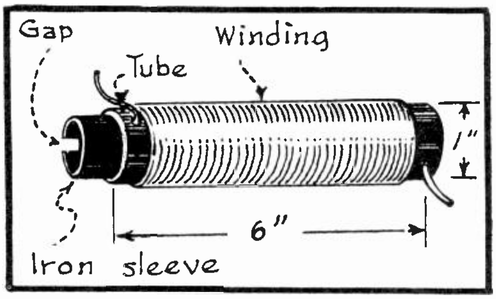

FIG. 11
Choke Coil of Approx. 200 Milli-Henries.

TO INSTALL SUCH A FILTER, ALL THAT IS NECESSARY IS TO DISCONNECT THE POWER LINES WHILE THE LINE WIRES ARE DISCONNECTED FROM THE SOURCE OF E.M.F. AND THEN TO CONNECT THE FILTER BETWEEN THE MOTOR AND POWER LINES. IN ORDER FOR THE FILTER TO OPERATE PROPERLY, THE CONDENSERS MUST BE CONNECTED ON THE MOTOR SIDE OF THE FILTER CIRCUIT AND THE FILTER CIRCUIT AS A WHOLE, SHOULD BE CONNECTED AS CLOSE AS POSSIBLE TO THE MOTOR OR SOURCE OF INTERFERENCE.

CONSTRUCTION OF CHOKES

THE CONSTRUCTION OF THE CHOKES USED IN FIGS. 9 AND 10 IS ILLUSTRATED FOR YOU IN FIG. 11. EACH OF THESE CHOKES IS MADE UP OF 180 TURNS OF

DOUBLE COTTON COVERED WIRE. THIS WIRE IS WOUND ON A PORCELAIN OR BAKELITE TUBING, WHICH IS 6" LONG AND HAVING A DIAMETER OF 1".

THE ENTIRE COIL IS MADE UP OF TWO LAYERS, WITH 90 TURNS OF WIRE TO EACH LAYER AND A PIECE OF EMPIRE CLOTH IS INSERTED BETWEEN THE TWO LAYERS. THE WHOLE COIL IS VARNISHED AND THEN SOME MORE EMPIRE CLOTH IS WRAPPED OVER THE OUTER LAYER AND OVER THIS YOU CAN WRAP SOME FRICTION TAPE AND LIKEWISE APPLY A FINAL COATING OF VARNISH OVER THE TAPE.

THE CORE CONSISTS OF A PIECE OF #18 GAUGE SHEET IRON (STOVE-PIPE IRON) WHICH IS CUT TO SUCH A SIZE, SO THAT IT CAN BE BENT INTO THE SHAPE OF A SLEEVE AND BE SLIPPED INTO THE HOLLOW WINDING TUBE. ITS ENDS, HOWEVER, SHOULD NOT OVERLAP OR EVEN TOUCH BUT THERE SHOULD BE A SEPARATION OF ABOUT 1/8" BETWEEN THEM.

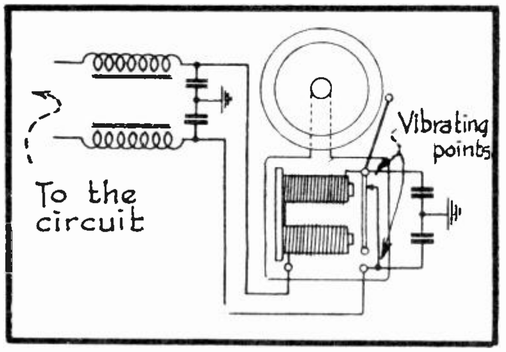

FIG. 12
Filter System for an Electric Bell.

WHEN CHOOSING WIRE SIZES FOR CHOKES, ONE MUST BE CAREFUL TO USE WIRE WHICH IS LARGE ENOUGH TO CARRY THE REQUIRED LOAD CURRENT, AS TOO SMALL A WIRE WILL HEAT UP AND THEREBY OFFER THE POSSIBILITY OF A FIRE. THE FOLLOWING TABLE GIVE YOU THE SAFE CARRYING CAPACITY OF VARIOUS SIZES OF WIRE, WHICH ARE SUITABLE FOR CHOKE USE.

TABLE I
SAFE CURRENT CARRYING CAPACITY OF COPPER WIRE

WIRE SIZE B&S GAUGE	ALLOWABLE CURRENT FOR RUBBER INSULATION	ALLOWABLE CURRENT FOR OTHER INSULATION
#18	3 AMP.	5 AMP.
#16	6 AMP.	10 AMP.
#14	15 AMP.	20 AMP.
#12	20 AMP.	25 AMP.
#10	25 AMP.	30 AMP.
#8	35 AMP.	50 AMP.
#6	50 AMP.	70 AMP.
#4	70 AMP.	90 AMP.
#3	80 AMP.	100 AMP.

IN FIG. 12, YOU WILL SEE A DIAGRAM OF AN EFFECTIVE FILTER CIRCUIT FOR USE ON AN ELECTRIC BELL, WHICH PRODUCES INTERFERENCE. HERE, TWO SERIES-CONNECTED 1 MFD. CONDENSERS ARE CONNECTED ACROSS THE VIBRATING POINTS OF THE BELL AND THEY ARE GROUNDED AT THEIR MID-POINT. WHENEVER, YOU ARE WORKING ON AN APPLIANCE OF ANY TYPE, WHICH USES A SET OF VIBRATING POINTS SIMILAR TO THIS BELL EXAMPLE, YOU WILL FIND THAT THIS CONDENSER CONNECTION ACROSS THE POINTS WILL AID MATERIALLY TO REDUCE INTERFERENCE.

IF THIS ALONE DOES NOT ELIMINATE THE INTERFERENCE ENTIRELY, THEN AN ADDITIONAL FILTER SHOULD BE INSTALLED IN THE LINE AS SHOWN IN FIG. 12, SO AS TO PREVENT THE INTERFERENCE CURRENTS FROM BEING DISTRIBUTED THROUGH THE LINES. REMEMBER, THAT THE REQUIRED WORKING VOLTAGE OF THE CONDENSERS AND WIRE SIZE OF THE CHOKES WILL DEPEND ENTIRELY UPON THE VOLTAGE AND CUR-

RENT USED BY THE APPLIANCE.

OTHER FILTER SYSTEMS

IN FIG. 13, YOU WILL SEE AN EXAMPLE OF HOW A FILTER SYSTEM IS INSTALLED IN A BUILDING BETWEEN THE ELECTRIC METER AND THE MAIN SERVICE SWITCH. THIS ARRANGEMENT PREVENTS INTERFERING NOISES, WHICH ORIGINATE WITHIN THE BUILDING, FROM BEING TRANSMITTED TO SURROUNDING BUILDINGS. AT THE SAME TIME, IT ALSO PREVENTS INTERFERING NOISES FROM ENTERING THIS SAME BUILDING BY WAY OF THE POWER LINES.

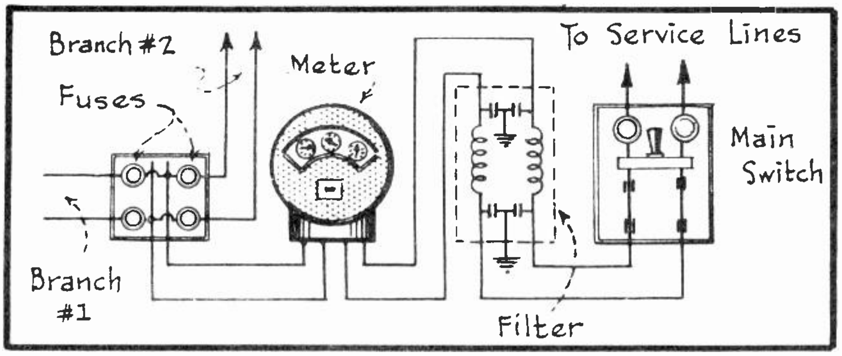

FIG. 13
Filter Installed in Lighting Circuit.

ON SMALL GENERATORS AND MOTORS, WHERE BUT LITTLE INTERFERENCE IS BEING PRODUCED, YOU WILL VERY OFTEN FIND THAT THE TROUBLE CAN BE RELIEVED SIMPLY BY ATTACHING TWO SERIES CONNECTED 1 MFD. CONDENSERS OF THE REQUIRED VOLTAGE RATING ACROSS THE TERMINALS OF THE APPLIANCE OR ACROSS THE LINE CLOSE TO THE APPLIANCE. THE MID-POINT OF THIS CONDENSER CONNECTION CAN THEN BE GROUNDED TOGETHER WITH THE METAL HOUSING OF THE APPLIANCE.

IF THIS PROVES TO BE INSUFFICIENT, THEN THE CHOKES MUST BE USED IN ADDITION AS WAS ALREADY SHOWN YOU.

THE SAME PLAN OF FILTERING, AS OUTLINED FOR YOU, IS CARRIED OUT IN PRACTICALLY ALL CASES. THERE ARE, HOWEVER, CASES THAT NOW AND THEN COME UP, WHICH ARE RATHER COMPLEX IN THEIR NATURE AND CONSEQUENTLY SOMEWHAT HARD TO HANDLE. IT IS THEN SIMPLY A MATTER OF EXPERIMENTING, IN TRYING OUT DIFFERENT FILTER CIRCUITS AND THEREBY DETERMINING WHICH OF THEM OVERCOMES THE TROUBLE.

ALTHOUGH THE FILTER SYSTEMS, WHICH WE HAVE SO FAR CONSIDERED, ARE READILY MADE BY THE RADIO SERVICE MAN, YET SPECIAL FACTORY BUILT RADIO INTERFERENCE FILTERS CAN BE PURCHASED FROM ANY GOOD RADIO STORE OR WHOLESALE HOUSE.

FACTORY-BUILT INTERFERENCE FILTERS

AN EXAMPLE OF SUCH A COMMERCIAL TYPE OF RADIO INTERFERENCE FILTER IS SHOWN IN FIG. 14. THESE UNITS ARE MADE IN DIFFERENT SIZES AND SHAPES AND EACH OF THEM HAS A DIFFERENT MODEL NUMBER. THEREFORE, IF ONE NEEDS A FILTER SYSTEM TO HANDLE A CERTAIN JOB, THEN ALL THAT IS NECESSARY IS TO DESCRIBE YOUR REQUIREMENTS TO THE DEALER AND

FIG. 14
A Commercial Filter for Interference.

HE WILL GIVE YOU THE PARTICULAR FILTER, WHICH HAS BEEN ESPECIALLY DESIGNED FOR THAT PARTICULAR JOB. THAT IS, IF YOU WANT A "TOBE FILTERETTE" (TRADE NAME FOR INTERFERENCE FILTER'S MANUFACTURED BY TOBE DEUTSCHMANN CORP.) TO INSTALL IN THE CIRCUIT OF AN ELECTRIC REFIGERATOR, WHICH IS BEING OPERATED AT 110 VOLTS A.C. AND DRAWING NOT MORE THEN 5 AMPERES, YOU WOULD STATE THESE FACTS TO YOUR DEALER AND HE WOULD PROVIDE YOU WITH A MODEL #110 TOBE FILTERETTE. THESE FILTERS ALL OPERATE ON THE SAME PRINCIPLES AS THE ONES WE HAVE BEEN DISCUSSING RIGHT ALONG.

NO MATTER WHAT KIND OF COMMERCIAL FILTER YOU BUY, FULL INSTRUCTIONS AS TO THE PROPER METHOD OF ITS INSTALLATION ALWAYS COME WITH IT AND THUS

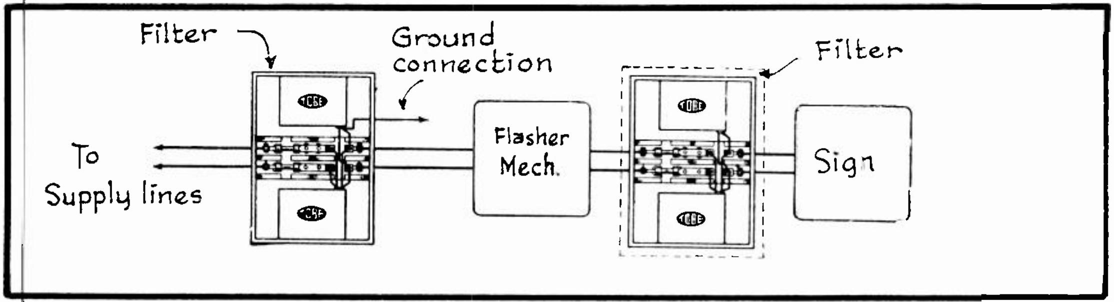

FIG. 15
Filter Installation In Flasher Sign Circuit.

MAKES IT EASY FOR ANYONE TO CONNECT UP.

FIG. 15 SHOWS YOU A TYPICAL EXAMPLE OF HOW SUCH A COMMERCIAL INTERFERENCE FILTER IS CONNECTED IN THE CIRCUIT OF A FLASHER TYPE SIGN, WHICH IS CAUSING INTERFERENCE. THESE FLASHER SIGNS ARE EXTREMELY BOTHERSOME AS AN INTERFERENCE PRODUCER AND SINCE THEY OPERATE AT NIGHT WHEN MOST PEOPLE ARE LISTENING TO THEIR RADIO, IT IS EVIDENT THAT CARE MUST BE TAKEN TO ELIMINATE ALL POSSIBLE CHANCE OF INTERFERENCE FROM THIS DEVICE.

ALL OF THE INTERFERENCE FILTERS, WHICH WE HAVE SO FAR CONSIDERED, WERE PERMANENTLY CONNECTED IN THE LINE, EITHER AT THE SOURCE OF THE INTERFERENCE NOISE OR IN THE HOUSE LIGHTING CIRCUIT, TO PREVENT THERE ENTRY. NOW IN FIG. 16, YOU WILL SEE A FACTORY BUILT INTERFERENCE ELIMINATOR, WHICH IS ESPECIALLY BUILT FOR INSTALLATION OF A PERMANENT OR TEMPORARY NATURE, EITHER AT THE SOURCE OF THE INTERFERENCE OR ELSE DIRECTLY AT THE RECEIVER.

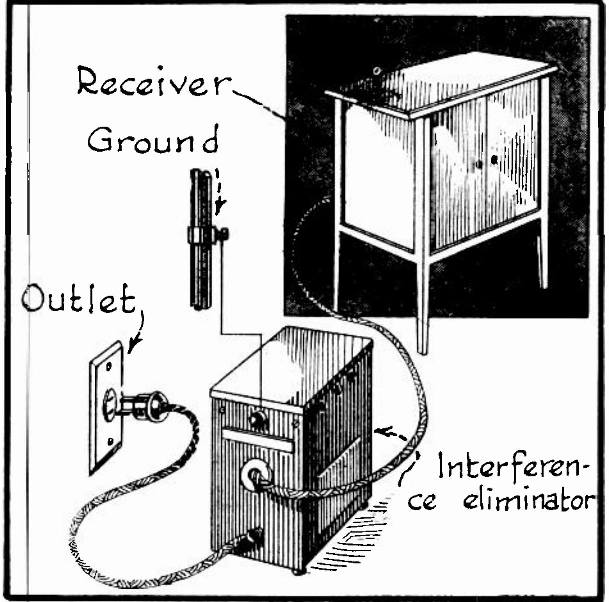

FIG. 16
Connecting Interference Eliminator to A.C. Receiver.

THESE DEVICES ARE ESPECIALLY SUITABLE FOR USE IN APARTMENT HOUSES ETC. WHERE LIGHTING CIRCUITS ARE CONTINUALLY BEING SWITCHED ON AND OFF THROUGHOUT THE ENTIRE BUILDING. EVERYTIME THAT THIS IS DONE, THERE IS A TENDENCY FOR A CRACKING SOUND TO COME OUT OF SOME OPERATING RECEIVER ELSEWHERE IN THE BUILD-

ING. TO PREVENT THIS, THE INTERFERENCE FILTER CAN BE CONNECTED IN SERIES BETWEEN THE RECEIVER AND THE LIGHTING OUTLET FROM WHICH IT IS BEING OPERATED. THIS IS CLEARLY ILLUSTRATED IN FIG. 16.

THE REMAINING TERMINAL OF THE INTERFERENCE ELIMINATOR IS THEN GROUNDED TO SOME NEARBY COLD WATER PIPE OR OTHER SUITABLE POINT AND RECEPTION WILL NOW BE GREATLY IMPROVED.

IN ACTUAL PRACTICE, IT IS OF COURSE GENERALLY DESIRABLE TO HOUSE THE INTERFERENCE ELIMINATOR WITHIN THE CABINET, SO THAT IT IS CONCEALED FROM VIEW. IT IS READILY INSTALLED AND DISCONNECTED AND IS THEREFORE IDEAL FOR PORTABLE USE AND CAN BE CARRIED AWAY WITH THE RECEIVER IN CASE THE TENANT SHOULD DECIDE TO MOVE.

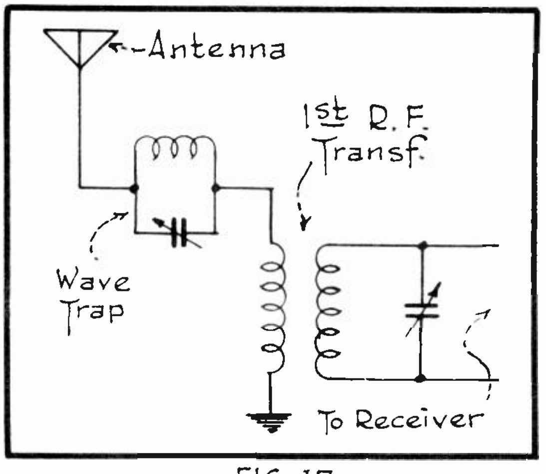

FIG. 17
A Series Connected Wave Trap.

REDUCING STATIC NOISES

NOW THAT WE HAVE INVESTIGATED THE MANNER OF SUPPRESSING MAN-MADE INTERFERENCE AT THE SOURCE, LET US NEXT SEE WHAT WE CAN DO ABOUT NATURE'S INTERFERENCE, NAMELY "STATIC." AS YOU WERE TOLD BEFORE, WE CANNOT ELIMINATE STATIC BUT THERE ARE METHODS WHEREBY WE CAN REDUCE THE AUDIBLE EFFECTS OF STATIC UPON OUR RECEIVER, DURING THE TIME WE ARE LISTENING TO A PROGRAM. THE SAME SUGGESTIONS WHICH ARE TO BE OFFERED YOU NOW, APPLY EQUALLY WELL TOWARDS REDUCING THE AUDIBLE EFFECTS OF MAN-MADE INTERFERENCE NOISES WHICH ARE PICKED UP BY THE RECEIVING ANTENNA.

THE FIRST THING TO CONSIDER IN THIS RESPECT IS THE ANTENNA INSTALLATION BECAUSE THE HIGHER AND LONGER THE ANTENNA AND THE LONGER THE LEAD-IN, THE GREATER WILL BE THE DISTURBANCE OF STATIC.

THE REASON FOR THIS IS THAT ALTHOUGH THE SIGNAL BECOMES WEAKER AS THE HEIGHT AND LENGTH OF THE ANTENNA WIRE IS DECREASED, YET THIS CONDITION HAS A STILL MORE MARKED EFFECT UPON THE STATIC BECAUSE IT CAUSES THE STATIC STRENGTH TO DECREASE MORE RAPIDLY THAN SIGNAL STRENGTH. CONVERSELY, WE HAVE THAT THE HIGHER AND LONGER WE MAKE OUR ANTENNA, THE STATIC STRENGTH WILL INCREASE AT A MORE RAPID RATE THAN OUR SIGNAL STRENGTH MEANING THAT WITH A GIVEN VOLUME OF BROADCAST PROGRAM, WE WILL NOW HAVE A GREATER PERCENTAGE OF STATIC NOISE AS COMPARED TO THE RESULTS OBTAINED WITH THE LOW AND SHORT ANTENNA.

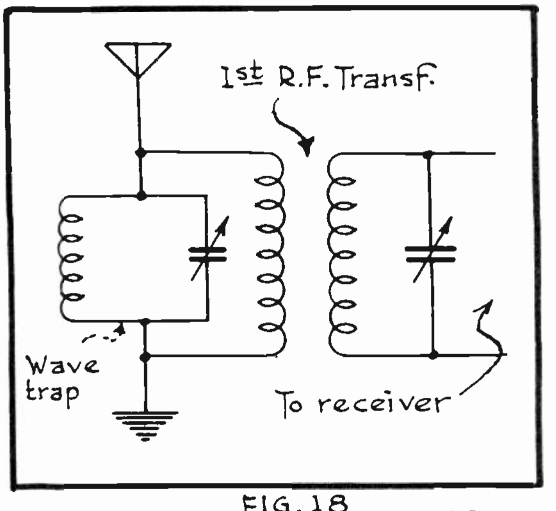

FIG. 18
A Parallel Connected Wave Trap.

TO TAKE ADVANTAGE OF THIS CONDI-

TION, IT IS ADVISABLE TO USE AN ANTENNA CONSISTING OF A SINGLE WIRE, WHICH IS NOT MORE THAN 50 FT. LONG AND ELEVATED AT A HEIGHT OF NOT MORE THAN 30 FT. THIS WILL CAUSE A MARKED DECREASE IN STATIC COMPARED TO SIGNAL STRENGTH.

WAVE TRAPS

ANOTHER IDEA, WHICH HAS BEEN WORKED OUT AND WHICH FREQUENTLY PRODUCES THE DESIRED RESULTS IN REDUCING STATIC NOISES IS SHOWN IN FIG. 17. HERE WE HAVE A WAVE TRAP CONNECTED IN SERIES BETWEEN THE ANTENNA AND PRIMARY WINDING OF THE RECEIVER'S 1ST R.F. TRANSFORMER.

THIS WAVE TRAP IS NOTHING MORE THAN A SINGLE TUNING CIRCUIT, CONSISTING OF A COIL AND VARIABLE CONDENSER. BY TUNING THIS TRAP TO A CERTAIN FREQUENCY, THIS PARTICULAR FREQUENCY WILL FIND IT VERY DIFFICULT TO GET INTO THE PRIMARY WINDING OF THE FIRST R.F. TRANSFORMER BUT ALL OTHER FREQUENCIES PASS THROUGH THE TRAP QUITE READILY.

NOT ONLY DOES SUCH A TRAP AID IN IN REDUCING STATIC NOISES BUT IT ALSO AIDS IN MAKING A POORLY DESIGNED RECEIVER MORE SELECTIVE IN THAT IT TENDS TO REJECT SOME POWERFUL STATION WHICH IS CAUSING FORCED OSCILLATIONS IN THE REGULAR TUNED CIRCUITS, WHEN THESE ARE TUNED TO AN ENTIRELY DIFFERENT FREQUENCY.

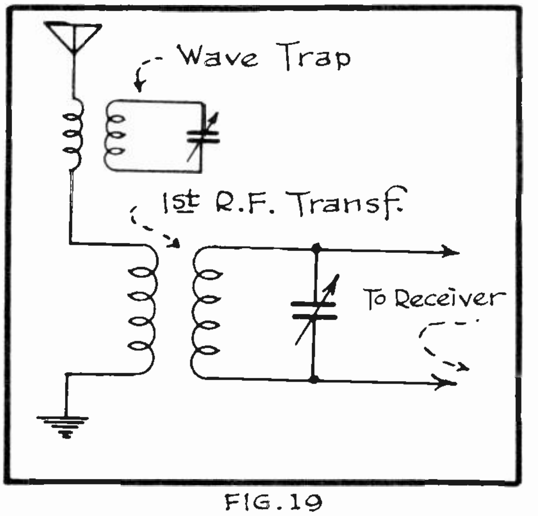

FIG. 19
Absorption Type Wave Trap.

ANOTHER INSTALLATION FOR A WAVE TRAP IS SHOWN IN FIG. 18 AND HERE THE TRAP IS CONNECTED PARALLEL TO THE PRIMARY WINDING OF THE 1ST. R.F. TRANSFORMER. IN THIS CASE, THE FREQUENCY TO WHICH THE TRAP IS TUNED, WILL BE FORCED THROUGH THE PRIMARY WINDING OF THE R.F. TRANSFORMER AND ALL REMAINING FREQUENCIES WILL FIND QUITE AN EASY PATH THROUGH THE TRAP.

STILL ANOTHER WAVE TRAP IS SHOWN IN FIG. 19. THIS IS THE ABSORPTION TYPE AND HERE YOU WILL NOTE THAT AN EXTRA R.F. COIL IS CONNECTED IN SERIES BETWEEN THE ANTENNA AND PRIMARY WINDING OF THE 1ST. R.F. TRANSFORMER. THE EXTRA WINDING IS THEN INDUCTIVELY COUPLED TO A TUNED WAVE TRAP AND WHEN THE WAVE TRAP IS TUNED TO SOME CERTAIN FREQUENCY, IT WILL ABSORB A GREAT DEAL OF POWER FROM THE ANTENNA CIRCUIT CAUSED BY THIS UNDESIRED FREQUENCY. THE RESULT IS THAT PRACTICALLY NO POWER OF THE FREQUENCY TO WHICH THE TRAP IS TUNED WILL EVER REACH THE RECEIVER AND WHAT LITTLE DOES ENTER THE RECEIVER, ITS STRENGTH IS REDUCED SUFFICIENTLY SO AS TO PREVENT IT FROM CAUSING MUCH TROUBLE.

THE ABSORPTION TYPE WAVE TRAP IS ABOUT THE MOST EFFECTIVE OF THOSE SHOWN YOU BUT ALL OF THEM HELP SOMEWHAT TO REDUCE STATIC NOISES AND FORCED OSCILLATIONS FROM UNWANTED STATIONS. THESE TRAPS CAN EITHER BE CONTAINED WITHIN A SEPARATE CASE AND CONNECTED TO THE RECEIVER ONLY AT THE TIME ONE CARES TO USE IT OR ELSE THEY CAN BE INCORPORATED AS A PERMANENT PART OF THE RECEIVER CIRCUIT.

INTERFERENCE-REJECTING ANTENNA SYSTEMS

CONTINUAL RESEARCH IS IN PROGRESS TO OVERCOME THE UNDESIRABLE EFFECTS OF INTERFERENCE NOISES UPON RADIO RECEPTION AND CONSTANT IMPROVEMENTS ARE BEING MADE.

EXPERIMENTS HAVE SHOWN THAT MOST OF THE SO-CALLED "MAN-MADE STATIC" IS PICKED UP BY THE ANTENNA LEAD-IN WIRE AND FROM HERE CARRIED TO THE RECEIVER, RATHER THAN BEING MOSTLY PICKED UP BY THE ELEVATED PORTION OF THE ANTENNA AS WAS FORMERLY GENERALLY SUPPOSED. CONDITIONS BEING SUCH, IT IS NO MORE BUT LOGICAL TO BELIEVE THAT A CONSIDERABLE PORTION OF THE INTERFERENCE NOISE CAN BE PREVENTED FROM ENTERING THE RECEIVER BY SIMPLY PROVIDING THE ANTENNA LEAD-IN WIRE WITH A GROUNDED SHIELD. IN THIS WAY, THE LEAD-IN WIRE WOULD SERVE SOLELY AS A CONDUCTOR OF RADIO FREQUENCY ENERGY FROM THE ELEVATED ANTENNA WIRE TO THE RECEIVER WITHOUT POSSESSING ANY SIGNAL PICK-UP CHARACTERISTICS OF ITS OWN.

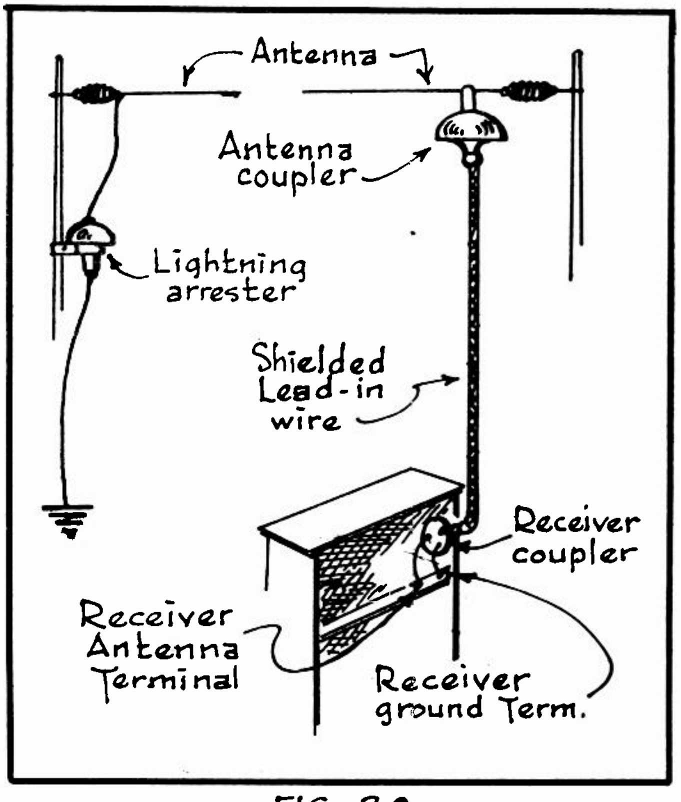

FIG. 20
A Noise-Rejecting Antenna System

SINCE THE TIME THIS DISCOVERY WAS MADE, SHIELDED LEAD-IN WIRE HAS BEEN GAINING IN POPULARITY. IT CONSISTS OF THE CUSTOMARY STRANDED COPPER CONDUCTOR. THIS IS SURROUNDED BY A LAYER OF COTTON OVER WHICH A LAYER OF RUBBER IS PROVIDED. THE RUBBER INSULATION IS IN TURN COVERED WITH A TINNED COPPER OR ALUMINUM BRAID.

THE COPPER CONDUCTOR IS THUS USED IN THE NORMAL MANNER TO CONDUCT THE SIGNAL ENERGY FROM THE ANTENNA TO THE RECEIVER AND BY SOLDERING A WIRE TO THE METALLIC BRAID COVERING AND THEN GROUNDING THIS WIRE, THE LEAD-IN WIRE WILL BE THOROUGHLY SHIELDED.

ALTHOUGH THE SHIELDED LEAD-IN WIRE WILL PREVENT CONSIDERABLE PICK-UP OF INTERFERENCE NOISE, YET IT OFFERS UNDESIRABLE CHARACTERISTICS AS WELL. THE CHIEF DISADVANTAGE OF THE PLAIN SHIELDED LEAD-IN WIRE IS THAT CONSIDERABLE CAPACITY IS INTRODUCED BETWEEN THE LEAD-IN CONDUCTOR AND ITS GROUNDED SHIELD COVERING. THIS CAPACITY PERMITS CONSIDERABLE RADIO FREQUENCY OR SIGNAL ENERGY TO PASS FROM THE LEAD-IN WIRE TO GROUND WITHOUT REACHING THE RECEIVER AND THIS NATURALLY RESULTS IN A CONSIDERABLE LOSS OF SIGNAL ENERGY.

TO OVERCOME THIS LOSS, SPECIAL ANTENNA COUPLING TRANSFORMERS HAVE been developed by several concerns. Two of these couplers are generally used to complete the installation—one of them being used to couple the antenna to the shielded lead-in wire and the other to couple the lead-in wire to the antenna terminal of the receiver.

To make an antenna installation as this, it is preferable to erect the antenna as high as possible and out in the clear so that it will be located as far away as practical from all nearby known sources of man-made static.

The antenna coupler is attached to the antenna and from this coupler the shielded lead-in wire is run to the receiver. The receiver coupler is then mounted within the receiver cabinet and the lead-in wire attached to it, without making any additional connections in the entire length of the lead-in. The receiver coupler is in turn connected to the antenna and ground terminals of the receiver, thus completing the installation. It is important that the shielding of the lead-in wire be securely grounded.

A number of these noise-reducing antenna coupling device are being manufactured by different concerns and can be purchased ready for installation from any good radio supply house. The manufacturers supply complete instructions regarding the installation of their particular units so as to insure satisfactory performance.

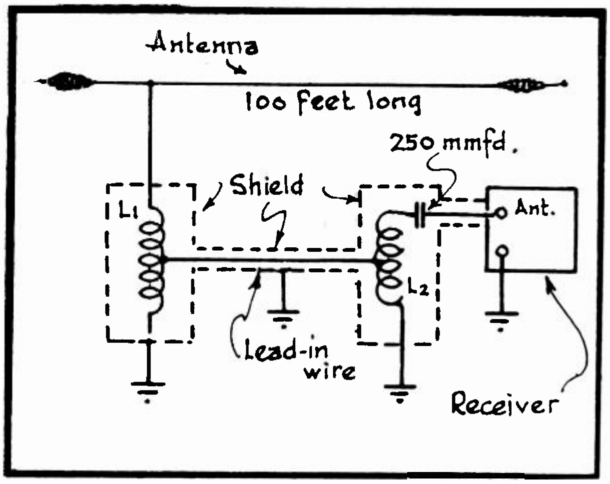

FIG. 21
Construction of the Antenna System.

So as to give you a better idea of the constructional features of such an antenna coupling system, we have prepared Fig. 21 for you. Here the antenna coupler is represented by L_1 and the receiver coupler by L_2. Coils L_1 and L_2 each consist of 150 turns of #30 B&S double cotton covered wire scramble-wound on a ½" diameter form. The width of the finished coils is ½" and they are each tapped at the 25th turn.

One end of L_1 is connected directly to the antenna and its other end is grounded. One end of L_2 is grounded while its other end is connected to the antenna terminal of the receiver through a .00025 mfd. fixed condenser.

Each of the coils is housed in an individual metallic can, which is grounded so as to form a shield and the cans are filled with paraffine to protect the coils against moisture.

The lead-in wire is connected to the taps of the two coils. The shielding of the lead-in wire is also thoroughly grounded.

This particular system is designed to be used in conjunction with an antenna of 100 ft. length and a lead-in of 100 ft. length. Such a long

LEAD-IN IS NOT SO DETRIMENTAL WITH A COUPLED INSTALLATION AS IN THE ANTENNAS SYSTEMS WITHOUT THIS FEATURE DUE TO THE ABSENCE OF NOISE PICK-UP WITH THE SHIELDED LEAD-IN, AND THE BOOSTING EFFECT OBTAINED FROM THE COUPLING DEVICES.

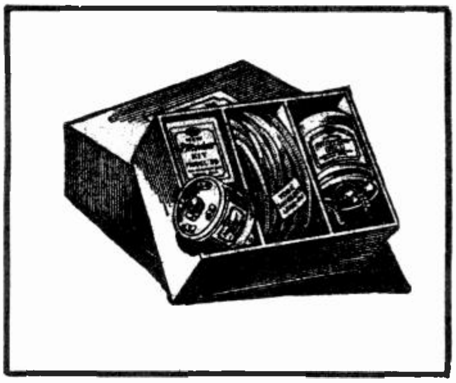

FIG. 22
Noise Rejecting Kit.

IN FIG. 22 YOU ARE SHOWN A TYPICAL ANTENNA NOISE-REJECTING KIT SUCH AS OFFERED BY SEVERAL MANUFACTURERS. THESE ATTRACTIVELY PACKED KITS CONTAIN THE ANTENNA COUPLER, THE RECEIVER COUPLER, 75 FT. OF SHIELDED LEAD-IN WIRE AND COMPLETE INSTRUCTIONS FOR INSTALLATION. ALL UNITS ARE BUILT UP FOR IMMEDIATE USE AND ALL THAT YOU HAVE TO DO IS TO CONNECT THEM INTO THE SYSTEM.

THE INFORMATION GIVEN YOU IN THIS LESSON SHOULD BE OF CONSIDERABLE VALUE TO YOU BECAUSE THERE IS A GREAT DEMAND FOR TRAINED RADIO MEN, WHO KNOW HOW TO OVERCOME THESE DIFFICULTIES OF INTERFERENCE. TAKE ADVANTAGE OF THE OPPORTUNITIES OFFERED YOU IN THIS BRANCH OF RADIO WORK AND HELP IN THIS LARGE UNDERTAKING TO MAKE RADIO RECEPTION STILL MORE ENJOYABLE FOR THE MILLIONS OF RADIO LISTENERS THROUGHOUT THE WORLD.

YOU WILL BE WELL REPAID FOR YOUR EFFORTS IN THIS FASCINATING SEARCH AND ELIMINATION OF ONE OF RADIO'S WORST ENEMIES--"INTERFERENCE."

"EXAMINATION QUESTIONS"
LESSON #23

1. - WHAT DO WE MEAN BY "MAN-MADE INTERFERENCE?"

2. - DESCRIBE A SIMPLE METHOD WHEREBY YOU CAN DETERMINE WHETHER OR NOT THE INTERFERENCE NOISE IS BEING PICKED UP BY THE ANTENNA OR GROUNDING SYSTEM.

3. - HOW CAN YOU DETERMINE WHETHER OR NOT THE INTERFERENCE NOISE ORIGINATES OUTSIDE OF THE BUILDING IN WHICH THE RECEIVER IS BEING OPERATED?

4. - DESCRIBE HOW IT IS POSSIBLE TO LOCATE THE SOURCE OF INTERFERENCE IF IT ORIGINATES OUTSIDE OF THE BUILDING IN WHICH THE RECEIVER IS BEING OPERATED.

5. - HAVING FOUND AN ELECTRIC MOTOR AS PRODUCING INTERFERENCE, WHAT WOULD YOU DO TO PREVENT RADIATION OF THIS DISTURBANCE?

6. - DESCRIBE HOW A CHOKE MAY BE CONSTRUCTED IN ORDER TO SUPPRESS INTERFERENCE.

7. - WHAT SHOULD BE DONE TO PREVENT A SET OF VIBRATOR POINTS OF SOME ELECTRICAL APPLIANCE FROM PRODUCING INTERFERENCE?

8. - WHY IS IT ADVISABLE TO INCLUDE A SET OF FUSES WHEN INTERFERENCE FILTER CONDENSERS ARE CONNECTED ACROSS A POWER LINE?

9. - DESCRIBE ONE FORM OF WAVE TRAP AND EXPLAIN HOW IT WORKS.

10. - DESCRIBE AN INTERFERENCE--REJECTING ANTENNA SYSTEM.

"Opportunity Knocks at a Man's Door But Once"

Many a time you have heard that expression and perhaps it is true, but there is no law of God or man that prohibits a man from knocking at Opportunity's door just as often as he may wish. If he knocks often enough, sooner or later, he is sure to find opportunity at home. If he is ready it will mean Success.

Opportunity means nothing to the man who is not ready. If he is not prepared he won't even be recognized. Whatever we amount to in this world depends entirely upon ourselves, and our own efforts. If we make no effort we get nothing. If we make a big effort to get ahead we can and will succeed. In other words, we are going to be rewarded for exactly what we do.

Success will not come by merely wishing for it. It is something we must fight for. We have got to conquer every obstacle—we cannot give in to pleasures or idle dreams. And the harder we fight the greater will be our success.

Opportunity waits for no one—it's up to us to make ourselves ready and catch her.

RADIO - TELEVISION

Practical • J. A. ROSENKRANZ, Pres. • Training

NATIONAL SCHOOLS

Established 1905

Los Angeles, California

LESSON NO. 24

AUTOMOBILE RECEIVERS

THE PUBLIC HAS BECOME SO FASCINATED BY THE RECEPTION OF RADIO BROADCAST PROGRAMS THAT BESIDES HAVING A RECEIVER INSTALLED IN THEIR HOMES, MANY PEOPLE ALSO NOW HAVE A RECEIVER INSTALLED IN THEIR AUTOMOBILE AS WELL. IT IS THUS THAT THE SLOGAN "RADIO AS YOU DRIVE" CAME INTO BEING.

THE SALE OF AUTO RECEIVERS IS BEING PUSHED QUITE HARD AND WE FIND THAT RADIO EQUIPMENT ON THE MOTOR CAR IS GAINING RAPIDLY IN POPULARITY.

THE AVERAGE AUTOMOBILE MECHANIC IS NOT CAPABLE OF TAKING CARE OF THE CONSTRUCTION, INSTALLATION, AND SERVICING OF AUTO RECEIVERS AND CONSEQUENTLY THIS PROFITABLE WORK FALLS INTO THE HANDS OF THE SKILLED RADIO SPECIALIST. ALTHOUGH MANY FACTORY BUILT AUTO RECEIVERS ARE AVAILABLE ON THE MARKET, YET THIS DOES NOT PREVENT THE AMBITIOUS RADIO MAN FROM BUILDING "CUSTOM-BUILT" RECEIVERS FOR THIS PURPOSE.

FIG. 1
A Radio-Equipped Automobile.

CONSTRUCTION OF AUTO RECEIVERS

WE WILL BEGIN OUR DISCUSSION OF AUTO RECEIVERS BY FIRST CONSIDERING THE BASIC CONSTRUCTIONAL FEATURES OF THIS TYPE OF RECEIVER AND THEN WE WILL WORK OUR WAY THROUGH THE INSTALLATION ETC.

FURTHERMORE, SO THAT YOU MAY BE FAMILIAR WITH THE PRINCIPLES OF CONSTRUCTION USED IN THE EARLIER MODELS OF AUTOMOBILE RECEIVERS, WE SHALL INVESTIGATE THESE DESIGNS FIRST AND THEN CONTINUE WITH THE STUDY OF THE MORE MODERN CIRCUITS AND THEIR RELATED ACCESSORY EQUIPMENT. THIS WILL GIVE YOU A BROADER KNOWLEDGE OF THESE AUTO SETS IN THAT YOU WILL BECOME BETTER ACQUAINTED WITH THE FIELD IN GENERAL, AS WELL AS TO BE BETTER INFORMED OF THE PROGRESS MADE IN THIS PARTICULAR BRANCH OF RADIO DURING THE PAST FEW YEARS.

TO BEGIN WITH, IT IS LOGICAL THAT SINCE THE AUTO RECEIVER IS MORE OR LESS OF A PORTABLE NATURE, IT SHOULD BE CONSTRUCTED AS LIGHT AND SMALL IN SIZE AS POSSIBLE. STRENGTH, HOWEVER, SHOULD NOT BE SACRIFICED TO OBTAIN THESE AFORE MENTIONED QUALITIES, FOR IT MUST NOT BE FORGOTTEN THAT THE AUTO RECEIVER IS SUBJECTED TO VIBRATION AND ROAD SHOCKS DURING THE COURSE OF DRIVING.

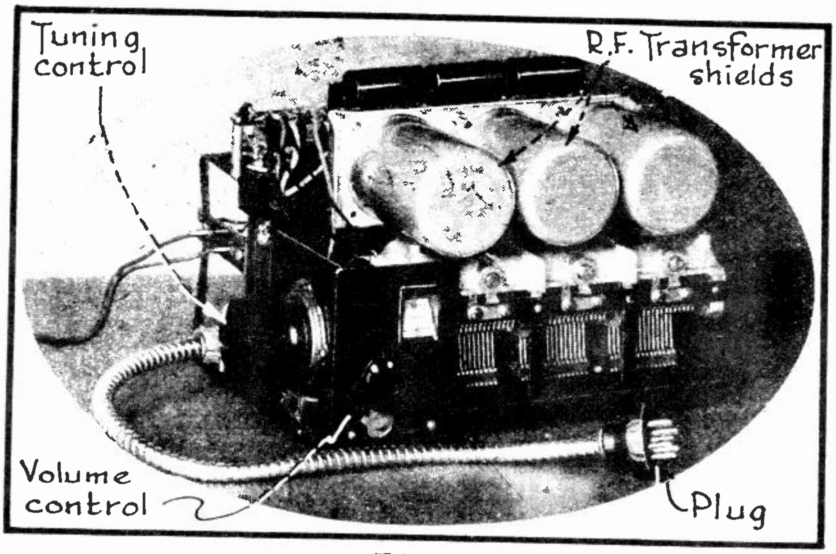

FIG. 2
Front View of Auto Receiver Chassis.

A FRONT VIEW OF A TYPICAL AUTO RECEIVER CHASSIS IS SHOWN IN FIG. 2, WHEREAS THE REAR VIEW OF THIS SAME UNIT IS SHOWN IN FIG. 3.

THE RECEIVER HERE SHOWN IS A COMMERCIAL MODEL, KNOWN AS THE NATIONAL RECEIVER. AS YOU WILL NOTE IN THESE TWO ILLUSTRATIONS, THE ENTIRE ASSEMBLY IS COMPLETE TO THE MINUTEST DETAIL AND YET ITS OVERALL DIMENSIONS ARE REASONABLY PROPORTIONED, SO THAT THE UNIT CAN BE MOUNTED BEHIND THE DASH OF THE CAR AND ITS CONTROLS ARE JUST AS ACCESSIBLE TO THE DRIVER AS ANY OF THE LEVERS CONTROLLING THE AUTOMOBILE.

THE CHASSIS OF THIS RECEIVER, IS NOT LEFT IN AN EXPOSED CONDITION AS ILLUSTRATED HERE BUT IT IS HOUSED WITHIN A BOX-LIKE METALLIC CONTAINER IN THE MANNER SHOWN IN FIG. 4.

FIG. 4 SHOWS THE VARIOUS PARTS, WHICH GO TOGETHER TO MAKE UP THIS UNIT. NOTICE THAT IT CONSISTS OF THE RECEIVER ITSELF, THE LOUD SPEAKER, A WATER PROOF METAL CONTAINER FOR THE "B" AND "C" BATTERIES, A JUNCTION AND FUSE BLOCK AND THE NECESSARY WIRING TO COMPLETE THE CIRCUIT CONNECTIONS.

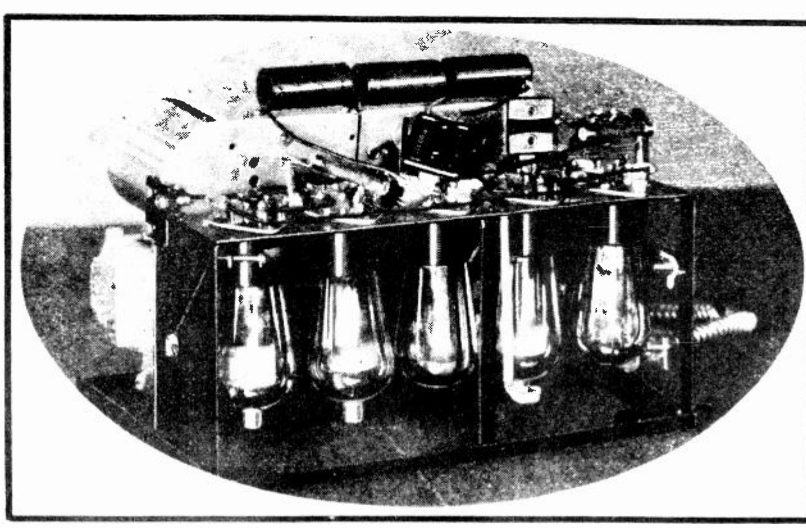
FIG. 3
Rear View of Auto Receiver Chassis.

TYPICAL AUTO RECEIVER CIRCUIT

THE CIRCUIT DIAGRAM FOR THIS SAME RECEIVER IS SHOWN IN FIG. 5. THE CIRCUIT HERE ILLUSTRATED CONSISTS OF TWO STAGES OF R.F. AMPLIFICATION EMPLOYING THE TYPE -24 SCREEN GRID TUBES, POWER DETECTION USING THE TYPE

-12A TUBE; A -24 FIRST AUDIO TUBE, USED WITH THE SPACE CHARGE GRID PRINCIPLE AND A -12A POWER TUBE, WHICH IS CONNECTED TO THE A.F. TUBE BY RESISTANCE-CAPACITY COUPLING.

THE "A" SUPPLY FOR THE AUTO RECEIVERS IS FURNISHED BY THE CAR'S STORAGE BATTERY, WHEREAS THE "B" AND "C" BATTERIES ARE CARRIED ALONG AS EXTRA EQUIPMENT. THE TYPE -24 TUBES AS USED HERE, ALTHOUGH THE RECEIVER BE A BATTERY OPERATED UNIT, WILL GIVE THE RECEIVER THE NECESSARY R.F. GAIN BESIDES DELIVERING A QUITE UNIFORM ELECTRON EMISSION ON ACCOUNT OF THE CATHODE'S ABILITY TO RESIST TEMPERATURE CHANGES.

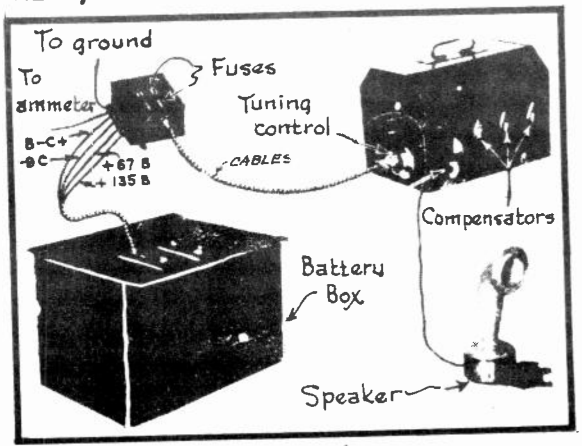

FIG. 4
Assembly Making-up The National Auto Receiver.

THE ADVANTAGE OF USING THE -12A TUBE AS A DETECTOR LIES IN THE FACT THAT THIS TUBE'S FILAMENT ALSO HAS A TENDENCY TO HOLD HEAT, WHILE AT THE SAME TIME REQUIRING BUT A COMPARATIVELY SMALL FILAMENT CURRENT. IN AUTO RECEIVERS, IT IS ADVISABLE TO KEEP THE FILAMENT CURRENT DOWN TO AS LOW A VALUE AS POSSIBLE WITHOUT DESTROYING THE EFFICIENCY OF THE APPARATUS BECAUSE AN EXCESSIVE DRAIN FROM THE STORAGE BATTERY WILL IMPAIR THE PROPER OPERATION OF THE AUTOMOBILE'S ELECTRICAL SYSTEM.

THE -24 TUBE, USED IN A SPACE-CHARGE GRID ARRANGEMENT, GIVES HIGH A.F. AMPLIFICATION AND THUS THIS SYSTEM CAN BE USED HERE ADVANTAGEOUSLY IN ORDER TO REDUCE THE NUMBER OF REQUIRED AUDIO AMPLIFYING STAGES.

THE -12 A TUBE, AS USED IN THE POWER STAGE, NOT ONLY SERVES AS A SUITABLE POWER TUBE FOR AUTO USE BUT ONLY DRAWS A SMALL AMOUNT OF FILAMENT CURRENT, THE SAME AS THE DETECTOR TUBE OF THIS RECEIVER.

THE PURPOSE OF THE DOUBLE-POLE, SINGLE-THROW SWITCH, IN FIG. 5, IS TO OPEN BOTH THE FILAMENT AND B BATTERY LEADS WHEN THE SET IS NOT IN USE, THEREBY SAVING CURRENT.

PROBABLY YOU HAVE BEEN THINKING OF THE -24 TUBES IN FIG. 5 AS DRAWING

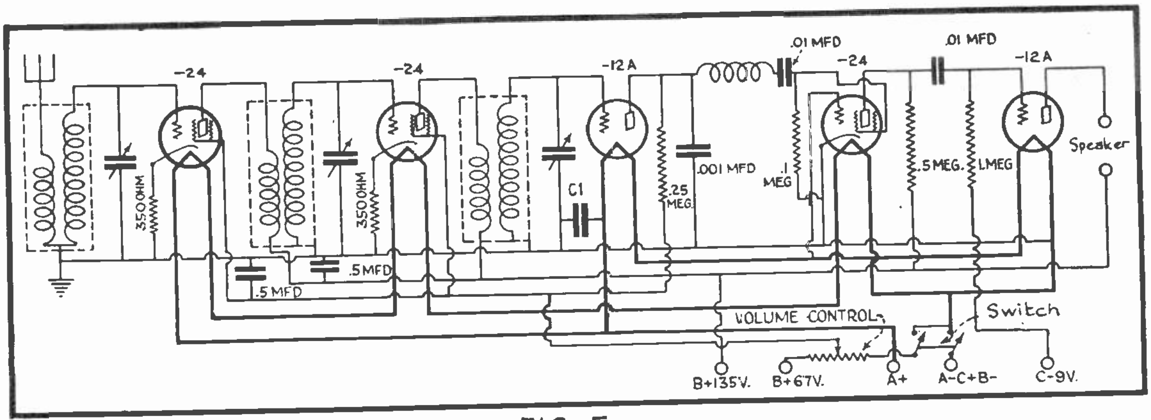

FIG. 5
Circuit Diagram of the NATIONAL Auto Receiver.

CONSIDERABLE BATTERY CURRENT, FOR EACH TUBE OF THIS TYPE IS RATED AS BEING CAPABLE OF PASSING 1.75 AMPERES THROUGH ITS FILAMENT WITH 2.5 VOLTS IMPRESSED ACROSS THE FILAMENT TERMINALS. HOWEVER, BY AGAIN LOOKING AT FIG. 5 CLOSELY, YOU WILL NOTE THAT THE THREE-24 TUBES ARE NOT CONNECTED IN PARRALLEL BUT IN SERIES.

BY MEANS OF THIS METHOD OF CONNECTING THESE THREE TUBES, A FULLY CHARGED STORAGE BATTERY, AS USED IN THE CAR, WILL BE CAPABLE OF SENDING THE SAME 1.75 AMPERES THROUGH THE FILAMENTS OF EACH OF THE -24 TUBES INSTEAD OF A SEPARATE 1.75 AMPERES THRU EACH. THIS BRINGS ABOUT A GREAT SAVING IN THE CURRENT WHICH IS DRAINED FROM THE STORAGE BATTERY.

THE FILAMENTS OF THE TWO -12 A'S ARE ALSO CONNECTED IN SERIES WITH EACHOTHER, SO AS TO KEEP THE FILAMENT CURRENT CONSUMPTION DOWN TO A MINIMUM VALUE.

BEFORE CONTINUING WITH THE ACTUAL INSTALLATION OF RADIO EQUIPMENT

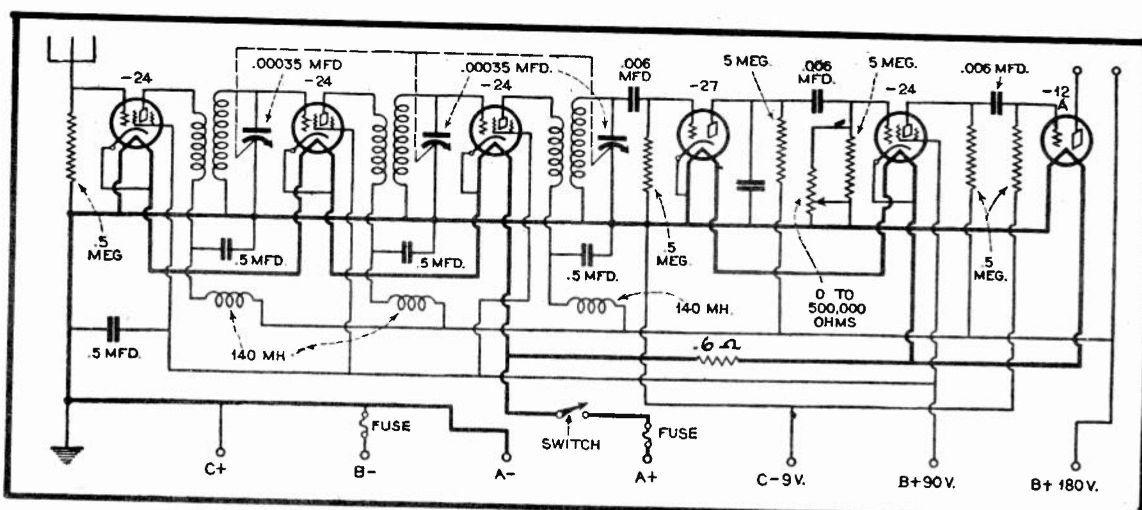

FIG. 6

Another Circuit Diagram for An Auto Receiver.

UPON THE AUTOMOBILE, LET US FIRST INSPECT SOME MORE RECEIVER CIRCUITS WHICH HAVE PROVED THEMSELVES AS BEING SATISFACTORY FOR THIS USE. YOU SEE, GREAT CARE MUST BE EXERCISED IN THE DESIGN OF SUCH A RECEIVER FOR IN SPITE OF ITS SMALL SIZE, IT MUST BE VERY SENSITIVE BECAUSE THE METAL BULK OF THE AUTOMOBILE ACTS AS A SHIELD AROUND THE RECEIVER INSTALLATION, THEREBY DIMINISHING TO A MARKED DEGREE THE EFFECTIVENESS OF THE AVAILABLE INPUT ENERGY.

ANOTHER AUTO RECEIVER CIRCUIT

ANOTHER INTERESTING RECEIVER CIRCUIT FOR AUTOMOTIVE USE IS SHOWN IN FIG. 6. IN THIS CASE, THREE R.F. STAGES ARE USED, EMPLOYING TYPE-24 TUBES. THE DETECTOR IS OF THE GRID CONDENSER AND LEAK TYPE, USED IN CONJUNCTION WITH A -27 TYPE TUBE. THE AUDIO STAGE MAKES USE OF A -24 TYPE TUBE WITH RESISTANCE-CAPACITY COUPLING AND A TYPE -12A TUBE IS MADE USE OF IN THE POWER STAGE.

NOW THEN, HERE AGAIN NOTICE THE SERIES-PARALLEL FILAMENT CONNECTIONS SO AS TO REDUCE THE DEMAND UPON THE STORAGE BATTERY. THE THREE R.F. TUBES ARE CONNECTED IN SERIES ACROSS THE 6 VOLT "A" BATTERY. THIS WILL IMPRESS

A VOLTAGE OF 2 VOLTS ACROSS THE FILAMENT TERMINALS OF EACH OF THESE AND ALTHOUGH A LITTLER LOWER THAN THE REQUIRED A.C. FILAMENT VOLTAGE FOR THIS TYPE OF TUBE, IT WILL BE FOUND THAT THIS FACT WILL NOT IMPAIR THE EFFICIENCY OF THE TUBE'S OPERATION TO ANY NOTICEABLE DEGREE. ALL THREE OF THESE TUBES WILL THUS ONLY DRAW SLIGHTLY LESS THAN 1.75 AMPERES.

THE FILAMENT OF THE -27 DETECTOR TUBE IS IN SERIES WITH THE -24 FIRST AUDIO, AS WELL AS WITH A .6 OHM RESISTOR, THEREFORE 5 VOLTS WILL BE IMPRESSED ACROSS ITS FILAMENT.

SO HERE AGAIN, YOU ARE LOOKING AT AN EXAMPLE OF AN AUTO RADIO RECEIVER, IN WHICH THE QUALITIES OF STRENGTH AND STABLE OPERATION OF THE A.C. TUBES ARE USED IN A BATTERY CIRCUIT WITHOUT OVER-TAXING THE BATTERY.

NOTE THE TWO FUSES IN THE CIRCUIT OF FIG. 6. THESE ARE PROVIDED TO PROTECT THE WIRING OF THE CAR IN CASE THAT A SHORT SHOULD DEVELOPE IN THE CIRCUITS OF THE RECEIVER IN WHICH THESE FUSES ARE INSTALLED. TO FURTHER STABLIZE THE RECEIVER, 140 MILLIHENRY R.F. CHOKES ARE INSTALLED IN THE PLATE CIRCUIT OF THE R.F. TUBES AND THESE ARE USED IN CONJUNCTION WITH THREE OF THE .5 MFD. BY-PASS CONDENSERS.

THE REASON FOR THE UNTUNED INPUT CIRCUIT OF THIS RECEIVER IS TO DO AWAY WITH THE ANTENNA EFFECT IN CASE THAT THE RECEIVER BE USED WITH VARIOUS SIZED ANTENNAS. THIS CASE WOULD BE ENCOUNTERED WHEN USING THE SAME RECEIVER FOR AUTO, BOAT OR CAMP ETC. IN WHICH CASE THE AERIAL LENGTHS AND HEIGHTS WOULD DIFFER.

THE NEW AUTO RECEIVER TUBES

DURING THE DEVELOPMENT OF AUTO RECEIVERS, THE -01 A, THE -22, THE -24, THE -27, ETC. WERE ALL TRIED, YET NONE OF THEM MET WITH AS MUCH SUCCESS AS WAS DESIRED. THE D.C. TYPES WERE TOO FRAGILE FOR AUTOMOBILE USE AND THUS PERMITTED MICROPHONIC NOISES WHEN SUBJECTED TO THE VIBRATION OF THE MOVING CAR. EVEN THE A.C. TUBES DIDN'T PERFORM AS WAS EXPECTED, FOR THESE TOO WERE NOT SPECIALLY DESIGNED FOR AUTOMOTIVE USE.

THESE SHORT-COMINGS HAD TO BE OVERCOME, IN ORDER TO KEEP THE AUTO RADIO ON A FIRM FOOTING, SO TO PROMOTE ITS ADVANCEMENT, TUBE MANUFACTURERS INTRODUCED SOME NEW TUBES TO THE MARKET, WHICH ARE ESPECIALLY ADAPTED TO AUTOMOTIVE USE., THE FIRST OF THE AUTOMOBILE TYPE TUBES, WHICH WERE INTRODUCED TO THE INDUSTRY, INCLUDED THE -36, -37, -38 AND THE -39. THE ESSENTIAL CHARACTERISTICS OF THESE THREE AUTO TUBES ARE GIVEN IN THE FOLLOWING PARAGRAPHS.

OPERATING CHARACTERISTICS OF THE -36.

THE -36 IS A SCREEN GRID TUBE CONSISTING OF A HEATER, CATHODE, PLATE, CONTROL GRID AND SCREEN GRID. IT HAS A 5-PRONG BASE AND A CAP ON TOP OF THE GLASS BULB AT WHICH THE CONTROL GRID CONNECTION IS MADE. THIS TUBE MAY BE USED EITHER AS AN R.F. AMPLIFIER OR DETECTOR.

FROM THIS GENERAL DESCRIPTION, YOU WILL NOTICE THAT THE -36 IN ITS CONSTRUCTIONAL FEATURES AND APPLICATION IS SOMEWHAT SIMILAR TO THE TYPE -24 TUBES WHICH IS USED IN A.C. RECEIVERS. THE OPERATING CHARACTERISTICS OF THE -36, HOWEVER, ARE DIFFERENT IN ORDER TO BEST ADAPT IT TO AUTOMOTIVE USE. ITS CHARACTERISTICS ARE AS FOLLOWS:

HEATER VOLTAGE	6.3 VOLTS
HEATER CURRENT	0.3 AMPERE
PLATE VOLTAGE	90 TO 180 VOLTS
SCREEN GRID VOLTAGE	55 TO 90 VOLTS
CONTROL GRID VOLTS	-1.5 TO -3 VOLTS
PLATE CURRENT	1.8 TO 3.1 MA.
AMPLIFICATION FACTOR	275 TO 370

THE TYPE -37 TUBE

THE -37 IS A GENERAL-PURPOSE AUTOMOTIVE TRIODE AND IN CONSTRUCTION IS SOMEWHAT SIMILAR TO THE -27 A.C. TUBE. THAT IS, IT CONSISTS OF A HEATER, CATHODE, PLATE AND CONTROL GRID AND A FIVE-PRONG BASE. THE OPERATING CHARACTERISTICS OF THE -37 ARE AS FOLLOWS:

HEATER VOLTAGE	6.3 VOLTS
HEATER CURRENT	0.3 AMPERE
PLATE VOLTAGE	90 TO 135 VOLTS
GRID BIAS	-6 TO -9 VOLTS
PLATE CURRENT	2.6 TO 4.3 MA.
AMPLIFICATION FACTOR	9

FIG. 7
The -38

THE TYPE -38 TUBE

THE -38 IS A HEATER TYPE PENTODE POWER TUBE DESIGNED PRIMARILY TO DELIVER RELATIVELY LARGE AUDIO POWER OUTPUT WITH COMPARATIVELY SMALL SIGNAL VOLTAGES IMPRESSED UPON ITS GRID. IT HAS A FIVE-PRONG BASE TO WHICH ARE CONNECTED ITS HEATER, CATHODE, SCREEN GRID AND PLATE, WHILE ITS CONTROL GRID CONNECTION IS MADE TO THE METALLIC CAP PROVIDED ON TOP OF THE GLASS BULB. THIS TUBE IS ILLUSTRATED FOR YOU IN FIG. 7.

THE OPERATING CHARACTERISTICS OF THE -38 ARE AS FOLLOWS:

HEATER VOLTAGE	6.3 VOLTS
HEATER CURRENT	0.3 AMPERE
PLATE VOLTAGE	135 VOLTS
SCREEN GRID VOLTAGE	135 VOLTS
CONTROL GRID VOLTS	-13.5 VOLTS
PLATE CURRENT	9 MA.
AMPLIFICATION FACTOR	100
POWER OUTPUT	525 MILLIWATTS

THE TYPE -39 TUBE

THE -39 IS AN R.F. PENTODE WITH VARIABLE-MU CHARACTERISTICS AND THUS CONSISTS OF A HEATER, CATHODE, PLATE, SCREEN GRID, CONTROL GRID AND THE SUPPRESSOR GRID IS ALREADY FASTENED TO THE CATHODE WITHIN THE TUBE, THEREBY DOING AWAY WITH THE NEED FOR AN ADDITIONAL CONNECTION PRONG FOR THIS ELEMENT. ALTOGETHER THEN, THERE ARE FIVE BASE PRONGS AND A CONTROL GRID CONNECTION ON TOP OF THE TUBE. ITS OPERATING CHARACTERISTICS ARE:

HEATER VOLTAGE	6.3 VOLTS
HEATER CURRENT	0.3 AMPERE

PLATE VOLTAGE.................... 90 TO 180 VOLTS
SCREEN GRID VOLTAGE.....................90 VOLTS
CONTROL GRID VOLTS.............. -3 VOLTS MINIMUM
PLATE CURRENT..................... 4.4 TO 4.5 MA.
AMPLIFICATION FACTOR.................360 TO 750

THE MAIN IDEA BEHIND THE DESIGN OF THESE TUBES WAS TO CONSTRUCT THEM WITH SUFFICIENT RIGIDITY, SO THAT THEY COULD WITHSTAND A NORMAL AMOUNT OF VIBRATION WITHOUT BECOMING MICROPHONIC. FURTHERMORE, YOU WILL NOTICE BY CONSULTING THEIR OPERATING CHARACTERISTICS THAT THEY REQUIRE A FILAMENT VOLTAGE EQUIVALENT TO THAT OF THE CAR'S STORAGE BATTERY AND BESIDES THIS, ALL FOUR OF THESE TUBES DRAW BUT .3 OF AN AMPERE OF FILAMENT CURRENT PER TUBE, WHICH MEANS A DECIDED SAVING IN FILAMENT CURRENT.

THE HEATER CONSTRUCTION OF THESE TUBES IS SUCH THAT THEIR EFFICIENCY WILL NOT BE IMPAIRED BY THE FACT THAT THE VOLTAGE OF THE STORAGE BATTERY VARIES DURING USE. THAT IS, THESE TUBES WILL OPERATE AT FULL EFFICIENCY IF THE APPLIED FILAMENT VOLTAGE IS ANYWHERES WITHIN THE LIMITS OF 5.5 VOLTS AND 8.5 VOLTS.

ANOTHER INTERESTING FACT CONCERNING THESE SPECIAL AUTOMOTIVE TUBES IS THAT THEY ARE SMALLER IN OVER-ALL SIZE AS COMPARED TO THE OLDER TYPES OF A.C. TUBES SUCH AS THE -24, -27, AND -47. BECAUSE OF THIS REDUCTION IN

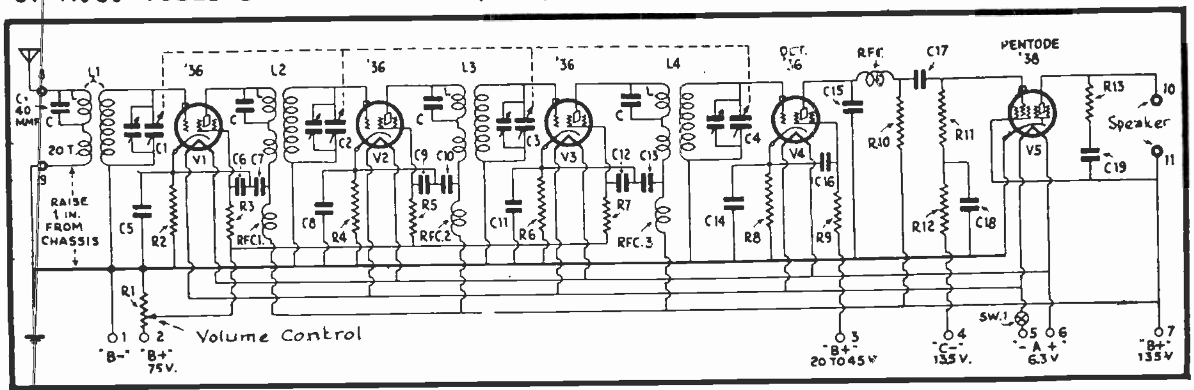

FIG. 8
An Auto Receiver, Employing the latest Tubes.

SIZE, THEY WILL NOT REQUIRE SO MUCH MOUNTING SPACE AND THIS OF COURSE WILL ASSIST MATERIALLY IN KEEPING THE RECEIVER DIMENSIONS WITHIN REASONABLE LIMITS.

NOT ONLY ARE THESE TUBES SATISFACTORY FOR AUTOMOTIVE USE BUT THEY WILL ALSO PERFORM SPLENDIDLY IN ANY D.C. CIRCUIT, IN WHICH THE VOLTAGE CONDITIONS ETC. CORRESPOND TO THE REQUIREMENTS AS DEMANDED IN AUTOMOTIVE USE.

A RECEIVER USING SPECIAL AUTOMOTIVE TUBES

A CIRCUIT DESIGNED ESPECIALLY FOR THE USE OF THE TYPE -36 AND -38 TUBES IN AN AUTO RECEIVER IS ILLUSTRATED IN FIG. 8. THE CHOKE COILS "L" IN THIS CASE ARE HONEYCOMB-WOUND COILS, CONSISTING OF 400 TURNS OF #36 SILK COVERED WIRE. THE INSIDE DIAMETER OF THESE HONECOMB COILS IS 3/8" AND THE COIL IS 1/4" WIDE. THESE SPECIFICATIONS HOLD TRUE FOR ALL OF THE COILS MARKED "L" IN FIG. 8.

EACH OF THESE CHOKES IS SHUNTED BY A 40 MMFD. FIXED CONDENSER, SO

AS TO TUNE THE CHOKES "L" TO RESONANCE BETWEEN 500 AND 600 METERS. THIS EFFECT WILL AID IN PROVIDING UNIFORM AMPLIFICATION AT ALL BROADCAST FREQUENCIES.

THE PRIMARY WINDING IN THE ANTENNA CIRCUIT CONSISTS OF 20 TURNS OF #30 SILK COVERED WIRE WOUND ON A 1¼" DIAMETER TUBE. THIS WINDING, YOU WILL NOTE IN FIG. 8, IS CONNECTED IN SERIES WITH THE FIRST CHOKE "L".

THE PRIMARIES OF THE REMAINING R.F. TRANSFORMERS CONSIST OF 12 TURNS OF #30 SILK COVERED WIRE ALSO WOUND ON A 1½" DIAMETER TUBE AND THE R.F. SECONDARIES ARE ALL MADE UP OF 110 TURNS OF #30 ENAMELED WIRE. THE PRIMARIES AND SECONDARIES OF ALL THESE COILS ARE WOUND ON THE OUTSIDE OF THE TUBE FORM IN THE CONVENTIONAL MANNER AND THE HONECOMB TYPE CHOKE COILS "L" ARE SLIPPED INSIDE OF THE TUBE FORM.

ALSO NOTICE IN FIG. 8 THAT A TYPE -36 SCREEN GRID TUBE IS USED AS A POWER DETECTOR IN THIS CIRCUIT AND THAT FOUR TUNING CIRCUITS ARE EMPLOYED. THE HIGH GAIN IN THE R.F. STAGES IS REQUIRED TO COMPENSATE FOR THE TENDENCY OF THE METAL STRUCTURE OF THE MOTOR CAR TO ABSORB SIGNAL ENERGY AS ALREADY STATED AND FURTHERMORE, THIS EXTENSIVE USE OF TUNED CIRCUITS ADDS TO THE SELECTIVITY OF THE SET, THUS PROVIDING A RECEIVER OF BOTH GOOD SENSITIVITY AND SELECTIVITY.

THE USE OF THE AUTO TYPE PENTODE (-38) IN THE POWER STAGE PERMITS A MARKED REDUCTION IN THE SPACE REQUIRED FOR THE A.F. AMPLIFIER. THE REASON FOR THIS BEING THAT THIS TUBE NOT ONLY DELIVERS A SATISFACTORY POWER OUTPUT BUT IT ALSO HAS SUFFICIENT VOLTAGE AMPLIFICATION SO AS TO BE CAPABLE OF REPLACING AN AUDIO AMPLIFYING CHANNEL CONSISTING OF BOTH A CONVENTIONAL A.F. AMPLIFIER STAGE IN ADDITION TO A POWER STAGE USING A TRIODE TUBE.

IN ORDER TO OBTAIN THE BEST ADVANTAGE OF THIS PENTODE, THE SPEAKER USED WITH THIS RECEIVER SHOULD HAVE A WINDING WITH AN IMPEDANCE OF 15,000 OHMS.

THE FOLLOWING TABLE GIVES YOU THE LIST OF PARTS REQUIRED IN THE CONSTRUCTION OF THIS MORE MODERN AUTO RECEIVER. THE INDEX NUMBERS HERE GIVEN AS C_1, C_2, C_3 ETC. ALL CORRESPONDS TO THE PARTS WHICH ARE INDEXED IN THE SAME MANNER IN THE CIRCUIT DIAGRAM OF FIG. 8.

PARTS LIST FOR THE RECEIVER OF FIG.8

C1-C2-C3-C4	4 GANG .00035 MFD. TUNING CONDENSER
C5-C6-C7-C8-C9-C10-C11-C12-C13	0.1 MFD. BY-PASS CONDENSERS
C14-C16-C18-	1 MFD. BY-PASS CONDENSERS (200 WORKING VOLTS D.C.)
C15	.001 MFD. FIXED MICA CONDENSER
C17-C19	.01 MFD. FIXED MICA CONDENSERS
R1	50,000 OHM POTENTIOMETER
R2-R4-R6-	400 OHM FLEXIBLE WIRE RESISTORS
R3-R5-R7-R12	50,000 OHM 1 WATT RESISTOR
R8-R13	10,000 OHM 1 WATT RESISTORS
R9	100,000 OHM 1 WATT RESISTOR
R10-R11	250,000 OHM 1 WATT RESISTORS
LEADS #1-2-3-4-5-6-7	COMBINED IN A 7 WIRE CABLE
8-9-10-11	4 BINDING POSTS.

L1-L2-L3-L4.........SHIELDED R.F. TRANSFORMERS TO MATCH .00035 MFD. TUNING CONDENSERS
C...................00004 MFD. FIXED MICA CONDENSERS.
R.F.C.-1-2-3........85 MILLIHENRY R.F. CHOKES
V1-V2-V3-V4.........TYPE -36 SCREEN-GRID TUBES.
V5..................TYPE -38 PENTODE TUBE
5...................ALUMINUM TUBE SHIELDS
5...................UY SOCKETS
1...................12 GAUGE ALUMINUM SHEET 22"X13" FOR CHASSIS BASE.

HOOK-UP WIRE AND MISCELLANEOUS HARDWARE SUCH AS SCREWS, NUTS ETC. (THE TYPE OF TUNING AND VOLUME CONTROLS WILL DEPEND UPON THE LOCATION AND METHOD USED IN INSTALLING THE RECEIVER IN THE AUTOMOBILE.)

SHOULD YOU CARE TO CONSTRUCT THIS RECEIVER, THEN THE ILLUSTRATIONS SHOWN IN FIG. 9 WILL AID YOU IN THE WORK. NOTICE THAT THE ALUMINUM SHEET HAS BEEN BENT ON ALL FOUR SIDES SO AS TO FORM THE CHASSIS, WHICH IS 16" LONG, 7" WIDE AND 3" HIGH. HOLES ARE DRILLED FOR THE SOCKETS, SO THAT THE WAFER TYPE SOCKETS CAN BE USED.

THE CONDENSER GANG IS MOUNTED ON TOP OF THE CHASSIS AS SHOWN, WHEREAS THE SHIELDED R.F. COILS L1-L2-L3-AND L4 ARE MOUNTED ON THE UNDERSIDE OF THE CHASSIS, DIRECTLY BELOW THE TUNING CONDENSERS, BEING FASTENED TO THE SIDE WALL OF THE CHASSIS. THE MISCELLANEOUS PARTS, SUCH AS FIXED CONDEN-

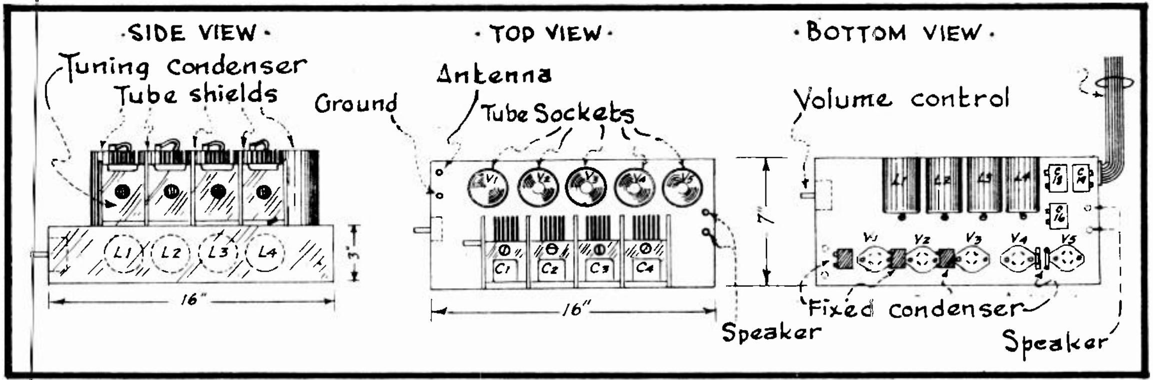

FIG. 9
Parts Arrangement of the Receiver Circuit.

SERS ETC. ARE MOUNTED ON THE UNDERSIDE OF THE CHASSIS AS SHOWN.

THE BATTERY LEADS FOR THE SET ARE ALL BROUGHT OUT OF THE CHASSIS IN THE FORM OF A CABLE AND IT IS ADVISABLE THAT EACH OF THESE HAVE A DIFFERENT COLORED INSULATION SO AS TO MAKE TRACING OF THE CIRCUITS MORE SIMPLE.

SPEAKERS FOR AUTO USE

SO FAR, YOU HAVE BEEN FAMILIARIZED WITH THE CIRCUITS OF AUTOMOTIVE RECEIVERS AND SO LET US NOW PASS ON TO THE SUBJECT OF SPEAKERS FOR THIS PURPOSE. A PECULIAR ACOUSTICAL CONDITION EXISTS IN THE AUTOMOBILE, ESPECIALLY IN A CLOSED CAR. THE RESULT OF THIS CONDITION IS THAT SOME SPEAKERS WHICH ARE ORDINARILY CONSIDERED AS OF A RATHER POOR QUALITY, GIVE BETTER RESULTS IN AUTO INSTALLATIONS THAN THE HIGHER QUALITY DYNAMIC SPEAKERS SUCH AS USED IN THE HOME.

The reason for the above condition lies in the fact that the upholstering of the car absorbs much more of the high frequencies than of the low and the bass notes are still further reinforced by the resonance brought about within the small space. Consequently, if a good dynamic speaker be used, which in itself is a good reproducer of the lower notes it is obvious that the low notes will be over-emphasized due to the absorption of the higher frequencies by the upholstering and the high notes will be heard in the background as if in a distance.

The easiest way to remedy this condition is to use a speaker which has comparatively little response to the bass notes and pronounced resonance at the higher frequencies. Although this speaker would sound shrill and tinny in a room, yet when mounted in the car, it will sound better than a speaker of high quality.

The magnetic type speaker, as a rule, filled the bill the best in the earlier auto sets because it is naturally deficient at the lower frequencies and at the same time, does not require a field exciting current as used by the common type of dynamic. The common dynamic speaker field would put quite a drain upon the batteries.

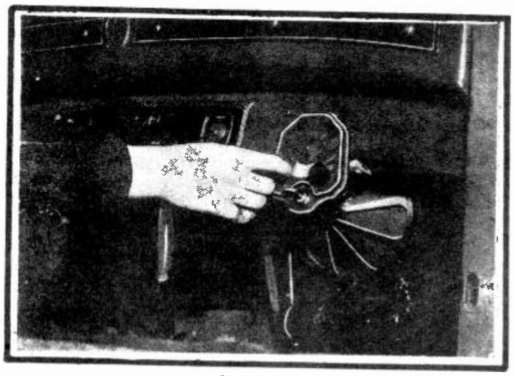

FIG. 10
Installation of a Cone Speaker

Fig. 10 shows you an example of how a cone type speaker can be mounted under the dash, whereas in Fig. 4, you were shown a typical example of a speaker especially designed for automotive use. It is interesting to note in respect to the horn in Fig. 4 that horns of the exponential type, when they are very long, respond equally to all frequencies from high to low.

The lowest note to which full volume is given has a wavelength of equal to four times the diameter of the mouth of the horn but below this critical point on the frequency scale, the response falls off abruptly. Consequently, as the horn is made shorter, this response will fall off gradually and therefore, by choosing the proper length of horn and the proper diameter at the mouth, it is possible to match the acoustics of the car quite accurately.

As to the location of the horn, it will have to be placed wherever there is enough room. The best place acoustically is generally over the windshield and in a great many cases, it will be found that an exponential horn about 12" long and with a 4" bell diameter will fit into this space and deliver satisfactory results.

The speaker of Fig. 4, by the way, is so designed that it may be mounted behind an opening cut into the dashboard of a coupe, where rear seat acoustics need not be considered.

In the more modern automobile receivers, dynamic speakers specially designed for automotive use are being used and in the following lesson, you will be told more about them.

THE INSTALLATION OF AUTO RECEIVERS

NOW LET US PROCEED WITH THE INSTALLATION OF THE SET ITSELF. HERE AGAIN, ONE IS GOVERNED BY THE SPACE AVAILABLE AND THE BEST LOCATIONS AT HAND. FIG. 11 GIVES YOU A GOOD IDEA OF A TYPICAL ARRANGEMENT FOR THE COMPONENT PARTS OF AN AUTO RECEIVER AND AN ARRANGEMENT WHICH IS USED IN A GREAT MANY CASES.

NOTICE IN FIG. 11 THAT THE RECEIVER CHASSIS IS ENCLOSED WITHIN A METALLIC BOX WHICH IS MOUNTED EITHER UNDER THE COWL OR UNDER THE HOOD. THE SPEAKER IS ALSO MOUNTED UNDER THE COWL BUT AT A LOW ENOUGH LEVEL SO AS TO OFFER A GOOD ACCESS FOR THE EMITTED SOUNDS TO BE PROPOGATED TOWARDS THE SEATING QUARTERS. THE REMOTE CONTROL ASSEMBLY, HOWEVER, CONSISTING OF THE TUNING CONTROL, VOLUME CONTROL AND SWITCH IS MOUNTED ON THE INSTRUMENT PANEL OF THE CAR SO AS TO BE WITHIN EASY REACH OF THE DRIVER.

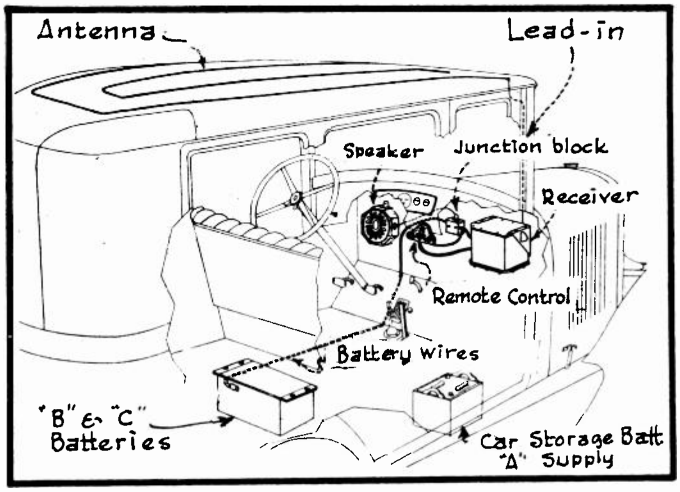

FIG. 11
Typical Auto Radio Installation.

TUNING WITH THIS REMOTE CONTROL SYSTEM IS ACCOMPLISHED THROUGH THE USE OF A FLEXIBLE DRIVE SHAFT, WHICH IS HOUSED WITHIN A CABLE SIMILAR TO A SPEEDOMETER CABLE OF THE AUTOMOBILE. ONE END OF THE ENCLOSED DRIVE SHAFT IS CONNECTED TO THE TUNING CONTROL AND THE OTHER TO A SMALL DRIVE GEAR, WHICH IS MESHED WITH A GEAR MOUNTED ON THE END OF THE TUNING CONDENSER SHAFT. THUS BY ROTATING THE TUNING CONTROL, THIS ROTATIVE MOTION IS TRANSFERRED TO THE CONDENSER SHAFT SO THAT THIS UNIT WILL RESPOND ACCORDINGLY.

VARIOUS OTHER MECHANICAL ARRANGEMENTS HAVE ALSO BEEN WORKED OUT SO THAT TUNING MAY BE ACCOMPLISHED FROM A REMOTE CONTROL UNIT. THESE REMOTE CONTROL UNITS CAN BE PURCHASED ALREADY BUILT UP FOR CONNECTING TO ANY TYPE OF AUTO RECEIVER.

THE "B" AND "C" BATTERIES, IN THE CASE ILLUSTRATED IN FIG. 11, ARE HOUSED IN A METAL BOX WHICH IS MOUNTED UNDER THE FLOOR AT THE REAR PORTION OF THE CAR. THE "B" AND "C" WIRES ARE ENCLOSED TOGETHER WITHIN A CABLE, WHICH RUNS ALONG THE UNDER SIDE OF THE FLOOR BOARDS BETWEEN THE BATTERY BOX AND A POINT JUST BELOW THE DASH. HERE IT COMES THROUGH THE FLOOR AND IS CONNECTED TO THE JUNCTION BOX. THE "A" BATTERY IS ALREADY INSTALLED IN THE CAR, SO NO FURTHER INSTALLATION WORK WILL HAVE TO BE DONE IN THIS RESPECT.

IN FIG. 12, THE CIRCUIT CONNECTIONS FOR THIS SAME RECEIVER ARE SHOWN IN GREATER DETAIL. OBSERVE CAREFULLY HOW ALL OF THE WIRES, WITH THE EXCEPTION OF THE ANTENNA LEAD-IN, ARE CABLED TOGETHER AND EACH OF THESE WIRES IS CODED. THAT IS, THE WIRE INSULATION FOR EACH CIRCUIT IS OF A DIFFERENT COLOR SO AS TO MAKE IDENTIFICATION MORE SIMPLE.

These cabled wires all terminate in a junction or terminal box from which they all branch off to the remainder of the circuit, such as speaker, switch, volume control, "B" and "C" batteries etc. Also notice in Fig. 12 that the general practice is to terminate the cabled "B" and "C" battery leads with a special plug, which has the same number of prongs as there are "B" and "C" battery leads in the cable.

By having a corresponding socket mounted to the battery box, which is already connected up to the battery terminals, it becomes a simple problem to complete the connections between the receiver and its "B" and "C" battery supply.

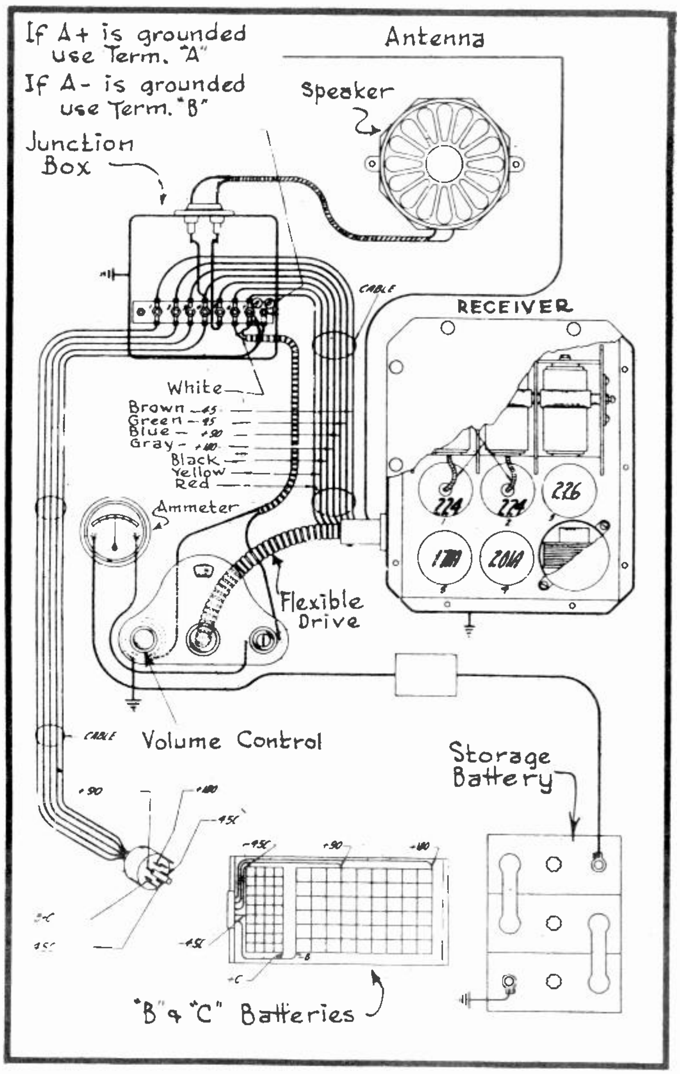

FIG. 12
Circuit Arrangement for An Auto Radio

The car's storage battery is already connected to the ammeter on the instrument board and therefore to obtain the filament supply, it is only necessary to connect one side of the filament switch to the ammeter as shown, while the other side of the switch leads to the junction box and thence to the filament circuits within the receiver.

One side of the storage battery is already grounded to the car's frame and thus by grounding one side of the filament circuit, the filament circuit is complete. Notice the provision made in the junction box of Fig. 12 to take care of the case in which either of the two storage battery terminals may be grounded. By reading the notes in the upper left hand corner of Fig. 12 regarding this fact, you will note that if the positive side of the storage battery is grounded, then the B- C+ wire is connected to terminal "A" of the junction box. This will serve to connect the B- C+ wire to the A- side of the filament circuit. On the other hand, if the negative side of the storage battery is grounded, then by connecting the B- C+ wire to terminal "B" of the junction box, which is already grounded to the box, we will again have the B- C+ line connected to A-.

Although the remote control unit, of Figs 11 and 12 was described as being mounted on the instrument panel of the car, yet it is equally common to mount this unit on the steering column. Then too, there are cas

ES WHERE NO REMOTE CONTROL IS USED AT ALL AND THE RECEIVER CHASSIS IS SIMPLY SO MOUNTED THAT THE CONTROLS AS MOUNTED DIRECTLY UPON IT, ARE ACCESSIBLE TO THE DRIVER. THE SWITCH SHOULD PREFERABLY BE OF THE "LOCK TYPE" SO THAT IT CAN ONLY BE OPERATED BY ONE HAVING THE KEY.

IT IS ALSO ADVISABLE AT THIS TIME TO POINT OUT THAT THE INSTALLATION AS A WHOLE SHOULD BE WEATHERPROOF SO THAT WATER, DIRT ETC. ARE EXCLUDED FROM THE WIRING AND WORKING PARTS OF THE INSTALLATION. IN ORDER TO GUARD AGAINST UNWANTED PICK-UP, IT IS ALSO ADVISABLE TO GROUND ALL OF THE METAL ENCLOSURES OF THE INSTALLATION TO THE CAR FRAME AND TO DO LIKEWISE WITH ANY METALLIC TUBING THROUGH WHICH WIRES ARE RUN.

THE METAL FRAME AND THE BALANCE OF THE CONTACTING METAL MAKING UP THE CAR'S STRUCTURE SERVES AS THE GROUND SIDE OF THE RADIO CIRCUIT, SO WE MIGHT CONSIDER THIS AS BEING ALREADY MADE. THE NEXT QUESTION BEFORE US THEN CONCERNS THE ANTENNA INSTALLATION.

THE TAPE TYPE OF AUTO ANTENNA

MANY TYPES OF AUTO ANTENNAS HAVE BEEN USED AND IN FIG 11 AN EXAMPLE OF ONE OF THESE IS SHOWN. IN THIS CASE, THE ANTENNA CONSISTS OF A TIN FOIL COVERED TAPE, WHICH IS LAID LENGTHWISE ON THE ROOF OF OF THE CAR. IT COMES IN $\frac{1}{4}$" WIDE ROLLS AND IT IS INSTALLED IN THE FOLLOWING MANNER:

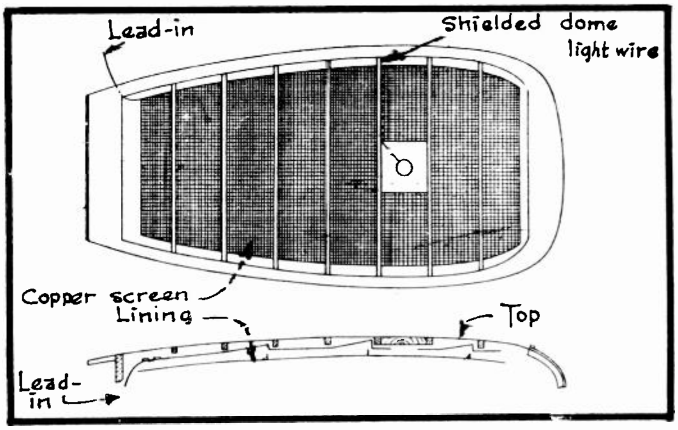

FIG. 13
Copper Screen Antenna Installation on a closed Car.

FIRST CLEAN THE TOP, REMOVING ALL MOISTURE AND DIRT. THEN DRILL A HOLE THRU THE ROOF OF THE CAR, MAKING IT LARGE ENOUGH FOR THE LEAD-IN WIRE TO BE PULLED THROUGH. IF THE RECEIVER CHASSIS IS MOUNTED ON THE RIGHT SIDE OF THE CAR, THEN IT WILL BE MOST CONVENIENT TO LET THE LEAD-IN WIRE COME IN NEAR THE RIGHT FRONT CORNER POST AS SHOWN IN FIG. 11. IT IS ALSO ADVISABLE TO DRILL THIS HOLE THROUGH ONE OF THE ROOF BOWS. THIS DONE, TAKE THE ROLL OF ANTENNA TAPE AND STARTING AT THE HOLE FOR THE LEAD-IN UNROLL THE TAPE AND LAY IT ON THE TOP OF THE ROOF, SO THAT THE ENTIRE ROOF WILL BE COVERED AT THE TWO SIDE AND BACK EDGES AND FINISH UP IN THE CENTER OF THE TOP. IN DOING THIS WORK, TAKE SPECIAL NOTE THAT THE TAPE IS KEPT AT LEAST 3" AWAY FROM THE METAL PART OF THE ROOF SO AS TO AVOID ANY SHIELDING EFFECT.

AFTER THE TAPE IS LAID OUT ON THE ROOF AND SECURELY SOLDERED TO THE LEAD IN WIRE, TAKE THE ROLL OF ADHESIVE TAPE, WHICH IS SUPPLIED WITH THIS TYPE OF ANTENNA EQUIPMENT AND COVER OVER THE ANTENNA TAPE WITH IT. THE FOLLOWING STEP IS TO PAINT OVER THE ADHESIVE TAPE WITH TOP DRESSING, USING AT LEAST TWO COATS. IN FACT, FOR THE SAKE OF APPEARANCE, IT IS ADVISABLE TO GO OVER THE ENTIRE TOP WITH DRESSING AT THIS TIME. THE INSULATED LEAD-IN WIRE IS RUN TO THE ANTENNA POST OF THE RECEIVER IN THE USUAL WAY.

SOME CARS ARE ALREADY EQUIPPED WITH AN ANTENNA BUILT INTO THE TOP. IN THIS CASE, THE LEAD-IN IS GENERALLY PLACED SO THAT IT RUNS DOWN THE RIGHT FRONT BODY POST AND IS TUCKED UNDER THE COWL.

THE SCREEN TYPE OF AUTO ANTENNA

A VERY EFFECTIVE TYPE OF AUTO ANTENNA FOR CLOSED CARS IS ILLUSTRATED IN FIG. 13. HERE A LARGE SHEET OF COPPER ANTENNA SCREEN IS USED. TO MAKE THE INSTALLATION, REMOVE THE CLOTH COVERING FROM THE CEILING OF THE CAR AND IN CASE THE TOP CONSTRUCTION EMPLOYS IRON MESH IN THE ROOF, THEN THIS WILL FIRST HAVE TO BE CAREFULLY REMOVED AND UPHOLSTERERS WEBBING STRAPS USED IN ITS PLACE.

THE COPPER SCREEN CAN THEN BE SECURELY FASTENED INTO POSITION AND BE SURE THAT IT IS SEPARATED FROM THE DOME-LIGHT AND THE METAL BODY OF THE CAR BY AT LEAST 3". NOTICE THE SQUARE HOLE, WHICH HAS BEEN CUT INTO THE COPPER MESH IN ORDER TO CLEAR THE DOME LIGHT IN FIG. 13. THE UPPER ILLUSTRATION OF FIG. 13 SHOWS THE ANTENNA INSTALLATION AS SEEN FROM ABOVE, WHEREAS THE LOWER ILLUSTRATION SHOWS A SIDE VIEW OF THE SAME INSTALLATION.

THE ANTENNA LEAD-IN CAN THEN BE SOLDERED TO THE FRONT RIGHT CORNER OF THE COPPER SCREEN AND RUN DOWN THE RIGHT FRONT CORNER POST THRU NON-METALLIC INSULATING HOUSING FOR BEST EFFICIENCY. THE CLOTH COVERING IS THEN REPLACED ON THE CEILING AND THE ANTENNA INSTALLATION IS THEN COMPLETE.

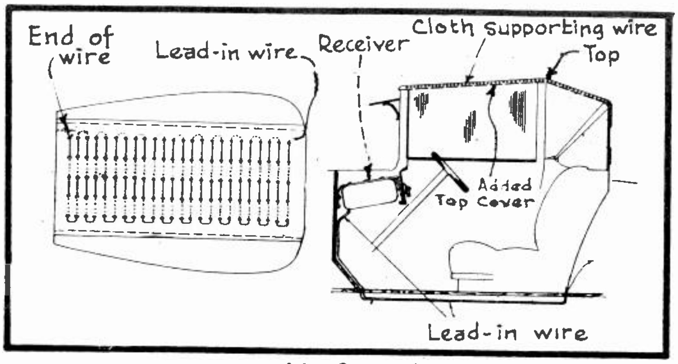

FIG. 14
Antenna Installation On An Open Car.

A SUITABLE ANTENNA FOR OPEN CARS

THE SCREEN TYPE OF ANTENNA IS NOT SUITABLE FOR OPEN CARS IN WHICH THE TOP MAY OCCASSIONALLY BE FOLDED DOWN. THE RECOMMENDED ANTENNA FOR THIS TYPE OF INSTALLATION CONSISTS OF FROM 65 TO 100 FEET OF #18 B&S GAUGE RUBBER-COVERED, STRANDED WIRE, WHICH IS LACED IN GRID FORMATION THRU DRILL CLOTH AND SANDWICHED BETWEEN THE TOP OF THE CAR AND A HEAD LINING OF THE SAME CLOTH.

AT THE LEFT OF FIG. 14, YOU ARE LOOKING AT THE TOP OF THE CAR FROM ABOVE. NOTICE HOW THE FRONT END OF THE WIRE IS PASSED THROUGH A HOLE IN THE DRILL CLOTH AND KNOTTED, SO AS TO PREVENT IT FROM LOOSENING ITSELF. THE WIRE IS THEN WOVEN OR LACED IN AND OUT THROUGH HOLES AT EQUAL INTERVALS IN THE CLOTH AS SHOWN, AT THE SAME TIME WEAVING BACK AND FORTH ACROSS THE WIDTH OF THE CLOTH.

THE ANTENNA LEAD IN IS FINALLY BROUGHT OUT AT THE REAR AND IT IS CLEAR THAT BY WEAVING THE WIRE THROUGH A PIECE OF HEAVY CLOTH IN THIS WAY, THE ANTENNA WILL RETAIN ITS GRID FORMATION WHEN THE TOP IS IN USE AND AT THE SAME TIME, OFFERING THE REQUIRED FLEXIBILITY, SO THAT THE TOP CAN BE FOLDED BACK WHEN SO DESIRED.

BY SANDWICHING THIS ANTENNA BETWEEN THE TOP AND A HEAD LINING, IT IT CONCEALED FROM VIEW. IF THE CAR IS NOT ALREADY EQUIPPED WITH A HEAD

LINING, THEN SOME EXTRA MATERIAL SHOULD BE OBTAINED FOR THIS PURPOSE AND INSTALLED OVER THE DRILL CLOTH AS INDICATED BY THE "ADDED TOP COVER" IN THE RIGHT HAND ILLUSTRATION OF FIG. 14.

THE ANTENNA LEAD-IN WITH THIS TYPE OF INSTALLATION MUST BE TAKEN FROM THE BACK END OF THE CAR. IT MAY BE CARRIED TO THE DASH IN A GROOVE CUT IN THE FLOOR BOARDS OR ELSE IT MAY BE RUN UNDERNEATH THE BODY OF THE CAR AS SHOWN AT THE RIGHT OF FIG. 14. IT CAN THEN BE BROUGHT UP THRU THE FLOOR UNDER THE DASH AND THENCE RUN TO THE RECEIVER BUT ABOVE ALL, DON'T RUN THIS LEAD-IN WIRE THROUGH THE MOTOR COMPARTMENT OF THE CAR, AS HERE IT WOULD PICK-UP ALL KINDS OF INTERFERENCE NOISES. ALSO KEEP THE LEAD-IN AS FAR AS POSSIBLE FROM THE METALLIC MASS OF THE CAR.

IT MIGHT ALSO BE WELL TO MENTION AT THIS TIME THAT IN CLOSED CARS, IN WHICH POULTRY WIRE IS USED IN THE CONSTRUCTION OF THE TOP, THIS WIRE CAN BE USED AS A FAIRLY GOOD ANTENNA, PROVIDED THAT IT IS PERFECTLY INSULATED FROM THE METAL STRUCTURE OF THE CAR, SO AS TO PREVENT ITS GROUNDING.

ONE OF THE MOST IMPORTANT QUALITIES OF THE AUTO ANTENNAS DISCUSSED IN THIS LESSON IS THAT THEY ARE NOT DIRECTIONAL IN THEIR RESPONSE TO SIGNAL ENERGY, AS IS THE CASE WITH VARIOUS OTHER TYPES OF AUTO ANTENNAS WHICH HAVE BEEN OR STILL ARE IN USE. A DIRECTIONAL TYPE ANTENNA, HAS A TENDENCY TO PICK UP SIGNALS COMING FROM A CERTAIN DIRECTION WITHOUT BEING AFFECTED VERY FAVORABLY BY THOSE COMING FROM OTHER DIRECTIONS.

IN THE FOLLOWING LESSON, YOU ARE GOING TO CONTINUE YOUR STUDY OF AUTOMOBILE RECEIVERS BY INVESTIGATING THE METHODS EMPLOYED TO REDUCE ENGINE INTERFERENCE, AS WELL AS TO FAMILIARIZE YOURSELF WITH THE VERY LATEST OF AUTOMOBILE RECEIVER CIRCUITS AND THE IMPROVED ACCESSORY EQUIPMENT, SUCH AS BATTERY ELIMINATORS ETC., WHICH ARE NOW SO COMMONLY USED WITH THEM.

Examination Questions

LESSON NO. 24

"Don't throw stones at your neighbors', if your own windows are glass."

1. - How does an automobile receiver compare in general with the conventional type of receiver such as used in the home?

2. - What form of filament circuit connection is usually employed when A.C. type tubes are used in automobile receivers?

3. - Why are the ordinary battery type tubes not desirable for use in automobile receivers?

4. - What are the operating characteristics of the type -38 automobile tube?

5. - What are some of the most important points to be considered in designing and constructing an automobile receiver?

6. - What important acoustical conditions must be taken into consideration with respect to the installation of a speaker in the automobile?

7. - Describe a typical automobile receiver installation in which "B" and "C" batteries are used.

8. - Describe one type of automobile antenna.

9. - What serves as the conventional "ground" in an auto receiver installation?

10.- What special precautions should be exercised when connecting the lead-in wire to the antenna system of the automobile so as to avoid excessive signal loss and so that a minimum amount of engine interference will be picked up by it?

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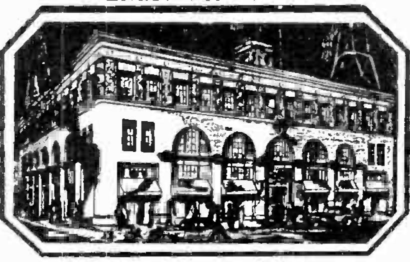

LESSON NO. 25

MODERN AUTOMOBILE RECEIVERS

IN THIS LESSON, YOU ARE GOING TO CONTINUE YOUR STUDY OF AUTOMOBILE RECEIVERS BY LEARNING MORE ABOUT THE CORRECT METHODS OF INSTALLING THEM, AS WELL AS TO FAMILIARIZE YOURSELF WITH THE MORE MODERN DESIGNS, AUTOMOBILE TYPE BATTERY ELIMINATORS, ETC.

REDUCING ENGINE INTERFERENCE

EVEN THOUGH THE INSTALLATION, AS SO FAR DESCRIBED IN THE PREVIOUS LESSON, BE MADE WITH THE MOST EXTREME CARE, AND WITH ALL SHIELDING ETC., CAREFULLY ATTENDED TO, YET THE QUALITY OF RECEPTION WOULD BE IMPAIRED BY INTERFERENCE NOISES WHICH HAVE THEIR ORIGIN WITHIN THE ENGINE COMPARTMENT.

THE MOST PRONOUNCED INTERFERENCE PRODUCED BY THE AUTOMOBILE'S ELECTRICAL SYSTEM IS RADIATED BY THE HIGH VOLTAGE CABLES, WHICH RUN FROM THE DISTRIBUTOR TO THE ENGINE SPARK PLUGS, AND THE HIGH VOLTAGE CABLE WHICH IS CONNECTED BETWEEN THE CAR'S IGNITION COIL AND THE DISTRIBUTOR HEAD.

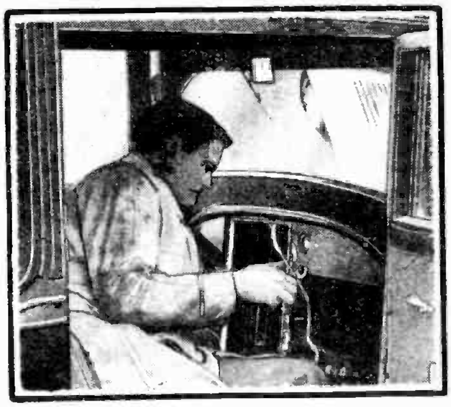

FIG. 1
Installing An Auto Receiver

IN FIG. 2, YOU ARE LOOKING AT THE GENERAL LAY-OUT OF A TYPICAL AUTO IGNITION AND GENERATOR CIRCUIT, WITH THE NECESSARY ADDITIONS MADE SO AS TO REDUCE ENGINE INTERFERENCE NOISES AS MUCH AS POSSIBLE.

THE HIGH VOLTAGE CURRENT WHICH FLOWS THROUGH THE SPARK PLUG CABLES, AS WELL AS THROUGH THE CABLE BETWEEN THE COIL AND DISTRIBUTOR, CAUSES THESE CABLES TO ACT AS SMALL ANTENNAS. THE INTERFERENCE ENERGY RADIATED BY THESE WIRES IS IN THE FORM OF HIGHLY DAMPED WAVE TRAINS, WHICH IMPRESS THEMSELVES UPON THE ANTENNA SYSTEM. THE RESULTING INTERFERENCE IS SIMILAR TO THAT EXPERIENCED BY BROADCAST RECEIVERS FROM ANY ELECTRICAL APPLIANCE WHICH RADIATES HIGHLY DAMPED WAVES. IN AN AUTOMOBILE, THE INTERFERING DAMPED WAVE TRAIN FROM THE IGNITION SYSTEM HAS A FREQUENCY LYING IN THE NEIGHBORHOOD OF 10 TO 60 MEGACYCLES AND IN SOME CASES EVEN HIGHER (1 MEGACYCLE IS EQUAL TO 1 MILLION CYCLES).

ALTHOUGH A GOOD JOB OF SHIELDING OF THESE CABLES WILL PREVENT THE RADIATION FROM INTERFERING WITH THE RECEIVER'S OPERATION, YET THIS METHOD IS COSTLY AND DIFFICULT TO INSTALL. FOR THIS REASON, SPECIAL INTERFERENCE SUPPRESSORS WERE DEVELOPED AND THESE CONSIST OF RESISTANCE ELEMENTS, HAVING A RESISTIVE VALUE OF SOME 15,000 TO 25,000 OHMS. THESE SUPPRESSORS ARE CONNECTED IN THE HIGH VOLTAGE CIRCUITS OF THE IGNITION SYSTEM AS SHOWN BOTH IN FIGURES 2 AND 3.

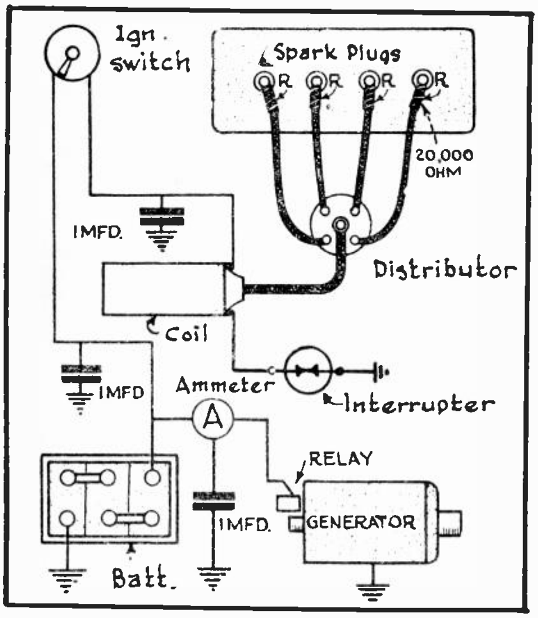

FIG. 2
Filtering the Ignition System.

THIS ADDED RESISTANCE ALTERS THE OSCILLATORY CHARACTERISTIC OF THE CIRCUIT AND CAUSES THE HIGH VOLTAGE CURRENT TO PASS THROUGH THESE WIRES MORE AS A SINGLE PULSE INSTEAD OF OSCILLATORY. IT IS ALSO INTERESTING TO NOTE THAT SPECIAL AUTOMOBILE SPARK PLUGS ARE NOW BEING MANUFACTURED TO DO AWAY WITH THE NECESSITY OF USING ADDITIONAL SUPPRESSORS IN THE SPARK PLUG CABLES.

IT IS ADVISABLE TO NOTE IN FIG. 3 THAT IT IS BETTER PRACTICE TO INSTALL AN INTERFERENCE SUPPRESSOR AT BOTH ENDS OF THE HIGH VOLTAGE CABLE, WHICH IS CONNECTED BETWEEN THE COIL AND DISTRIBUTOR HEAD.

THIS TREATMENT OF THE HIGH VOLTAGE CIRCUITS OF THE IGNITION SYSTEM WILL OVERCOME THE MAJOR SOURCE OF ENGINE INTERFERENCE BUT IT IS ALSO WELL TO FILTER THE LOW VOLTAGE CIRCUITS BY MEANS OF SEVERAL 1 OR 2 MFD. BY-PASS CONDENSERS, WHICH ARE CONNECTED ACROSS THE VARIOUS CIRCUITS IN THE MANNER ILLUSTRATED IN FIG. 2.

ALTHOUGH THE FREQUENCY IS RATHER LOW IN THE PRIMARY (LOW VOLTAGE) IGNITION CIRCUIT, PROBABLY NOT HIGHER THAN 2500 CYCLES, YET THIS WOULD OFFER A POSSIBILITY OF BEING PICKED UP BY THE AUDIO CIRCUITS OF THE RECEIVER. THE BY-PASS CONDENSERS, HOWEVER, OFFER THESE CURRENTS AN EASY ESCAPE TO GROUND.

THE AUTOMOBILE GENERATOR WILL AS A RULE CAUSE LITTLE IF ANY INTERFERENCE, PROVIDED THAT THE COMMUTATOR IS IN GOOD CONDITION. GENERATOR INTERFERENCE CAUSES A HUMMING NOISE AND THE BEST REMEDY IS TO CORRECT THIS CONDITION BY SANDING DOWN THE GENERATOR COMMUTATOR WITH #00 SANDPAPER OR OTHERWISE REPAIRING THE UNIT. THE NEXT BEST THING IS TO CONNECT A BY-PASS CONDENSER ACROSS THE GENERATOR TERMINAL AND GROUND AS SHOWN IN FIG. 2.

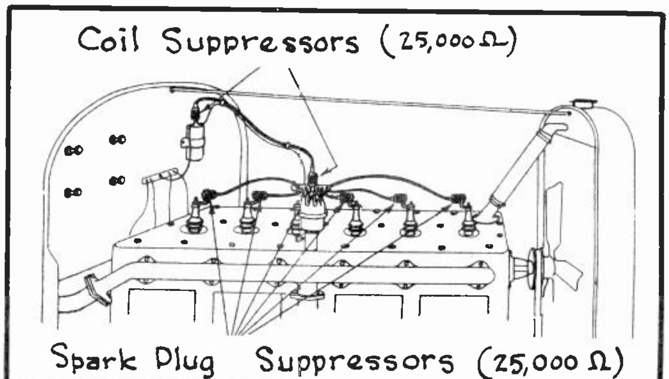

FIG. 3
Location of the Suppressors.

TO STILL FURTHER REDUCE THE AMOUNT OF ENGINE INTERFER-

ENCE PICKED UP BY THE RECEIVER, IT IS ADVISABLE TO KEEP THE ANTENNA LEAD-IN WIRE AS FAR AS POSSIBLE FROM THE ENGINE COMPARTMENT AND TO USE SHIELDED WIRE FOR THIS PURPOSE. THE BRAID SHIELDING SHOULD OF COURSE BE EFFECTIVELY GROUNDED TO SOME CONVENIENT POINT OF THE CAR FRAME. REMEMBER, THAT IN THE CASE OF AUTOMOBILE RECEIVERS, THE METALLIC MASS OF THE CAR SUCH AS THE ENGINE, FRAME ETC. SERVES AS THE GOUND OF THE ENTIRE RADIO SYSTEM, AS WELL AS FOR THE CAR'S REGULAR ELECTRIC SYSTEM.

DESIGN IMPROVEMENTS

CONSTANT IMPROVEMENTS ARE BEING MADE IN AUTOMOBILE RECEIVERS--THE MORE IMPORTANT ADVANCEMENTS BEING MORE COMPACT DESIGNS IN WHICH THE RECEIVER, SPEAKER, AND POWER SUPPLY ARE BUILT INTO A SINGLE UNIT SO AS TO MATERIALLY SIMPLIFY INSTALLATION; RECEIVERS OFFERING BETTER ALL-AROUND PERFORMANCE AND NEW TYPE POWER SUPPLY UNITS WHICH DO AWAY WITH THE NEED FOR AUXILIARY BATTERY EQUIPMENT.

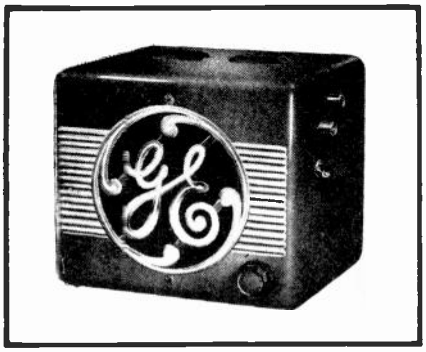

FIG. 4
A Modern Self-Contained Automobile Receiver

IN FIG. 4, FOR INSTANCE, YOU WILL SEE A TYPICAL EXAMPLE OF SUCH A MODERN AUTOMOBILE RECEIVER IN WHICH A SINGLE METAL CASE HOUSES THE RECEIVER ITSELF, THE SPEAKER AND THE POWER SUPPLY. THE ENTIRE ASSEMBLY IS THEN MOUNTED AS A COMPACT UNIT BELOW THE INSTRUMENT PANEL OF THE CAR, THUS REQUIRING ONLY A SIMPLE FORM OF SUSPENSION. THE REMOTE CONTROL UNIT IS FASTENED TO THE STEERING COLUMN.

ANOTHER MODERN COMMERCIAL-TYPE AUTOMOBILE RECEIVER IN ITS COMPLETE FORM IS SHOWN YOU IN FIG. 5. HERE THE RECEIVER, SPEAKER, AND "B" ELIMINATOR ARE ALSO CONTAINED IN A SINGLE METAL HOUSING, WHICH REQUIRES ONLY A SINGLE BOLT FOR MOUNTING. THIS FEATURE MAKES THE RECEIVER COMPACT AND EASY TO INSTALL, REMOVE, OR INSPECT. THE REMOTE-CONTROL UNIT FOR THIS RECEIVER, WHICH IS ALSO SHOWN IN FIG. 5, HAS AN ILLUMINATED DIAL AND IS DESIGNED TO BE MOUNTED ON THE INSTRUMENT PANEL OF THE CAR.

RECEIVERS OF SIMILAR COMPACT FEATURES ARE BEING BUILT BY SEVERAL OF THE PROMINENT RADIO MANUFACTURERS.

MANY REFINEMENTS SUCH AS TONE CONTROL, AUTOMATIC VOLUME CONTROL, DYNAMIC SPEAKERS, ETC., WHICH WERE FORMERLY CONFINED TO THE FINER RECEIVERS DESIGNED PRIMARILY FOR HOME USE, ARE ALSO NOW INCORPORATED IN THE AUTOMOBILE RECEIVER. THUS IT CAN BE SEEN THAT THE AUTOMOBILE RECEIVER OF MODERN DESIGN WILL PERFORM REMARKABLY WELL IN SPITE OF THE FACT THAT IT IS OF A PORTABLE NATURE.

STILL ANOTHER MODERN AUTOMOBILE RECEIVER OF SOMEWHAT DIFFERENT DESIGN IS SHOWN YOU IN FIG. 6. THIS IS A SIX-TUBE SUPERHETERODYNE, HOUSED IN A METAL CASE UPON WHICH THE CONTROLS ARE MOUNTED DIRECTLY. THE SPEAKER, HOWEVER, IS IN THIS INSTANCE AN INDIVIDUAL UNIT, REQUIRING A SINGLE BOLT FOR MOUNTING. THE B-POWER SUPPLY UNIT IS IN THIS CASE ALSO MOUNTED IN THE SAME CABINET WITH THE RECEIVER. THIS ARRANGEMENT IS USED QUITE EXTENSIVELY IN AUTOMOBILE RADIO INSTALLATIONS.

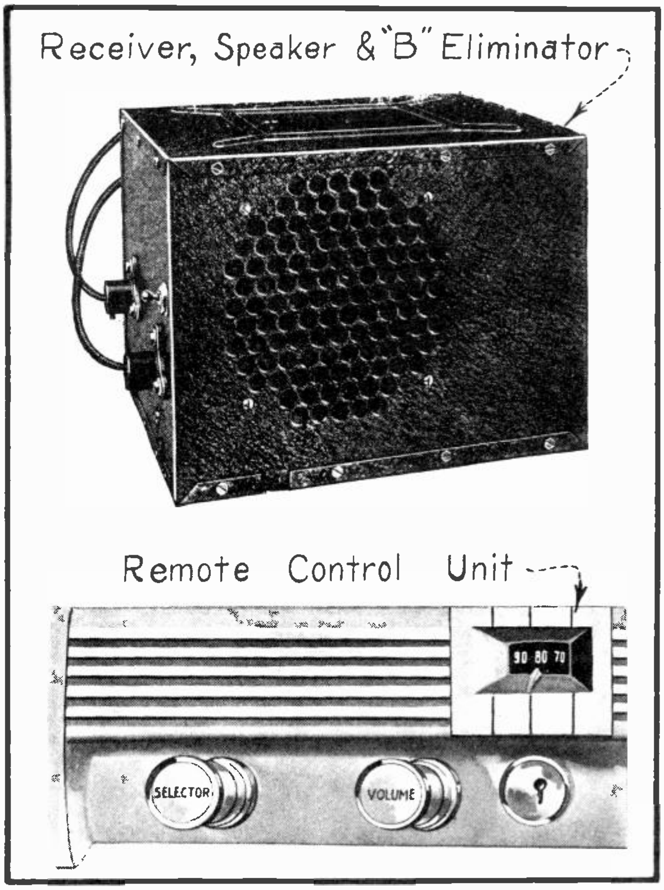

FIG. 5
Complete Auto Receiver With Remote Control

BEFORE GOING INTO A DETAILED STUDY OF THE MODERN RECEIVER CIRCUITS IN THEMSELVES, LET US FIRST INVESTIGATE THE CONSTRUCTION AND OPERATION OF THE VARIOUS TYPES OF THE AUTOMOTIVE TYPE "B" ELIMINATORS.

THE "GENEMOTOR" "B" ELIMINATOR

IN FIG. 7 YOU ARE SHOWN THE CARTER "GENEMOTOR." THIS UNIT, AS ITS NAME INDICATES, IS A MOTOR-GENERATOR OF COMPACT DESIGN. IT IS CONNECTED ACROSS THE BATTERY CIRCUIT OF THE CAR AND IS DRIVEN AS A MOTOR BY THIS SOURCE OF POWER. ADDITIONAL WINDING IS FURNISHED IN THE UNIT SO THAT WHILE OPERATING AS A MOTOR, IT AT THE SAME TIME GENERATES A HIGH VOLTAGE D.C. SUPPLY SUITABLE FOR "B" USE. FURTHERMORE, A FILTER CIRCUIT IS HOUSED WITHIN THE BASE OF THE UNIT TO SMOOTH OUT ANY RIPPLE IN THE GENERATED D.C. OUTPUT BEFORE DELIVERING IT TO THE RECEIVER.

A TERMINAL STRIP IS PROVIDED ON THE SIDE OF THE BASE TO WHICH THE CIRCUIT CONNECTIONS CAN BE MADE AND A METAL COVER SERVES TO SHIELD THE ENTIRE UNIT. IT CAN BE MOUNTED AT ANY CONVENIENT POINT SUCH AS UNDER THE FRONT OR BACK SEAT, UNDER THE INSTRUMENT BOARD ETC. SPECIAL RUBBER MOUNTINGS PREVENT VIBRATION, THUS AIDING TO MAKE THE UNIT PRACTICALLY NOISELESS AND IT IS GUARANTEED BY THE MANUFACTURER NOT TO CAUSE INTERFERENCE OF ANY KIND IN THE RECEIVER.

ONE SIZE OF CARTER "GENEMOTOR" DRAWS 2.2 AMP. OF STORAGE BATTERY CURRENT AND OFFERS AN OUTPUT OF 180 VOLTS D.C. AT 30 MILLIAMPERES, WHILE ANOTHER SIZE DRAWS 1.7 AMP. OF STORAGE BATTERY CURRENT AND PROVIDES AN OUTPUT OF 135 VOLTS D.C. AT 30 MILLIAMPERES.

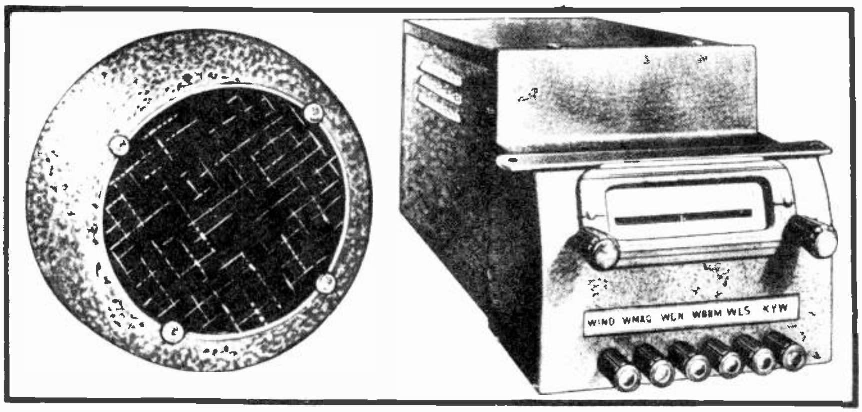

FIG. 6
A Superheterodyne Receiver With Separate Speaker

THE EMERSON "B" POWER UNIT

Another motor-generator or dynamotor type automobile "B" eliminator is shown you in Fig. 8. This particular device is known as the "Emerson B-Power Unit" and is also of very compact design, with the following over all dimensions: 8 7/8" long, 7 3/4" wide and 6" high.

This unit also has a filter mounted on its base and is completely enclosed in a removable metal shield can. It operates on the 6 volt car storage battery, drawing 2 amps. of battery current and delivers an output of 180 volts D.C. at 40 milliamperes.

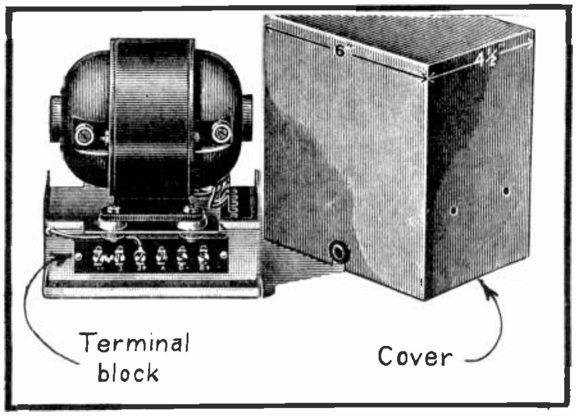

FIG. 7
The Carter "Genemotor"

VIBRATOR TYPE "B" ELIMINATORS

In Fig. 9 you are shown the "Premier B Power Unit", which is a typical example of a vibrator or electro-magnetic rectifier type "B" eliminator. In this case, the device is also operated from the car's six volt storage battery, only that an electromagnetically operated vibrator is connected in the battery circuit together with the primary winding of a special transformer--the vibrator serving to "chop up" the flow of battery current through this transformer winding so that it flows in "spurts" rather than uniformly.

In this way, corresponding voltage variations are generated in the secondary winding of the transformer, only that the secondary voltage is greater in magnitude than that which is effective across the primary winding. In short, this action is similar to that experienced with vibrator type induction coils such as used for ignition purposes on the old Model "T" Ford automobile with the necessary refinements in design to best meet the car's radio requirements.

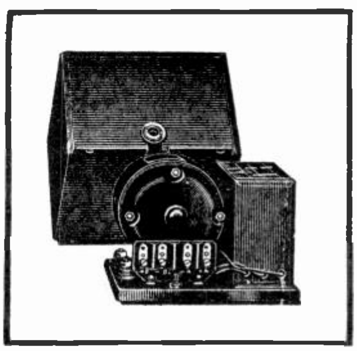

FIG. 8
The Emerson "B" Power Unit.

The secondary current is then rectified and filtered by means of a tube type rectifier and conventional filter circuit and thus the energy is finally made suitable for "B" use.

The unit illustrated in Fig. 9 is completely enclosed in a compact metal cabinet which is $5\frac{1}{2}$" wide, $5\frac{1}{2}$" high and $3\frac{1}{2}$" deep and weighs 5 pounds. It can be mounted in any position and at any convenient point. It is furnished in two models, one offering a D.C. output of 135 volts at 30 milliamperes and another with an output of 180 volts at 30 milliamperes. It draws approximately 2 amperes of battery current.

THE ELKON ELIMINATOR

The "Elkon Eliminator," which is shown you in Fig. 10, is also of the vibrator type and is housed in a compact metal cabinet whose overall

DIMENSIONS ARE $10 X 7 X 3\frac{1}{2}$ INCHES.

THIS UNIT IS AVAILABLE WITH A 135 VOLT D.C. OUTPUT AT 16 MA. TO 46 MA., OR WITH A 180 VOLT D.C. OUTPUT AT 12 MA. TO 35 MA. THE STORAGE BATTERY CURRENT REQUIRED RANGES FROM 1.1 AMPERE TO 2.45 AMPERES, DEPENDING UPON THE OUTPUT REQUIREMENTS.

THESE DIFFERENT OUTPUT CAPACITIES ARE SUPPLIED IN ORDER TO EXACTLY FIT THE NEEDS OF EVERY AUTO RECEIVER NOW ON THE MARKET. THIS VARIATION IN CAPACITY IS ENTIRELY TAKEN CARE OF BY ASSEMBLING IN ONE METAL ENCASED UNIT, KNOWN AS THE " ELKONODE," ALL OF THE VARIABLE DEVICES THAT GO TO CHANGE THE CAPACITY OF THE OUTPUT. THE "ELKONODE" PLUGS INTO A REGULAR TUBE SOCKET AND THUS ONE MAIN UNIT CAN BE ADAPTED TO ANY ONE PARTICULAR CAR RECEIVER BY SIMPLY INSTALLING THE PROPER "ELKONODE".

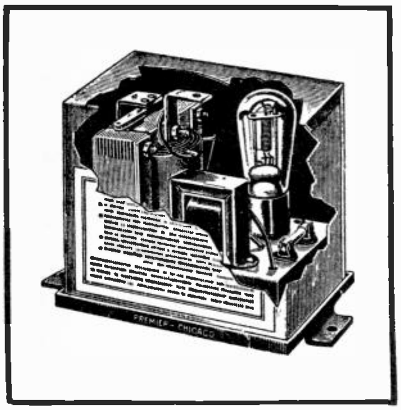

FIG. 9
The Premier "B" Power Unit.

THE ELKON ELIMINATOR CAN BE MOUNTED IN ANY ONE OF MANY CONVENIENT POINTS IN THE CAR, SUCH AS UNDER A SEAT, IN A CONTAINER SUSPENDED UNDER THE FLOOR, IN THE LUGGAGE CARRIER, UNDER THE INSTRUMENT PANEL ETC.

VARIOUS ELIMINATOR DESIGNS

BESIDES THE EXAMPLES SHOWN YOU SO FAR IN THIS LESSON, VARIOUS OTHER TYPES OF MOTOR-GENERATOR UNITS ARE AVAILABLE. FOR INSTANCE, THERE ARE UNITS OF THIS FORM WHICH OPERATE OFF THE 6 VOLT STORAGE BATTERY AND IN TURN FURNISH A 110 VOLT A.C. SUPPLY OR ELSE ARE DRIVEN BY THE ENGINE FAN BELT AS A CONVENTIONAL GENERATOR, SUPPLYING AN OUTPUT OF 110 VOLTS A.C.

THERE ARE ALSO MANY MORE VIBRATOR TYPE ELIMINATORS THAN THOSE MENTIONED IN THIS LESSON. HOWEVER, IN A LESSON OF THIS TYPE, IT IS THE PRINCIPLES IN WHICH WE ARE CHIEFLY INTERESTED RATHER THAN THE DIFFERENT COMMERCIAL MODELS. WE HAVE SIMPLY CHOSEN SOME OF THESE COMMERCIAL MODELS MERELY TO SERVE AS TYPICAL EXAMPLES OF THE VARIOUS CLASSES OF ELIMINATORS NOW IN USE.

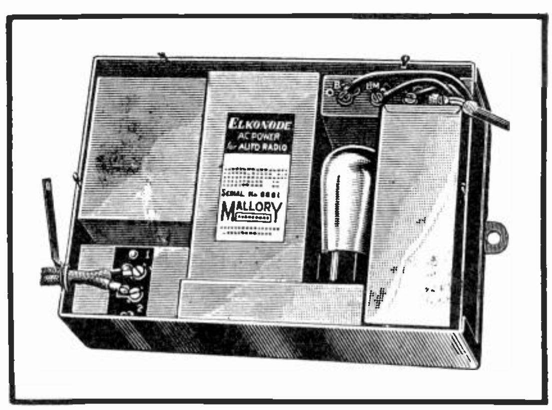

FIG. 10
The "Elkon" Eliminator

"B" ELIMINATOR CIRCUITS

HAVING SO FAR FAMILIARIZED YOURSELF WITH THE GENERAL APPEARANCE OF THE DIFFERENT TYPES OF AUTOMOBILE "B" ELIMINATORS, WE SHALL NOW PROCEED WITH THE STUDY OF THE CIRCUITS EMPLOYED IN THESE DIFFERENT UNITS.

IN FIG. 11, YOU ARE SHOWN THE CIRCUIT DIAGRAM OF ONE MOTOR-GENERATOR TYPE ELIMINATOR. IN THIS PARTICULAR EXAMPLE, YOU ARE SHOWN HOW THE MOTOR BRUSHES ARE CONNECTED TO THE CAR'S STORAGE BATTERY CIRCUIT THROUGH LEADS A+ AND A-. THE 1 MFD. CONDENSER WHICH IS CONNECTED ACROSS THESE

LEADS, AS WELL AS ACROSS THE MOTOR BRUSHES, IS INCORPORATED RIGHT WITHIN THE UNIT AND ITS PURPOSE IS TO BYPASS ANY INTERFERENCE THAT MIGHT EXIST THERE.

THE GENERATOR BRUSHES, ON THE OTHER HAND, LEAD TO THE OUTPUT TERMINALS WHICH ARE MARKED AS B+180 VOLTS AND B- IN THIS DIAGRAM. ALSO OBSERVE THE EFFECTIVE FILTER CIRCUIT, WHICH IS INCLUDED IN THE GENERATOR CIRCUIT IN ORDER TO MINIMIZE ANY RIPPLE IN THE "B" OUTPUT DUE TO THE ACTION OF THE GENERATOR COMMUTATOR SEGMENTS.

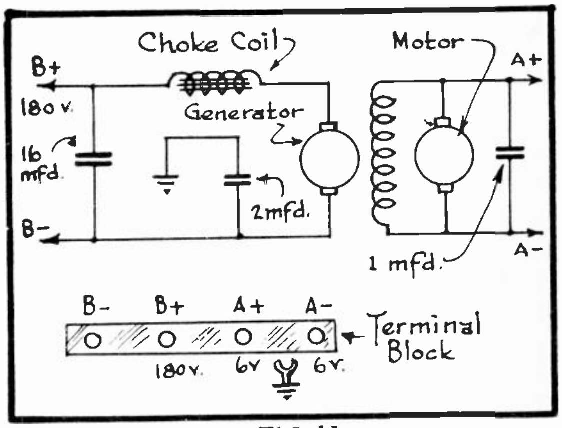

FIG. 11
A Typical Motor-Generator Eliminator Circuit.

THE COMMON GROUND CONNECTION IS MADE AT THE A+ TERMINAL OF THE TERMINAL BLOCK WHENEVER THE A+ TERMINAL OF THE CAR'S STORAGE BATTERY IS GROUNDED. HOWEVER, IF THE A- TERMINAL OF THE CAR'S STORAGE BATTERY IS GROUNDED, THEN THE GROUND CONNECTION IS MADE TO THE A- TERMINAL OF THE TERMINAL BLOCK.

DUE TO THE CURRENT DEMANDS OF THE MOTOR SECTION OF SUCH A UNIT, IT IS IMPORTANT THAT THE A+ AND A- LEADS TO THE DEVICE BE MADE WITH A WIRE SIZE NOT LESS THAN #12 B&S. ALL WIRES TO THE UNIT SHOULD BE SHIELDED AND THE SHIELDING SHOULD BE GROUNDED TO THE CAR FRAME AT INTERVALS NOT GREATER THAN EVERY 6 INCHES.

WHEN MOUNTING MOTOR-GENERATOR TYPE ELIMINATORS, THE MANUFACTURER'S INSTRUCTIONS SHOULD BE FOLLOWED ACCURATELY BECAUSE SOME OF THESE UNITS ARE NOT ADAPTED FOR MOUNTING IN SUCH POSITIONS WHICH WILL PLACE THEIR ROTOR SHAFT IN A VERTICAL PLANE.

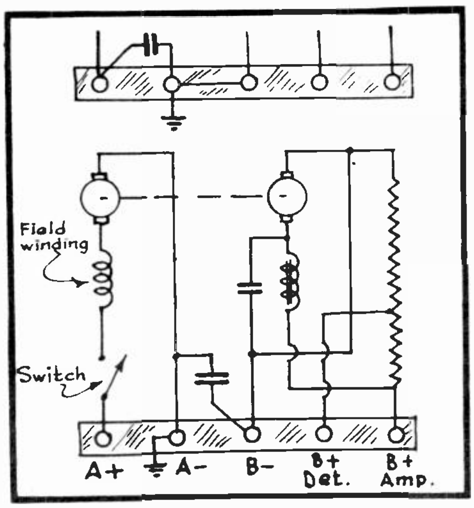

FIG. 12
Circuit Diagram of the "Esco" Power Unit.

THE "ESCO" DYNAMOTOR

A CIRCUIT DIAGRAM OF THE "ESCO" POWER UNIT IS ILLUSTRATED FOR YOU IN FIG. 12. HERE THE MOTOR BRUSHES AND FIELD WINDING ARE CONNECTED IN SERIES WITH THE A+ AND A- TERMINALS OF THE TERMINAL BLOCK AND THUS THE CURRENT, AS FURNISHED BY THE CAR'S STORAGE BATTERY, FEEDS INTO THE UNIT CAUSING THE ARMATURE TO REVOLVE BETWEEN THE FIELD POLES WHICH ARE ALSO EXITED BY THE FLOW OF BATTERY CURRENT THROUGH THE FIELD WINDING.

THE SECONDARY OR HIGH VOLTAGE WINDING ALSO ROTATES ON THE SAME SHAFT AS THE MOTOR ARMATURE AND THE HIGH VOLTAGE DIRECT CURRENT, WHICH IS GENERATED BY IT, IS FILTERED AND DELIVERED TO THE "B" TERMINALS OF THE TERMINAL BLOCK TO BE USED BY THE RECEIVER.

THE TAPPED RESISTOR, WHICH IS CONNECTED ACROSS THE OUTPUT OF THE

GENERATOR END OFFERS A MEANS WHEREBY THE MAXIMUM, AS WELL AS AN INTERMEDIATE "B" VOLTAGE, CAN BE OBTAINED.

THE PURPOSE OF THE SWITCH IS TO PERMIT THE STARTING AND STOPPING OF THE DYNAMOTOR AT WILL AND IF DESIRED CAN BE CONTROLLED BY THE REGULAR RADIO SWITCH. THE GROUND AND BYPASS CONDENSER CONNECTION CAN BE MADE AT THE TERMINAL BLOCK AS SHOWN BOTH IN THE UPPER AND LOWER ILLUSTRATIONS OF FIG. 12. IN OTHER WORDS, BOTH CONNECTIONS CAN BE TRIED AND THE ONE USED WHICH OFFERS THE BEST RESULTS FOR THE PARTICULAR RECEIVER IN QUESTION.

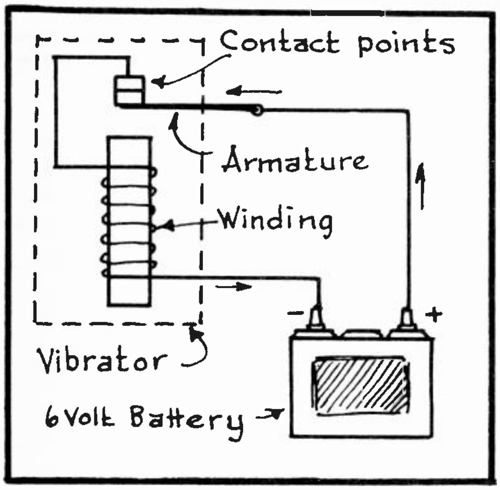

FIG. 13
A Simple Vibrator.

OPERATION OF VIBRATOR "B" ELIMINATORS

IN ORDER TO GAIN AN INTELLIGENT UNDERSTANDING OF THE MODERN DESIGNS OF VIBRATOR TYPE "B" ELIMINATORS, IT IS NECESSARY THAT YOU FIRST FAMILIARIZE YOURSELF WITH THE OPERATION OF THE VIBRATOR ITSELF. A SIMPLE FORM OF VIBRATOR IS ILLUSTRATED FOR YOU IN FIG. 13 AND PROBABLY YOU ALREADY RECOGNIZE IT AS BEING NO DIFFERENT FROM THE ORDINARY TYPE OF ELECTRIC BUZZER, SUCH AS USED SO EXTENSIVELY FOR SIGNAL PURPOSES.

ESSENTIALLY, THIS VIBRATOR CONSISTS OF A SINGLE WINDING WOUND ON AN IRON CORE. AN ARM, WHICH IS TECHNICALLY SPOKEN OF AS THE "ARMATURE", IS PLACED ABOVE ONE END OF THE CORE AND IS PIVOTED AT ONE OF ITS EXTREMETIES SO THAT IT CAN BE ACTUATED SOMEWHAT AS A HINGE. ONE CONTACT POINT IS MOUNTED ON THE FREE END OF THE ARMATURE AND A STATIONARY CONTACT POINT IS SO PLACED THAT THE TWO CONTACT POINTS ARE NORMALLY PRESSED TOGETHER, SPRING TENSION EXERTED UPON THE ARMATURE BEING THE MEDIUM FOR SUPPLYING THIS FORCE. THERE IS A SLIGHT CLEARANCE OR AIR GAP BETWEEN THE ARMATURE AND THE UPPER END OF THE CORE.

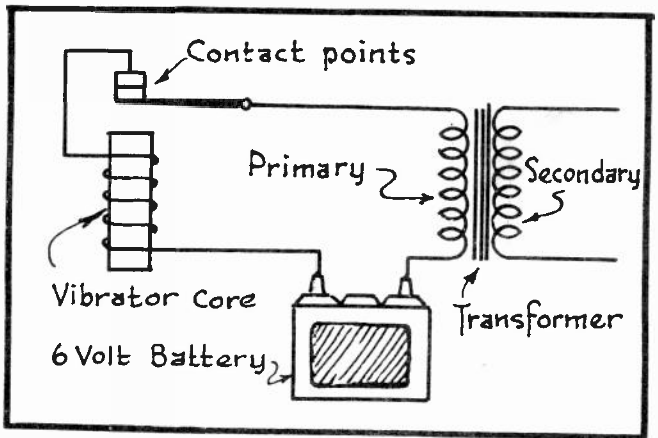

FIG. 14
Producing Induction.

NOW THEN, SINCE THE WINDING IS CONNECTED ACROSS THE BATTERY TERMINALS WITH THE CONTACT POINTS IN SERIES AND SINCE THE CONTACT POINTS ARE NORMALLY HELD CLOSED BY SPRING TENSION, IT IS CLEAR THAT BATTERY CURRENT WILL FLOW THROUGH THE CLOSED CONTACT POINTS AND WINDING AS POINTED OUT IN FIG. 13.

THE INSTANT THAT THIS CURRENT FLOW PASSES THROUGH THE WINDING OF THE VIBRATOR, THE RESULTING MAGNETIC FIELD, WHICH IS ESTABLISHED AROUND ITS IRON CORE, OVERCOMES THE SPRING TENSION AND PULLS THE ARMATURE DOWNWARDS OR TOWARDS THE CORE. THIS MOVEMENT OF THE ARMATURE CAUSES THE CONtact points to separate and thereby stops all further flow of battery current.

Due to the interruption of battery current, the vibrator core loses its magnetic power and the spring tension therefore causes the armature to be forced upward rapidly and closes the contact points so that another surge of battery current may flow through the system.

So rapid is the response of this system to the flow and interruption of current that the contact points are actuated at a tremendous speed, resulting in the vibratory action which you so often noticed in electric door bells and buzzers.

Our next step will be to connect the vibrator and battery in series with the primary winding of a transformer as shown in Fig. 14. This done, the battery current will have to flow through the primary winding of the transformer as well as through the vibrator. Consequently, the vibrator will control current surges and interruptions through the transformer winding and the resulting magnetic field which builds up and collapses around the primary winding in step with the vibrator action will induce voltages at corresponding frequency in the secondary winding of the same transformer.

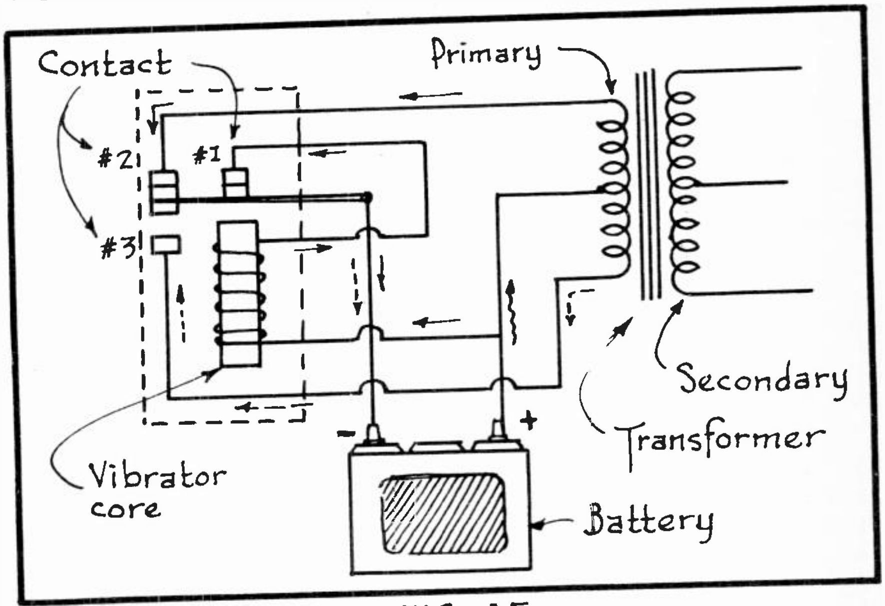

FIG. 15
Producing An A.C. Primary Current.

This idea can still be further improved by resorting to the system which is illustrated in Fig. 15. Here the primary and secondary windings of the transformer are both center-tapped and the relay mechanism is provided with three sets of contacts.

With spring tension holding the armature in the position illustrated, contact sets #1 and #2 will both be closed. Battery current will therefore flow through the vibrator winding and contacts #1. At the same time, battery current will also flow through the upper half of the transformer's primary winding and through contacts #2, as pointed out by the solid arrows.

As the vibrator core becomes magnetized and attracts the armature downwards, contacts #1 and #2 will separate while contacts #3 will close. Battery current will therefore now flow from the primary winding's center tap towards its lower end and through the closed contact points #3 as

INDICATED BY THE DOTTED ARROWS. NOTICE ESPECIALLY THAT THE CURRENT IS NOW FLOWING THROUGH THE PRIMARY WINDING IN THE OPPOSITE DIRECTION THAN FORMERLY. CONSEQUENTLY, AS THE ARMATURE UNDERGOES ITS VIBRATING ACTION, THE CURRENT THROUGH THE PRIMARY WINDING WILL BE PERIODICALLY REVERSING ITS DIRECTION OF FLOW AND THUS WE HAVE IN EFFECT AN ALTERNATING CURRENT PASSING THROUGH THE PRIMARY WINDING. A.C. VOLTAGES OF CORRESPONDING FREQUENCY WILL THUS BE INDUCED INTO THE SECONDARY WINDING OF THE TRANSFORMER. BY USING MORE TURNS OF SECONDARY WINDING THAN PRIMARY WINDING, THE REQUIRED STEP-UP IN VOLTAGE CAN BE OBTAINED.

THE NEXT JOB IS TO RECTIFY THE HIGH VOLTAGE A.C. WHICH IS BEING GENARATED IN THE SECONDARY WINDING AND ONE METHOD OF ACCOMPLISHING THIS IS TO EMPLOY A RECTIFIER TUBE AS SHOWN IN FIG. 16. IN FACT, HERE YOU ARE SHOWN THE "B" ELIMINATOR IN ITS COMPLETE FORM.

OBSERVE IN FIG. 16 HOW THE EXTREMETIES OF THE SECONDARY WINDING OF THE TRANSFORMER ARE CONNECTED TO THE PLATES OF A TYPE-84 RECTIFIER TUBE.

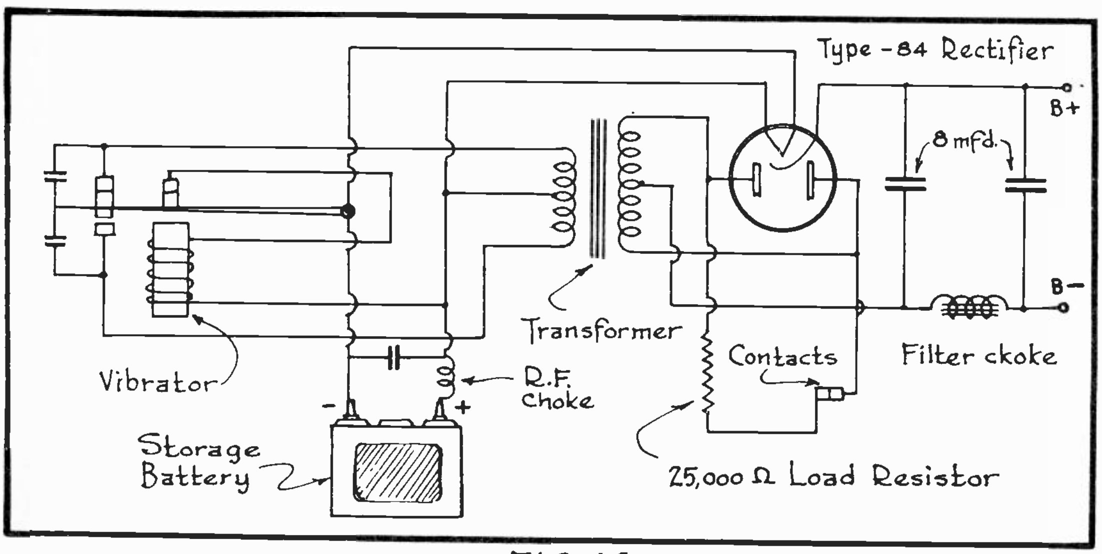

FIG. 16
The Complete Vibrator-Type "B" Eliminator.

THIS TUBE IS A FULL-WAVE RECTIFIER OF THE HEATER-CATHODE TYPE, THE CATHODE SERVING AS THE ELECTRON EMITTER AND B+ SIDE OF THE SYSTEM. THE OPERATING CHARACTERISTICS OF THE -84 TUBE ARE AS FOLLOWS: HEATER VOLTAGE = 6.3 VOLTS; HEATER CURRENT = 0.5 AMP; MAXIMUM A.C. VOLTAGE PER PLATE 225 VOLTS AND THE MAXIMUM D.C. OUTPUT CURRENT = 50 MILLIAMPERES.

THE HEATER VOLTAGE RATING OF THE -84 TUBE IS SUCH THAT ITS HEATER CAN BE CONNECTED DIRECTLY ACROSS THE CAR'S STORAGE BATTERY CIRCUIT AND IN FIG. 16 THIS IS ACCOMPLISHED BY INTERCONNECTING THE CIRCUITS AT THE VIBRATOR SYSTEM.

THE CENTER TAP OF THE HIGH VOLTAGE WINDING SERVES AS THE NEGATIVE SIDE OF THE "B" CIRCUIT IN THE CUSTOMARY MANNER, WHILE THE TUBE'S CATHODE SERVES AS THE POSITIVE SIDE OF THE SYSTEM. A CONVENTIONAL FILTER CIRCUIT IS INCLUDED IN THE OUTPUT CIRCUIT OF THE RECTIFIER.

BY AGAIN LOOKING CLOSELY AT THE SECONDARY CIRCUIT OF THE TRANSFORMER, YOU WILL OBSERVE THAT A 25,000 OHM RESISTOR, WITH A SET OF CONTACT POINTS IN SERIES, IS CONNECTED ACROSS THE SECONDARY WINDING OF THE TRANSFORMER. WHILE THE TUBES ARE STILL COLD, THESE CONTACT POINTS ARE CLOSED AND THEREBY CONNECT THE 25,000 OHM RESISTOR DIRECTLY ACROSS THE ENDS OF THE TRANSFORMER'S SECONDARY WINDING. THIS SERVES TO COMPLETE THE SECONDARY LOAD SO THAT THE SECONDARY WINDING WILL NOT BE COMPLETELY OPEN CIRCUITED DURING THE WARMING UP PERIOD REQUIRED BY THE TUBES. HEATER TYPE TUBES ARE COMPARATIVELY SLOW TO WARM UP TO THE POINT WHERE THEY WILL DRAW PLATE CURRENT AND THEREBY PLACE THE NORMAL LOAD UPON THE SECONDARY WINDING OF THE TRANSFORMER. WERE NO LOAD AT ALL APPLIED ACROSS THE SECONDARY WINDING DURING THE WARMING UP PERIOD, THE HIGH SECONDARY VOLTAGE MIGHT PUNCTURE THE INSULATION OF THIS WINDING AND THUS DAMAGE THE TRANSFORMER.

AS SOON AS THE TUBES WARM UP AND BEGIN TO DRAW THEIR PLATE CURRENT, THIS PLATE CURRENT WILL NATURALLY FLOW THROUGH THE FILTER CHOKE OF THE ELIMINATOR. THE RESULTING MAGNETIC FIELD, WHICH IS ESTABLISHED AT THE CHOKE BY THIS CURRENT FLOW, WILL THEN ACT UPON THE POINTS, OPENING THEM, AND IN THIS WAY EXCLUDE THE 25,000 OHM RESISTOR FROM THE CIRCUIT. WHEN THE RECEIVER IS NO LONGER BEING OPERATED, THE POINTS AUTOMATICALLY CLOSE.

THE PURPOSE OF THE MANY BYPASS CONDENSERS IN THE PRIMARY CIRCUIT OF THE ELIMINATOR, AS WELL AS THE R.F. CHOKE, IS TO FILTER OUT ALL SOURCES OF INTERFERENCE NOISES WHICH ARE LIKELY TO BE SET UP BY THE EQUIPMENT IF NOT PROPERLY TAKEN CARE OF. THE AVERAGE CAPACITIVE VALUE OF THESE BYPASS CONDENSERS IS APPROXIMATELY .5 MFD. THESE SAME CONDENSERS ALSO INCREASE THE WORKING LIFE OF THE VIBRATOR POINTS BY REDUCING THE ARCING ACROSS THEM.

MECHANICAL RECTIFIER TYPE ELIMINATOR

THIS TYPE OF ELIMINATOR IS SOMEWHAT DIFFERENT AS REGARDS RECTIFICATION OF THE HIGH VOLTAGE A.C., IN THAT IT EMPLOYS A SPECIAL VIBRATOR INSTEAD OF A RECTIFIER TUBE. THE FUNDAMENTAL CIRCUIT OF THIS UNIT IS ILLUSTRATED FOR YOU IN FIG. 17 AND BY A GENERAL INSPECTION OF THIS CIRCUIT, YOU WILL NOTICE THAT THE VIBRATOR CIRCUIT IS SOMEWHAT SIMILAR TO THE SYSTEM JUST DESCRIBED TO YOU. HOWEVER, THERE ARE IN THIS NEW CIRCUIT FIVE SETS OF VIBRATOR CONTACTS INSTEAD OF ONLY THREE.

NOW THEN, WITH THE ARMATURE IN THE POSITION SHOWN IN FIG. 17, BATTERY CURRENT WILL FLOW THROUGH THE SYSTEM AS INDICATED BY THE HEAVY ARROWS, THAT IS, FROM A+, THROUGH THE ARMATURE AND CONTACT POINTS #1, THRU THE LEFT HALF OF THE TRANSFORMER'S PRIMARY WINDING AND BY WAY OF THE CENTER-TAP BACK TO THE A- TERMINAL OF THE BATTERY. SOME OF THIS BATTERY CURRENT WILL ALSO FLOW THROUGH CONTACT POINTS #3 AND THE WINDING OF THE VIBRATOR, THEREBY ENERGIZING THE VIBRATOR CORE.

THIS MOMENTARY SURGE OF BATTERY CURRENT WILL INDUCE A HIGH VOLTAGE IN THE SECONDARY WINDING, MAKING THE LEFT END OF THIS WINDING OF A NEGATIVE POTENTIAL AND ITS RIGHT END OF A POSITIVE POTENTIAL. THE CENTER TAP OF THE SECONDARY WINDING WILL THEREFORE ALSO BE POSITIVE IN RESPECT TO THE LEFT END. CONSEQUENTLY, A SURGE OF CURRENT WILL AT THIS INSTANT PASS OUT THROUGH THE SECONDARY'S CENTER TAP, THROUGH THE FILTER CHOKE, THROUGH THE "B" CIRCUITS OF THE RECEIVER AND TO B- WHICH IS GROUNDED.

AT THIS POINT, IT WILL UNITE WITH THE BATTERY CURRENT AND FLOW TO THE ARMATURE, THROUGH CONTACT POINTS #4 AND THENCE TO THE NEGATIVE END OF THE SECONDARY WINDING TO COMPLETE ITS JOURNEY. YOU WILL NO DOUBT NOTICE THAT THE ACTUAL FLOW OF SECONDARY CURRENT AT THIS INSTANT PASSED ONLY THROUGH THE LEFT HALF OF THE SECONDARY WINDING AND NOT THROUGH ITS RIGHT HALF ON ACCOUNT OF CONTACTS #5 BEING OPEN.

IN THE MEAN TIME, THE VIBRATOR CORE HAS BECOME SUFFICIENTLY ENERGIZED TO ATTRACT THE ARMATURE TOWARDS THE RIGHT OR TO THE POSITION DESIGNATED BY THE BROKEN LINES. THE ARMATURE WILL THEREFORE NOW BE CLOSING CONTACE POINTS #2 AND #5, WHILE AT THE SAME TIME OPENING CONTACT POINTS #1, #3, AND #4. THIS BEING THE CASE, BATTERY CURRENT WILL NOW FLOW FROM A+, THROUGH THE ARMATURE AND THE CLOSED CONTACT POINTS #2, INTO THE RIGHT END OF THE PRIMARY WINDING AND BY WAY OF THE CENTER TAP TO A–. THE CURRENT FLOW AT THIS INSTANT IS DESIGNATED BY THE DOTTED ARROWS.

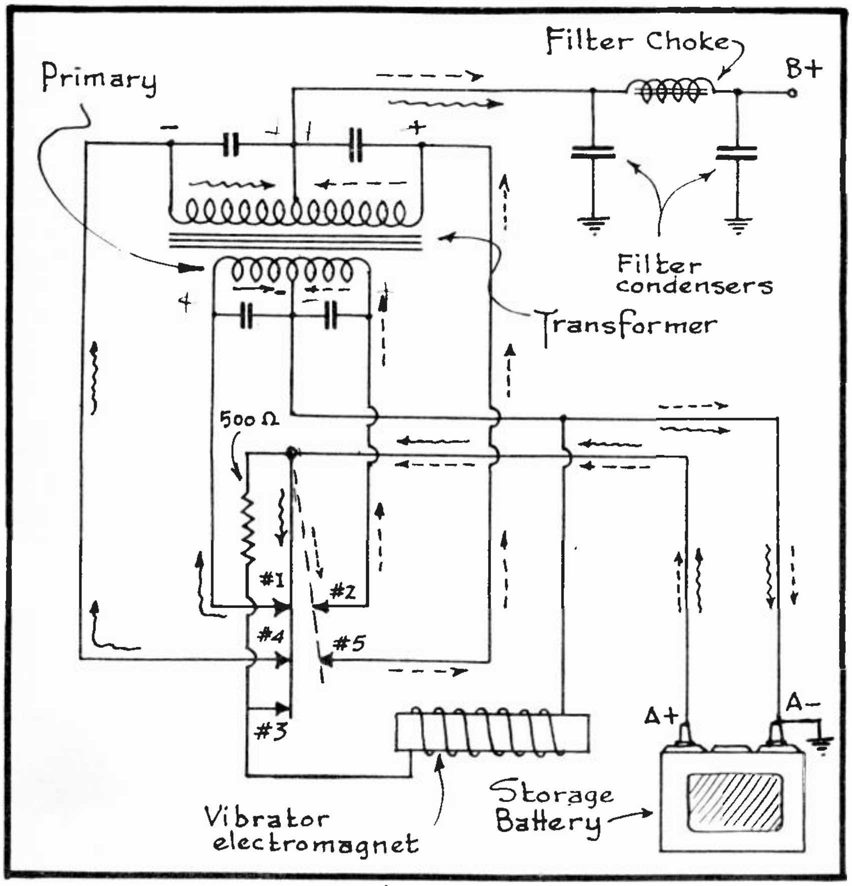

FIG. 17

Principles of the Mechanical Rectifier Type Eliminator.

NOTICE ESPECIALLY THAT THE BATTERY CURRENT IS NOW FLOWING THRU THE PRIMARY WINDING IN THE OPPOSITE DIRECTION THAN FORMERLY AND THEREFORE THE POLARITY OF THE SECONDARY WINDING WILL BE REVERSED ACCORDINGLY. THIS MEANS THAT THE RIGHT END OF THE SECONDARY WILL NOW BE OF A NEGATIVE POTENTIAL AND THE LEFT END OF A POSITIVE POTENTIAL. THE CENTER TAP WILL THEREFORE BE OF A POSITIVE POTENTIAL WITH RESPECT TO THE RIGHT END AND SO THE SECONDARY CURRENT WILL AGAIN FLOW OUT OF THE WINDING'S CENTER TAP, THROUGH THE FILTER CHOKE AND "B" CIRCUITS OF THE RECEIVER TO B– OR GROUND.

RETURNING FROM B– OR GROUND, THIS SECONDARY CURRENT IS CARRIED TO THE ARMATURE OF THE VIBRATOR, THROUGH THE CLOSED CONTACTS #5 AND THUS RETURNED TO THE RIGHT END OF THE SECONDARY WINDING TO COMPLETE ITS JOURNEY. NO SECONDARY CURRENT FLOWS THROUGH THE LEFT HALF OF THE SECONDARY WINDING AT THIS INSTANT BECAUSE THIS CIRCUIT IS NOW INTERRUPTED AT THE VIBRATOR.

IN THE MEAN TIME, THE VIBRATOR MAGNET WILL HAVE LOST IS ATTRACTIVE

FORCE DUE TO THE LACK OF EXITING CURRENT THROUGH ITS WINDING AND AS A RESULT, THE ARMATURE WILL BE RETURNED TO ITS ORIGINAL POSITION. THIS CYCLE OF EVENTS IS THEN REPEATED OVER AND OVER AT A RAPID RATE AS THE VIBRATOR UNDERGOES ITS VIBRATING ACTION.

THE IMPORTANT THING TO REMEMBER IS THAT THE CURRENT THROUGH BOTH THE PRIMARY AND SECONDARY WINDINGS REVERSES ITS DIRECTION OF FLOW PERIODICALLY BUT THAT CONTACT POINTS #4 AND #5 OPERATE IN SUCH A MANNER THAT THE CENTER TAP OF THE SECONDARY WINDING IS MAINTAINED AT A POSITIVE POTENTIAL REGARDLESS OF WHICH HALF OF THE WINDING IS WORKING AT THE TIME. FOR THIS REASON, THE "B" CURRENT ALWAYS FLOWS OUTWARD, OR IN THE SAME DIRECTION, AS IT LEAVES THE ELIMINATOR.

ALTHOUGH IT IS TRUE THAT THE "B" CURRENT AT THE SECONDARY WINDING IS IN THE FORM OF SURGES OR "SPURTS," YET THE ACTION OF THE VIBRATOR IS SO RAPID THAT THE "B" OUTPUT APPEARS AS A SOMEWHAT STEADY FLOW AND THE FILTER HELPS TO SMOOTHEN IT OUT STILL MORE. WE WOULD CLASSIFY THIS FORM OF RECTIFICATION AS BEING OF THE VIBRATOR OR MECHANICAL TYPE. THE "ELKONODE" IS OF THIS TYPE.

THE PURPOSE OF THE BYPASS CONDENSERS, WHICH ARE USED WITH THIS SYSTEM, IS TO REDUCE ARCING AT THE CONTACT POINTS AND THUS PROLONG THEIR USEFUL LIFE. AT THE SAME TIME, THEY ALSO AID IN FILTERING OUT ANY SOURCES FOR INTERFERENCE NOISE. THE 500 OHM RESISTOR, WHICH IS SHOWN IN FIG. 17, ALSO AIDS TO PREVENT EXCESSIVE ARCING AT THE CONTACT POINTS.

MODERN RECEIVER CIRCUIT

SO THAT YOU MAY SEE WHAT RADICAL IMPROVEMENTS HAVE BEEN MADE IN THE DESIGN OF THE LATER MODEL AUTOMOBILE RECEIVERS, WE ARE SHOWING YOU IN FIG. 18 THE COMPLETE CIRCUIT DIAGRAM OF BOTH THE RECEIVER AND "B" ELIMINATOR AS USED IN THE "MODEL 55 MOTOROLA".

THIS IS A FIVE-TUBE SUPERHETERODYNE EMPLOYING AUTOMATIC VOLUME CONTROL, A VIBRATOR TYPE "B" ELIMINATOR AND A DYNAMIC SPEAKER. THE TYPES OF TUBES USED ARE A 77, TWO 78'S, A 75 AND A TYPE "LA".

THE 77 IS A TRIPLE-GRID AMPLIFIER OR DETECTOR, SIMILAR TO THE -57 AS USED IN A.C. RECEIVERS, ONLY THAT ITS FILAMENT OR HEATER IS RATED AT 6.3 VOLTS. THE COMPLETE OPERATING CHARACTERISTICS OF THIS TUBE AS AN AMPLIFIER ARE AS FOLLOWS: HEATER VOLTAGE = 6.3 VOLTS; HEATER CURRENT = 0.3 AMP; PLATE VOLTAGE = 100 TO 250 VOLTS; BIAS VOLTAGE = -1.5 TO -3 VOLTS; SCREEN VOLTAGE = 60 TO 100 VOLTS; PLATE CURRENT = 1.7 TO 2.3 MA.; SCREEN CURRENT = 0.4 TO 0.5 MA.; AMPLIFICATION FACTOR = 715 TO 1500. AS A POWER DETECTOR, ITS PLATE VOLTAGE SHOULD BE 250 VOLTS AND GRID BIAS -1.95 VOLTS; THE SCREEN VOLTAGE SHOULD BE 50 VOLTS AND THE COMBINED SCREEN AND PLATE CURRENT WILL THEN BE 0.65 MA.

THE 77 IN THE CIRCUIT OF FIG. 18 IS BEING USED IN A SPECIAL CIRCUIT, SO THAT IT WILL SERVE BOTH AS THE FIRST DETECTOR AND OSCILLATOR AND THE DETAILS OF THIS SYSTEM'S OPERATION WILL BE GIVEN YOU IN A LATER LESSON WHICH IS DEVOTED EXCLUSIVELY TO VARIOUS FORMS OF OSCILLATOR CIRCUITS AS NOW USED IN THE DIFFERENT SUPERHETERODYNE DESIGNS.

THE 78 TUBE IS A TRIPLE-GRID R.F. AMPLIFIER WITH VARIABLE-MU FEATURES AND IS THE D.C. EQUIVALENT FOR THE POPULAR TYPE -58 A.C. TUBE. THE COMPLETE

OPERATING CHARACTERISTICS OF THE -78 ARE AS FOLLOWS: HEATER VOLTAGE=6.3 VOLTS; HEATER CURRENT = 0.3 AMP. MINIMUM BIAS VOLTAGE -3 VOLTS.

PLATE VOLTAGE	SCREEN VOLTAGE	SCREEN CURRENT	PLATE CURRENT	AMPLIFICATION FACTOR
90	90	1.5 MA.	5.4 MA.	400
180	75	1.0 MA.	4.0 MA.	1100
250	100	2.0 MA.	7.0 MA.	1160
250	125	3.0 MA.	10.5 MA.	990

THE 75 TUBE IS A DUPLEX-DIODE, HIGH-MU TRIODE AND SIMULTANEOUSLY SERVES AS A SECOND DETECTOR, AUTOMATIC VOLUME CONTROL TUBE AND A.F. AMPLIFIER. THE OPERATION OF TUBES OF THIS TYPE REQUIRES A RATHER LENGTHY DESCRIPTION WHICH WOULD BE OUT OF PLACE IN THIS PARTICULAR LESSON. YOU WILL FIND A COMPLETE EXPLANATION REGARDING IT IN A MORE ADVANCED LESSON DEALING EXCLUSIVELY WITH AUTOMATIC VOLUME CONTROL SYSTEMS.

FOR YOUR PRESENT INFORMATION WE SHALL, HOWEVER, SUPPLY YOU WITH THE

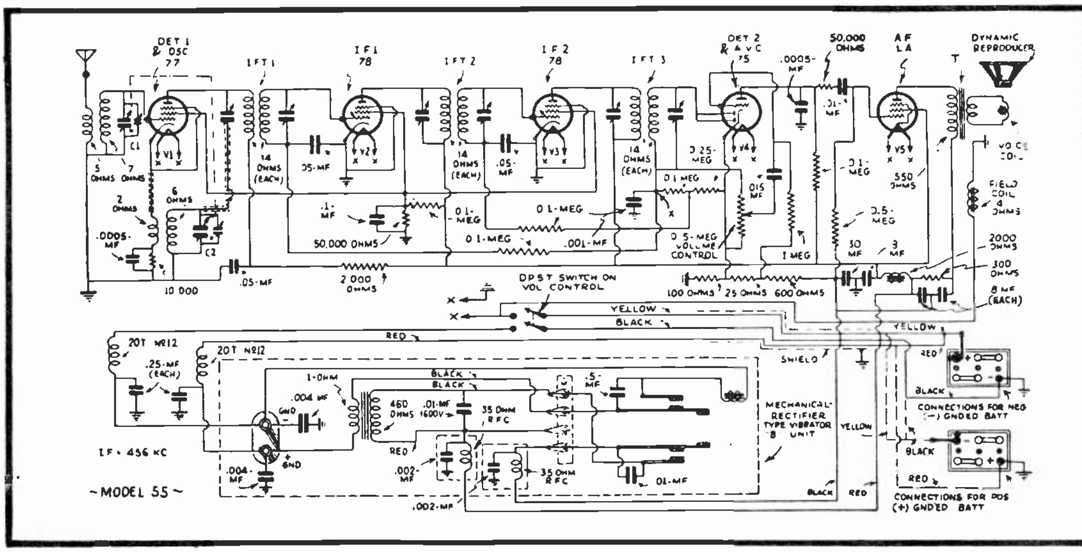

FIG. 18
A Modern Auto Receiver Circuit.

OPERATING CHARACTERISTICS OF THE 75. HERE THEY ARE: HEATER VOLTAGE=6.3 VOLTS; HEATER CURRENT = 0.3 AMP; MAXIMUM PLATE VOLTAGE = 250 VOLTS; BIAS VOLTAGE -1.35; PLATE CURRENT=0.4 MA; GAIN PER STAGE 50-60.

THE TYPE "LA" TUBE IS DESIGNATED AS THE 6A4 BY SOME TUBE MANUFACTURERS. THIS IS A POWER AMPLIFIER PENTODE HAVING THE FOLLOWING CHARACTERISTICS: FILAMENT VOLTAGE = 6.3 VOLTS; FILAMENT CURRENT = 0.3 AMP; PLATE VOLTAGE = 180 VOLTS; GRID BIAS = -12 VOLTS; SCREEN VOLTS = 180VOLTS; SCREEN CURRENT = 3.9 MA.; PLATE CURRENT = 22 MA., AMPLIFICATION FACTOR 100; POWER OUTPUT = 1.4 WATTS; RECOMMENDED LOAD = 8000 OHMS.

THE SPEAKER, AS USED WITH THIS RECEIVER IS OF THE NOW POPULAR AUTOMOBILE DYNAMIC TYPE, HAVING A FIELD COIL RESISTANCE RATING OF 4 OHMS AND WHICH IS CONNECTED ACROSS THE CAR'S BATTERY CIRCUIT.

THE VIBRATOR TYPE "B" ELIMINATOR, AS USED WITH THIS PARTICULAR RECEIVER, IS OF THE HALF-WAVE TYPE RATHER THAN FULL-WAVE, AS THE OTHER SYSTEMS DESCRIBED TO YOU IN THIS LESSON. IT IS FOR THIS REASON THAT THE TWO WINDINGS OF THE ELIMINATOR ARE NOT CENTER TAPPED. HOWEVER, BY APPLYING THE SAME PRINCIPLES WHICH YOU HAVE ALREADY LEARNED IN THIS LESSON REGARDING VIBRATOR TYPE "B" ELIMINATORS, YOU SHOULD HAVE NO DIFFICULTY IN TRACING OUT THE CIRCUITS OF THE UNIT HERE ILLUSTRATED.

THE SWITCH OF THIS RECEIVER CIRCUIT IS OF THE DOUBLE-POLE, SINGLE-THROW TYPE AND IS INCORPORATED IN THE VOLUME CONTROL. THE TOTAL CURRENT DRAWN FROM THE STORAGE BATTERY TO OPERATE THIS RECEIVER IS 4.5 AMPERES.

SPECIAL ANTENNAS

BESIDES THE AUTOMOBILE ANTENNAS SO FAR SHOWN YOU, THERE ARE ALSO SEVERAL DIFFERENT COMMERCIAL FORMS BEING MANUFACTURED WHICH TO SOME EXTENT SIMPLIFY THE WORK OF INSTALLING THE SYSTEM.

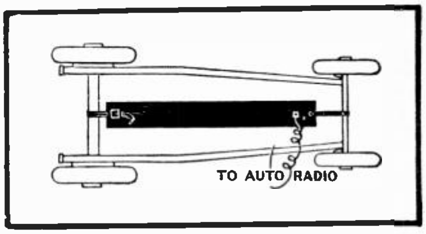

FIG. 19
Axle to axle Antenna

IN FIG. 19, FOR EXAMPLE, YOU ARE SHOWN A SPECIAL FORM OF ANTENNA WHICH CONSISTS OF A WATER-PROOF FABRIC ENVELOPE IN WHICH THE COPPER SCREEN IS CONTAINED. AN EYELET IS PROVIDED AT EACH END AND TO ONE EYELET IS FASTENED A COIL SPRING WHILE A 36" WEB STRAP IS FASTENED TO THE OTHER EYELET. THIS ARRANGEMENT PROVIDES FOR EASY AND SECURE INSTALLATION IN CARS OF ANY SIZE FROM AXLE TO AXLE OR OTHER CONVENIENT POINT OF THE CAR. A 10 FOOT RUBBER COVERED LEAD-IN IS FURNISHED WITH THIS ANTENNA.

A RUNNING BOARD ANTENNA IS SHOWN YOU IN FIG. 20. THIS UNIT OFFERS A RATHER LARGE AREA OF METALLIC SURFACE FOR SIGNAL PICK UP AND IS SUSPENDED SLIGHTLY BELOW THE CAR'S RUNNING BOARD AND PARALLEL TO IT.

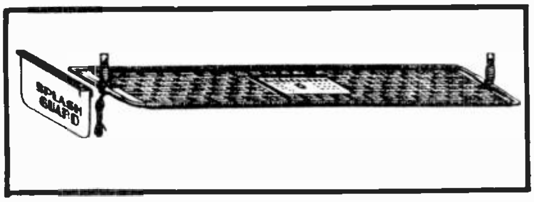

FIG. 20
Running Board Antenna

THEN THERE IS ALSO THAT TYPE OF "READY-PREPARED" ANTENNA WHICH UTILIZES A FINE GRADE OF COPPER ENCASED IN A SPECIALLY PREPARED CLOTH. IN THIS CASE, IT IS ONLY NECESSARY TO OPEN THE ROOF LINING ABOUT A FOOT AND THEN TO SLIP THIS FLEXIBLE ANTENNA INTO THE OPENING THUS AFFORDED, GRADUALLY WORKING IT BACK INTO PLACE SO AS TO SPREAD OUT OVER THE ROOF AREA. A LEAD-IN IS ALREADY ATTACHED TO THE ANTENNA SO AS TO MAKE INSTALLATION AS SIMPLE AS POSSIBLE.

HAVING COMPLETED THESE TWO LESSONS CONCERNING AUTOMOBILE RECEIVERS, YOU SHOULD NOW HAVE A GOOD WORKING UNDERSTANDING OF THEM AND DUE TO THE INCREASING POPULARITY OF AUTO RECEIVERS, IT IS ADVISABLE THAT YOU GIVE THESE LESSONS YOUR UTMOST ATTENTION SO THAT YOU TOO CAN OBTAIN YOUR SHARE OF PROFIT OUT OF THIS BRANCH OF THE RADIO INDUSTRY.

EXAMINATION QUESTIONS

LESSON NO. 25

The restless fellow fails where the steady worker wins. Are you big enough to conquer impatience, detail, routine, and seeming monotony? You have to stick to win. You have to prove your worth.

1. - WHAT STEPS SHOULD BE TAKEN WHEN INSTALLING AN AUTOMOBILE RECEIVER SO AS TO REDUCE THE PICK-UP OF ENGINE INTERFERENCE AS MUCH AS POSSIBLE?

2. - WHAT IS THE CHIEF ADVANTAGE OF BUILDING AUTOMOBILE RECEIVERS, TOGETHER WITH THEIR POWER SUPPLY, INTO A SINGLE UNIT?

3. - DESCRIBE BRIEFLY THE OPERATING PRINCIPLES OF THE "GENEMOTOR" OR DYNAMOTOR TYPE "B" ELIMINATOR.

4. - DRAW A CIRCUIT DIAGRAM OF AN AUTOMOTIVE "B" ELIMINATOR, USING A VIBRATOR IN CONJUNCTION WITH A RECTIFIER TUBE, AND EXPLAIN HOW IT OPERATES.

5. - EXPLAIN HOW THE MECHANICAL RECTIFIER ELIMINATOR OPERATES.

6. - IN GENERAL, HOW DO THE MODERN AUTOMOBILE RECEIVERS COMPARE WITH THE OLDER MODEL AUTOMOBILE RECEIVERS?

7. - WHAT ARE THE OPERATING CHARACTERISTICS OF THE TYPE-78 TUBE?

8. - HOW IS THE FIELD COIL OF A DYNAMIC SPEAKER GENERALLY CONNECTED TO THE CIRCUITS OF AN AUTOMOBILE RECEIVER?

9. - DESCRIBE THE GENERAL CONSTRUCTION AND SPECIFY THE OPERATING CHARACTERISTICS OF THE TYPE-84 TUBE.

10. - DESCRIBE BRIEFLY, VARIOUS FORMS OF ANTENNAS WHICH ARE SUITABLE FOR AUTOMOTIVE USE.

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LESSON NO. 26

· MIDGET RECEIVER DESIGNS ·

UP TO THE PRESENT TIME, OUR RECEIVER STUDIES HAVE BEEN INTENDED PRIMARILY TO FAMILIARIZE YOU WITH THE BASIC PRINCIPLES WHICH GOVERN THE OPERATION OF THE DIFFERENT COMPONENTS INCORPORATED IN THE STANDARD TYPES OF CIRCUITS. FURTHERMORE, THE MAJORITY OF THE CIRCUITS BROUGHT TO YOUR ATTENTION SO FAR ARE DESIGNED TO USE SIX TUBES OR MORE AND FOR THE GREATER PART INTENDED TO BE INSTALLED IN CONSOLE TYPE CABINETS.

IN ADDITION TO THESE LARGER RECEIVERS, WE FIND THAT THE MIDGET DESIGNS HAVE BECOME ESPECIALLY POPULAR DURING THE PAST FEW YEARS AND SINCE VARIOUS IDEAS HAVE BEEN DEVELOPED IN ORDER TO ENABLE THESE SMALLER RECEIVERS TO OFFER SATISFACTORY PERFORMANCE, IT WILL BE WELL WORTH-WHILE FOR US TO SPEND A LITTLE TIME AT THIS PERIOD OF YOUR TRAINING IN A STUDY OF THESE CIRCUITS IN PARTICULAR. A TYPICAL MIDGET RECEIVER, HOUSED IN AN ATTRACTIVELY DESIGNED CABINET, IS SHOWN YOU IN FIG. 1.

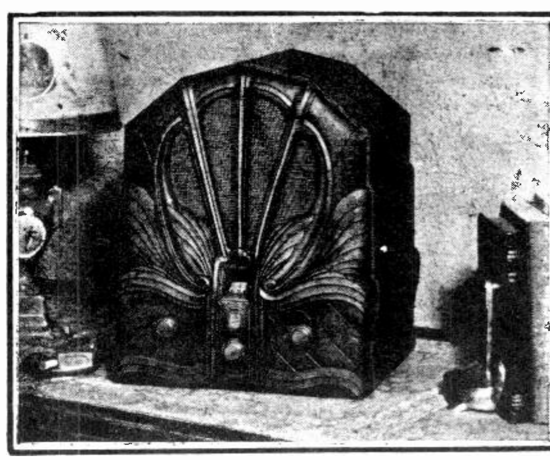

FIG. 1
A Modern Midget Receiver.

THE MAIN REASON WHY THIS TYPE OF RECEIVER WAS INTRODUCED TO THE INDUSTRY AND ACCEPTED SO FAVORABLY BY THE RADIO PUBLIC IS THAT THE UNIT IS COMPACT SO THAT IT REQUIRES BUT LITTLE MORE ROOM-SPACE THAN THE AVERAGE MANTEL CLOCK AND ITS SELLING PRICE CAN BE KEPT WELL BELOW THAT OF THE "FULL-SIZE" RECEIVER. ALTHOUGH THE MIDGET IS AN ABREVIATED DESIGN, WHEN COMPARED TO ITS LARGER BROTHERS, YET IT IS COMPLETE IN EVERY DETAIL AND SERVES AS AN ADDED ATTRACTION TO ANY WELL FURNISHED HOME.

IT IS TRUE THAT MOST FULL-SIZE RECEIVERS WILL OUT-PERFORM THE AVERAGE MIDGET IN RESPECT TO SENSITIVITY, TONE QUALITY AND IN SOME CASES SELECTIVITY, DUE TO THE FACT THAT IN ORDER TO ASSEMBLE THE MIDGET TO SUCH COMPACTNESS, CALLS FOR A REDUCTION IN THE NUMBER OF TUBES, TUNING CIRCUITS,

SMALLER SPEAKER WITH LESS BAFFLE ETC. NEVERTHELESS, THESE DEFICIENCIES OF THE MIDGET RECEIVER ARE NOT SO GREAT BUT THAT THE UNIT IS REALLY CAPABLE OF GIVING REMARKABLE PERFORMANCE.

LOOKING AT THE REAR OF THE MIDGET, ONE SEES AN ARRANGEMENT OF PARTS SIMILAR TO THAT SHOWN IN FIG. 2. NOTICE THE METHOD OF MOUNTING THE TUNING CONDENSER, TUBES, POWER TRANSFORMER ETC. CARE MUST BE EXERCISED IN THE LAY-OUT OF SUCH A UNIT, SO THAT UNDESIRABLE COUPLING WILL NOT EXIST BETWEEN THE VARIOUS PARTS WHICH ARE PLACED SO CLOSE TOGETHER.

ALTHOUGH IT IS TRUE THAT THE GREATER PORTIONS OF THE MIDGET RECEIVERS ARE CONVENTIONAL, YET THERE ARE CERTAIN DETAILS WHICH MIGHT CONFUSE YOU WHEN WORKING ON SUCH SETS, WERE THEY NOT FIRST BROUGHT TO YOUR ATTENTION.

WE SHALL START WITH THE OLDER MODEL BUT NOT OBSOLETE POPULAR MIDGET CIRCUITS AND THEN WORK OUR WAY THRU THE MORE MODERN DESIGNS STEP BY STEP.

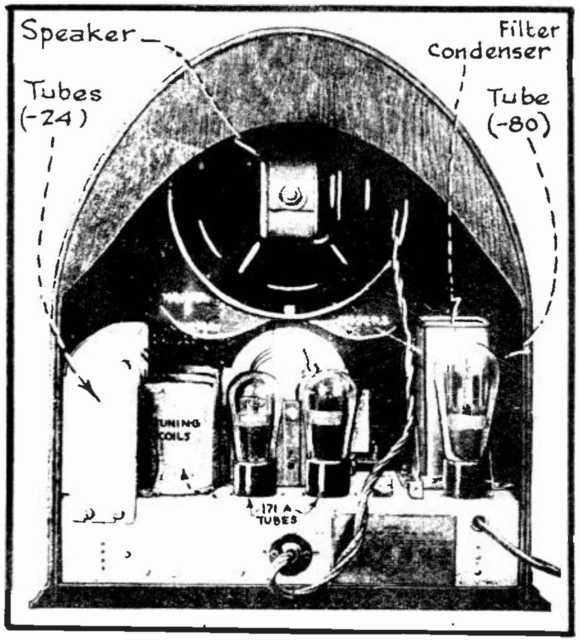

FIG. 2
Rear View of Midget Receiver.

A FIVE-TUBE MIDGET EMPLOYING TYPE -24 AND -45 TUBES

THE FIRST MIDGET CIRCUIT, WHICH WE SHALL STUDY, IS ILLUSTRATED FOR YOU IN FIG. 3. FROM ITS GENERAL APPEARANCE, YOU WILL FIND IT TO BE QUITE CONVENTIONAL, EMPLOYING TYPE -24 R.F. TUBES, A -24 POWER DETECTOR AND A -45 RESISTANCE- CAPACITY COUPLED POWER TUBE. BY CLOSER INSPECTION OF THE CIRCUIT, HOWEVER, YOU WILL OBSERVE THAT THERE ARE SOME SPECIAL FEATURES IN THE CIRCUIT WHICH ARE NOT GENERALLY FOUND IN THE LARGER RECEIVERS. WE SHALL NOW INVESTIGATE THESE DIFFERENCES IN DETAIL.

TO BEGIN WITH, A SINGLE 2.5 VOLT SECONDARY WINDING FURNISHES THE FILAMENT VOLTAGE FOR ALL THREE OF THE TYPE-24 TUBES, AS WELL AS FOR THE TYPE -45 POWER TUBE. THIS PERMITS THE USE OF A SMALLER POWER TRANSFORMER, WHICH AT THE SAME TIME REDUCES THE COST.

THE SPEAKER FIELD SERVES AS THE ONLY FILTER CHOKE AND IS CONNECTED IN THE NEGATIVE SIDE OF THE "B" SUPPLY. ALSO NOTICE HOW THIS DIAGRAM ILLUSTRATES THE FACT THAT A PLUG AND SOCKET CONNECTION IS PROVIDED BETWEEN THE RECEIVER CHASSIS AND THE SPEAKER ASSEMBLY. THE SOCKET IN THIS CASE IS OF THE USUAL FIVE-PRONG RECEIVER TYPE AND IS WIRED TO THE OUTPUT CIRCUIT OF THE RECEIVER, AS WELL AS TO THE "B" SUPPLY. A FIVE-PRONG PLUG IN TURN IS WIRED TO THE SPEAKER FIELD AND OUTPUT TRANSFORMER, WHICH IS MOUNTED DIRECTLY UPON THE SPEAKER FRAME. THE SECONDARY WINDING OF THE OUTPUT TRANSFORMER IS OF COURSE CONNECTED DIRECTLY TO THE SPEAKER VOICE COIL.

THE FIFTH PRONG OF THE SPEAKER PLUG IS WIRED TO THE METALLIC SPEAK-

ER FRAME, WHILE ITS CORRESPONDING SOCKET TERMINAL IS GROUNDED TO THE CHASSIS BASE OF THE RECEIVER. HENCE BY INSERTING THE SPEAKER PLUG INTO THE SOCKET, THE SPEAKER FIELD AND OUTPUT TRANSFORMER WILL BE CORRECTLY CONNECTED TO THE RECEIVER CIRCUITS, WHILE THE METAL SPEAKER FRAME WILL AT THE SAME TIME BE GROUNDED. THE PURPOSE OF GROUNDING THE SPEAKER FRAME IS TO KEEP THE HUM LEVEL DOWN TO AS LOW A VALUE AS POSSIBLE.

A PLUG AND SOCKET ARRANGEMENT AS THIS OFFERS A CONVENIENT MEANS WHEREBY THE SPEAKER CAN BE DISCONNECTED FROM THE RECEIVER CHASSIS WHENEVER IT BECOMES NECESSARY TO REMOVE EITHER OF THESE TWO UNITS FROM THE CABINET FOR REPAIRS. THIS FEATURE IS BEING USED ON MOST MODERN RECEIVERS, ALTHOUGH IN MANY CASES NO PROVISION IS MADE FOR GROUNDING THE SPEAKER FRAME AND THEREFORE A FOUR-PRONG SOCKET AND PLUG ASSEMBLY CAN BE USED.

CONSIDERING THE SPEAKER FIELD COIL CIRCUIT AT THE TIME THE SPEAKER PLUG IS INSERTED IN ITS SOCKET, WE FIND THAT ONE END OF THE SPEAKER FIELD WILL BE GROUNDED WHILE ITS OTHER END IS CONNECTED TO THE CENTER TAP OF THE POWER TRANSFORMER'S HIGH-VOLTAGE SECONDARY WINDING. THIS MEANS THAT ALL "B" CURRENT WILL BE DISTRIBUTED TO THE VARIOUS TUBE CIRCUITS DIRECTLY FROM THE CENTER-TAP CIRCUIT OF THE RECTIFIER TUBE'S FILAMENT

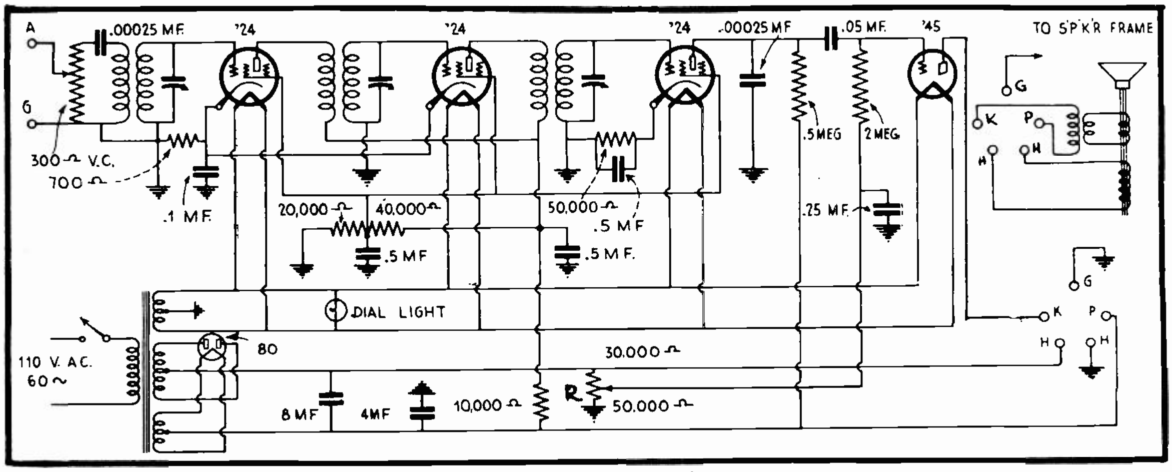

FIG. 3
A Five-Tube Midget Receiver.

WINDING AND UPON ARRIVING AT GROUND, WILL ENTER THE GROUNDED END OF THE SPEAKER FIELD AND RETURN TO THE HIGH VOLTAGE WINDING'S CENTER TAP BY WAY OF THE SPEAKER FIELD. IN OTHER WORDS, THE SPEAKER FIELD IS CONNECTED IN THE NEGATIVE LEG OF THE "B" CIRCUIT.

IT IS IMPORTANT TO NOTICE WITH RESPECT TO THE 4 AND 8 MFD. FILTER CONDENSERS THAT ONE TERMINAL OF THE 4 MFD. CONDENSER MAY BE GROUNDED, WHEREAS BOTH TERMINALS OF THE 8 MFD. CONDENSER MUST IN THIS PARTICULAR CASE BE OF THE INSULATED TYPE.

NOW FOR THE METHOD OF OBTAINING THE BIAS VOLTAGES.

THE PLATE CURRENT FOR ALL OF THE TYPE -24 TUBES WILL OF COURSE FLOW THROUGH THE CATHODES AND RESISTORS INCLUDED BETWEEN THE CATHODES AND GROUND, THEREBY PRODUCING THE BIAS VOLTAGES FOR THESE TUBES IN THE CUSTOMARY MANNER. THE BIAS VOLTAGE FOR THE -45 POWER TUBE, HOWEVER, IS OBTAINED IN A DIFFERENT MANNER AS WILL BE EXPLAINED IN THE FOLLOWING PARAGRAPHS.

As you will observe, the center tap of the 2.5 volt transformer winding is grounded and therefore, offers a means whereby the plate current flow through the -45 tube can reach ground. In addition, a tapped resistor "R" is connected between grounc and the center-tap of the high voltage transformer winding, thereby being in parallel with the speaker field coil. This is the bias resistor for the -45 tube and its tap is so fixed that 50,000 ohms will be included between the tap and ground and 30,000 ohms between the tap and its other extremity.

The "B" current, upon returning from ground to B-, will divide itself between the speaker field coil and the bias resistor "R", the greater portion of it passing through the field coil which offers less resistance. However, what current does flow through R will develope a voltage drop, with the ground end being positive with respect to the other end. The position of the tap is then so chosen on "R" that the proper value of bias voltage will be impressed upon the grid of the -45 tube through the 2 megohm leak resistor.

The volume control for this receiver consists of a 300 ohm potentiometer connected across the primary of the antenna stage transformer with a .00025 mfd. fixed condenser in series. The lower end of the potentiometer is connected to the ground terminal of receiver while the arm is connected to the antenna terminal. By regulating the position of the arm, the amount of signal energy passed into the receiver circuits is controlled.

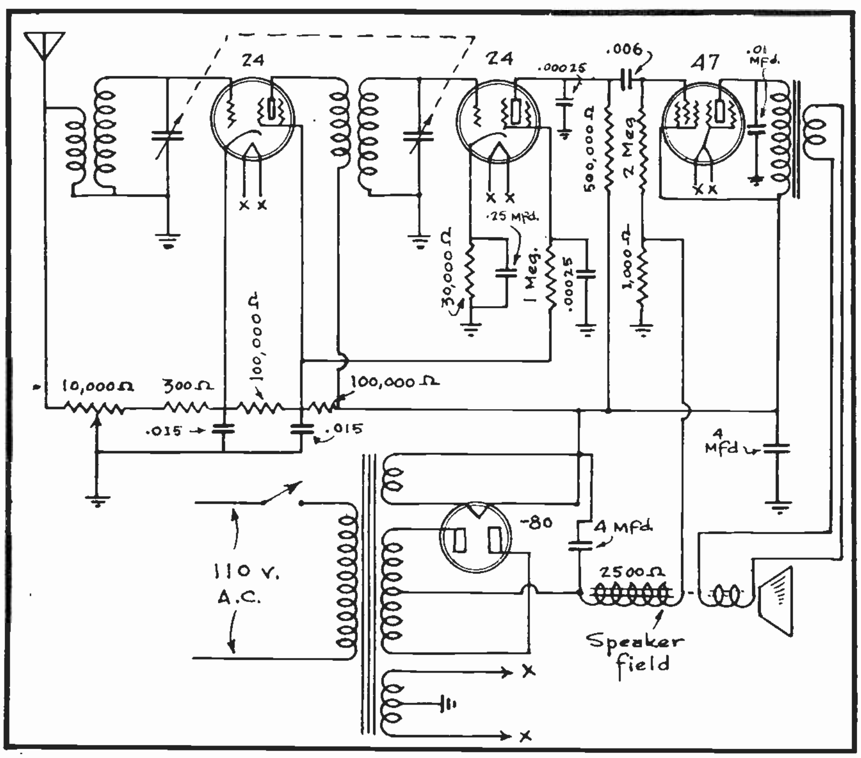

FIG. 4
A Four-Tube Receiver Circuit.

A FOUR-TUBE MIDGET DESIGN

In Fig. 4 we have the circuit diagram of a four tube midget receiver using a type -24 R.F. tube, a -24 power detector, a -47 power tube and an -80 recitifier. In this case, there are only two tuning circuits, both being controlled by a two-gang variable condenser.

Here too, a single 2.5 volt secondary winding is furnished on the power transformer and all B voltages are distributed directly from the 5 volt transformer winding to the various circuits.

THE SPEAKER FIELD WINDING SERVES AS THE ONLY FILTER CHOKE AND IS CONNECTED BETWEEN THE CENTER TAP OF THE POWER TRANSFORMER'S HIGH VOLTAGE WINDING AND GROUND, WITH A 1000 OHM RESISTOR IN SERIES. THEREFORE, ALL "B" CURRENT, UPON REACHING GROUND, WILL FLOW THROUGH THE 1000 OHM RESISTOR AND THE 2500 OHM SPEAKER FIELD COIL, RETURNING TO THE CENTER TAP OF THE HIGH VOLTAGE TRANSFORMER WINDING OR B-.

THE VOLTAGE DROP WHICH IS DEVELOPED BY THIS CURRENT FLOW THROUGH THE 1000 OHM RESISTOR IS USED TO SUPPLY THE NEGATIVE BIAS FOR THE TYPE -47 POWER TUBE. THE CURRENT FLOWING AWAY FROM THE GROUNDED END OF THIS RESISTOR MAKES ITS GROUND END POSITIVE WITH RESPECT TO ITS OTHER END. THEREFORE, SINCE THE NEGATIVE END OF THIS RESISTOR IS CONNECTED TO THE GRID OF THE -47 TUBE THROUGH THE 2 MEGOHM LEAK RESISTOR AND THE FILAMENT OF THE -47 IS GROUNDED THROUGH ITS TRANSFORMER WINDING, A NEGATIVE BIAS VOLTAGE WILL BE IMPRESSED UPON THIS TUBE.

TWO 4 MFD. CONDENSERS ARE USED TO ASSIST IN FILTERING THE "B" SUPPLY WITH THE ASSISTANCE OF THE SPEAKER FIELD.

A 10,000 OHM POTENTIOMETER IS USED TO CONTROL THE VOLUME BY OFFERING A MEANS WHEREBY THE BIAS VOLTAGE FOR THE R.F. TUBE, AS WELL AS THE SIGNAL INPUT TO THE CIRCUITS, CAN BE VARIED.

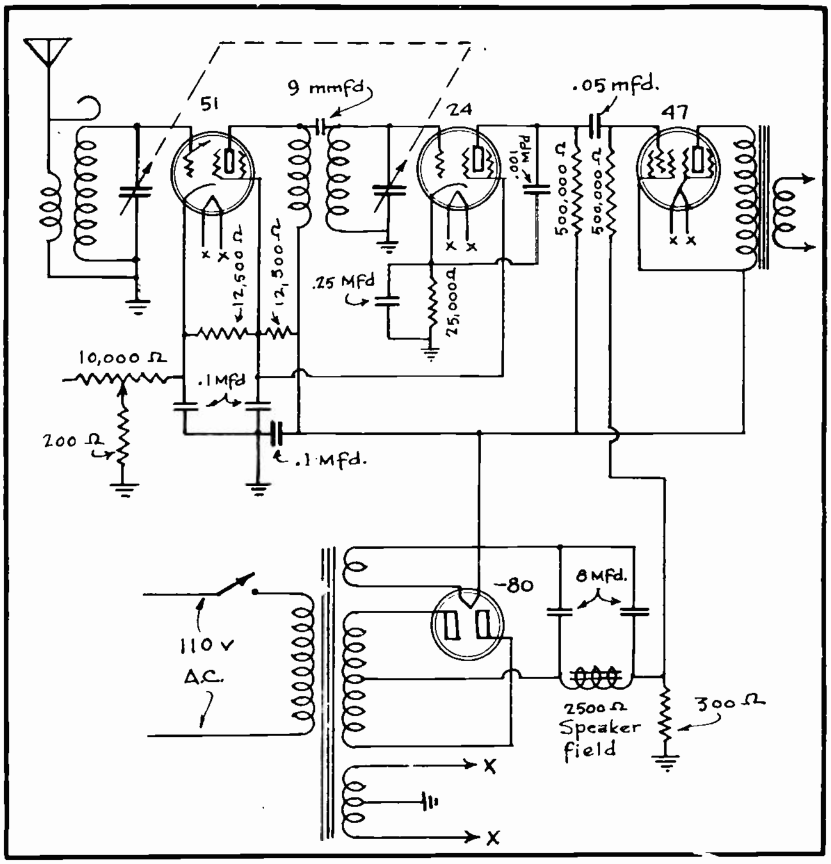

FIG. 5
A 4 Tube Receiver with Constant-Gain Transf.

THE PURPOSE OF THE .01 MFD., CONDENSER WHICH IS CONNECTED BETWEEN GROUND AND THE PLATE OF THE -47 TUBE, IS TO BYPASS SOME OF THE HIGHER AUDIO FREQUENCIES SO THAT THEY WILL NOT BE PASSED ON THROUGH THE OUTPUT TRANSFORMER. IN THIS WAY, THE AVERAGE PITCH OF THE SOUND REPRODUCTION WILL BE LOWERED SOMEWHAT AND THEREBY PROVIDE A DEEPER TONE QUALITY.

THE BALANCE OF THE CIRCUIT IN FIG. 4 IS OF THE CUSTOMARY DESIGN AND THEREFORE IT WILL NOT BE NECESSARY TO SPEND ANY MORE TIME UPON IT.

A FOUR-TUBE RECEIVER WITH CONSTANT-GAIN R.F. TRANSFORMERS

IN FIG. 5 YOU WILL SEE A CIRCUIT DIAGRAM OF ANOTHER FOUR-TUBE RECEIVER, ONLY THAT HERE A TYPE -51 OR -35 VARIABLE-MU SCREEN GRID TUBE IS

USED IN THE FIRST R.F. STAGE, A TYPE -24 POWER DETECTOR, A -47 POWER TUBE AND AN -80 RECTIFIER. IN ADDITION, CONSTANT-GAIN TRANSFORMERS ARE USED IN THE R.F. AND DETECTOR STAGE AND TUNING IS ACCOMPLISHED THROUGH THE USE OF A TWO-GANG CONDENSER. STUDY THIS CIRCUIT CAREFULLY.

NOTICE THAT THE 200 OHM FIXED BIAS RESISTOR FOR THE -51 TUBE IS CONNECTED BETWEEN GROUND AND THE ARM OF A 10,000 OHM POTENTIOMETER. ONE END TERMINAL OF THIS POTENTIOMETER IS LEFT FREE, WHILE ITS OTHER END TERMINAL IS CONNECTED TO THE CATHODE OF THE R.F. TUBE.

THE GRID BIAS VOLTAGE FOR THE -47 TUBE IS IN THIS CASE OBTAINED THROUGH THE USE OF THE 300 OHM RESISTOR WHICH IS CONNECTED BETWEEN GROUND AND ONE END OF THE SPEAKER FIELD COIL--THE 2500 OHM SPEAKER FIELD COIL IN THIS INSTANCE BEING INSERTED IN THE NEGATIVE SIDE OF THE "B" SUPPLY CIRCUIT. THEN BY HAVING THE FILAMENT OF THE -47 TUBE GROUNDED THROUGH THE CENTER TAP OF THE 2.5 VOLT TRANSFORMER WINDING AND ITS CONTROL GRID CONNECTED TO THE UNGROUNDED END OF THE 300 OHM RESISTOR THROUGH THE 500,000 OHM LEAK, THE VOLTAGE DROP DEVELOPED ACROSS THE 300 OHM RESISTOR BY THE "B" CURRENT PASSING THROUGH IT, WILL BE UTILIZED AS BIAS VOLTAGE FOR THE -47. THE GROUND END OF THE 300 OHM RESISTOR WILL OF COURSE BE POSITIVE WITH RESPECT TO ITS OTHER END ON ACCOUNT OF THE DIRECTION OF THE "B" CURRENT FLOW THROUGH IT.

THE NEXT THING WHICH WE ARE GOING TO CONSIDER RELATIVE TO THE CIRCUIT OF FIG. 5 IS THE CONSTRUCTION AND OPERATING PRINCIPLES OF THE CONSTANT-GAIN TYPE R.F. TRANSFORMERS, OR AS THEY ARE OFTEN CALLED, "CONSTANT GAIN COILS". THESE CONSTANT-GAIN COILS ARE INTENDED TO INTRODUCE TWO IMPORTANT FEATURES INTO THE CIRCUIT IN WHICH THEY ARE USED. THE FIRST IS TO OFFER AS GREAT AMPLIFYING ABILITY AS POSSIBLE, OR "HIGH-GAIN" AND SECOND, TO PROVIDE PRACTICALLY UNIFORM AMPLIFICATION THROUGHOUT THE ENTIRE BROADCAST BAND.

STRAIGHT TUNED R.F. AMPLIFIERS, EMPLOYING THE ORDINARY OR SIMPLE TYPES OF R.F. TRANSFORMERS, HAVE A NATURAL TENDENCY TO OFFER GREATER AMPLIFICATION AT THE HIGHER FREQUENCIES THAN AT THE LOWER FREQUENCIES OF THE BROADCAST BAND. THIS IS DUE TO THE FACT THAT THE MAGNETIC FIELD OF THE R.F. TRANSFORMER'S PRIMARY WINDING IS MORE ACTIVE AT THE HIGHER FREQUENCIES THAN AT THE LOWER FREQUENCIES AND THEREBY CAUSES GREATER INDUCTION IN THE SECONDARY WINDING WITH A CORRESPONDING INCREASE IN AMPLIFICATION AT THE HIGHER FREQUENCIES.

WITH THIS FACT IN MIND, THE NEXT POINT OF IMPORTANCE IS THAT THE AMPLIFYING ABILITY OF A VACUUM TUBE CIRCUIT INCREASES AS THE LOAD IN ITS PLATE CIRCUIT IS INCREASED. THIS BEING TRUE, YOU CAN SEE THAT BY USING A PRIMARY WINDING OF CONSIDERABLE INDUCTANCE (MANY TURNS) ON AN R.F. TRANSFORMER, THE AMPLIFYING ABILITY OF THE CIRCUIT WILL BE INCREASED. HOWEVER, TOO GREAT A PLATE CIRCUIT LOAD IN AN R.F. AMPLIFIER MAY CAUSE THE CIRCUIT TO OSCILLATE DUE TO EXCESSIVE FEED-BACK THROUGH THE TUBE.

IT IS ALSO INTERESTING TO NOTE THAT IN MODERN COIL DESIGNING PRACTICE, WHERE THE PRIMARY INDUCTANCE IS MADE QUITE LARGE, THE "BUNCHED" PRIMARY WINDING, TOGETHER WITH ITS DISTRIBUTED CAPACITY, WILL TUNE OR CAUSE THE PRIMARY WINDING TO RESONATE AT A FREQUENCY SLIGHTLY BELOW THE LOWEST BROADCAST FREQUENCY. AS A RESULT, THE AMPLIFIER WILL HAVE A TENDENCY TO AMPLIFY VERY WELL AT THE LOWER BROADCAST FREQUENCIES WHICH ARE SOMEWHAT NEAR THE RESONANT FREQUENCY OF THE HIGH INDUCTANCE PRIMARY WINDING. WITH

CONDITIONS BEING SUCH, HOWEVER, THE AMPLIFYING ABILITY OF THE CIRCUIT WILL DROP OFF AT THE HIGHER BROADCAST FREQUENCIES.

NOW IN ORDER TO RETAIN THE ADVANTAGES OF GOOD AMPLIFICATION AT THE LOWER FREQUENCIES, WHILE AT THE SAME TIME HOLD THE AMPLIFYING ABILITY TO AN EQUAL VALUE AT THE HIGHER FREQUENCIES, SEVERAL REFINEMENTS HAVE BEEN MADE IN THE DESIGN AND CONSTRUCTION OF MODERN R.F. COILS. THE FIRST OF THESE IS SHOWN YOU IN FIG. 6.

IN FIG. 6 YOU WILL SEE THAT THE PRIMARY WINDING CONSISTS OF A SMALL HONEY COMB OR LATTICE-WOUND COIL AND WHICH IS SIMILAR IN APPEARANCE TO AN R.F. CHOKE. THIS WINDING, THEREFORE, HAS CONSIDERABLE INDUCTANCE, IS WOUND ON A WOODEN DOWEL AND PLACED IN THE LOWER END OF THE COIL FORM.

THE SECONDARY IS WOUND ON THE COIL FORM IN THE CONVENTIONAL MANNER. A SMALL CONDENSER IS MOUNTED ON THE SIDE OF THE COIL FORM, NEAR ITS BASE, AND ONE OF ITS TERMINALS IS CONNECTED TO THE PLATE END OF THE PRIMARY WINDING WHILE ITS OTHER TERMINAL IS CONNECTED TO THE CONTROL GRID TERMINAL TO WHICH ONE END OF THE SECONDARY WINDING IS ATTACHED.

THE PURPOSE OF THIS CONDENSER IS TO PRODUCE A CAPACITIVE RELATION OR CONDENSER COUPLING BETWEEN THE PRIMARY AND SECONDARY WINDINGS. THE CHARACTERISTIC OF ANY CONDENSER, YOU WILL REMEMBER, IS THAT ITS CAPACITIVE REACTANCE DECREASES WITH AN INCREASE IN FREQUENCY--JUST THE OPPOSITE TO AN INDUCTANCE'S EFFECT IN THIS RESPECT.

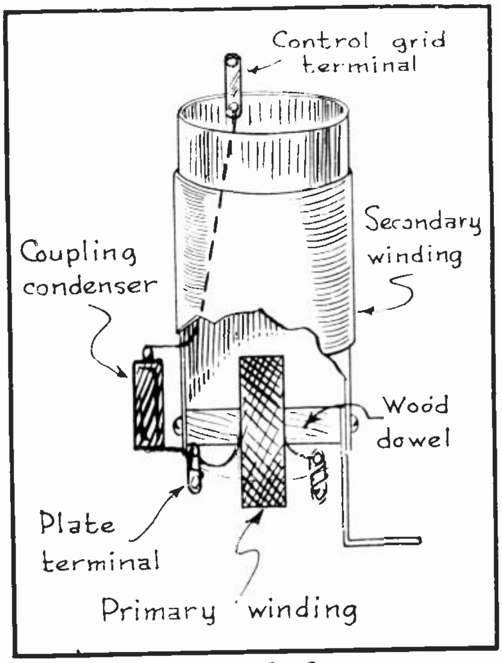

FIG. 6
A Constant-Gain R.F. Transf. With Coupling Condenser.

WITH THIS IN MIND, AND RETURNING TO THE TRANSFORMER OF FIG. 6, WE FIND THAT AT THE TIME THE RECEIVER IS TUNED TO THE LOWER BROADCAST FREQUENCIES, THE CAPACITIVE REACTANCE AS OFFERED BY THE SMALL COUPLING CONDENSER IS VERY GREAT AND CONSEQUENTLY THIS CONDENSER IS OF NO PARTICULAR VALUE WHEN THE RECEIVER IS TUNED TO FREQUENCIES IN THE LOWER PORTION OF THE BROADCAST BAND. AT THIS TIME, THE PRIMARY IS TRANSFERRING ITS MAXIMUM ENERGY BECAUSE IT IS OPERATING NEAR ITS NATURAL RESONANT FREQUENCY.

NOW IF THE RECEIVER IS TUNED TO THE HIGHER BROADCAST FREQUENCIES, AT WHICH TIME THE FREQUENCIES ARE FAR REMOVED FROM THE PRIMARY WINDING'S RESONANT FREQUENCY, WE FIND THAT THE INDUCTIVE ENERGY TRANSFER BETWEEN THE PRIMARY AND SECONDARY NATURALLY DECREASES. IN DIRECT CONTRAST, HOWEVER, WE ALSO FIND THAT THE CAPACITIVE REACTANCE, AS OFFERED BY THE COUPLING CONDENSER, BECOMES LESS AT THESE HIGHER FREQUENCIES AND THEREFORE, A PROPORTIONATELY GREATER ENERGY TRANSFER OCCURS AT THIS TIME FROM THE PRIMARY TO THE SECONDARY THROUGH THE COUPLING CONDENSER. THIS WILL COMPENSATE FOR THE DECREASE IN THE ENERGY TRANSFER BY INDUCTION.

IN PRACTICE, THE CAPACITIVE VALUE OF THE COUPLING CONDENSER IS SO CHOSEN THAT THE ENERGY TRANSFER THROUGH THIS CONDENSER WILL INCREASE AT

APPROXIMATELY THE SAME RATE AS THE ENERGY TRANSFER BY INDUCTION DECREASES WHILE THE RECEIVER'S OPERATING FREQUENCY INCREASES. IN THIS WAY, IT CAN BE SEEN THAT A PROPER BALANCE BETWEEN THESE TWO COUPLINGS CAN BE ATTAINED, SO THAT THE AMPLIFICATION WILL REMAIN PRACTICALLY CONSTANT THROUGHOUT THE BROADCAST BAND.

AT THE SAME TIME, THE AMPLIFICATION CAN BE KEPT AT A HIGH VALUE THROUGHOUT THE BROADCAST BAND AND IT IS FOR THIS REASON THAT THIS TYPE OF COIL IS ALSO FREQUENTLY REFERRED TO AS BEING A HIGH-GAIN COIL.

THE PRESENCE OF THE COUPLING CONDENSER, AS USED ON THIS TYPE OF COIL, IS INDICATED IN THE DIAGRAM OF FIG. 5 BY THE STANDARD CONDENSER SYMBOL INTERCONNECTING THE TWO WINDINGS IN THE SECOND R.F. TRANSFORMER.

R.F. TRANSFORMERS WITH CAPACITY-LOOP

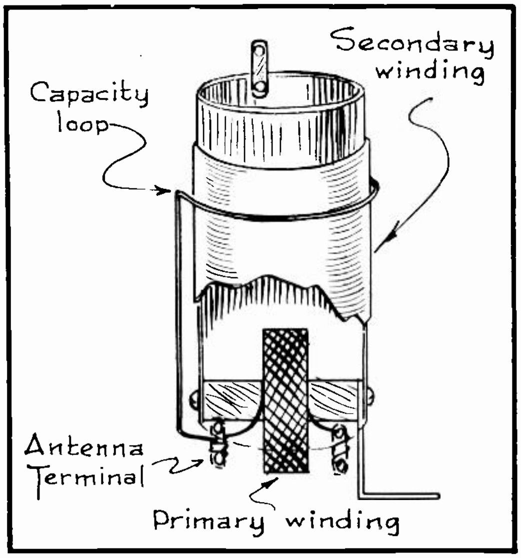

FIG. 7
Application of the Capacity loop.

ANOTHER FORM OF CONSTANT-GAIN OR HIGH-GAIN R.F. TRANSFORMER, AS FREQUENTLY USED, IS ILLUSTRATED FOR YOU IN FIG. 7. THE PRIMARY AND SECONDARY WINDINGS ARE PRACTICALLY THE SAME AS USED WITH THE TRANSFORMER IN FIG. 6 BUT THE COUPLING CONDENSER IS REPLACED BY A RATHER HEAVY, STIFF, BARE WIRE, THE LOWER END OF WHICH IS CONNECTED TO THE ANTENNA OR PLATE TERMINAL OF THE TRANSFORMER, WHILE ITS UPPER END IS BENT INTO THE SHAPE OF AN INCOMPLETE LOOP SURROUNDING THE GRID END OF THE SECONDARY WINDING.

THIS LOOP ACTS AS ONE PLATE OF A SMALL CONDENSER, WHILE THE SECONDARY WINDING SERVES AS THE OTHER PLATE OF THE CONDENSER--THE WINDING INSULATION AND SPACING BETWEEN THE SECONDARY WINDING AND THE LOOP ACTING AS THE DIELECTRIC FOR THIS CONDENSER.

THE OPERATION OF THIS TRANSFORMER IS EXACTLY THE SAME AS ALREADY DESCRIBED RELATIVE TO THE UNIT ILLUSTRATED IN FIG. 6, ONLY THAT THE CAPACITY COUPLING BETWEEN THE PRIMARY AND SECONDARY WINDINGS IS OFFERED BY THE LOOP CAPACITY INSTEAD OF THROUGH THE CONVENTIONAL TYPE OF CONDENSER.

THE PRESENCE OF SUCH A CAPACITY LOOP IS INDICATED ON A WIRING DIAGRAM AS SHOWN ON THE SYMBOL OF THE ANTENNA STAGE R.F. TRANSFORMER IN FIG. 5.

SOMETIMES INSTEAD OF THE STIFF WIRE LOOP, YOU WILL COME ACROSS A UNIT WHERE SMALL-SIZE INSULATED WIRE IS USED FOR THIS PURPOSE. IN THIS CASE, ONE END OF THIS WIRE IS CONNECTED TO THE ANTENNA OR PLATE TERMINAL OF THE TRANSFORMER AND ITS OTHER END IS WRAPPED AROUND THE COIL FORM BESIDE THE GRID END OF THE SECONDARY. ABOUT TWO OR THREE TURNS ARE GENERALLY EMPLOYED AND THE UPPER END OF THIS WINDING IS SIMPLY FASTENED TO THE COIL FORM SO AS TO PREVENT IT FROM UNWINDING BUT IS NOT CONNECTED TO ANY OTHER CIRCUIT. THIS SMALL WINDING WILL SUPPLY THE NECESSARY CAPACITY EFF-

ECT BETWEEN THE PRIMARY AND SECONDARY WINDINGS.

ALTHOUGH WE HAVE DESCRIBED THESE SPECIAL COIL DESIGNS IN THIS LESSON, WHICH DEALS CHEIFLY WITH MIDGET RECEIVER CIRCUITS, YET THIS DOES NOT MEAN THAT THIS TYPE OF COIL IS ONLY USED IN MIDGET RECEIVERS. COILS OF THIS TYPE ARE ALSO EXTENSIVELY USED IN THE CIRCUITS OF FULL-SIZE RECEIVERS.

A MODERN FOUR-TUBE CIRCUIT

IN FIG. 8 YOU ARE SHOWN THE CIRCUIT DIAGRAM OF A MIDGET RECEIVER IN WHICH A TYPE -58 TUBE IS USED IN THE R.F. STAGE, A -57 POWER DETECTOR, A-47 POWER TUBE, AND AN -80 RECTIFIER.

THE CIRCUITS OF THIS RECEIVER ARE VERY SIMILAR TO THOSE OF THE OTHER RECEIVERS SO FAR PRESENTED TO YOU IN THIS LESSON, WITH THE EXCEPTION OF THE NECESSARY CHANGES TO ACCOMMODATE THE -57 AND -58 TUBES AND WITH WHICH YOU ARE ALREADY FAMILIAR. ALSO NOTE THE USE OF THE CONSTANT- - GAIN

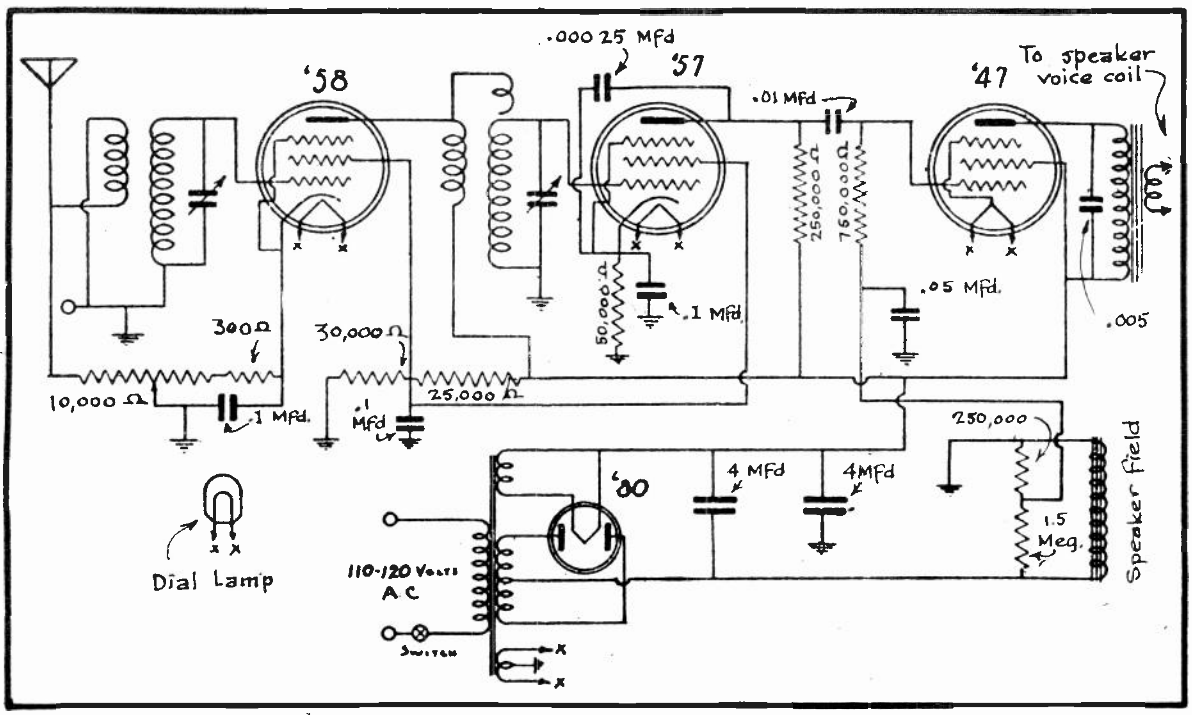

FIG. 8

A Modern Four-Tube Midget Circuit.

R.F. TRANSFORMER IN THE DETECTOR STAGE.

THE SERIES-CONNECTED 250,000 AND 1.5 MEGOHM RESISTORS, WHICH ARE CONNECTED ACROSS THE SPEAKER FIELD WINDING, FURNISH THE BIAS VOLTAGE FOR THE -47 TUBE, AS YOU ALREADY KNOW BY THIS TIME.

A MODERN FIVE-TUBE CIRCUIT

THE CIRCUIT OF THE FIVE-TUBE RECEIVER SHOWN YOU IN FIG. 9, ALTHOUGH SOMEWHAT LARGER, WILL NEVERTHELESS SUPPLY YOU WITH CONSIDERABLE DATA WHICH YOU WILL FIND TO BE OF VALUE.

HERE THERE ARE TWO TYPE-58 R.F. TUBES, A -57 POWER DETECTOR, A 2A5 POWER TUBE AND AN -80 RECTIFIER. THIS CIRCUIT IS CONVENTIONAL THROUGH

OUT AND YOU SHOULD HAVE NO TROUBLE WHATEVER IN ANALYZING IT. WE MIGHT MENTION, HOWEVER, THAT THE 250,000 OHM RESISTOR BETWEEN THE SCREEN GRID OF THE -57 DETECTOR TUBE AND THE SCREEN GRID CIRCUIT OF THE R.F. TUBES IS BEING USED TO REDUCE THE VOLTAGE WHICH IS EFFECTIVE AT THE SCREEN GRID OF THE DETECTOR TUBE. FURTHERMORE, THE SPEAKER FIELD IS CONNECTED IN THE POSITIVE SIDE OF THE RECTIFIER OUTPUT. THE BIAS VOLTAGES FOR ALL OF THE TUBES IS OBTAINED THROUGH THE USE OF THE FIXED RESISTORS WHICH ARE CONNECTED BETWEEN GROUND AND THE CATHODE OF THE VARIOUS TUBES.

A MODERN FOUR-TUBE MIDGET RECEIVER

THE MIDGET RECEIVER CIRCUIT, WHICH IS ILLUSTRATED FOR YOU IN FIG. 10, USES A TYPE -58 R.F. TUBE, A -57 POWER DETECTOR, A -47 POWER TUBE AND AN -80 RECTIFIER--MAKING FOUR TUBES IN ALL. THIS RECEIVER EMPLOYS A TWO-GANG CONDENSER FOR TUNING.

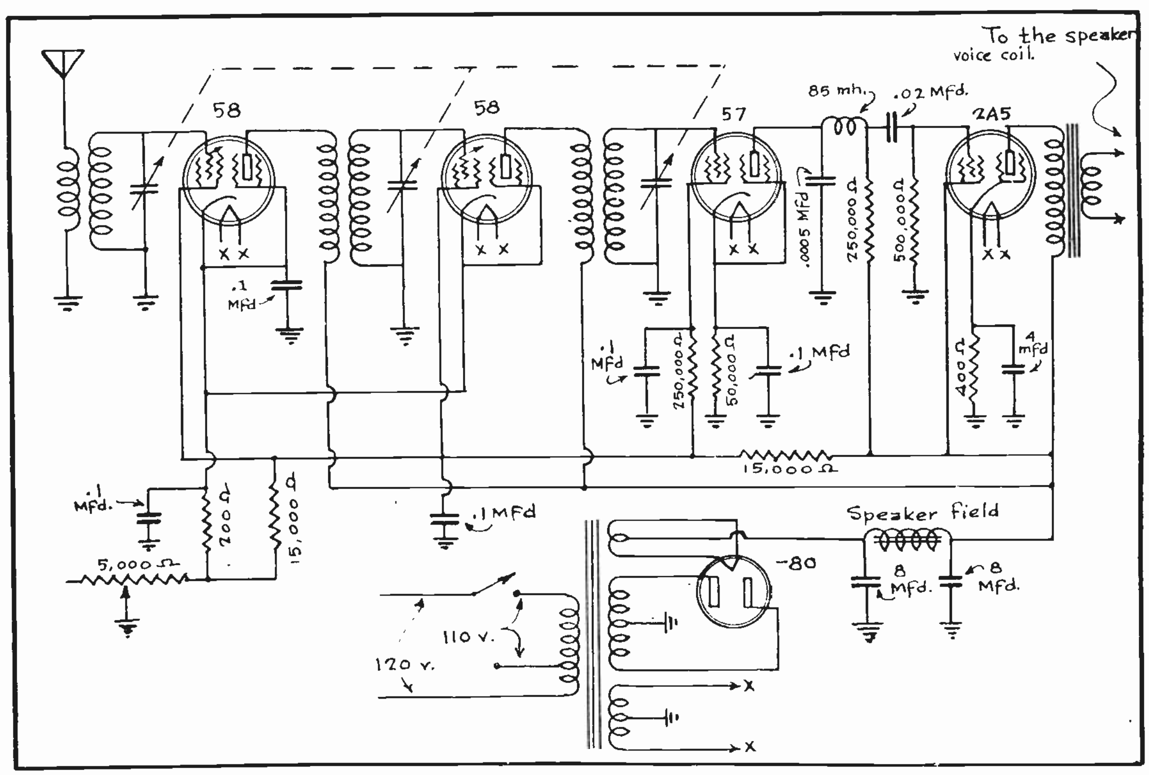

FIG. 9
A Modern Five-Tube Circuit.

NOTICE IN THIS DIAGRAM HOW THE "GROUND END" OF THE FIRST R.F. TRANSFORMER'S PRIMARY WINDING IS CONNECTED TO THE PRIMARY CIRCUIT OF THE POWER TRANSFORMER THROUGH A .00025 MFD. FIXED CONDENSER. THIS DOES AWAY WITH THE NEED FOR AN EXTERNAL GROUND CONNECTION BECAUSE ONE SIDE OF THE A.C. LIGHTING CIRCUIT IS ALREADY GROUNDED BY THE POWER COMPANY. THE .00025 MFD. CONDENSER OFFERS THE R.F. SIGNAL ENERGY READY ACCESS TO THE GROUNDED WIRING SYSTEM, WHILE AT THE SAME TIME PREVENTING THE 110 VOLT LIGHTING CIRCUIT VOLTAGE FROM "SHOCKING" ONE WHEN HANDLING THE RECEIVER.

THE VOLUME CONTROL CONSISTS OF A 15,000 OHM POTENTIOMETER, ONE END OF WHICH IS GROUNDED, WHILE ITS OTHER END IS CONNECTED TO THE POINT OF SCREEN GRID POTENTIAL THROUGH A 10,000 OHM FIXED RESISTOR. THE ARM OF THE

POTENTIOMETER IS CONNECTED TO THE CATHODE OF THE R.F. TUBE THROUGH A 390 OHM FIXED RESISTOR.

THE FILTER CIRCUIT FOR THE "B" SUPPLY CONSISTS OF THE SPEAKER FIELD SERVING AS THE CHOKE AND TWO 8 MFD. FILTER CONDENSERS. THE CIRCUIT REQUIREMENTS ARE SUCH THAT ONE OF THESE CONDENSERS MUST HAVE BOTH OF ITS TERMINALS INSULATED, WHILE ONE TERMINAL OF THE OTHER FILTER CONDENSER IS TO BE GROUNDED.

OBSERVE THAT THE SPEAKER FIELD IS CONNECTED IN THE POSITIVE LEG OF THE "B" CIRCUIT AND THAT THE 600 OHM FIXED RESISTOR, WHICH IS CONNECTED BETWEEN GROUND AND THE CENTER-TAP OF THE POWER TRANSFORMER'S HIGH VOLTAGE WINDING, SUPPLIES THE BIAS VOLTAGE FOR THE POWER TUBE. ALSO NOTICE THAT THE SPEAKER VOICE COIL CIRCUIT IS GROUNDED SO AS TO REDUCE HUM.

IN THIS LESSON, YOU HAVE BEEN SUPPLIED WITH THE DATA CONCERNING THE CIRCUITS OF A NUMBER OF DIFFERENT TYPES OF MIDGET RECEIVERS. NOT ONLY SHOULD YOU FIND THIS INFORMATION OF INSTRUCTIVE VALUE BUT YOU MAY ALSO AVAIL YOURSELF OF THE OPPORTUNITY OF USING THIS DATA FOR THE CONSTRUCTION OF SIMILAR RECEIVERS WHICH YOU MAY WISH TO BUILD EITHER FOR YOUR OWN USE OR FOR SELLING PURPOSES.

THE MIDGET CIRCUITS EMPLOYING SUPERHETERODYNE PRINCIPLES WILL BE BROUGHT TO YOU IN A LATER LESSON, AS WILL ALSO THE A.C.-D.C. COMBINATION MIDGETS ETC

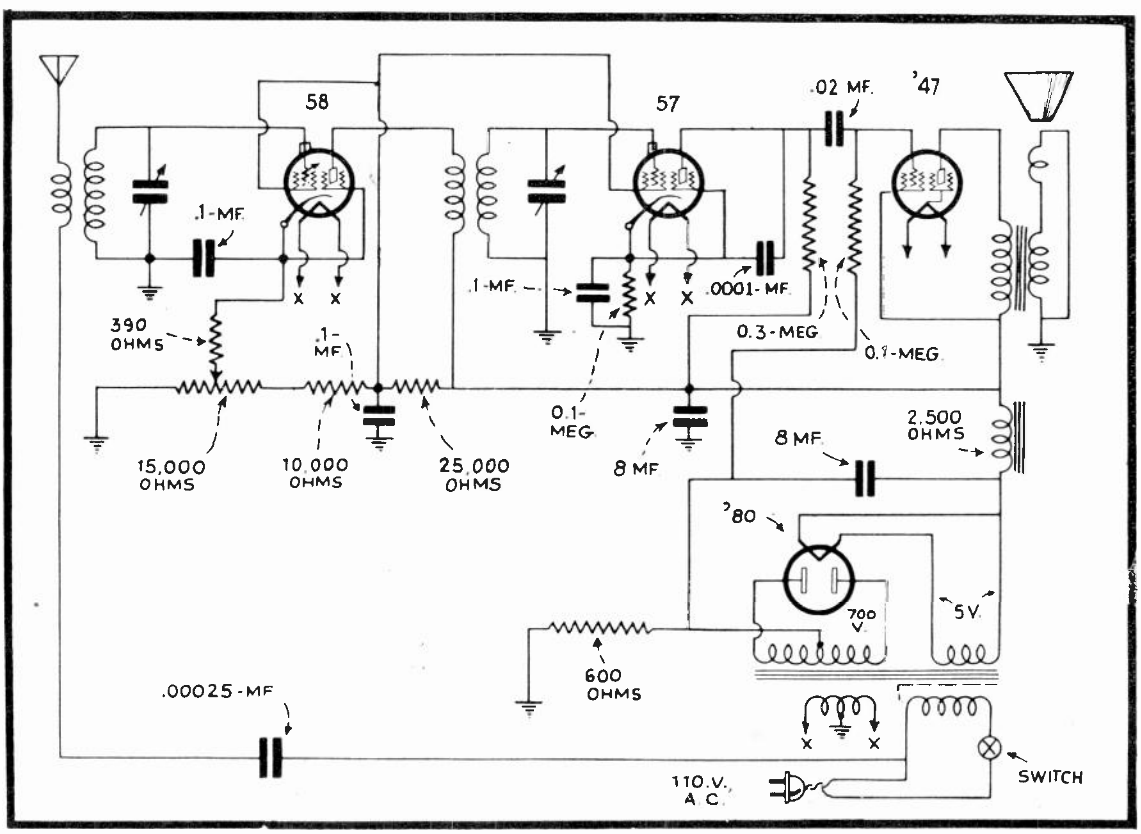

FIG. 10

A Modern Four-Tube Midget Design.

Examination Questions

LESSON NO. 26

"A good man is seldom uneasy, an ill one never easy."

1. – WHAT ARE SOME OF THE MOST OUTSTANDING DIFFERENCES IN THE CIRCUIT FEATURES OF THE CONVENTIONAL TYPE OF MIDGET RECEIVER AS COMPARED WITH THE LARGER CONSOLE TYPE RECEIVERS?

2. – DRAW A CIRCUIT DIAGRAM OF A FOUR TUBE MIDGET RECEIVER USING A -58 R.F. TUBE, A -57 POWER DETECTOR, A -47 POWER TUBE AND AN -80 RECTIFIER.

3. – EXPLAIN HOW THE BIAS VOLTAGE FOR THE -47 TUBE IS OBTAINED IN THE CIRCUIT WHICH YOU HAVE DRAWN AS REQUESTED IN QUESTION #2.

4. – WHAT ADVANTAGES DOES A CONSTANT-GAIN TYPE R.F. TRANSFORMER HAVE TO OFFER OVER THE SIMPLE TYPE OF R.F. TRANSFORMER?

5. – DESCRIBE THE CONSTRUCTIONAL FEATURES AND OPERATING PRINCIPLES OF ONE TYPE OF CONSTANT-GAIN R.F. TRANSFORMER.

6. – WHY IN THE CIRCUIT OF FIG. 3 IS IT IMPORTANT THAT BOTH TERMINALS OF THE 8 MFD. FILTER CONDENSER BE OF THE INSULATED TYPE?

7. – WHAT IS THE CHIEF ADVANTAGE OF USING A PLUG AND SOCKET CONNECTION BETWEEN THE SPEAKER ASSEMBLY AND RECEIVER CHASSIS?

8. – HOW IS THE RECEIVER GROUND CONNECTION MADE IN THE CIRCUIT WHICH IS SHOWN IN FIG. 10 OF THIS LESSON?

9. – HOW IS THE GRID BIAS VOLTAGE FOR THE -45 TUBE IN FIG. 3 OF THIS LESSON OBTAINED?

10.– DRAW A CIRCUIT DIAGRAM OF A FIVE-TUBE RECEIVER CIRCUIT USING TWO TYPE -58 R.F. TUBES, A -57 POWER DETECTOR, A 2A5 POWER TUBE AND AN -80 RECTIFIER.

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LESSON NO. 27

· PORTABLE RECEIVERS ·

ALTHOUGH WE SOMETIMES CONSIDER RADIO INSTALLATIONS ABOARD SHIPS, AIRCRAFT, AUTOMOBILES ETC. AS BEING PORTABLE EQUIPMENT, YET THIS IS NOT STRICTLY TRUE, FOR THE INSTALLATION IN THESE CASES IS MADE IN SUCH A WAY THAT THE RADIO IS ACTUALLY A PART OF THE CRAFT'S EQUIPMENT.

A TRULY PORTABLE SET IS ONE THAT IS SELF CONTAINED, INCLUDING ITS POWER SUPPLY ETC. AND CAN BE CARRIED AROUND BY ONE MUCH THE SAME AS A SUITCASE AND SET UP FOR OPERATION AT ANY POINT DESIRED.

MANY USES ARE AVAILABLE FOR THE PORTABLE RECEIVER AND EVEN FOR A PORTABLE TRANSMITTER FOR THAT MATTER. FOR EXAMPLE, THE PORTABLE RADIO ADDS ENJOYMENT TO THE VACATIONIST AS HE RESTS IN CAMP, OR WHILE SPENDING HIS TIME PADDLING A CANOE ACROSS A QUIET LAKE. HIKERS, SURVEYING AND CONSTRUCTION CREWS ETC. QUITE OFTEN "PACK" A PORTABLE RECEIVER ALONG THEIR JOURNEY, SO THAT THEY CAN LISTEN-IN TO ENTERTAINING PROGRAMS DURING THEIR IDLE MOMENTS AND THUS REMAIN IN CONTACT WITH THE REST OF THE WORLD. IT REQUIRES BUT LITTLE IMAGINATION TO PICTURE MANY MORE WORTHWHILE APPLICATIONS FOR PORTABLE RECEIVERS.

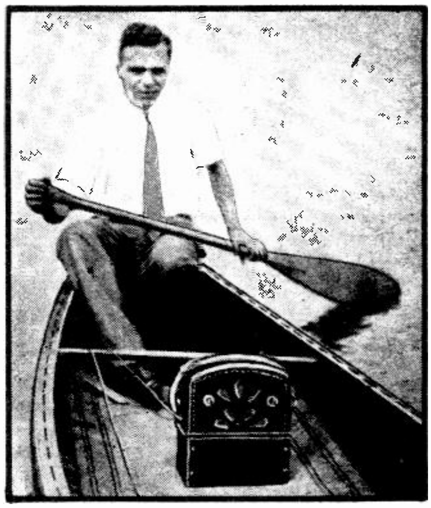

FIG. 1
Vacationing With a Portable Radio.

IN THIS LESSON, YOU WILL FIND MANY VALUABLE SUGGESTIONS AND CIRCUIT DIAGRAMS WHICH WILL NOT ONLY FAMILIARIZE YOU WITH THESE TYPES OF CIRCUITS BUT WHICH WILL AT THE SAME TIME, SUPPLY YOU WITH THE NECESSARY INFORMATION SO THAT YOU CAN CONSTRUCT SUCH RECEIVERS AND IN THIS WAY AVAIL YOURSELF OF AN ADDITIONAL INCOME. THERE ARE COMPARATIVELY FEW STRICTLY PORTABLE RECEIVERS BEING MANUFACTURED BY THE LARGER COMPANIES AND YOU, THEREFORE, HAVE AN EXCELLENT OPPORTUNITY OF "CASHING IN" ON THIS BRANCH OF THE BUSINESS.

THE LOOP ANTENNA

BEFORE GOING INTO DETAILS CONCERNING THE CIRCUITS OF PORTABLE RECEIVERS, IT IS ADVISABLE THAT YOU FIRST BECOME MORE FAMILIAR WITH THE CON

STRUCTION AND OPERATION OF THE LOOP TYPE ANTENNA, WHICH IS USED A GREAT DEAL IN RECEIVER DESIGNS OF A PORTABLE NATURE. YOU HAVE, OF COURSE, ALREADY BEEN INTRODUCED TO THIS TYPE OF ANTENNA IN A PRECEDING LESSON BUT WE DID NOT PAUSE AT THAT TIME TO CONSIDER IT IN DETAIL.

TO REFRESH YOUR MEMORY, WE ARE SHOWING YOU A TYPICAL LOOP ANTENNA IN FIG. 2. AS A GENERAL RULE, YOU WILL FIND THEM HAVING FOUR SIDES, AS HERE ILLUSTRATED ALTHOUGH SIX SIDES ARE SOMETIMES USED. TO MAKE SATISFACTORY USE OF THIS TYPE OF ANTENNA, HOWEVER, REQUIRES THAT THE RECEIVER WITH WHICH IT IS USED BE A SENSITIVE ONE.

THE ORDINARY OUTDOOR ANTENNA HAS CAPACITY AS ITS CHIEF CHARACTERISTIC AND ANTENNAS OF THIS TYPE COLLECT SIGNAL ENERGY BECAUSE ELECTRICAL CHARGES ARE DEVELOPED ON THE ANTENNA SYSTEM, WITH THE ELEVATED AERIAL WIRE ACTING AS ONE PLATE OF A LARGE CONDENSER AND THE GROUND ACTING AS THE OTHER PLATE OF THIS SAME LARGE CONDENSER.

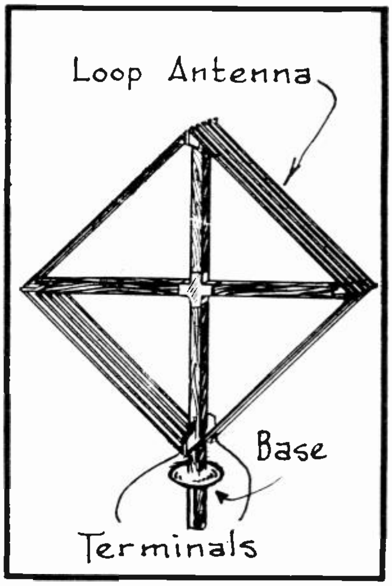

FIG. 2
A Typical Loop Antenna.

THE LOOP ANTENNA, ON THE OTHER HAND, HAS INDUCTANCE AS ITS CHIEF CHARACTERISTIC AND IT COLLECTS ITS ENERGY BECAUSE IT ACTS JUST LIKE ANY OTHER COIL, IN THAT THE CUTTING OF LINES OF FORCE THROUGH ITS WIRES GENERATES VOLTAGES IN THESE SAME WIRES.

THE EFFECTS OF THE LOOP'S POSITION AND LOCATION

BY PLACING THE LOOP ANTENNA IN SUCH A POSITION, SO THAT ITS SIDES ARE IN THE SAME PLANE AS THE PASSING WAVE TRAIN AS PICTURED IN THE UPPER ILLUSTRATION OF FIG. 3, MAXIMUM SIGNAL ENERGY WILL BE PICKED UP.

IN THE UPPER ILLUSTRATION OF FIG. 3, EQUALLY STRONG SIGNALS WILL BE OBTAINED WHETHER THE WAVE TRAIN BE MOVING FROM RIGHT TO LEFT OR FROM LEFT TO RIGHT, AS LONG AS THE EDGES OF THE LOOP ARE IN THE SAME PLANE WITH THE WAVE. WITH THE LOOP TURNED, AS ILLUSTRATED AT THE BOTTOM OF FIG. 3, THE LEAST POSSIBLE SIGNAL ENERGY IS BEING PICKED UP.

FIG. 3, BY THE WAY, ALSO SHOWS YOU A TYPICAL EXAMPLE OF HOW LOOP ANTENNAS ARE QUITE FREQUENTLY MOUNTED ON PORTABLE RECEIVERS.

ANOTHER INTERESTING FEATURE CONCERNING THE LOOP TYPE ANTENNA IS THAT AT TIMES, THE LOOP WILL BE POINTED DIRECTLY TOWARDS A STATION AS FAR AS GEOGRAPHICAL DIRECTION IS CONCERNED AND YET THE SIGNALS OF THIS STATION WILL NOT COME IN AS STRONG AS WHEN THE LOOP'S POSITION IS SHIFTED SLIGHTLY. THE REASON FOR THIS IS THAT THE RADIATED RADIO WAVES DO NOT ALWAYS FOLLOW A TRUE COURSE AS THEY LEAVE THE TRANSMITTER. INSTEAD OF THIS, THEY ARE FREQUENTLY DEFLECTED ONE WAY AND ANOTHER BY VARIOUS NATURAL OBJECTS UNTIL THEY FINALLY REACH THE LOOP ANTENNA, THUS DECEIVING THE OPERATOR AS TO THE ACTUAL DIRECTION TOWARDS THE TRANSMITTER.

LOOP ANTENNAS, WHEN OPERATED INSIDE OF BUILDINGS, WILL VERY OFTEN

PRODUCE PECULIAR RESULTS. THIS IS ESPECIALLY TRUE IF THE BUILDING HAS CONSIDERABLE METAL INCORPORATED IN ITS STRUCTURE, FOR IN SUCH A CASE, THIS METAL WILL ACT AS A SHIELD, THUS EITHER PREVENTING THE SIGNAL ENERGY FROM TAKING EFFECT UPON THE ANTENNA OR ELSE CAUSING THE SIGNAL TO FOLLOW A PECULIAR COURSE AFTER ONCE ENTERING THE BUILDING.

TUNING THE LOOP ANTENNA

NOW THERE IS STILL AN EXCEEDINGLY IMPORTANT POINT REGARDING LOOP ANTENNAS, WHICH WE HAVE AS YET NOT CONSIDERED AND THAT IS, THAT SINCE THIS TYPE OF ANTENNA CAN BE THOUGHT OF AS BEING CHIEFLY AN INDUCTANCE, THEN IT IS TRUE THAT IT WILL QUITE NATURALLY OPPOSE THE FLOW OF HIGH FREQUENCY CURRENTS THROUGH IT.

IN YOUR STUDIES OF TUNED RADIO FREQUENCY CIRCUITS, YOU LEARNED THAT IF A CONDENSER IS CONNECTED ACROSS AN INDUCTANCE AND ITS CAPACITY SO ADJUSTED THAT THE CIRCUIT IS TUNED TO RESONANCE WITH A GIVEN FREQUENCY, THEN THE MAXIMUM VOLTAGE WILL BE GENERATED ACROSS THIS TUNED CIRCUIT. A SIMILAR CONDITION EXISTS IN THE CASE WHERE A LOOP TYPE ANTENNA IS COUPLED TO THE INPUT OF A RECEIVER AND THIS IS ILLUSTRATED IN FIG. 4.

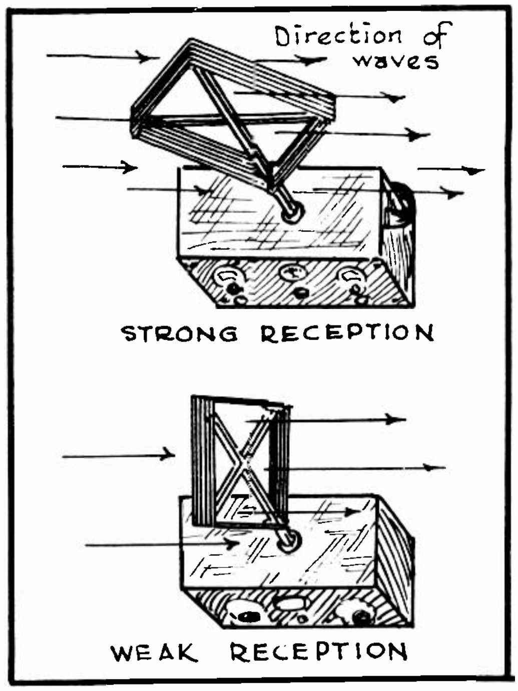

FIG. 3
Directional Qualities of a Loop Antenna.

NOTICE IN FIG. 4 HOW A REGULAR VARIABLE OR TUNING CONDENSER IS CONNECTED ACROSS THE ENDS OF THE LOOP ANTENNA. HERE WE HAVE A TUNED CIRCUIT, THE SAME AS WHEN HAVING A TUNING CONDENSER CONNECTED ACROSS THE ENDS OF AN R.F. TRANSFORMER'S SECONDARY WINDING IN ANY CONVENTIONAL R.F. AMPLIFYING STAGE. FURTHERMORE, THIS TUNED CIRCUIT IS CONNECTED ACROSS THE GRID CIRCUIT OF THE RECEIVER'S INPUT TUBE, THUS PROVIDING US WITH A TUNED OSCILLATING CIRCUIT, WITH WHICH TO ACTUATE THE GRID OF THIS FIRST TUBE IN THE CUSTOMARY MANNER, OR THE SAME AS THOUGH THIS TUBE WERE CONNECTED UP TO A CONVENTIONAL AERIAL SYSTEM AND TUNED R.F. STAGE.

IN ORDER TO PERMIT A TUNING CONDENSER OF A CERTAIN RATED CAPACITY TO TUNE OVER THE ENTIRE BROADCAST RANGE WHEN USED WITH A LOOP ANTENNA, IT IS OBVIOUS THAT THE INDUCTANCE OF THE LOOP ANTENNA MUST BE SOMEWHAT MATCHED TO THE TUNING RANGE OF THE CONDENSER. BY ADDING MORE TURNS TO THE LOOP ANTENNA, ITS INDUCTANCE WILL BE INCREASED AND THE USE OF MORE INDUCTANCE CALLS FOR A SMALLER TUNING CONDENSER, IN ORDER TO TUNE TO A GIVEN BAND OF FREQUENCIES. THEN TOO, THE ADDITION OF MORE TURNS TO THE LOOP ALSO INCREASES THE DISTRIBUTED

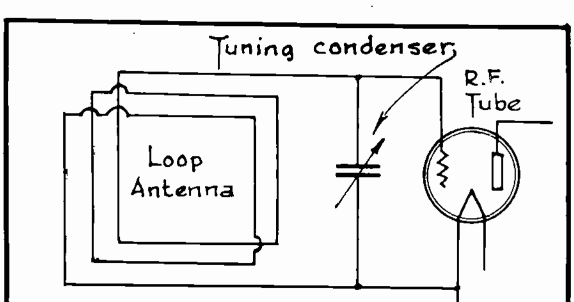

FIG. 4
Coupling the Loop Antenna to the Input or First R.F. Tube.

capacity of the antenna and this in turn prevents the circuit from being tuned to the higher frequencies.

We also find that the loop's distributed capacity is reduced by spacing its turns farther appart and by using a smaller wire size but it is of course understood that wider spacing between turns also decreases the inductance of the loop. The possible voltage to be generated across a certain inductance by a given frequency in turn becomes less with a decrease in inductance, so from this fact it can be seen that a certain amount of signal strength will be sacrificed by spacing the turns.

The tuning condensers generally employed with a loop antenna have a capacity rating of .00035 mfd. or else .0005 mfd. and of these two, the latter is more popular for this use.

A typical loop antenna for broadcast use can be 24 inches high, 12 inches wide and containing 14 turns, which are spaced 1/4 inch apart. The dimensions here given refer to the wired portion of the loop and NOT to the overall dimensions including stand etc. The wire most generally used for loop antenna construction is stranded flexible wire known as "Litz wire". For loop use, this wire is often made up of 20 strands of #38 wire and either silk or cotton covered insulation can be used. The loop antenna, which was just described, will tune over the broadcast range when used in conjunction with a 0.0005 mfd. variable condenser.

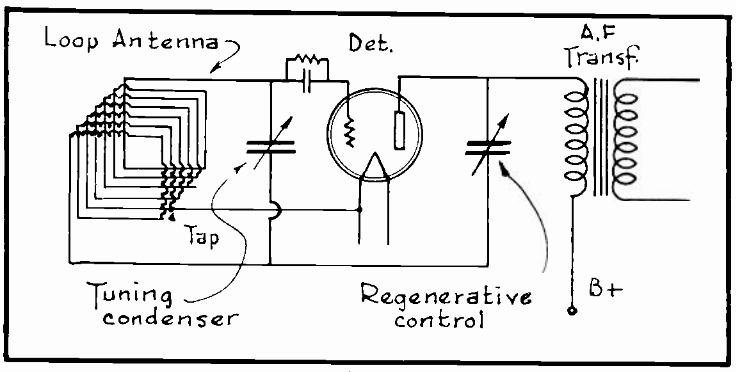

FIG. 5
Using Regeneration With a Loop Antenna.

THE REGENERATIVE LOOP ANTENNA

In some cases, the loop antenna has three leads coming from it. Two of these are the ends of the loop and the third may be a tap taken off at some turn of the antenna.

A tapped loop antenna as this can be used for regeneration when connected up to a circuit as shown in Fig. 5. Here you will see that the two ends of the loop are connected across the tuning condenser in the customary way. One of these ends, however, is also connected to the plate circuit of the tube through a small regeneration control condenser and the loop's tap is connected to the tube's filament.

The connections are now such that some of the turns of the loop will act as a tickler coil, the same as the tickler coil on any R.F. transformer with a stationary tickler. Hence by means of the regeneration control condenser in Fig. 5, the amount of regenerative energy, which is fed back to the loop antenna, can be controlled.

A TYPICAL PORTABLE RECEIVER

In Fig. 6, you will see a good example of a portable receiver. In

THIS CASE, THE RECEIVER PARTS, SUCH AS THE TUBES, COILS, BATTERIES ETC. ARE ALL CONTAINED WITHIN A CASE, WHICH HAS A LEATHER COMPOSITION COVERING. A HANDLE IS PROVIDED SO THAT THE ASSEMBLY CAN BE CARRIED AROUND IN THE FORM OF A GRIP.

TO USE THE RECEIVER, THE COVER IS OPENED AND SLIPPED OFF ITS PIN TYPE HINGES. THIS WILL EXPOSE THE CONTROL PANEL AND THE GRILL (OPENING) FOR THE BUILT-IN SPEAKER. THE LOOP ANTENNA IS THEN ERECTED ON A VERTICAL STUD WHICH IS INSERTED IN A HOLE ON THE UPPER EDGE OF THE CASE, AS SHOWN IN THE ILLUSTRATION, SO THAT IT CAN BE ROTATED.

THE ANTENNA LEADS ARE THEN CONNECTED TO THE SET AS SHOWN AND OF COURSE IN THIS INSTANCE, AS WELL AS IN ANY OTHER RECEIVER WHERE A LOOP ANTENNA IS USED, NO GROUND CONNECTION IS NECESSARY.

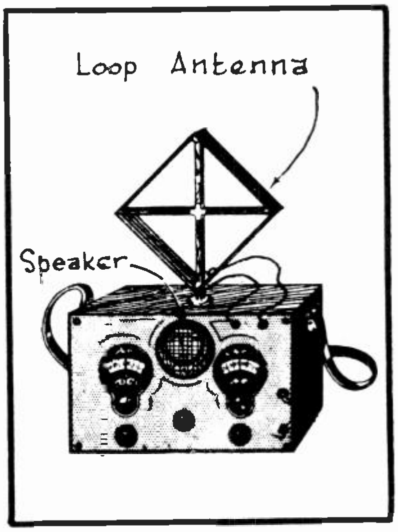

FIG. 6
A Typical Portable Receiver.

THE RECEIVER IS NOW SET UP READY TO OPERATE. TO OPERATE IT, THE SWITCH IS TURNED ON, THE VOLUME CONTROL IS TURNED ON PART WAY AND THE TUNING DIAL IS SLOWLY OPERATED UNTIL A STATION IS BROUGHT IN. THE LOOP ANTENNA IS THEN TURNED ABOUT ITS AXIS TO THE POSITION DELIVERING BEST VOLUME AND THE REST OF THE CONTROLS ARE THEN ADJUSTED SO THAT THE UNIT OPERATES AT ITS BEST.

ANOTHER PORTABLE RECEIVER OF SLIGHTLY DIFFERENT DESIGN IS SHOWN YOU IN FIG. 7 WITH ITS COVER REMOVED. NOTE HOW COMPACT IT IS ASSEMBLED IN THE LEATHERETTE CARRYING CASE, WITH THE SPEAKER GRILL PLACED AT THE LEFT SIDE OF THE PANEL, WHILE THE CONTROLS AND TUNING DIAL ASSEMBLY OCCUPY, THE RIGHT SIDE OF THE PANEL. ALL OF THE RECEIVERS COMPONENTS AND BATTERIES ARE HOUSED WITHIN THE CASE.

THIS PARTICULAR RECEIVER DOES NOT HAVE A LOOP ANTENNA INCLUDED AS A PART OF THE SET AND THEREFORE, A SIMPLE FORM OF TEMPORARY ANTENNA SHOULD BE ERECTED. ONE METHOD OF ACCOMPLISHING THIS IS TO SUSPEND A 50 FT. LENGTH OF FLEXIBLE INSULATED WIRE FROM A TREE OR OTHER CONVENIENT OBJECT AND TO CONNECT THE FREE END TO THE ANTENNA TERMINAL OF THE RECEIVER.

ANOTHER SIMPLE FORM OF ANTENNA FOR THIS USE IS TO USE A MAST-TYPE ANTENNA, SUCH AS ILLUSTRATED IN FIG. 8. HERE A WOODEN POLE, OR LENGTH OF BAMBOO, ABOUT 8 OR 10 FEET LONG IS WRAPPED WITH 30 TO 40 FEET OF HOOK-UP WIRE OR BELL WIRE. ONE END OF THIS WIRE IS FASTENED TO ONE END OF THE POLE AND THE WIRE IS THEN WOUND IN UNIFORM SPIRAL FORMATION AROUND THE POLE WITH A SEPARATION OF 1 TO 2 INCHES BETWEEN ADJACENT TURNS. THE FREE END OF THE WIRE SHOULD BE LONG ENOUGH SO THAT IT CAN BE CONNECTED TO THE ANTENNA TERMINAL OF THE RECEIVER CONVENIENTLY.

WHEN IN USE, THE MAST SHOULD BE PLACED IN A VERTICAL OR UPRIGHT POSITION BY STICKING ITS LOWER END INTO THE GROUND FOR A SUPPORT. THE MAST WILL ALSO SERVE AS A SATISFACTORY ANTENNA IN A CANOE OR ROW BOAT BY MOUNTING IT IN A VERTICAL POSITION IN THE CRAFT.

QUITE OFTEN, SATISFACTORY RECEPTION CAN BE OBTAINED BY USING ONLY

AN ANTENNA AND NO GROUND. HOWEVER, A TEMPORARY GROUND CONNECTION CAN GENERALLY BE MADE WITH LITTLE DIFFICULTY.

ONE SIMPLE METHOD OF PROVIDING SUCH A GROUND CONNECTION IS TO DRIVE A SHARP POINTED STEEL ROD WITH ATTACHED GROUND WIRE INTO MOIST EARTH A FOOT OR SO AND ATTACH THE WIRE TO THE GROUND TERMINAL OF THE RECEIVER. THE ROD CAN THEN BE EASILY "PULLED UP" WHEN NO LONGER NEEDED. ANOTHER METHOD, WHICH IS STILL MORE SIMPLE, IS TO USE ABOUT 20 FT. OF INSULATED WIRE AS A COUNTERPOISE BY JUST STRETCHING IT OUT OVER THE GROUND WITH ONE OF ITS ENDS LEFT FREE AND THE OTHER END ATTACHED TO THE GROUND TERMINAL OF THE RECEIVER.

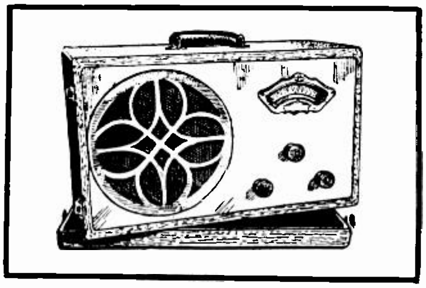

FIG. 7
Another Portable Receiver

IF THE RECEIVER IS BEING USED NEAR A BODY OF WATER, AS A LAKE OR STREAM, A GROUND WIRE FOUR OR FIVE FEET LONG CAN BE IMMERSED IN THE WATER BY ATTACHING A WEIGHT OR FISHING SINKER TO ITS END. IF NECESSARY AND PRACTICAL, THE LENGTH OF THIS WIRE CAN OF COURSE BE INCREASED TO MEET THE PARTICULAR CONDITION AT HAND.

HAVING CONSIDERED THE VARIOUS TYPES OF ANTENNA AND GROUNDING SYSTEMS WHICH ARE SUITABLE FOR PORTABLE RECEIVERS, LET US NOW CONTINUE WITH A STUDY OF THE DETAILS REGARDING THE CONSTRUCTION OF DIFFERENT RECEIVERS WHICH ARE ADAPTED TO THIS USE.

A THREE-TUBE PORTABLE RECEIVER

IN CONSTRUCTING PORTABLE RECEIVERS, IT IS THE NATURAL TENDENCY TO BUILD SUCH SETS AS COMPACT AND LIGHT AS POSSIBLE. AT THE SAME TIME, THE CIRCUIT SHOULD PREFERABLY BE OF SIMPLE AND FOOL-PROOF DESIGN SO THAT THERE WILL BE LITTLE POSSIBILITY FOR DELICATE ADJUSTMENTS TO GET OUT OF ORDER WHEN THE SET IS SUBJECTED TO RATHER ROUGH USEAGE AS IS MOST GENERALLY THE CASE WITH ALL PORTABLE RECEIVERS.

IN THE DESIGN OF SUCH RECEIVERS, IT IS ALSO ADVISABLE TO USE A CIRCUIT WHICH WILL BE AS ECONOMICAL AS POSSIBLE WITH RESPECT TO THE DEMAND UPON THE BATTERIES USED TO OPERATE IT. THIS WILL PERMIT THE USE OF BATTERIES OF SMALLER SIZE AND THEREBY KEEP THE WEIGHT OF THE COMPLETE UNIT DOWN TO A SATISFACTORY VALUE.

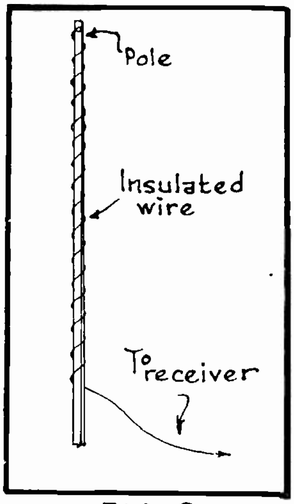

FIG. 8
The Mast Antenna

THE CIRCUIT DIAGRAM OF A THREE-TUBE PORTABLE RECEIVER IS SHOWN YOU IN FIG. 9 AND AS YOU WILL OBSERVE, A TYPE -34 TUBE IS USED IN THE R.F. STAGE, A -32 IN THE DETECTOR STAGE AND A -33 IN THE POWER OR OUTPUT STAGE. IN OTHERWORDS, ALL TUBES REQUIRE A TWO VOLT FILAMENT SUPPLY WHICH CAN BE FURNISHED BY TWO SERIES-CONNECTED DRY CELLS.

THE -34 TUBE IS AN R.F. PENTODE WITH VARIABLE-MU FEATURES AND IN THIS RESPECT CAN BE COMPARED TO THE -58 AS USED IN A.C. RECEIVERS, WITH THE EXCEPTION OF COURSE THAT IT IS DESIGNED ESPECIALLY FOR BATTERY OPER-

ATION. THE COMPLETE OPERATING CHARACTERISTICS OF THE -34 ARE AS FOLLOWS:

FILAMENT VOLTAGE = 2 VOLTS; FILAMENT CURRENT = 0.06 AMP. PLATE VOLTAGE = 135 TO 180 VOLTS; SCREEN GRID VOLTAGE = $67\frac{1}{2}$ VOLTS; GRID BIAS = -3 VOLTS MINIMUM; PLATE CURRENT = 2.8 MA. SCREEN CURRENT = 1.0 MA.; AMPLIFICATION FACTOR = 360 WITH 135 VOLTS ON PLATE AND 620 WITH 180 VOLTS ON PLATE. THIS TUBE HAS A STANDARD FOUR-PRONG BASE AND THE CONTROL GRID CONNECTION IS MADE AT THE SMALL METALLIC CAP ON TOP OF THE GLASS BULB. THE SYMBOL, OF COURSE, APPEARS IN THE CIRCUIT OF FIG. 9.

IN FIG. 10 YOU ARE SHOWN THE RECEIVER CHASSIS CORRESPONDING TO THE CIRCUIT DIAGRAM OF FIG. 9. BY REFERRING TO BOTH OF THESE ILLUSTRATIONS, YOU WILL NOTE THAT A TWO-GANG VARIABLE CONDENSER IS USED FOR TUNING PURPOSES.

THE CHASSIS BASE IS MADE BY BENDING A 13 3/4" X 4" SHEET OF #14 GAUGE ALUMINUM IN TO THE SHAPE SHOWN IN FIG. 10 SO THAT ITS TOP OR DECK AREA WILL BE $9\frac{1}{4}$" X 4". ITS END MEMBERS WILL THEN RAISE THE DECK OF THE CHASSIS $1\frac{1}{2}$" ABOVE THE TABLE AND AN EDGE OF 3/4" WIDTH CAN BE BENT AT RIGHT ANGLES TO THE END MEMBERS FOR MOUNTING PURPOSES.

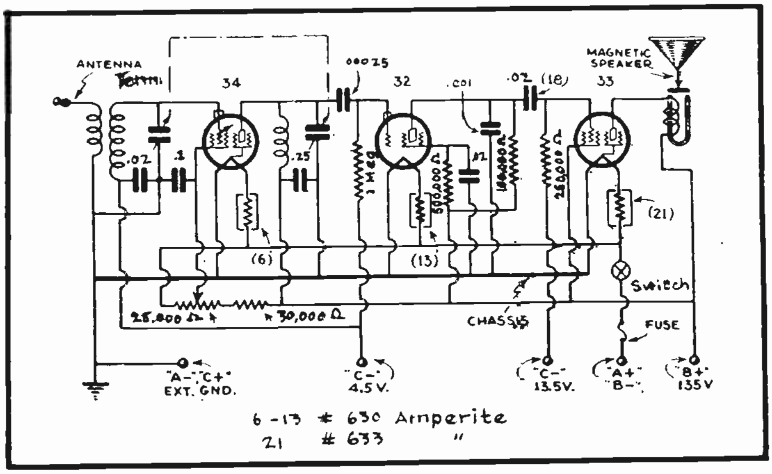

FIG. 9

Circuit Diagram of the 3-Tube Portable.

THE TUNING CONDENSER, VOLUME CONTROL, TUBES AND SPEAKER CAN THEN BE MOUNTED ON TOP OF THE CHASSIS AS SHOWN IN FIG. 10, WHILE THE BALANCE OF THE PARTS AND ALL GENERAL CIRCUIT WIRING CAN BE CONCEALED ON THE UNDERSIDE OF THE CHASSIS BASE. THUS WE HAVE A COMPACT AND NEAT APPEARING UNIT.

A RECTANGULAR CUT CAN BE MADE IN THE FRONT EDGE OF THE CHASSIS SO AS TO PERMIT THE SPEAKER CONE TO EXTEND BELOW THE CHASSIS DECK, WHILE AT THE SAME TIME BE FLUSH WITH THE FRONT EDGE OF THE CHASSIS. THE SPEAKER, OF COURSE, IS A SMALL SIZE MAGNETIC TYPE HAVING A CONE DIAMETER OF ABOUT 6".

RETURNING TO THE CIRCUIT DIAGRAM OF FIG. 9, YOU WILL OBSERVE THAT THIS PARTICULAR CIRCUIT EMPLOYS A DIFFERENT TYPE OF COUPLING BETWEEN THE R.F. AND DETECTOR STAGE THAN IS USUALLY USED. IN OTHER WORDS, INSTEAD OF USING AN R.F. TRANSFORMER FOR COUPLING PURPOSES, A WINDING IS CONNECTED IN SERIES WITH THE PLATE CIRCUIT OF THE R.F. TUBE AND ONE SECTION OF THE TUNING CONDENSER IS CONNECTED ACROSS ITS ENDS. THIS WINDING AND VARIABLE CONDENSER SECTION TOGETHER THEN CONSTITUTE A TUNING CIRCUIT. IN THIS MANNER, THE GRID AND PLATE CIRCUIT OF THE R.F. TUBE ARE BOTH TUNED.

THE PLATE CIRCUIT WINDING OF THE R.F. TUBE IN REALLITY IS NOTHING MORE THAN A DUPLICATE OF THE SECONDARY WINDING WHICH IS USED ON THE R.F.

TRANSFORMER IN THE ANTENNA STAGE OF THIS RECEIVER. THE .25 MFD. FIXED CONDENSER WHICH IS CONNECTED BETWEEN THE B+ END OF THE R.F. TUBE'S PLATE CIRCUIT WINDING AND THE GROUND END OF THE CORRESPONDING TUNING CONDENSER SECTION IS USED TO PREVENT THE PLATE CIRCUIT OF THIS TUBE FROM BECOMING GROUNDED FOR D.C., AS WOULD BE THE CASE IF THE PLATE CIRCUIT WINDING WERE CONNECTED DIRECTLY ACROSS THE TUNING CONDENSER SECTION. AT THE SAME TIME, THIS .25 MFD. CONDENSER WILL OFFER VERY LITTLE OPPOSITION TO THE FLOW OF THE HIGH FREQUENCY SIGNAL CURRENTS WHICH ONLY ARE AFFECTED BY THE TUNING CHARACTERISTICS OF THIS CIRCUIT.

IN THE PARTICULAR CIRCUIT OF FIG. 9, THE VOLUME IS CONTROLLED BY CONTROLLING THE SCREEN GRID VOLTAGE OF THE -34 TUBE THROUGH THE USE OF THE 25,000 OHM TAPERED POTENTIOMETER. THE SWITCH FOR OPENING AND CLOSING THE FILAMENT CIRCUIT IS INCORPORATED IN THIS VOLUME CONTROL SO THAT THE UNIT SERVES A DUAL PURPOSE.

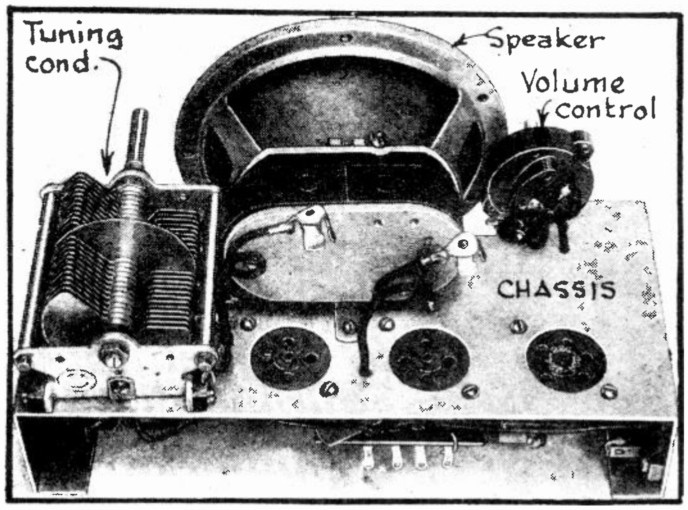

FIG. 10
A 3-Tube Receiver Chassis.

THE PURPOSE OF THE .02 MFD. CONDENSER WHICH IS CONNECTED BETWEEN THE GRID RETURN END OF THE ANTENNA STAGE'S R.F. TRANSFORMER'S SECONDARY WINDING AND THE GROUND SIDE OF THE FIRST TUNING CONDENSER SECTION IS INTENDED TO ISOLATE THE GRID RETURN CIRCUIT FROM GROUND AS FAR AS D.C. IS CONCERNED SO THAT THE -4.5 VOLT BIAS VOLTAGE CAN REACH THE CONTROL GRID OF THE R.F. TUBE. THIS SAME CONDENSER, HOWEVER, WILL PERMIT FREE PASSAGE FOR THESE HIGH SIGNAL FREQUENCIES THRU THIS SAME TUNING CIRCUIT.

THE DETECTOR TUBE IN THIS CIRCUIT IS BEING OPERATED AS A GRID CONDENSER AND LEAK DETECTOR, THE R.F. SIGNAL BEING IMPRESSED UPON THE CONTROL GRID OF THE -32 THROUGH THE .00025 MFD. FIXED CONDENSER, WHILE THE 1 MEGOHM LEAK IS USED IN THE CUSTOMARY MANNER. "AMPERITES" ARE USED TO CONTROL THE FILAMENT VOLTAGE AND CURRENT FOR THE TUBES. THE REST OF THE CIRCUIT IS CONVENTIONAL.

THE BATTERIES TO BE USED IN CONJUNCTION WITH THIS RECEIVER ARE TWO DRY CELLS FOR THE FILAMENT SUPPLY, THREE SMALL-SIZE 45 VOLT "B" BATTERIES AND THREE $4\frac{1}{2}$ VOLT "C" BATTERIES--ALL OF WHICH CAN BE HOUSED CONVENIENTLY IN THE SAME CASE WITH THE RECEIVER. A LOOP ANTENNA SHOULD NOT BE USED WITH THIS RECEIVER BUT ANY OF THE OTHER TYPES DESCRIBED IN THIS LESSON WILL BE SATISFACTORY.

A THREE-TUBE REGENERATIVE RECEIVER

A CIRCUIT DIAGRAM OF A THREE-TUBE REGENERATIVE PORTABLE RECEIVER IS SHOWN YOU IN FIG. 11, WHILE THE RECEIVER IN ITS COMPLETE FORM APPEARS IN FIG. 12.

ONE OF THE INTERESTING FEATURES OF THIS RECEIVER IS THAT IT IS

BUILT IN A SMALL MIDGET CABINET SUCH AS COMMONLY USED FOR THE SMALL A.C.-D.C. COMBINATION RECEIVERS AND THIS CABINET IS FIRMLY MOUNTED UPON A METAL BOX IN WHICH THE BATTERIES ARE CONTAINED. A STRAP OR HANDLE CAN THEN BE ATTACHED TO THE UNIT SO THAT IT CAN BE CARRIED WITH COMFORT.

BY REFERRING TO FIG. 11, YOU WILL OBSERVE THAT THE TUBES USED ARE A -32 IN THE R.F. STAGE, A -32 IN THE DETECTOR STAGE AND A -30 IN THE OUTPUT STAGE. THE CHIEF REASON FOR USING A TYPE -30 TUBE IN THE OUTPUT STAGE IN THIS PARTICULAR CASE IS THAT BY DOING SO, ONLY TWO 45 VOLT BATTERIES WILL BE REQUIRED FOR THE "B" SUPPLY AND THIS MEANS A LIGHTER RECEIVER. HOWEVER, IF A GREATER OUTPUT SHOULD BE DESIRED, THE FINAL STAGE COULD BE CHANGED TO ACCOMODATE A TYPE -33 TUBE WITHOUT VERY MUCH TROUBLE. TO OBTAIN SATISFACTORY RESULTS FROM THE -33 WOULD REQUIRE THE USE OF A 135 VOLT "B" SUPPLY AND -13.5 VOLTS OF "C" BIAS. THESE ADDITIONS, OF COURSE, WOULD INCREASE THE WEIGHT OF THE ASSEMBLY CONSIDERABLY.

A CONSTANT OR HIGH-GAIN TRANSFORMER IS USED IN THE R.F. STAGE SO THAT THE GREATEST POSSIBLE EFFICIENCY MAY BE REALIZED AT THIS POINT.

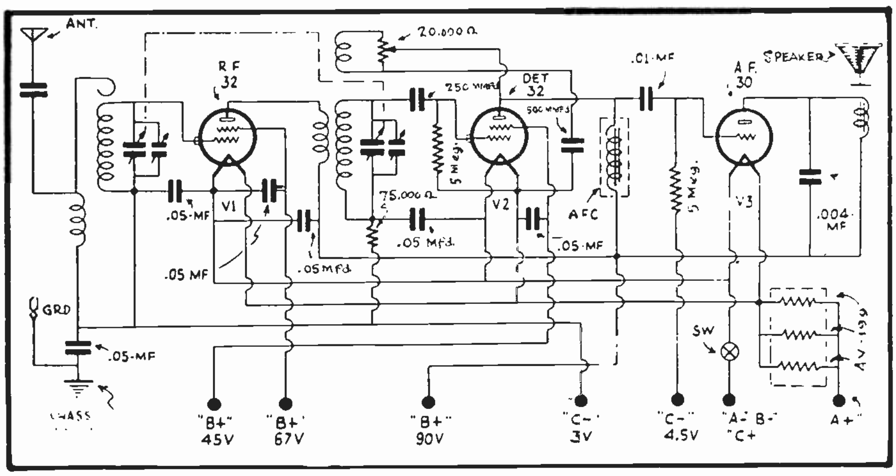

FIG. 11
A Three-Tube Regenerative Portable Receiver.

ASSUMING THE R.F. TRANSFORMERS TO BE WOUND ON TUBULAR FORMS OF 1" DIAMETER, THE REGENERATION COIL MAY CONSIST OF 50 TURNS OF #30 B&S ENAMELED WIRE. THIS COIL SHOULD BE WOUND COMPARATIVELY CLOSE TO THE GRID END OF THE 2ND R.F. TRANSFORMER'S SECONDARY WINDING.

REGENERATION IS CONTROLLED BY THE 20,000 OHM POTENTIOMETER WHICH IS CONNECTED ACROSS THE ENDS OF THE REGENERATION COIL. THE FILAMENT CIRCUIT SWITCH IS ALSO INCORPORATED WITH THIS POTENTIOMETER SO THAT THIS UNIT WILL SERVE AS A VOLUME CONTROL AS WELL AS THE "OFF-ON" SWITCH.

THIS RECEIVER IS ALSO TO BE USED WITH A MAGNETIC SPEAKER.

A SEVEN-TUBE PORTABLE SUPERHETERODYNE

ALL OF THE RECEIVER CIRCUITS, WHICH WE HAVE SO FAR CONSIDERED IN THIS LESSON, WERE OF RATHER SMALL SIZE BUT SUFFICIENTLY SENSITIVE AND SELECTIVE TO MEET THE REQUIREMENTS OF THE AVERAGE USE TO WHICH THIS TYPE OF RECEIVER WILL BE APPLIED. THERE ARE, HOWEVER, CASES WHERE A MORE POWERFUL AND SELECTIVE PORTABLE RECEIVER IS DESIRED AND IT IS FOR THIS REASON THAT THE CIRCUIT IN FIG. 13 IS PRESENTED. THIS IS A SUPERHETERODYNE RECEIVER EMPLOYING A -32 TUBE IN THE PRE-SELECTOR STAGE, A -32 FIRST DETECTOR, A -30 OSCILLATOR, A -32 I.F., A -32 SECOND DETECTOR, A -30 A.F. AND

A -33 POWER TUBE. SEVEN TUBES IN ALL AND EACH BEING OF THE 2 VOLT TYPE.

EVEN THOUGH SEVEN TUBES ARE USED, YET THE CIRCUIT DESIGN IS SIMPLE AND LENDS ITSELF WELL TOWARDS A COMPACTLY ASSEMBLED RECEIVER. IN FACT, A CIRCUIT AS THIS CAN ALSO BE USED ADVANTAGEOUSLY IN CONSTRUCTING A BATTERY OPERATED SUPERHETERODYNE FOR HOME USE IN SUCH CASES WHERE NO OTHER SOURCE OF POWER IS AVAILABLE FOR OPERATING A RECEIVER.

TUNING IS ACCOMPLISHED BY A THREE-GANG VARIABLE CONDENSER HAVING A CAPACITY RATING OF .00035 MFD. PER SECTION. THE R.F. TRANSFORMERS, THEREFORE, MAY BE OF THE STANDARD COMMERCIAL TYPED MATCHED TO THE TUNING CONDENSER CAPACITY BEING USED. SHOULD YOU WISH TO CONSTRUCT THESE TRANSFORMERS YOURSELF, THEN YOU CAN WIND THEM ON A TUBULAR BAKELITE OR CARDBOARD FORM HAVING A DIAMETER OF 1 INCH. BOTH SECONDARIES MAY THEN CONSIST OF 127 TURNS OF #32 B&S ENAMELED WIRE AND WITH ADJACENT TURNS TOUCHING EACHOTHER.

THE PRIMARY WINDING FOR THE ANTENNA STAGE R.F. TRANSFORMER MAY CONSIST OF ABOUT 50 TURNS OF #40 B&S DOUBLE SILK COVERED WIRE WITH ADJACENT TURNS WOUND SIDE BY SIDE AND A SEPARATION OF ABOUT 1/8" BETWEEN THE PRIMARY AND SECONDARY WINDINGS.

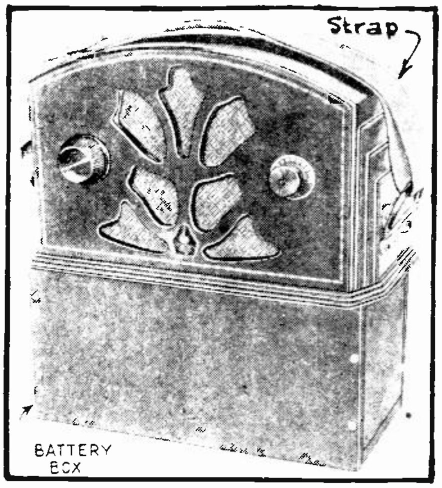

FIG. 12
The Complete Receiver.

THE PRIMARY WINDING FOR THE SECOND R.F. TRANSFORMER MAY CONSIST OF ABOUT 90 TURNS OF #40 B&S DOUBLE SILK COVERED WIRE WOUND DIRECTLY OVER THE TOP OF THE SECONDARY BUT WITH A PIECE OF EMPIRE CLOTH BETWEEN THE TWO WINDINGS.

THE OSCILLATOR COIL T3 CAN ALSO BE WOUND ON A TUBULAR FORM OF 1" DIAMETER BUT IN THIS CASE, THE TUNED WINDING SHOULD CONSIST OF 102 TURNS OF #32 B&S ENAMELED WIRE. THE TICKLER WINDING SHOULD CONSIST OF 25 TURNS OF #40 B&S WIRE WOUND OVER THE GROUND END OF THE TUNED WINDING WITH SUFFICIENT EMPIRE CLOTH OR INSULATION PAPER BETWEEN THESE TWO WINDINGS SO THAT A SEPARATION OF APPROXIMATELY 1/32" WILL EXIST BETWEEN THEM.

THE PICK UP COIL SHOULD CONSIST OF 10 TURNS OF THE SAME WIRE AS USED FOR THE TICKLER COIL AND IT CAN BE WOUND OVER THE TOP OF THE TICKLER COIL WITH EMPIRE CLOTH INSULATION BETWEEN THESE TWO COILS. THE I.F. TRANSFORMERS ARE OF THE CONVENTIONAL 175 KC. TYPE.

THE OSCILLATOR TUNING CIRCUIT IS PADDED BY THE SMALL VARIABLE CONDENSER C4 WHICH IS CONNECTED BETWEEN GROUND AND THE GROUND END OF THE OSCILLATOR'S TUNING COIL. THIS CONDENSER HAS A SCREW DRIVER ADJUSTMENT.

THE VALUES FOR THE VARIOUS PARTS USED IN THE CIRCUIT OF FIG. 13 ARE LISTED IN THE FOLLOWING TABLE.

PARTS LIST FOR FIG. 13

T1, T2--TWO RADIO FREQUENCY TRANSFORMERS AS DESCRIBED.
T3--ONE OSCILLATOR COIL AS DESCRIBED
T4, T5--TWO 175 KC INTERMEDIATE FREQUENCY TRANSFORMERS

C1,C2,C3--ONE GANG OF THREE 350 MMFD. TUNING CONDENSERS
C4--ONE 700-1,000 MMFD. ADJUSTABLE PADDING CONDENSER
C5,C7--TWO 250 MMFD. GRID CONDENSERS
C6--ONE FIXED 0.001 MFD. CONDENSER
C8,C9--TWO 0.01 MFD. FIXED CONDENSERS
C10--ONE 250 MMFD. BY-PASS CONDENSER
C11,C13--TWO ONE MICROFARAD BY-PASS CONDENSERS
C12--ONE 0.1 MFD. BY-PASS CONDENSER
P--ONE 10,000 OHM VOLUME CONTROL POTENTIOMETER
RH--ONE 6 OHM RHEOSTAT
R1--ONE 1 MEGOHM GRID LEAK
R2--ONE 10,000 OHM RESISTOR
R3--ONE 100,000 OHM RESISTOR
R4,R6,R8--THREE 2 MEGOHM GRID LEAKS
R5, R7--TWO 250,000 OHM RESISTORS
R9--ONE 1 OHM BALLAST RESISTOR

AS A MEANS OF KEEPING THE MINIMUM CAPACITY IN THE OSCILLATOR CIRCUIT DOWN TO THE PROPER VALUE, WHICH IS ESSENTIAL IF GOOD TRACKING IS TO BE OBTAINED, THE TUNED CIRCUIT IS ISOLATED FROM THE TUBE BY MEANS OF THE 10,000 OHM RESISTOR R2 AND THE .001 MFD. CONDENSER C6. THE 100,000 OHM RESISTOR R3 SERVES AS A GRID LEAK FOR THE OSCILLATOR TUBE SO AS TO PREVENT ITS BLOCKING AS WOULD OCCUR IF THE GRID OF THIS TUBE WERE COMPLETELY ISOLATED FROM THE CIRCUIT WITH RESPECT TO D.C. ON ACCOUNT OF THE USE OF CONDENSER C6. THIS GRID CONDENSER AND RESISTOR COMBINATION IN THE GRID

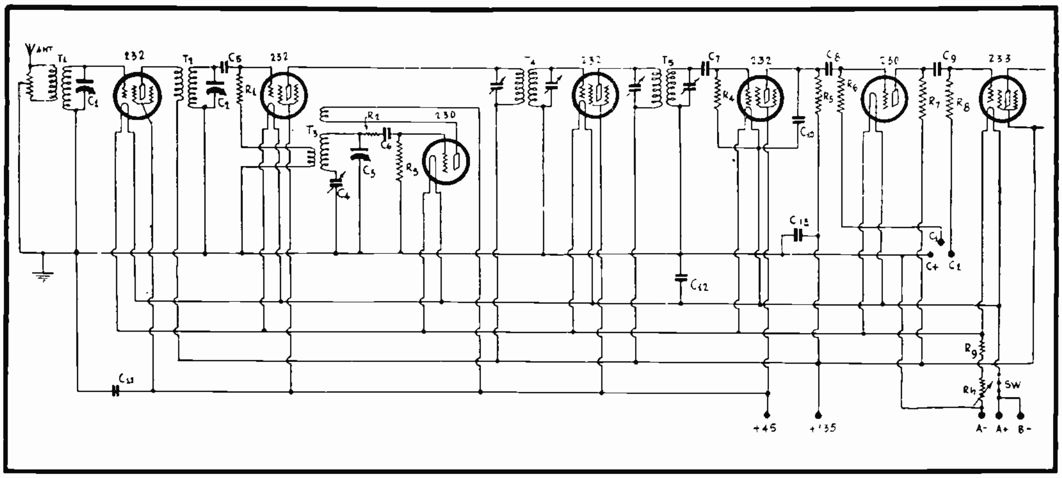

FIG. 13
Circuit Diagram of the Superheterodyne.

CIRCUIT OF THE OSCILLATOR ALSO AIDS IN KEEPING HARMONICS OUT OF THE GENERATED CURRENT.

IN THE FIRST DETECTOR OR MIXER CIRCUIT, GRID CIRCUIT MODULATION IS BEING USED. FOR THIS REASON, THE .00025 MFD. CONDENSER IS CONNECTED IN THE GRID CIRCUIT OF THIS TUBE AND THE PICK-UP COIL IS CONNECTED IN SERIES WITH THE LEAK RESISTOR R1 AND GROUND.

FOR THE "A" SUPPLY, FOUR #6 DRY CELLS SHOULD BE CONNECTED IN SERIES-PARALLEL. THE "C" BIAS CAN BE OBTAINED BY CONNECTING TWO MULTI-TAPPED 7.5 VOLT BATTERIES IN SERIES, THUS OFFERING A TOTAL VOLTAGE OF 15 VOLTS. IN-

TERMEDIATE TAPS THEN PERMIT THE GRID RETURN END OF R6 TO BE CONNECTED TO -4.5 VOLTS AT C1 SO THAT THIS BIAS VOLTAGE WILL BE AVAILABLE FOR THE -30 A.F. TUBE AND THE GRID RETURN END OF R8 CAN BE CONNECTED TO THE -13.5 VOLT TAP (C2) SO THAT THE BIAS VOLTAGE FOR THE -33 TUBE WILL BE -13.5 VOLTS. THE SPEAKER TO BE USED SHOULD BE OF THE MAGNETIC TYPE.

MODERN THREE-TUBE PORTABLE RECEIVER WITH LOOP ANTENNA

IN FIG. 14 YOU ARE SHOWN THE GENERAL APPEARANCE OF A MODERN THREE-TUBE PORTABLE RECEIVER WHICH OFFERS FOUR-TUBE PERFORMANCE AND AT THE SAME TIME IS ADAPTED TO USE WITH A LOOP ANTENNA.

THE ENTIRE RECEIVER, TOGETHER WITH THE SPEAKER AND BATTERIES, IS HOUSED IN A STANDARD PORTABLE TYPEWRITER CASE, WHILE THE LOOP ANTENNA IS BUILT INTO THE DETACHABLE COVER.

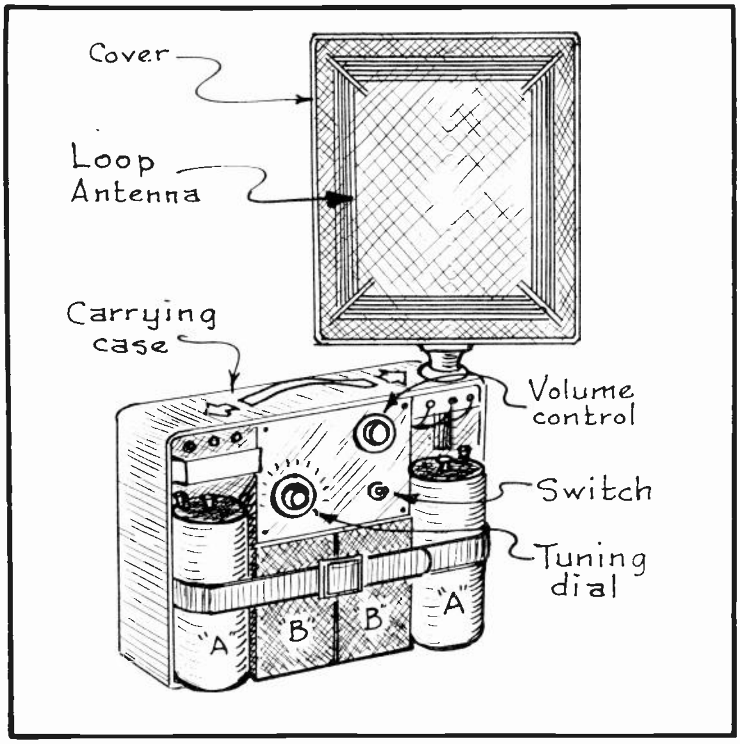

FIG. 14
Portable Receiver With Loop Antenna.

WHEN IN USE, THE COVER IS REMOVED AND MOUNTED ON ONE EDGE OF THE CASE WITH A PLUG-IN ATTACHMENT AS HERE SHOWN. THE LOOP ANTENNA CAN THUS BE ROTATED ABOUT ITS PIVOT AS DESIRED. THE OPENING OR GRILL FOR THE MAGNETIC SPEAKER IS PROVIDED ON THE OPPOSITE SIDE OF THE CASE AND FOR THIS REASON CANNOT BE SEEN IN THIS VIEW.

THE CIRCUIT DIAGRAM FOR THIS SAME RECEIVER IS PRESENTED TO YOU IN FIG. 15 AND IT EMPLOYS A -77 R.F. TUBE, A 6F7 COMBINATION R.F. AMPLIFIER AND DETECTOR AND AN -89 POWER OUTPUT TUBE. ALL OF THESE TUBES ARE OF THE HEATER-CATHODE TYPE DESIGNED PRIMARILY FOR AUTOMOTIVE USE AND REQUIRE A FILAMENT OR HEATER VOLTAGE OF 6.3 VOLTS.

THE REASON FOR USING THESE TUBES IN THIS PARTICULAR CIRCUIT IS THAT THEY ARE RIGIDLY CONSTRUCTED AND CAN THEREFORE STAND CONSIDERABLE ABUSE AS TO SHOCKS WHEN APPLIED TO PORTABLE USE. AT THE SAME TIME, THEIR CURRENT DEMAND IS NOT SO GREAT BUT THAT BATTERY LIFE WILL BE SATISFACTORY. YOU ARE ALREADY FAMILIAR WITH THE OPERATING CHARACTERISTICS OF THE 77 AND SO THERE WILL BE NO NEED FOR REPEATING THIS DATA AT THE PRESENT TIME.

THE 6F7 TUBE

THE 6F7 IS A COMBINATION PENTODE-TRIODE, WITH ALL OF THE ELEMENTS ENCLOSED IN A SINGLE GLASS BULB. THE SYMBOL FOR THIS TUBE IS SHOWN YOU IN

THE UPPER PART OF FIG. 16, WITH ALL OF THE ELEMENTS LABELED AS WELL AS NUMBERED.

IN THE LOWER PORTION OF FIG. 16, YOU ARE SHOWN THE SOCKET OR BASE PRONG ARRANGEMENT FOR THIS TUBE AS VIEWED FROM BELOW. EACH OF THE BASE-PRONG CONNECTIONS ARE NUMBERED TO CORRESPOND WITH THE NUMBERS GIVEN ON THE SYMBOL DIRECTLY ABOVE. ALTOGETHER, THERE ARE SEVEN BASE-PRONGS AND THE PENTODE CONTROL GRID CONNECTION IS MADE AT THE METTALIC CAP ON TOP OF THE TUBE'S GLASS BULB.

IN THE CIRCUIT OF FIG. 15, THE PENTODE PORTION OF THE 6F7 IS BEING USED AS AN R.F. AMPLIFIER WHILE THE TRIODE PORTION OF THE SAME TUBE FUNCTIONS AS A GRID CONDENSER AND LEAK TYPE DETECTOR. FOR THE SAKE OF CLARITY, THE PENTODE AND TRIODE SECTIONS ARE ILLUSTRATED SEPARATELY IN THE CIRCUIT OF FIG. 15 BUT IT IS TO BE UNDERSTOOD THAT THESE TWO COMPONENTS ARE ALL PART OF A SINGLE TUBE.

THE COMPLETE OPERATING CHARACTERISTICS FOR THE 6F7 ARE AS FOLLOWS: HEATER VOLTAGE = 6.3 VOLTS, HEATER CURRENT = 0.3 AMP; MAXIMUM PENTODE PLATE VOLTAGE = 250 VOLTS; MAXIMUM TRIODE PLATE VOLTAGE = 100: BIAS VOL-

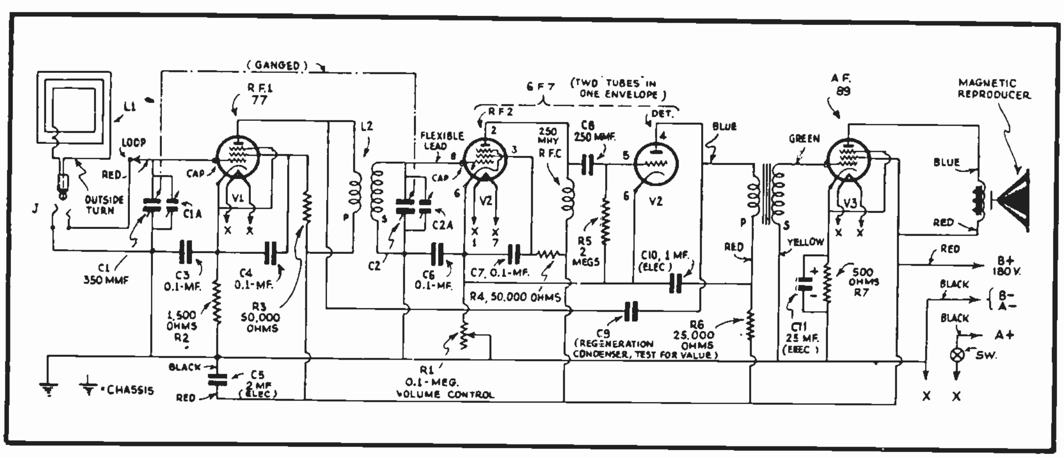

FIG. 15

Circuit Diagram of the Three-Tube Portable.

TAGE FOR PENTODE AND TRIODE = -3 VOLTS; SCREEN VOLTS = 100 VOLTS; SCREEN CURRENT = 1.5 MA.; TRIODE PLATE CURRENT = 3.5 MA.; PENTODE PLATE CURRENT = 6.5 MA.; PENTODE AMPLIFICATION FACTOR = 900; TRIODE AMPLIFICATION FACTOR = 8.

THE 89 TUBE

THE 89 IS A TRIPLE GRID POWER AMPLIFIER CONSISTING OF A HEATER, CATHODE, CONTROL GRID, SCREEN GRID, SUPPRESSOR GRID AND A PLATE. IT HAS A SIX PRONG BASE TO WHICH ALL OF THE CONNECTIONS ARE MADE AND ITS OPERATING CHARACTERISTICS WHEN USED AS A PENTODE ARE AS FOLLOWS: HEATER VOLTAGE = 6.3 VOLTS; HEATER CURRENT = 0.4 AMP.

PLATE VOLTAGE	SCREEN VOLTAGE	BIAS	PLATE CURRENT	SCREEN CURRENT	AMPLIF. FACTOR	LOAD	OUTPUT POWER
100	100	-10	9.5 MA.	1.6 MA.	125	10700 OHM.	0.33 WATTS
180	180	-18	20 MA.	3 MA.	125	8000 OHM.	1.5 WATTS
250	250	-25	32 MA.	5.5 MA.	125	6750 OHM.	3.4 WATTS

THE LOOP ANTENNA

THE LOOP ANTENNA FOR THE RECEIVER SHOWN IN FIGS. 14 AND 15 CONSISTS OF 25 TURNS OF #24 B&S DOUBLE COTTON COVERED WIRE WOUND INTO THE COVER AS SHOWN IN FIG. 14. THE FIRST TURN OF WIRE SHOULD BE WOUND INTO THE SHAPE OF A RECTANGLE MEASURING $5\frac{1}{2}$" X $10\frac{1}{2}$" AND THE NEXT TURN WOUND BESIDE THIS FIRST TURN ETC., UNTIL THE LOOP IS FINISHED. THE RESULTING LOOP ANTENNA WILL THEN BE A FLAT, RECTANGULAR-SHAPED UNIT.

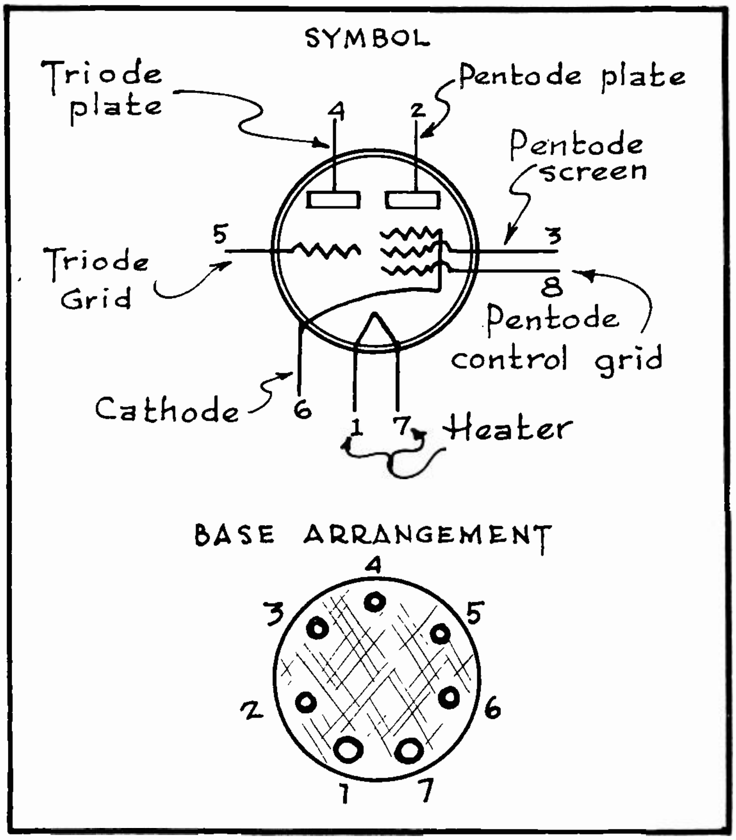

FIG. 16

Symbol and Base Arrangement of the 6F7 Tube.

THE SPEAKER IS OF THE MAGNETIC TYPE. THE "A" SUPPLY CONSISTS OF FOUR SERIES-CONNECTED #6 DRY CELLS; THE "B" SUPPLY IS FURNISHED BY FOUR SMALL "B" BATTERIES AND THE "C" BIAS VOLTAGES ARE OBTAINED THROUGH THE USE OF THE VARIOUS CATHODE CIRCUIT RESISTORS.

IN THE FOLLOWING LESSON, YOU ARE GOING TO STUDY ABOUT A STILL DIFFERENT TYPE OF RECEIVER CIRCUIT DESIGN, NAMELY THE D.C. TYPE OF RECEIVERS, OR THOSE WHICH ARE TO BE OPERATED FROM 110 AND 220 VOLT D.C. CIRCUITS. WITHOUT A DOUBT, YOU ARE GOING TO FIND THIS NEXT LESSON ESPECIALLY INTERESTING IN THAT MANY NEW "HOOK-UPS" WILL BE BROUGHT TO YOUR ATTENTION, AS WELL AS THE TECHNICAL EXPLANATIONS CONCERNING THEIR OPERATION.

"EXAMINATION QUESTIONS"
LESSON #27

1. - WHAT ARE SOME OF THE MOST IMPORTANT THINGS TO CONSIDER IN CONSTRUCTING RECEIVERS FOR PORTABLE USE?

2. - DESCRIBE HOW A LOOP ANTENNA MAY BE USED TO PROVIDE REGENERATION AS WELL AS TO "PICK-UP" THE SIGNAL.

3. - DESCRIBE THE TYPE -34 TUBE AND SPECIFY ITS OPERATING CHARACTERISTICS.

4. - EXPLAIN HOW YOU WOULD FURNISH A PORTABLE RECEIVER WITH A SUITABLE ANTENNA IN THE EVENT THAT NO LOOP ANTENNA IS AVAILABLE.

5. - HOW MAY A SATISFACTORY GROUND CONNECTION BE MADE FOR USE WITH A PORTABLE RECEIVER?

6. - DESCRIBE THE CONSTRUCTIONAL FEATURES OF THE 6F7 TUBE.

7. - WHAT ARE THE OPERATING CHARACTERISTICS OF THE 6F7 TUBE?

8. - WHAT ARE THE OPERATING CHARACTERISTICS OF THE 89 TUBE?

9. - HOW IS THE VOLUME CONTROLLED IN THE RECEIVER WHOSE CIRCUIT IS ILLUSTRATED IN FIG. 11?

10. - DRAW A CIRCUIT DIAGRAM OF A THREE-TUBE PORTABLE RECEIVER EMPLOYING A TYPE -34 R.F. TUBE., A -32 DETECTOR AND A -33 POWER TUBE.

You *Can* Succeed—but *Will* You

It is not enough to have ability to succeed. Multitudes of men and women who fail or who are only half successes have that. It is not so much a question of whether you can as of will you. Do you know that if you will you can be proprietor even on a salary; that you can, in fact, practically fix your salary, make your place in the firm for which you work? You can determine your destiny, whether you will be a perpetual clerk, whether you will spend all your years behind the counter, selling goods, or whether you will grow beyond these. It is just a question of whether you are made of the stuff that wins; whether you are willing to pay the price for leadership, whether you are willing to take the pains to develop executive ability, initiative and all of your other faculties which enter into mastership; or whether you want to satisfy your lower nature and let things slide and take things easier.

It depends upon how much you think of your comforts, as you call them, the easy chair, the pleasures that demoralize, whether you are willing to sacrifice those things that conflict with your aims and desires, your great life purpose. There is no other satisfaction quite like that which comes from the consciousness of growth, of enlargement, of life expansion, the reaching out of one's mental faculties, the stretching of them upward toward something higher, better and grander.

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NATIONAL SCHOOLS

Established 1905

Los Angeles, California

LESSON NO. 28

• D.C. RECEIVERS •

So far, all of your studies have applied to battery and A.C. operated receivers, There are, however, localities where the power company furnishes a 110 or 220 volt D.C. (direct current) supply and receivers which are designed especially for operation from this source of energy are generally classified as D.C. RECEIVERS so as to differentiate them from both the battery and A.C. types.

Although the D.C. receivers are not quite so popular as the battery and A.C. types, yet there are quite a number of them in use and so that your training may be complete, it is important that you acquaint yourself with this type also.

You will find this lesson to be devoted entirely to the circuits of D.C. receivers and their associated operating principles. As you advance thru this study, you will learn many new things in that special provisions must be made in a receiver's circuit so as to adapt it to D.C. operation. It is therefore of utmost importance that you give this lesson your fullest attention.

For the sake of simplicity, as well as to offer you complete details regarding the advancement made in the design of D.C. receivers, we shall start with the older circuits first and then gradually work our way through the more modern designs.

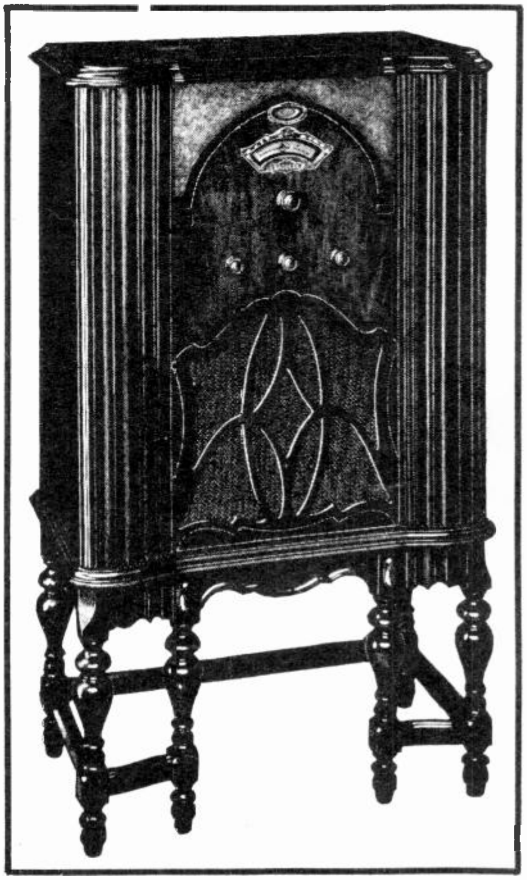


FIG. 1
A Modern D.C. Receiver.

SERIES FILAMENT CONNECTIONS

Due to the low filament voltage

REQUIRED BY EACH TUBE OF THE RECEIVER AND THE HIGH D.C. VOLTAGE AVAILABLE FOR THE FILAMENT SUPPLY, IT IS THE COMMON PRACTICE IN THE DESIGN OF D.C. RECEIVERS TO CONNECT THE VARICUS TUBE FILAMENTS IN SERIES RATHER THAN IN PARALLEL. THROUGH THIS MEANS, LESS FILAMENT CURRENT WILL BE DRAWN FROM THE CIRCUIT WHILE AT THE SAME TIME, ADVANTAGE CAN BE TAKEN OF THE VOLTAGE DROP DEVELOPED ACROSS EACH TUBE FILAMENT IN REDUCING THE EFFECTIVE VOLTAGE. THIS WILL ALL BECOME CLEARER TO YOU AS WE PROCEED WITH OUR INVESTIGATION.

IN FIG. 2 FOR INSTANCE, YOU WILL SEE A CIRCUIT DIAGRAM, SHOWING YOU HOW A WELL KNOWN MANUFACTURER OF D.C. RECEIVERS WENT ABOUT THE JOB OF CONNECTING TOGETHER THE FILAMENTS OF AN 8 TUBE D.C. RECEIVER. THE THREE R.F., DETECTOR, AND FIRST AND SECOND A.F. TUBES ARE ALL OF THE -01 A TYPE IN THIS CASE, WHILE THE TWO PUSH-PULL POWER TUBES ARE OF THE -71 A TYPE.

NOTICE THAT THE FILAMENTS OF ALL OF THESE TUBES ARE CONNECTED IN SERIES AND THEREFORE, THE FLOW OF FILAMENT CURRENT WILL BE THE SAME IN ALL PARTS OF THIS CIRCUIT. THE -01 A AND -71 A TUBES ALL HAVE A FILAMENT RESISTANCE OF 20 OHMS AND .25 AMPERE MUST FLOW THROUGH THEIR FILAMENTS, IN ORDER TO ENABLE THEM TO OPERATE AT MAXIMUM EFFICIENCY.

DUE TO THIS SERIES FILAMENT ARRANGEMENT, IT IS NECESSARY THAT THE

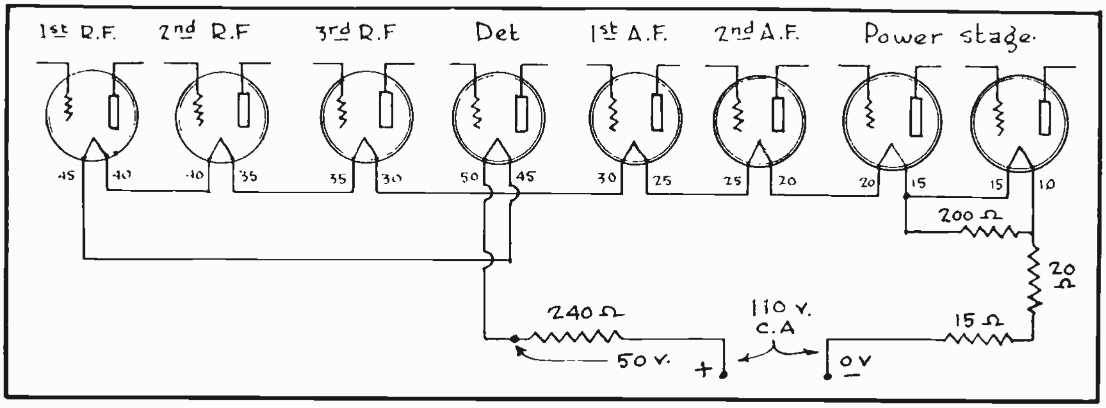


FIG. 2
Filament Connections In An Eight-Tube D.C. Receiver.

VOLTAGE WHICH IS APPLIED ACROSS THE ENTIRE FILAMENT CIRCUIT, BE EQUAL TO THE SUM OF THE VOLTAGE DROPS ACROSS THE FILAMENTS OF ALL THE TUBES AND FOR THIS REASON, THE FILAMENT VOLTAGE AS APPLIED TO THE CIRCUIT MUST BE QUITE HIGH. FOR THE SAKE OF SIMPLICITY, LET US ASSUME THAT THIS APPLIED FILAMENT VOLTAGE IS 50 VOLTS.

SINCE THIS IS A D.C. CIRCUIT, WE WILL START AT THE PLUS END AND GRADUALLY TRACE OUT THE CIRCUIT. THE PLUS END OF THIS CIRCUIT FIRST LEADS US UP TO THE FILAMENT OF THE DETECTOR TUBE AND WITH $\frac{1}{4}$ AMPERE FLOWING THRU THE FILAMENT OF THIS TUBE, THERE WILL BE A DROP OF 5 VOLTS ACROSS IT. ($E = I X R = .25$ AMP X 20 OHMS = 5 VOLTS). THEREFORE, ONLY 45 OF THE 50 VOLTS WILL REMAIN AT THE NEGATIVE OR OUTPUT END OF THE DETECTOR'S FILAMENT.

THIS SAME $\frac{1}{4}$ AMPERE CONTINUES FLOWING THROUGHOUT THE ENTIRE FILAMENT CIRCUIT AND AS IT FLOWS THROUGH THE 1ST R.F. TUBE, ANOTHER 5 VOLTS DROP OCCURS HERE, SO THAT ONLY 40 OUT OF THE ORIGINAL 50 VOLTS REMAIN AND SO

THE FLOW OF CURRENT CONTINUES, DROPPING 5 VOLTS AT EACH TUBE UNTIL AT THE OUTPUT OR NEGATIVE END OF THE LAST POWER TUBE, ONLY 10 VOLTS REMAIN AND BY THE TIME THE CURRENT HAS FLOWED THROUGH THE FOLLOWING RESISTORS, THE VOLTAGE DROPS TO ZERO AND HERE WE HAVE THE NEGATIVE END OF THE FILAMENT CIRCUIT. IT IS IMPORTANT TO NOTE THAT THE CURRENT FLOW THROUGH EACH OF THE TUBES IS ¼ AMPERE AND 5 VOLTS IS IMPRESSED ACROSS THE FILAMENT AT EACH OF THE TUBE SOCKETS, THE SAME AS IN A BATTERY OPERATED RECEIVER, USING THE SAME TYPE OF TUBES. FOR YOUR CONVENIENCE, WE ARE INDICATING THESE SUCCESSIVE DROPS IN VOLTAGE ON THE NEGATIVE SIDE OF EACH OF THE FILAMENTS.

PLATE VOLTAGE DISTRIBUTION IN D.C. RECEIVERS

NOW IN FIG. 3, WE HAVE ADDED THE PLATE CIRCUITS TO THE SAME SYSTEM AND THE ENTIRE IMPRESSED "B" VOLTAGE IS 100 VOLTS.

NEGLECTING THE VOLT DROP ACROSS THE PRIMARIES OF THE VARIOUS TRANSFORMERS, IT CAN BE SEEN THAT 100 VOLTS WILL REACH ALL OF THE PLATES WITH THE EXCEPTION OF THE DETECTOR BECAUSE HERE A SEPARATE RESISTOR IS INSERTED, IN ORDER TO REDUCE THE PLATE VOLTAGE FOR THIS TUBE.

CARRYING OUR INVESTIGATION STILL FARTHER, HOWEVER, WE FIND THAT 100 VOLTS IS NOT THE ACTUAL EFFECTIVE PLATE VOLTAGE OF THE BALANCE OF THE TUBES BECAUSE NONE OF THE TUBE'S FILAMENTS ARE AT A B– POTENTIAL. THE

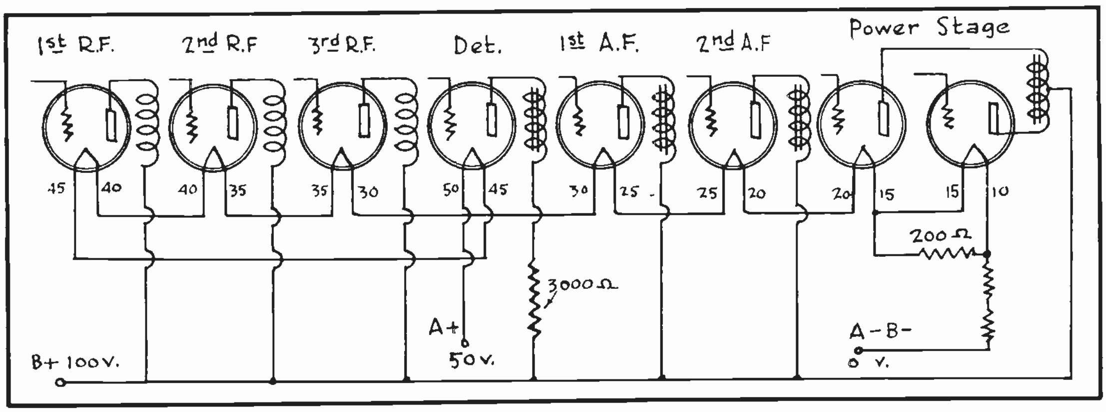


FIG. 3
Adding the Plate Circuits To the D.C. Receiver.

NEGATIVE SIDE OF THE FIRST R.F. TUBE'S FILAMENT, FOR EXAMPLE, IS 40 VOLTS POSITIVE AND SINCE THE EFFECT PLATE VOLTAGE AT A THREE-ELEMENT TUBE IS EQUAL TO THE VOLTAGE APPLIED ACROSS THE PLATE AND NEGATIVE SIDE OF THE TUBE'S FILAMENT, IT IS APPARENT THAT THE EFFECTIVE PLATE VOLTAGE AT THE 1ST R.F. TUBE IS ONLY 100 VOLTS MINUS 40 VOLTS OR 60 VOLTS. AT THE SECOND R.F. TUBE, IT IS ONLY 100 VOLTS MINUS 35 VOLTS OR 65 VOLTS ETC. AND FINALLY WHEN WE COME TO THE POWER TUBES, ONE OF THESE HAS A PLATE VOLTAGE OF 100 MINUS 15 OR 85 VOLTS AND THE OTHER 100 MINUS 10 OR 90 VOLTS.

NOTICE HOW THE PLATE VOLTAGE KEEPS INCREASING AS WE APPROACH THE POWER TUBES AND THAT THE POWER TUBES HAVE THE HIGHEST EFFECTIVE PLATE VOLTAGE WHILE THE FIRST R.F. TUBE HAS THE LOWEST. THIS CONDITION IS OF COURSE BROUGHT ABOUT BY THE FACT THAT THE VOLTAGE ON THE NEGATIVE SIDE OF THE TUBE FILAMENTS GRADUALLY DECREASES AS THE POWER TUBES ARE APPROACHED.

PLATE CURRENT DISTRIBUTION IN THE D.C. RECEIVER

PROBABLY YOU ARE WONDERING WHY THE 200 OHM RESISTOR IS CONNECTED

ACROSS THE FILAMENT OF THE LAST POWER TUBE, SO THIS WILL BE EXPLAINED NEXT. TO BEGIN WITH, OBSERVE THAT THE A- AND B- ENDS OF THE CIRCUIT ARE ONE AND THE SAME THING AND CONSEQUENTLY, BOTH FILAMENT AND PLATE CURRENT WILL FLOW THROUGH THIS SIDE OF THE CIRCUIT. LET US CONTINUE AND SEE WHAT EFFECT THAT THIS IS GOING TO HAVE.

STARTING WITH THE FIRST R.F. TUBE, WE FIND THAT ITS PLATE CURRENT, IN ORDER TO GET BACK TO B-, MUST FLOW THROUGH THE FILAMENTS OF THE REST OF THE TUBES SO THAT THE FILAMENT OF THE SECOND R.F. TUBE, FOR EXAMPLE, WILL NOT ONLY CARRY ITS NORMAL CURRENT BUT ALSO THE PLATE CURRENT OF THE 1ST R.F. TUBE AS WELL. THE FILAMENT OF THE 3RD R.F. TUBE IN TURN MUST CARRY THE PLATE CURRENT OF BOTH THE 1ST AND 2ND R.F. TUBES ETC.

FINALLY, WHEN WE GET TO THE AUDIO END OF THE RECEIVER, THE FILAMENTS OF THESE TUBES WILL HAVE TO CARRY THE COMBINED PLATE CURRENT OF ALL OF THE PRECEDING TUBES, IN ADDITION TO THE NORMAL FILAMENT CURRENT. SINCE THE -01 A TUBES DRAW COMPARATIVELY LITTLE PLATE CURRENT, THIS ACCUM-

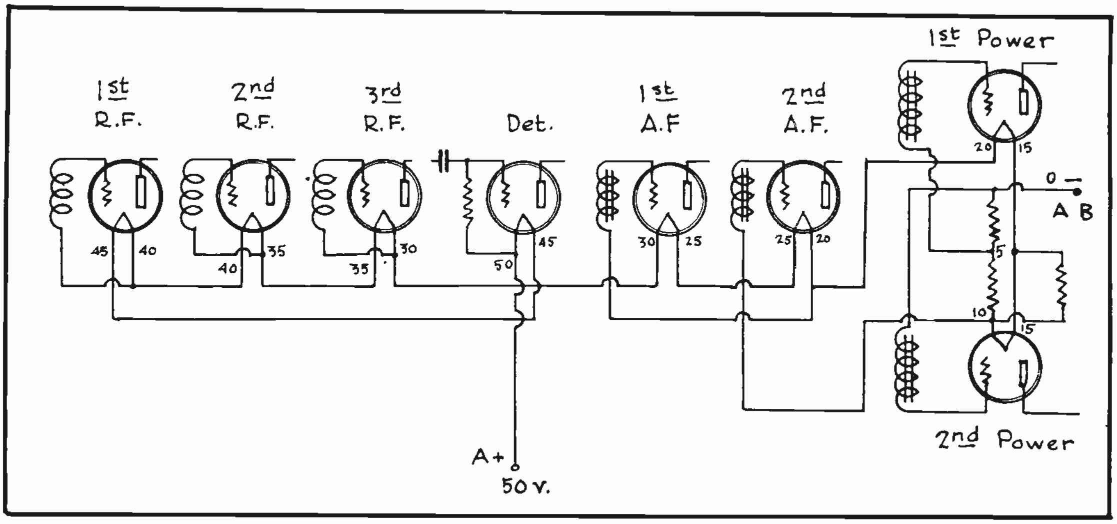


FIG. 4
Obtaining the Grid Bias In a D.C. Receiver.

MULATIVE ACTION WILL HAVE NO ILL EFFECT UPON THE FOLLOWING TUBES. THE 1ST POWER TUBE, HOWEVER, DRAWS CONSIDERABLE MORE PLATE CURRENT THAN THE -01 A'S AND FOR THIS REASON THE ADDITIONAL PLATE CURRENT FLOW THROUGH THE FILAMENT OF THE FINAL POWER TUBE WOULD BE CONSIDERABLE AND THEREFORE, A 200 OHM RESISTOR IS SHUNTED ACROSS THE FILAMENT OF THIS TUBE. IN THIS WAY, THE CURRENT REACHING THIS POINT CAN DIVIDE, PART OF IT FLOWING THROUGH THE TUBE'S FILAMENT AND PART THROUGH THE 200 OHM RESISTOR AND CONSEQUENTLY, THE FILAMENT WON'T HAVE TO CARRY THE ENTIRE LOAD.

PRODUCING GRID BIAS IN THE D.C. RECEIVER

OUR NEXT STEP IS TO SEE HOW THE GRID BIAS IS OBTAINED WHEN CONNECTING THE TUBES IN SERIES AND THIS IS ILLUSTRATED FOR YOU IN FIG.4. NOTICE THAT THE GRID RETURNS FOR THE 1ST, 2ND AND 3RD R.F. TUBES ARE ALL CONNECTED TO THE NEGATIVE SIDE OF THEIR OWN FILAMENT AND THEREFORE, THESE THREE TUBES WILL BE OPERATING WITH NO GRID BIAS AT ALL. THAT IS, THEY ARE OPERATING AT ZERO GRID BIAS. THE GRID RETURN OF THE DETECTOR TUBE IS connected to the positive side of this tube's filament, which you will remember as being a normal connection for grid detection.

Now the grid return of the 1st Audio tube, on the other hand, is not connected directly to this tube's own filament but instead of this, it is connected to the negative side of the 2nd audio tube's filament, which is at a potential of 20 volts. Therefore, the grid bias on the first audio tube is equal to 25 volts minus 20 volts or 5 volts negative.

The grid return of the 2nd A.F. tube is connected to the negative side of the final power tube, which is at a potential of 10 volts and consequently, the grid bias on the 2nd A.F. tube is 20 minus 10 or 10 volts. The two power tubes obtain their bias voltage from the drop across the resistor in the A- end of the filament circuit.

The 1st power tube, for instance, has its grid return connected between the two resistors at a point of 5 volts potential. Then since the negative side of this power tube's filament is at 15 volts potential, it is obvious that the grid bias for the 1st power tube is 15 minus 5 or 10 volts. The grid return of the 2nd power tube is connected to the end of the last resistor which is at zero voltage and since the negative side of this tube's filament is at 10 volts, the grid bias of the 2nd power tube is also 10 volts negative.

A COMPLETE D.C. RECEIVER CIRCUIT

Now that you are familiar with the practice of distributing the filament, plate and bias voltages in D.C. receiver circuits employing triodes, let us next look at such a circuit in its entirety. In Fig. 5 for instance, type -01 A tubes are used in the three R.F. stages, as well as in the detector and 1st A.F. stages, while four parallel connected -71 A's are used in the output or power stage.

Practically all receivers, which are intended to be operated from a 110 volt D.C. supply, are generally designed to handle an input or applied voltage of about 120 volts so that if the line voltage is slightly above its rated value of 110 volts, there will be no danger of burning out the tube filaments. Another point to remember is that the negative side of all commercial D.C. circuits is grounded by the power company.

Starting at the line plug for our receiver in Fig. 5, we find first an "off-on switch" and a 10 ohm resistor shunted with a "high-low switch". The "off-on" switch, of course, offers a means for connecting or disconnecting the receiver circuits from the power supply. By placing the "high-low" switch in the open position, the 10 ohm resistor will be inserted in the input circuit and thus reduces the applied voltage somewhat in the event that the line voltage slightly exceeds a value of 110 volts. Should the line voltage be 110 volts or slightly less, then this switch can be closed and in this way short circuit the 10 ohm resistor, thereby causing it to become ineffective.

The D.C. supply, as furnished by the power companies, has a certain amount of "ripple" in it and so a filter system, consisting of a choke and two condensers, is used so as to make the current more smooth for the receiver's use.

Following the filter system, we find a 240 and 23 ohm resistor connected in the positive side of the circuit so as to reduce the line voltage sufficiently for all of the filaments with the exception of those for the -71 A tubes. The dial lamp is connected across the ends of the 23 ohm resistor, utilizing the voltage drop which is produced by the current flow through this resistor in order to operate its filament.

Continuing from this point, we find the filaments of all the -01 A tubes to be connected in series and finally connected to the negative side of the line through the 12 ohm resistor.

The filaments of the four -71 A tubes, on the other hand, are connected in parallel and are fed from the positive side of the line from a point preceding the filter choke and the necessary reduction in voltage is obtained by the 90 ohm resistor. This same filament circuit is also connected to the negative side of the circuit through the 12 ohm resistor.

The plate circuits of all the tubes, with the exception of the de-

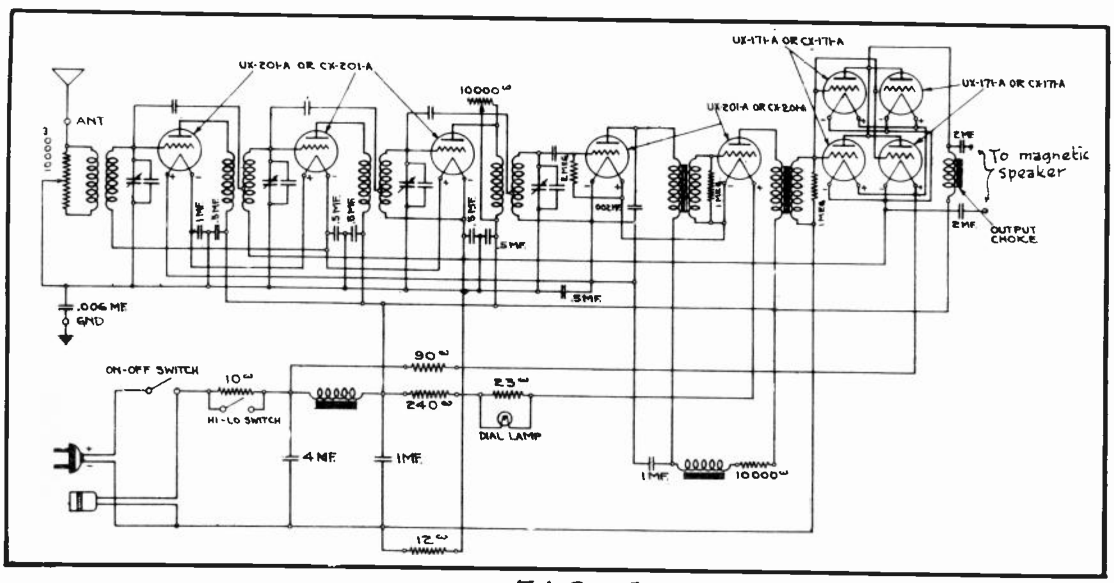


FIG. 5

A Nine-Tube D.C. Receiver.

tector, are connected directly to the output end of the filter choke. The plate circuit of the detector tube, however, has a 10,000 ohm resistor and another filter choke connected in series with it and the common B+ connection of the other tubes. This resistor aids in reducing the plate voltage of the detector tube to about 45 volts which is suitable for grid condenser and leak type detection, while the additional filter choke and the 1 mfd. condenser serve to offer further filtering for the detector tube's plate supply and thereby keep the hum level down to as low a value as possible.

The grid return circuit of the first R.F. tube is connected to the negative side of the second R.F. tube's filament and consequently the effective bias voltage for the first R.F. tube will be -5 volts. The grid return circuit of the second R.F. tube is connected to the

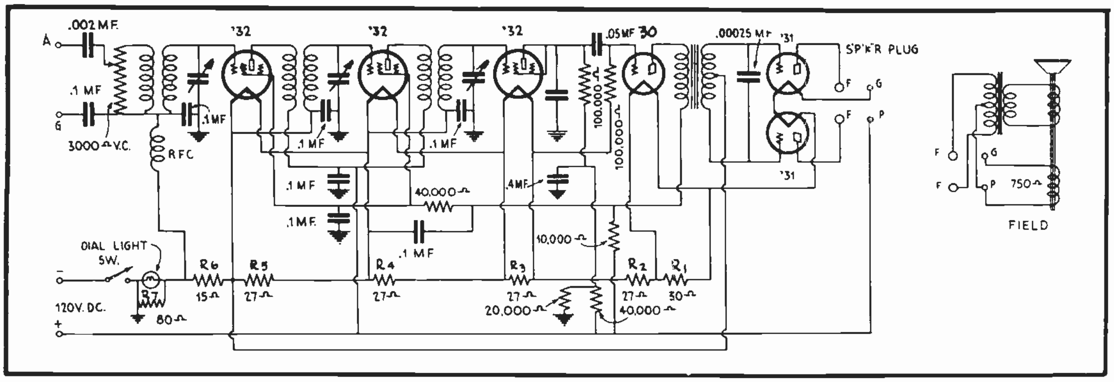
NEGATIVE SIDE OF THE THIRD R.F. TUBE'S FILAMENT AND SO THE EFFECTIVE BIAS VOLTAGE FOR THE SECOND R.F. TUBE WILL BE -5 VOLTS.

THE GRID RETURN CIRCUIT OF THE THIRD R.F. TUBE IS CONNECTED TO THE NEGATIVE SIDE OF THIS SAME TUBE'S FILAMENT AND SO NO BIAS VOLTAGE WILL BE EFFECTIVE UPON THIS TUBE. THE GRID OF THE DETECTOR TUBE IS CONNECTED TO THE POSITIVE SIDE OF THIS TUBE'S FILAMENT AS IS CUSTOMARY FOR THIS FORM OF DETECTION.

THE FIRST A.F. TUBE IN THIS PARTICULAR CIRCUIT ALSO OPERATES AT ZERO BIAS SINCE ITS GRID RETURN CIRCUIT IS CONNECTED TO THE NEGATIVE SIDE OF THIS SAME TUBE'S FILAMENT.

THE GRID RETURN CIRCUIT OF ALL THE -71A TUBES IS CONNECTED TO THE NEGATIVE END OF THE 12 OHM RESISTOR, WHILE THE NEGATIVE SIDE OF THE FILAMENT CIRCUIT FOR THESE SAME TUBES IS CONNECTED TO THE POSITIVE END OF THE 12 OHM RESISTOR. FOR THIS REASON THE VOLTAGE-DROP DEVELOPED ACROSS THIS RESISTOR WILL BE UTILIZED AS BIAS VOLTAGE FOR THE POWER TUBES.

ALTHOUGH IT IS TRUE THAT NOT ALL OF THE TUBE VOLTAGES IN THIS D.C. RECEIVER CIRCUIT ARE EXACTLY AS DESIRED FOR BEST PERFORMANCE, YET THEY ARE AS NEARLY CORRECT AS CONDITIONS PERMIT. IN FACT, IN THESE D.C. RECEIVERS ONE IS AT A DISADVANTAGE IN THAT ONLY A LIMITED SUPPLY VOLTAGE IS



F I G. 6
The Six-Tube Screen Grid D.C. Receiver.

AVAILABLE AND CANNOT BE MADE AS FLEXIBLE WITH RESPECT TO VOLTAGE DISTRIBUTION AS IS THE CASE IN A.C. RECEIVERS WHERE POWER TRANSFORMERS ARE EMPLOYED.

A SIX-TUBE SCREEN GRID D.C. RECEIVER

IN FIG. 6 YOU ARE SHOWN THE CIRCUIT DIAGRAM OF A MORE MODERN D.C. RECEIVER IN WHICH TYPE -32 TUBES ARE USED IN THE R.F. AND DETECTOR STAGES, A TYPE -30 TUBE IN THE FIRST A.F. AND A PAIR OF -31'S IN THE POWER STAGE. IN OTHER WORDS, "2-VOLT TUBES" THROUGHOUT.

SINCE THIS FILAMENT CIRCUIT IS SOMEWHAT COMPLEX, WE ARE IN FIG. 7 ILLUSTRATING IT FOR YOU AGAIN IN A MORE DETAILED FORM.

STARTING AT THE POSITIVE SIDE OF THE D.C. INPUT AND TRACING THE

FILAMENT CIRCUIT IN FIG. 7, THE FILAMENT CURRENT FIRST FLOWS THROUGH THE 750 OHM SPEAKER FIELD COIL, WHICH AT THE SAME TIME SERVES AS A FILTER CHOKE. THIS CURRENT FLOW THEN CONTINUES THROUGH THE TWO SERIES CONNECTED FILAMENTS OF THE -31 TUBES TO ONE END OF THE 30 OHM RESISTOR, R1. FROM HERE, IT CONTINUES ITS JOURNEY TO THE NEGATIVE SIDE OF THE CIRCUIT BY FLOWING THROUGH THE FOLLOWING RESISTORS WHICH ARE ALL CONNECTED IN SERIES

THE 27 OHM RESISTOR R2 DROPS THE VOLTAGE BY THE CORRECT AMOUNT FOR THE BALANCE OF THE CIRCUIT AND THE VOLTAGE DROP ACROSS THE RESISTORS R1, R3, R4, AND R5, CAUSED BY THE CURRENT FLOW THROUGH THEM, IS APPLIED ACROSS THE TUBE FILAMENTS WHICH ARE RESPECTIVELY CONNECTED ACROSS THEM. THE DIAL LIGHT UTILIZES THE VOLTAGE DROP ACROSS THE 80 OHM RESISTOR.

BY USING THIS SYSTEM OF VOLTAGE DISTRIBUTION, NONE OF THE -30 OR -32 FILAMENTS WILL BE REQUIRED TO CARRY THE FILAMENT CURRENT OF ANY OTHER TUBES BUT ITS OWN. THE RESISTORS HANDLE THE GREATER PORTION OF THE TOTAL CURRENT.

RETURNING TO FIG. 6 AGAIN, YOU WILL OBSERVE THAT THE "B" SUPPLY

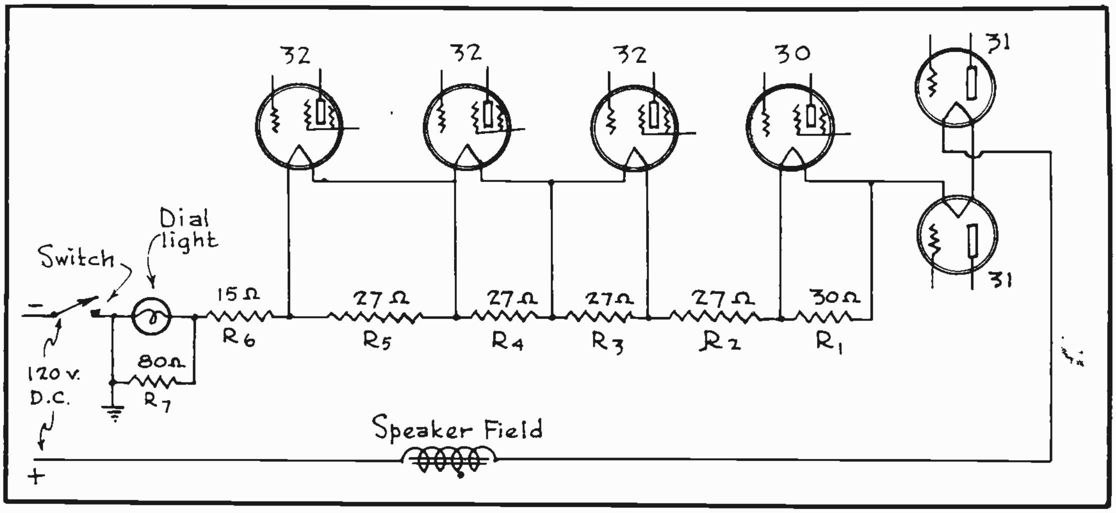


FIG. 7
The Filament Circuit.

FOR THE POWER TUBES IS TAKEN DIRECTLY FROM THE "HIGH SIDE" OF THE SPEAKER FIELD AND DELIVERED TO THE PLATES OF THESE TUBES THROUGH THE PRIMARY WINDING OF THE OUTPUT PUSH-PULL TRANSFORMER.

THE PLATE CIRCUITS OF BOTH THE R.F. TUBES ARE CONNECTED DIRECTLY TO THE POSITIVE SIDE OF THE D.C. CIRCUIT, WHILE THE PLATE CIRCUIT OF THE -30 A.F. TUBE IS CONNECTED TO THE POSITIVE SIDE OF THE LINE THROUGH A 10,000 OHM RESISTOR. THIS WILL BRING THE PLATE VOLTAGE FOR THE -30 TUBE DOWN TO A VALUE OF ABOUT 90 VOLTS.

THE SCREEN GRIDS OF THE TWO R.F. TUBES ARE ALSO CONNECTED TO THE 10,000 OHM RESISTOR BUT WITH AN ADDITIONAL 40,000 OHM RESISTOR IN SERIES SO THAT THE SCREEN GRID VOLTAGE WILL BE REDUCED.

THE PLATE CIRCUIT OF THE DETECTOR TUBE, IS ALSO CONNECTED TO THE POSITIVE LINE BUT WITH A 40,000 OHM RESISTOR IN SERIES, IN ADDITION TO

THE 100,000 OHM LOAD RESISTOR.

THE GRID RETURN CIRCUIT OF THE FIRST R.F. TUBE IS CONNECTED TO THE NEGATIVE END OF THE 15 OHM RESISTOR, WHILE THE FILAMENT OF THIS SAME TUBE IS CONNECTED TO THE POSITIVE END OF THIS RESISTOR, THEREFORE, THE VOLTAGE DROP ACROSS THIS RESISTOR WILL BE APPLIED TO THE FIRST R.F. TUBE AS A NEGATIVE BIAS.

THE GRID RETURN CIRCUITS OF THE SECOND R.F. AND DETECTOR STAGE ARE CONNECTED TO THE NEGATIVE SIDE OF THE PRECEDING TUBE'S FILAMENT, THUS USING THE VOLTAGE DROP ACROSS THE PRECEDING TUBE'S FILAMENT AND ASSOCIATE 27 OHM RESISTOR AS A NEGATIVE BIAS VOLTAGE. THE BIAS VOLTAGE FOR THE -30 TUBE IS OBTAINED BY CONNECTING THE GRID RETURN CIRCUIT OR THIS TUBE TO THE NEGATIVE END OF THE 27 OHM RESISTOR R2 AND SINCE THE POSITIVE END OF THIS SAME RESISTOR IS CONNECTED TO THE NEGATIVE SIDE OF THE -30 TUBE'S FILAMENT, THE VOLTAGE DROP ACROSS IT WILL BE USED AS THE NEGATIVE BIAS VOLTAGE FOR THIS TUBE.

THE POSITIVE END OF THE 30 OHM RESISTOR R1 IS CONNECTED TO THE NEGATIVE END OF THE FILAMENT FOR THE -31 TUBES, WHEREAS THE GRID RETURN CIR-

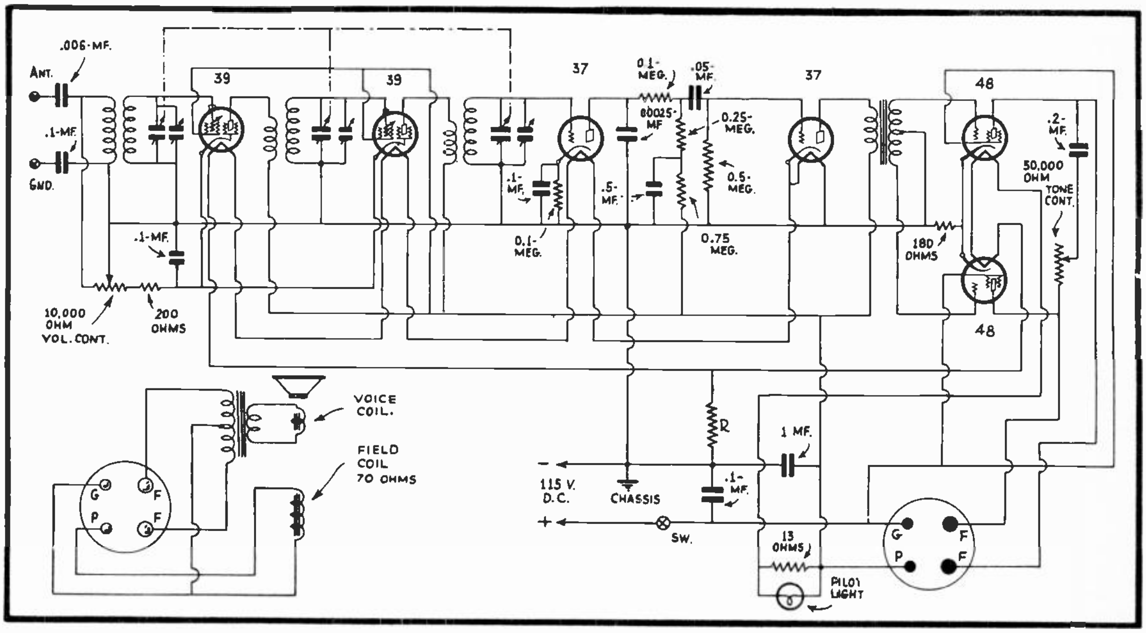


FIG. 8
The Modern Six-Tube Receiver.

CUIT OF THE POWER STAGE IS CONNECTED TO THE NEGATIVE END OF THE 27 OHM RESISTOR R5, THEREFORE THE VOLTAGE DROP ACROSS THE ENTIRE SERIES RESISTANCE COMBINATION FROM R1 TO R5 INCLUSIVE WILL BE USED AS THE NEGATIVE BIAS VOLTAGE FOR THE POWER TUBES.

A MODERN D.C. RECEIVER WITH PENTODE TUBES

IN FIG. 8 YOU ARE SHOWN STILL ANOTHER MODERN CIRCUIT DIAGRAM OF A D.C. RECEIVER, ONLY THAT IN THIS CASE, TYPE 39 TUBES ARE USED IN THE R.F. STAGES, -37'S IN THE DETECTOR AND FIRST A.F. STAGE AND A PAIR OF 48'S IN THE POWER STAGE.

THE -37 AND -39 YOU WILL RECALL AS BEING AUTOMOTIVE TYPE TUBES

WHICH WERE DESCRIBED TO YOU IN A PREVIOUS LESSON. IT IS ALSO TIMELY TO MENTION THAT THE CODE NUMBER 44 IS ALSO SOMETIMES ASSOCIATED WITH THE 39 TUBE. IN OTHER WORDS, THE OPERATING CHARACTERISTICS OF BOTH THE 39 AND 44 ARE THE SAME.

THE TYPE 48 TUBE

THE 48 IS A HEATER TYPE SCREEN GRID POWER TUBE DESIGNED PRIMARILY TO BE USED IN D.C. TYPE RECEIVERS. ITS OPERATING CHARACTERISTICS ARE AS FOLLOWS:

HEATER VOLTAGE = 30 VOLTS; HEATER CURRENT = 0.4 AMP.; PLATE VOLTAGE = 125 VOLTS; PLATE CURRENT = 50 MA; SCREEN VOLTAGE = 100 VOLTS; SCREEN CURRENT = 9 MA. GRID BIAS = -22.5 VOLTS; AMPLIFICATION FACTOR = 28; OUTPUT POWER = 2.5 WATTS.

THE 48 CAN ALSO BE OPERATED WITH A PLATE VOLTAGE OF 95 VOLTS, SCREEN VOLTAGE OF 95 VOLTS, AND A GRID BIAS OF -20 VOLTS. THE PLATE CURRENT WILL THEN BE 47 MA; SCREEN CURRENT 9 MA; AND A POWER OUTPUT OF 1.6 WATTS. ALL OTHER CHARACTERISTICS REMAIN THE SAME AS ALREADY SPECIFIED.

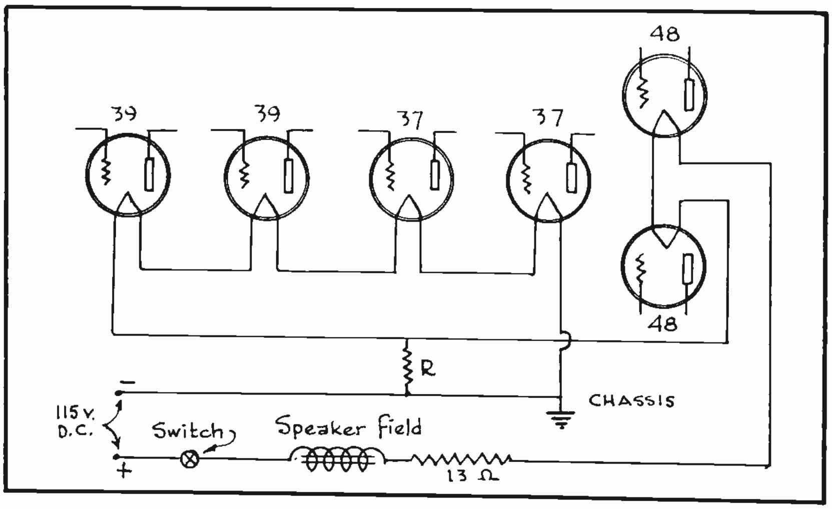


FIG. 9
Filament Circuit of the Modern Six-Tube Receiver.

BY STUDYING THESE OPERATING CHARACTERISTICS CAREFULLY AND NOTING ESPECIALLY THE HIGH HEATER VOLTAGE REQUIREMENTS AND COMPARATIVELY LOW "B" VOLTAGES NEEDED, YOU CAN READILY SEE HOW THIS TUBE IS PARTICULARY WELL ADAPTED FOR USE IN D.C. RECEIVERS.

IN FIG. 9 YOU ARE SHOWN IN DETAIL, THE FILAMENT CIRCUIT OF THE RECEIVER ILLUSTRATED IN FIG. 8. NOTICE HOW THE SWITCH, SPEAKER FIELD, THE 13 OHM RESISTOR, THE ADDITIONAL RESISTOR R AND THE HEATERS OF THE TWO 48'S ARE ALL TOGETHER CONNECTED IN SERIES WITH THE D.C. CIRCUIT.

THE HEATERS OF THE 37 AND 39 TUBES ARE CONNECTED IN SERIES INTO A SEPARATE GROUP AND THE ENTIRE GROUP IS CONNECTED IN PARALLEL WITH THE RESISTOR R. THE NEGATIVE SIDE OF THE D.C. CIRCUIT IS GROUNDED TO THE CHASSIS BUT NOT TO THE EXTERNAL GROUNDING SYSTEM..

THE GRID BIAS VOLTAGES FOR THE VARIOUS TUBES CAN BE OBTAINED QUITE EASILY SIMPLY BY INSERTING RESISTORS IN THE CATHODE CIRCUITS IN THE CONVENTIONAL MANNER. THE VOLUME IS CONTROLLED BY MEANS OF THE 10,000 OHM POTENTICMETER WHICH REGULATES THE BIAS VOLTAGE OF THE R.F. TUBES, AS WELL AS THE SIGNAL INPUT ENERGY.

NOTICE THAT IN THIS RECEIVER, THE CHASSIS BASE IS NOT CONNECTED TO

THE EXTERNAL GROUND CONNECTION. INSTEAD, THE "GROUND END" OF THE FIRST R.F. TRANSFORMER'S PRIMARY WINDING IS CONNECTED TO THE EXTERNAL GROUND THROUGH A .1 MFD. FIXED CONDENSER.

220 VOLT RECEIVERS

ALL OF THE RECEIVERS, WHICH WE HAVE SO FAR CONSIDERED, WERE DESIGNED FOR 110 VOLT OPERATION OR SLIGHTLY HIGHER, SUCH AS 115 OR 120 VOLTS. SINCE A 110 VOLT POWER SUPPLY IS MORE POPULAR THAN A 220 VOLT SUPPLY, IT IS THE MORE COMMON PRACTICE AMONG THE RECEIVER MANUFACTURERS TO DESIGN THEIR EQUIPMENT FOR 110--120 VOLT OPERATION. THEN IF A 110 VOLT D.C. RECEIVER IS TO BE OPERATED FROM A 220 VOLT SUPPLY, IT IS ONLY NECESSARY TO INSTALL AN ADDITIONAL RESISTOR OF THE PROPER OHMIC VALUE IN SERIES WITH THE RECEIVER AND THE 220 VOLT LINE SO AS TO REDUCE THE LINE VOLTAGE OF 220 VOLTS DOWN TO 110 VOLTS. THE RECEIVER THEN ACTUALLY OPERATES AT 110 VOLTS.

THERE ARE, HOWEVER, SOME EXCEPTIONS TO THIS RULE AND IN WHICH CASE THE RECEIVER IS DESIGNED ESPECIALLY FOR 220 VOLTS, ADVANTAGE OF THIS HIGHER VOLTAGE BEING TAKEN FOR THE "B" VOLTAGES TO BE APPLIED TO THE VARIOUS CIRCUITS. THE GENERAL CONSTRUCTION AND OPERATING THEORY FOR THE 220 VOLT D.C. RECEIVERS IS THE SAME AS ALREADY DESCRIBED FOR THE 110 VOLT D.C. RECEIVERS.

IN THE CASE OF A.C. RECEIVERS, THE ONLY DIFFERENCE BETWEEN THE 110 AND 220 VOLT SETS LIES IN THE POWER TRANSFORMER, THE REST OF THE CIRCUITS BEING EXACTLY ALIKE. IN OTHER WORDS, FOR 220 VOLT OPERATION, THE PRIMARY WINDING OF THE POWER TRANSFORMER IS DESIGNED FOR 220 VOLTS, WHILE THE SECONDARY WINDINGS ARE DESIGNED TO FURNISH THE SAME VOLTAGES AS THE 110 VOLT TRANSFORMER.

Examination Questions

LESSON NO. 28

"He that cannot obey, cannot command."

1. - WHAT FORM OF POWER SUPPLY IS USED TO OPERATE THE D.C. TYPE OF RECEIVERS?

2. - WHY IS IT THE CONVENTIONAL PRACTICE IN THE DESIGN AND CONSTRUCTION OF D.C. RECEIVERS TO CONNECT THE TUBE FILAMENTS OR HEATERS IN SERIES RATHER THAN IN PARALLEL?

3. - EXPLAIN HOW THE GRID BIAS VOLTAGES FOR THE VARIOUS TUBES IN THE CIRCUIT OF FIG. 4 ARE OBTAINED.

4. - WHY IS A FILTER CIRCUIT GENERALLY NECESSARY IN A D.C. RECEIVER EVEN THOUGH THE SOURCE OF OPERATING POWER IS ALREADY IN THE FORM OF DIRECT CURRENT?

5. - WHAT ARE THE OPERATING CHARACTERISTICS OF A TYPE 48 TUBE?

6. - WHY IS THE TYPE 48 TUBE ESPECIALLY ADAPTED TO D.C. RECEIVERS?

7. - HOW IS IT POSSIBLE TO OPERATE A 110 VOLT D.C. RECEIVER FROM A 220 VOLT D.C. POWER SUPPLY?

8. - WHAT IS THE ESSENTIAL DIFFERENCE BETWEEN A 110 VOLT A.C. RECEIVER AND A 220 VOLT A.C. RECEIVER?

9. - WHAT ADVANTAGES CAN YOU SUGGEST FOR USING HEATER TYPE TUBES, SUCH AS THE AUTOMOBILE TYPE, IN D.C. RECEIVERS?

10.- DRAW THE CIRCUIT DIAGRAM OF A SIX-TUBE D.C. RECEIVER EMPLOYING TYPE 39 TUBES IN THE TWO R.F. STAGES, 37'S IN THE DETECTOR AND FIRST A.F. STAGE AND A PAIR OF 48'S IN A PUSH-PULL POWER STAGE.

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Established 1905

Los Angeles, California

LESSON NO. 29

A.C. D.C. RECEIVERS

DUE TO THE FACT THAT SOME DISTRICTS ARE FURNISHED WITH AN A.C. LIGHTING SUPPLY WHILE OTHER DISTRICTS HAVE A D.C. LIGHTING SUPPLY OR NONE AT ALL, WE FIND THE RECEIVER OWNER WHO TRAVELS OR MOVES FREQUENTLY, TO BE AT A CONSIDERABLE DISADVANTAGE. FOR INSTANCE, IF A PERSON LIVES IN A DISTRICT SUPPLIED WITH A.C. LIGHTING FASCILITIES, HE WOULD NATURALLY PURCHASE AN A.C. RECEIVER. HOWEVER, SHOULD HE AT SOME LATER DATE MOVE INTO A 110 VOLT D.C. DISTRICT, HE WILL NOT BE ABLE TO OPERATE HIS A.C. RECEIVER FROM THE D.C. SUPPLY. A PERSON MOVING FROM A D.C. DISTRICT INTO AN A.C. DISTRICT WOULD ENCOUNTER SIMILAR DIFFICULTIES IF HE DESIRED TO CONTINUE USING HIS D.C. RECEIVER.

IT IS OF COURSE TRUE THAT SPECIAL AUXILIARLY EQUIPMENT IS AVAILABLE WHICH WILL ENABLE ONE TO OPERATE AN A.C. RECEIVER FROM A D.C. LIGHTING CIRCUIT OR VICE VERSA BUT IN THE MAJORITY OF CASES, THE ADDITIONAL EQUIPMENT NECESSARY FOR THIS PROCEDURE COSTS MORE THAN THE MARKET VALUE OF THE "USED RECEIVER." FOR THIS REASON, THIS METHOD IS NOT ALTOGETHER PRACTICAL.

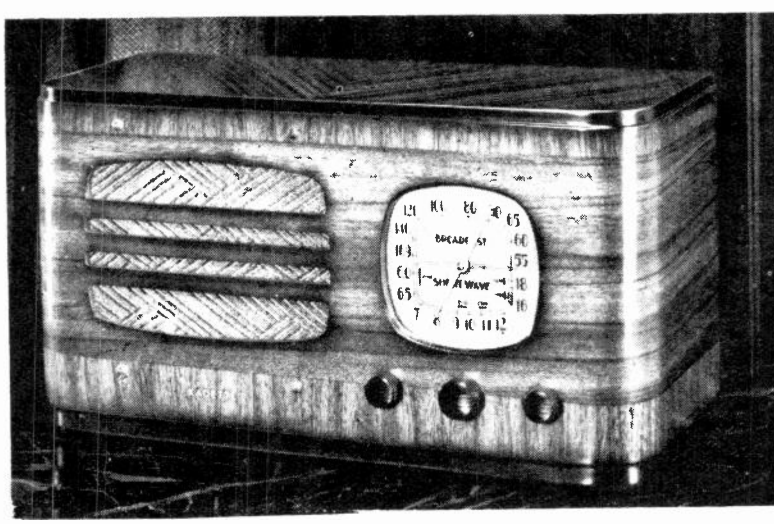

FIG. 1
A Modern A.C.-D.C. Receiver.

ALTHOUGH IT IS ALSO TRUE THAT A SET CAN BE REDESIGNED AND REBUILT TO ADAPT IT TO ANOTHER TYPE OF POWER SUPPLY, YET THIS PROCEDURE IS ALSO OFTEN EXPENSIVE AND UNDESIRABLE.

FOR SOME TIME, RECEIVER MANUFACTURERS HAVE BEEN EXPERIMENTING WITH CIRCUITS WHICH WILL PERMIT OPERATING A RECEIVER SATISFACTORILY WITH EITHER AN A.C. OR D.C.

SOURCE OF POWER AND WITH THE INTRODUCTION OF SOME NEW TYPES OF TUBES, THEY HAVE SUCCEEDED REMARKABLY WELL. RECEIVERS WHICH WILL MEET THESE REQUIREMENTS ARE KNOWN AS "A.C.-D.C. RECEIVERS". OR "UNIVERSAL RECEIVERS". THE LINE PLUG OF SUCH A RECEIVER CAN BE PLUGGED DIRECTLY INTO A LIGHTING CIRCUIT OUTLET SUPPLIED WITH EITHER A.C. OR D.C. ENERGY AND NO AUXILIARLY EQUIPMENT OF ANY FORM IS REQUIRED.

MOST OF THE COMMERCIAL TYPES OF COMBINATION A.C.-D.C. RECEIVERS ARE OF THE COMPACT MIDGET DESIGN; SUCH AS ILLUSTRATED IN FIG. I OF THIS LESSON. THIS IS QUITE LOGICAL UPON CONSIDERING THE FACT THAT PEOPLE WHO DO REMAIN LONG IN ANY ONE LOCATION, DO NOT WANT TO TRANSPORT A LARGE HEAVY RECEIVER WITH THEM WHILE IN TRANSIT. FOR THOSE WHO DO NOT MOVE OUT OF EITHER THE A.C. OR D.C. DISTRICT, SUCH A COMBINATION RECEIVER OFFERS NO PARTICULAR ADVANTAGE.

CONSTRUCTIONAL FEATURES

IN FIG. 2, YOU ARE SHOWN A FRONT VIEW OF THE CHASSIS ASSEMBLY OF A TYPICAL UNIVERSAL RECEIVER. AS YOU WILL OBSERVE, IT IS OF COMPACT CONSTRUCTION WHICH IS CHARACTERISTIC OF ALL MIDGET DESIGNS AND IN THE MAJORITY OF CASES, THE SPEAKER IS MOUNTED AT THE FRONT-CENTER OF THE CHASSIS AS HERE SHOWN. A REAR VIEW OF THE SAME CHASSIS ASSEMBLY IS ILLUSTRATED FOR YOU IN FIG. 3.

BY USING A CHASSIS LAY-OUT AS HERE ILLUSTRATED, THE CABINET CAN BE CONSTRUCTED ALONG THE LINES OF THE ONE SHOWN IN FIG. I AND IN WHICH CASE, THE SPEAKER GRILL IS AT THE FRONT CENTER OF THE CABINET AND THE TUNING CONTROL AND VOLUME CONTROL-SWITCH COMBINATION TO EITHER SIDE OF THE SPEAKER GRILL. THIS FORM OF DESIGN DECREASES THE OVERALL HEIGHT OF THE CABINET MATERIALLY AND THEREBY ENABLES THE CABINET TO BE CONSTRUCTED MORE NEARLY RECTANGULAR IN SHAPE, AND SMALLER IN SIZE.

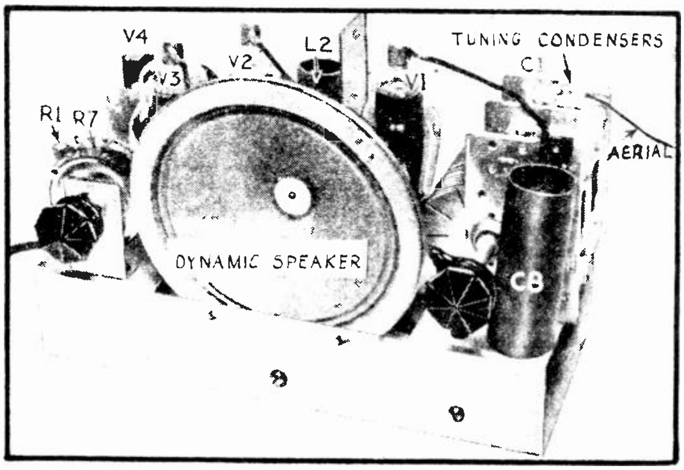

FIG. 2
Front View of the Chassis.

SO MUCH FOR THE GENERAL CONSTRUCTIONAL FEATURES OF THESE RECEIVERS--NOW LET US TURN OUR ATTENTION TO THE CIRCUITS.

A FOUR-TUBE 110 VOLT A.C.-D.C. RECEIVER

IN FIG. 4 YOU ARE SHOWN A CIRCUIT OF A SIMPLE DESIGN IN WHICH A TYPE -39 TUBE IS USED IN THE R.F. STAGE, A -36 POWER DETECTOR, A -38 POWER OUTPUT TUBE AND A -37 AS A RECTIFIER. ALL OF THESE TUBES YOU WILL RECALL AS BEING OF THE AUTOMOTIVE TYPE REQUIRING A HEATER VOLTAGE OF 6.3 VOLTS PER TUBE.

THE HEATER CIRCUIT FOR THIS SAME RECEIVER IS ILLUSTRATED FOR YOU INDIVIDUALLY IN FIG. 5 SO AS TO SIMPLIFY THE ANALYSIS OF THE SYSTEM.

ASSUMING THAT THE POWER SUPPLY IS D.C. AND STARTING AT THE POSITIVE END OF THE CIRCUIT IN FIG. 5, WE FIND THAT BY TRACING THE CIRCUIT FROM THIS POSITION, WE COME FIRST TO THE POINT WHERE THE PLATE AND GRID OF THE -37 TUBE ARE CONNECTED TOGETHER. WE NEXT PASS THROUGH THE 315 OHM RESISTOR AND THEN SUCCESSIVELY THROUGH THE HEATERS OF THE 38, 39, 36, AND 37 TUBES AND BACK TO THE NEGATIVE SIDE OF THE LINE.

NOTICE ESPECIALLY THAT THE HEATERS OF ALL THESE TUBES, TOGETHER
WITH THE 315 OHM RESISTOR, ARE ALL CONNECTED IN SERIES WITH THE 110 VOLT
LINE. THIS MEANS THAT A 6 VOLT DROP (APPROXIMATELY) WILL BE PRODUCED A-
CROSS EACH HEATER, ACCOUNTING FOR A TOTAL VOLTAGE DROP OF 4 TIMES 6 OR
ABOUT 24 VOLTS ACROSS ALL FOUR TUBES. THE REMAINDER OF THE LINE VOLTAGE
IS DISSIPATED OR "DROPPED" ACROSS THE 315 OHM RESISTOR, AND FOR THIS REASON
A RESISTOR USED IN THIS WAY, IS CALLED A BALLAST RESISTOR. IT IS COMMON TO FIND THESE BALLAST RESISTORS TO HAVE A WATT RATING OF AROUND 25 WATTS.

REGARDLESS, OF WHETHER THE 110 VOLT POWER SUPPLY IS OF THE D.C. OR A.C. FORM, THE VOLTAGE DISTRIBUTION FOR THE HEATER CIRCUIT IS EXACTLY THE SAME. FURTHERMORE, SINCE ALL OF THE TUBES ARE OF THE HEATER CATHODE TYPE, THEY ARE EQUALLY WELL ADAPTED TO BOTH A D.C. AND A.C. HEATER SUPPLY.

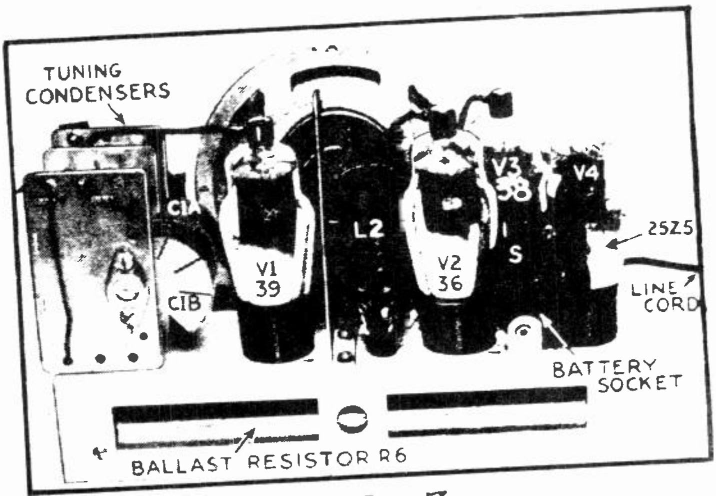

FIG. 3

Rear View of the chassis

WHAT NO DOUBT HAS BEEN PUZZLING YOU MOST IS THE
METHOD EMPLOYED IN FIG. 4 IN
USING A TYPE 37 TUBE AS A RECTIFIER, WHEN THE TUBE IS ORIGINALLY DESIGNED
TO BE USED AS AN AMPLIFIER OR DETECTOR. SO THIS WILL BE THE POINT WHICH WE
SHALL INVESTIGATE NEXT.

BY CONNECTING THE GRID AND PLATE OF THE 37 TUBE TOGETHER AS HERE
SHOWN, THE TUBE IS ACTUALLY CONVERTED INTO A HEATER-CATHODE TYPE HALF-WAVE
RECTIFIER. THE PLATE AND GRID IN THIS CASE BOTH TOGETHER SERVING AS A
SINGLE CONVENTIONAL PLATE THE SAME AS IN ANY ORDINARY HALF-WAVE RECTIFIER.

THE "B" AND "C" CIRCUITS

SO THAT YOU CAN MORE READILY GRASP THE THEORY OF HOW THE "B" AND
"C" SUPPLY IS FURNISHED TO THIS RECEIVER, WE HAVE IN FIG. 6 ILLUSTRATED
THIS PORTION OF THE CIRCUIT IN GREATER DETAIL, OMITTING ALL THOSE UNITS

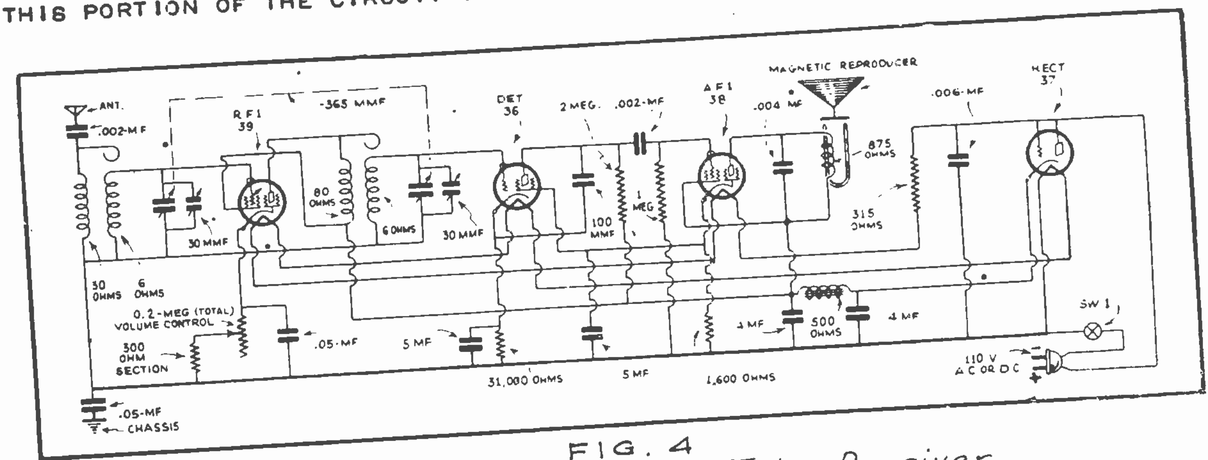

FIG. 4

Circuit Diagram of the Four-Tube Receiver.

AND CIRCUITS WHICH TAKE NO PART IN THIS PARTICULAR PROCESS.

TO BEGIN WITH, WE SHALL AGAIN ASSUME THAT THE RECEIVER IS CONNECTED TO THE 110 VOLT D.C. LIGHTING SUPPLY. WITH THE CONNECTIONS AS HERE ILLUSTRATED, YOU WILL NOTICE THAT THE POSITIVE SIDE OF THE LINE IS CONNECTED TO THE PLATE OF THE 37 RECTIFIER. THEN SINCE THE SUPPLY VOLTAGE IS IN THE FORM OF D.C., A POSITIVE POTENTIAL WILL BE MAINTAINED UPON THE PLATE OF THIS TUBE.

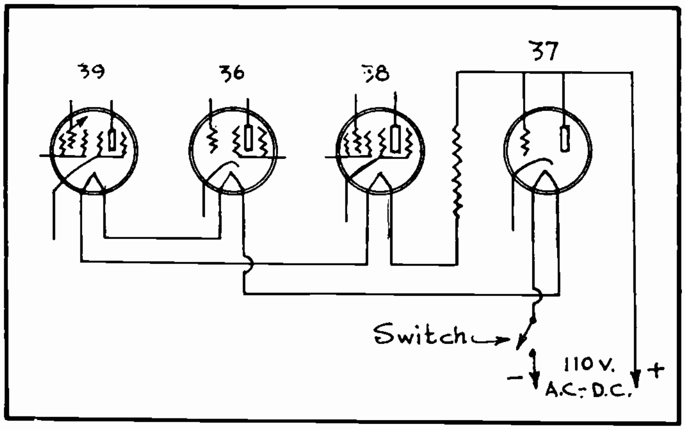

FIG. 5
The Heater Circuit.

THE CATHODE OF THE 37 BEING HEATED BY ITS HEATER, WILL EMIT A STREAM OF ELECTRONS WHICH ARE ATTRACTED OVER TO THE PLATE, PERMITTING "PLATE CURRENT" TO PASS FROM THE PLATE TO THE CATHODE IN THE USUAL MANNER. THE CIRCUIT OF THE 37 DELIVERS THIS "PLATE CURRENT" TO THE FILTER SYSTEM WHERE ANY REMAINING RIPPLES MAY BE SMOOTHED OUT. THE FILTERED CURRENT IS THEN DISTRIBUTED TO THE PLATE AND SCREEN CIRCUITS OF THE REGULAR RECEIVER TUBES IN THE USUAL WAY.

SINCE THE LINE POLARITY NEVER REVERSES IN A D.C. CIRCUIT, IT IS CLEAR THAT THE 37 TUBE DOES NOT AT THIS TIME FUNCTION AS A RECTIFIER BUT ONLY AS A MEANS FOR PASSING "B" CURRENT FROM THE LINE TO THE RECEIVER CIRCUITS OR SIMPLY AS RESISTANCE OF COMPARATIVELY LOW OHMIC VALUE.

SHOULD BY CHANCE THE LINE PLUG BE REVERSED IN THE D.C. LIGHTING

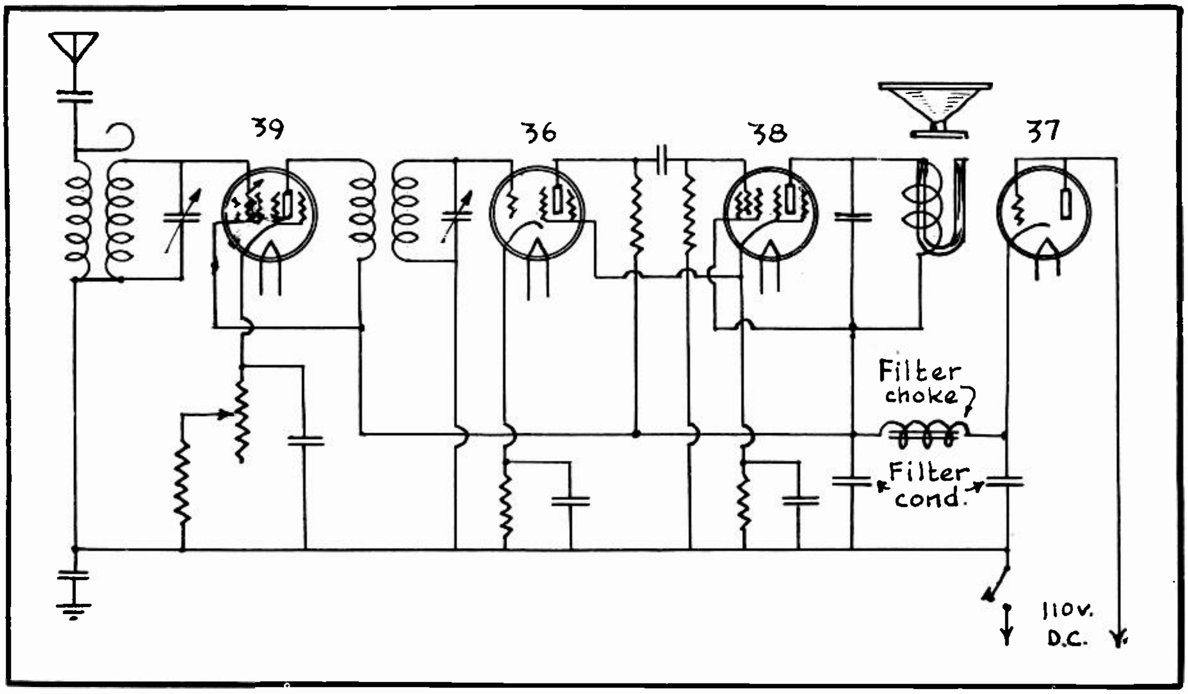

FIG. 6
Details of the "B" and "C" Circuits.

CIRCUIT OUTLET SO THAT THE PLATE OF THE 37 TUBE IS CONNECTED TO THE NEGATIVE SIDE OF THE LINE, THEN THE SYSTEM WOULD NOT OPERATE. THE REASON FOR THIS OF COURSE BEING THAT UNDER SUCH CONDITIONS, THE PLATE OF THE 37 TUBE WOULD BE MAINTAINED AT A NEGATIVE POTENTIAL AND WOULD THEREBY PREVENT THE ELECTRONS EMITTED BY THE CATHODE TO BE ATTRACTED TOWARDS THE PLATE. AS A RESULT, NO "PLATE CURRENT" WOULD PASS THROUGH THE 37 TUBE AND THE RECEIVER WOULD FAIL TO FUNCTION DUE TO THE ABSENCE OF A "B" SUPPLY. SO FROM THIS EXPLANATION, YOU CAN READILY SEE THAT WHEN CONNECTING A.C.-D.C. RECEIVERS OF SUCH DESIGN TO A D.C. CIRCUIT, IT IS OF VITAL IMPORTANCE NOT TO REVERSE THE LINE PLUG CONNECTIONS.

NOW THEN, IF THE LINE PLUG IS CONNECTED TO AN A.C. LIGHTING CIRCUIT, THE POTENTIAL APPLIED TO THE PLATE OF THE 37 TUBE WILL ALTERNATELY BECOME POSITIVE AND NEGATIVE IN DIRECT STEP WILL THE A.C. REVERSALS. THEREFORE, WHENEVER THE PLATE IS POSITIVE, PLATE CURRENT WILL PASS THROUGH IT AND FROM ITS CATHODE BE DELIVERED TO THE FILTER SYSTEM AND THEN BE DISTRIBUTED TO THE "B" CIRCUITS OF THE OTHER TUBES.

AT THE TIME THE LINE VOLTAGE REVERSES AND IMPRESSES A NEGATIVE POTENTIAL UPON THE PLATE OF THE 37 TUBE, THE ELECTRONS WHICH ARE EMITTED BY THE CATHODE WILL BE REPELLED AND NO "PLATE CURRENT" WILL BE PERMITTED TO PASS THROUGH THIS TUBE. IN OTHER WORDS, THE 37 TUBE WILL NOW FUNCTION AS A CONVENTIONAL HALF-WAVE RECTIFIER AND THEREBY FURNISH THE RECEIVER CIRCUITS WITH A D.C. "B" SUPPLY. FURTHERMORE, IF THE LIGHTING SUPPLY IS A.C. IT DOESN'T MATTER IF THE LINE PLUG IS REVERSED IN THE OUTLET OF THE CIRCUIT.

THE NEGATIVE "C" BIAS VOLTAGE FOR THIS RECEIVER IS OBTAINED BY UTILIZING THE VOLTAGE DROP DEVELOPED ACROSS THE FIXED RESISTORS WHICH ARE CONNECTED BETWEEN THE CATHODES OF THE VARIOUS TUBES AND THE NEGATIVE SIDE OF THE "B" CIRCUIT. THE SPEAKER, WHICH IS USED WITH THIS RECEIVER, IS OF THE MAGNETIC TYPE. THE PURPOSE OF THE .006 MFD. BYPASS CONDENSER IS TO REDUCE LINE NOISE.

BY LOOKING AT FIG. 4 AGAIN, YOU WILL NOTICE THAT THE METAL CHASSIS BASE IS INSULATED FROM ALL OF THE WIRING BY MEANS OF THE .05 MFD. BYPASS OR INSULATING CONDENSER. THIS IS A VERY COMMON PRACTICE AMONG THE MANUFACTURERS OF UNIVERSAL RECEIVERS AND IS DONE SO AS TO AVOID ANY POSSIBILITY OF A SHORT CIRCUIT OR SERIOUS SHOCK WHEN HANDLING THE RECEIVER IN THE EVENT THAT THE METAL-CHASSIS SHOULD BECOME ACCIDENTALY GROUNDED BECAUSE USUALLY ONE SIDE OF THE LIGHTING CIRCUIT IS GROUNDED AND THE NEGATIVE "B" SUPPLY OF THE RECEIVER IS CONNECTED DIRECTLY TO ONE SIDE OF OF THE LIGHTING CIRCUIT. OR THIS REASON, IT IS IMPORTANT WHEN MOUNTING SUCH PARTS AS THE TUNING CONDENSER, METALLIC CONTAINERS OF ELECTROLYTIC FILTER CONDENSERS, VOLUME CONTROL ETC. THAT THESE UNITS BE CAREFULLY INSULATED FROM THE METAL CHASSIS BASE. BAKELITE SUPPORTS OR FIBER WASHERS CAN BE USED TO PREVENT MOUNTING SCREWS FROM GROUNDING THESE PARTS TO THE CHASSIS.

WITH THE EXCEPTION OF THOSE FEATURE'S JUST BROUGHT TO YOUR SPECIAL ATTENTION WITH RESPECT TO FIG. 4, THE CIRCUIT IS CONVENTIONAL IN ALL OTHER DETAILS.

THE APPLICATION OF DUAL RECTIFIER TUBES

THE TYPE -37 TUBE NOT BEING SPECIALLY DESIGNED FOR RECTIFYING PURPOSES OFFERS A DISADVANTAGE WHEN USED AS A RECTIFIER IN THAT THE "B" CUR

RENT, WHICH IT PASSES, IS RATHER LIMITED. THIS DIFFICIENCY CAN, HOWEVER, TO A CERTAIN EXTENT BE OVERCOME BY USING TWO OF THESE TUBES IN PARALLEL AS DONE IN THE RECEIVER WHOSE CIRCUIT DIAGRAM IS PRESENTED TO YOU IN FIG. 7.

BY STUDYING THIS DIAGRAM, YOU WILL READILY NOTICE THAT THE HEATERS OF ALL THE TUBES, THE 280 OHM BALLAST RESISTOR AND SWITCH ARE ALL CONNECTED IN SERIES WITH THE 110 VOLT LINE.

IN FIG. 8 YOU ARE SHOWN IN DETAIL THE RECTIFYING AND FILTER SYSTEM FOR THIS SAME CIRCUIT. OBSERVE CLOSELY IN FIG. 8 HOW THE GRID AND PLATE OF EACH OF THE 37 TUBES ARE INTERCONNECTED AND THAT THE PLATES OF BOTH THESE TUBES ARE TOGETHER CONNECTED TO THE POSITIVE SIDE OF THE D.C. LINE. THE CATHODES OF THESE SAME TUBES ARE ALSO CONNECTED TOGETHER AND THEREFORE TWO TUBES WILL BE CONNECTED IN PARALLEL. THIS MEANS THAT THESE TWO TUBES TOGETHER WILL BE CAPABLE OF PASSING ABOUT TWICE THE AMOUNT OF "B" CURRENT OF EITHER ONE OF THE TUBES ALONE.

THE HOOK-UP OF THIS CIRCUIT, HOWEVER, IS STILL SUCH THAT IF THE RECEIVER IS CONNECTED TO AN A.C. LINE, ONLY HALF-WAVE RECTIFICATION WILL BE OBTAINED. IN OTHER WORDS, THE PLATES OF BOTH TUBES WILL HAVE THEIR POTENTIAL ALTERED SIMULTANEOUSLY AND WILL THEREFORE ACT AS ONE IN CONTROLLING THE FLOW OF "B" CURRENT.

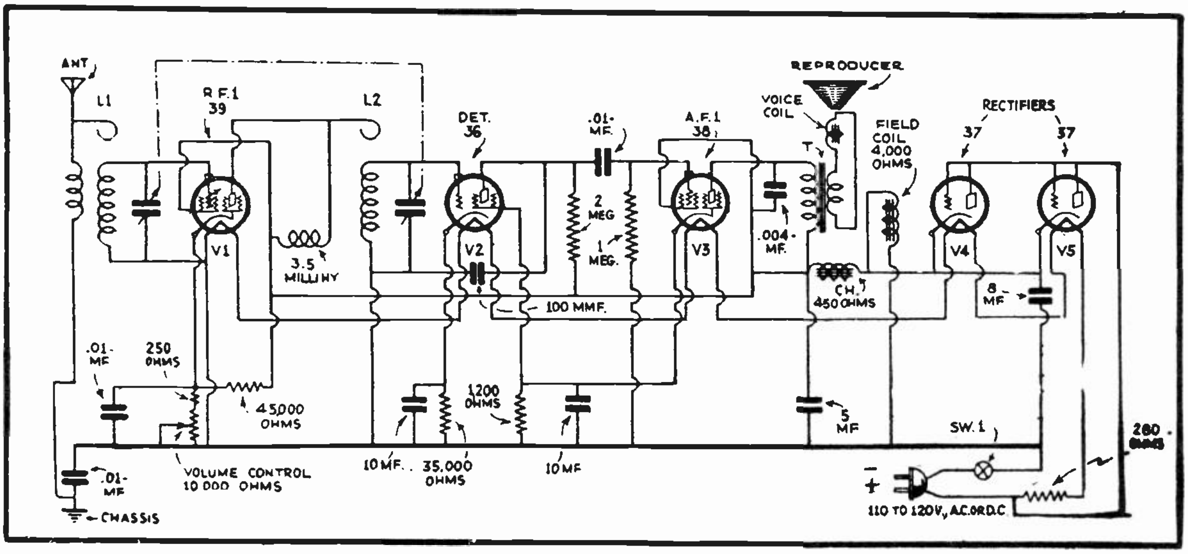

FIG. 7

A Receiver With Dual Rectifier Tubes.

THE FILTER CIRCUIT IS CONVENTIONAL AND ITS OUTPUT FEEDS THE "B" CIRCUITS OF THE RECEIVER IN THE CUSTOMARY MANNER. THE 4,000 OHM FIELD COIL OF THE DYNAMIC SPEAKER WHICH IS USED WITH THIS RECEIVER, IS CONNECTED ACROSS THE FILTER CIRCUIT AS SHOWN IN BOTH FIGS. 7 AND 8. IN FACT, THE CURRENT DEMAND OF THIS SPEAKER ALONE REQUIRES THE USE OF AN ADDITIONAL RECTIFIER TUBE.

THE REST OF THE CIRCUITS OF THIS RECEIVER ARE QUITE SIMILAR TO THE ONE ILLUSTRATED IN FIG. 4, THE METALLIC CHASSIS BASE IN THIS CASE ALSO BEING INSULATED FRAME THE B- SIDE OF THE CIRCUIT BY THE .01 MFD. FIXED CONDENSER.

THE TYPE 12Z3 TUBE

AS THE UNIVERSAL TYPE OF RECEIVERS INCREASED IN POPULARITY IT BE-

CAME NECESSARY TO DESIGN RECTIFIER TUBES WHICH ARE ESPECIALLY ADAPTED TO THESE SETS. IN OTHER WORDS, A RECTIFIER TUBE WAS NEEDED WHOSE FILAMENT OR HEATER DRAWS THE SAME CURRENT AS THE AUTOMOTIVE TUBES GENERALLY USED IN SUCH RECEIVERS SO THAT A SERIES HEATER CIRCUIT WOULD BE PRACTICAL, WHILE AT THE SAME TIME BEING CAPABLE OF PASSING ADEQUATE "B" CURRENT WITH A RATHER LOW IMPRESSED PLATE VOLTAGE.

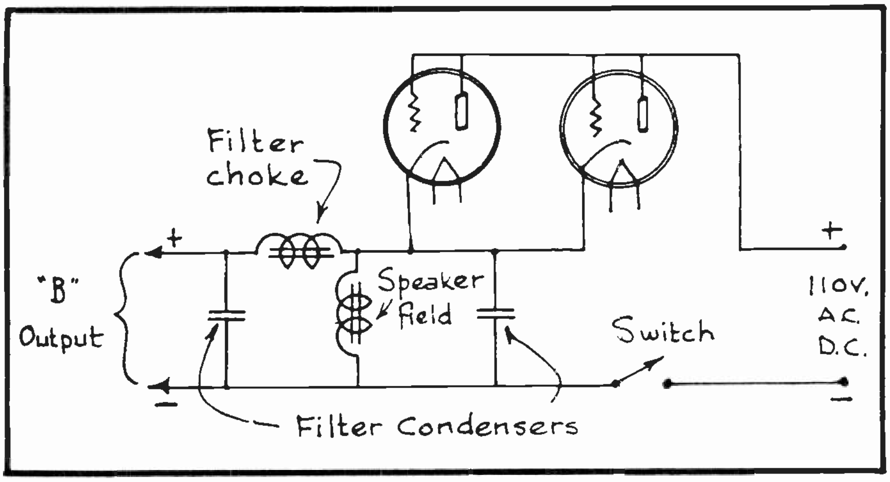

FIG. 8
The rectifying and Filter System.

ONE OF THESE SPECIAL RECTIFIER TUBES FOR UNIVERSAL TYPE RECEIVERS SOON APPEARED ON THE MARKET BEARING THE CODE NUMBER "12Z3." THIS TUBE IS A HALF-WAVE, HIGH-VACUUM RECTIFIER TUBE OF THE HEATER--CATHODE TYPE. IT CONSISTS OF A HEATER, CATHODE AND A PLATE ALL ENCLOSED IN AN EVACUATED GLASS BULB FITTED WITH A STANDARD FOUR-PRONG BASE.

THE SYMBOL FOR THE 12Z3 IS SHOWN YOU IN THE UPPER PORTION OF FIG.9 WHILE THE SOCKET CONNECTIONS FOR THIS SAME TUBE, AS VIEWED FROM BELOW, ARE PICTURED IN THE LOWER PORTION OF FIG. 9.

THE OPERATING CHARACTERISTICS OF THE 12Z3 ARE AS FOLLOWS:

HEATER VOLTAGE = 12.6 VOLTS A.C. OR D.C.; HEATER CURRENT = 0.3 AMP.; MAXIMUM A.C. PLATE VOLTAGE = 250 VOLTS; MAXIMUM D.C. OUTPUT CURRENT=60 MA.

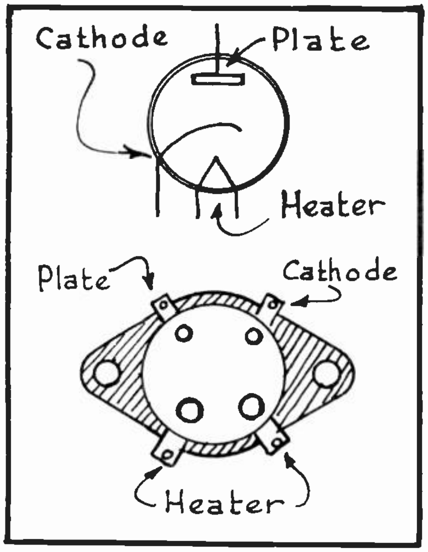

FIG.9
Symbol and Base Arrangement of the 12Z3.

THE FACT THAT THE HEATER OF THIS TUBE IS RATED AT 12.6 VOLTS, REDUCES SOMEWHAT THE HEAT DISSIPATION REQUIRED OF THE BALLAST RESISTOR WHICH IS CONNECTED IN SERIES WITH THE HEATERS OF THE CONVENTIONAL TYPE OF UNIVERSAL RECEIVERS. THIS MEANS THAT THE RECEIVER WILL NOT BECOME QUITE SO HOT WHEN IN OPERATION. FURTHERMORE, SINCE MOST UNIVERSAL RECEIVERS REQUIRE A TOTAL PLATE CURRENT OF ABOUT 30 TO 40 MA., THE 12Z3 CAN MEET THIS DEMAND SATISFACTORILY.

APPLICATION OF THE 12Z3

IN FIG. 10 YOU ARE SHOWN THE CIRCUIT DIAGRAM OF A FOUR-TUBE UNIVERSAL RECEIVER IN WHICH THE 12Z3 IS USED. THE HEATER OF THE 39, 36, 38, 12Z3 AND THE 280 OHM BALLAST RESISTORS ARE ALL CONNECTED IN SERIES WITH THE 110 VOLT CIRCUIT AND THE PLATE OF THE 12Z3 IS CONNECTED TO ONE SIDE OF THE LINE (THE POSITIVE SIDE OF A D.C.

supply is being used.)

The cathode of the 12Z3 is connected to the filter system consisting of the 15 henry choke and two 4 mfd. condensers. The output of this filter system then furnishes the "B" supply to the receiver tubes.

The 12Z3 operates in the same manner when subjected to an A.C. or D.C. supply as already explained to you earlier in this lesson with respect to the 37 tube when used as a rectifier.

The rest of the circuit in Fig. 10 is practically of standard design for this type of receiver, with the exception that the screen grid of the 36 tube is connected directly to the cathode of the 38 tube so that a positive potential is obtained for the screen grid of the 36 tube and which will be equal to the grid bias voltage of the type 38 tube. Also notice how the metal chassis base is insulated from the negative side of the D.C. line circuit by the .1 mfd. fixed condenser.

THE 25Z5 TUBE

Another tube, which is being extensively used in the late model universal type receiver, is known as the 25Z5. This tube is especially flex-

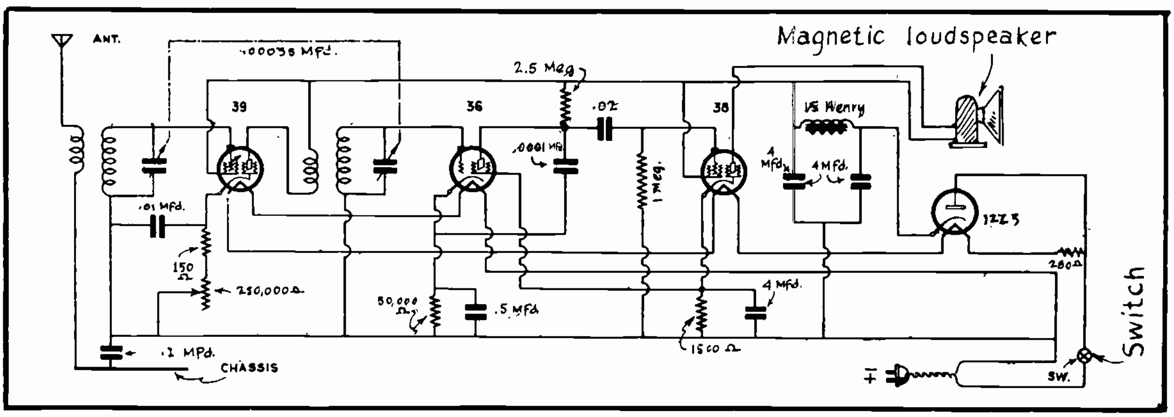

FIG. 10
Four-Tube Universal Receiver Employing a 12Z3 Rectifier.

ible as regards the methods in which it may be employed. For instance, it may be used as a simple half-wave rectifier, as a full-wave rectifier, as a voltage doubler, or in special split-circuit arrangements.

Generally speaking, the 25Z5 is practically two 12Z3 tubes contained in a single glass bulb. For example, its heater is constructed in the form of a dual section connected in series within the tube. In addition, the tube is equipped with two cathodes and two plates, while the base is of the standard six prong type.

The symbol for the 25Z5 appears in the upper section of Fig. 11, while the socket connections for this same tube as viewed from below appear in the lower section of Fig. 11.

The operating characteristics of the 25Z5 are as follows:

Heater voltage = 25 volts; heater current = 0.3 amp; maximum A.C. vol-

TAGE PER PLATE = 125 VOLTS; MAXIMUM D.C. OUTPUT CURRENT = 100 MA.

NOTICE THAT THE HEATER CURRENT REQUIREMENTS OF THIS TUBE ARE THE SAME AS FOR THE AUTOMOTIVE TYPE TUBES AND THEREFORE, ITS HEATER CAN BE CONNECTED IN SERIES WITH THE HEATERS OF THE AUTOMOTIVE TYPE TUBES USED IN THE VARIOUS STAGES OF THE RECEIVER. FURTHERMORE, SINCE THE HEATER OF THE 25Z5 WILL ACCOUNT FOR A 25 VOLT DROP IN THE HEATER CIRCUIT, NOT SO GREAT A DEMAND WILL BE PLACED UPON THE BALLAST RESISTOR.

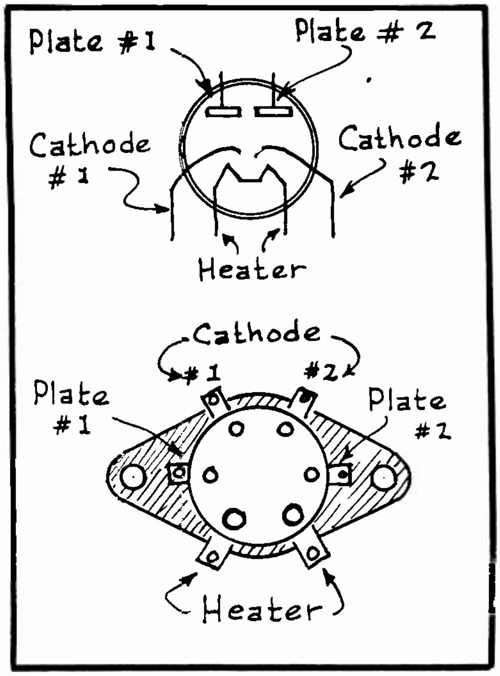

FIG. 11
Symbol and Base Arrangement of the 25Z5.

IT IS ALSO OF INTEREST TO NOTE THE TRUE MEANING OF THE CODE EXPRESSION "25Z5" AS USED WITH THIS TUBE. THE NUMBER 25, FOR INSTANCE, MEANS THAT THE HEATER VOLTAGE IS 25 VOLTS; THE NUMBER "5" MEANS THAT THE TUBE HAS FIVE ELEMENTS--A HEATER, TWO CATHODES AND TWO PLATES; THE "Z" CONVEYS THE MEANING THAT THE TUBE IS A RECTIFIER. THE CODE OF THE 12Z3 WORKS OUT IN THE SAME WAY--THE "12" DESIGNATING A HEATER VOLTAGE OF 12 VOLTS (NEGLECTING THE .6); THE "3" INDICATES THAT THREE ELEMENTS ARE USED AND THE "Z" TELLS US THAT THE TUBE IS A RECTIFIER.

THE CODING OF THE 2A3, 2A5 ETC. CONVEY SIMILIAR MEANINGS, IN WHICH CASE THE FIRST NUMBER OF THE CODE OR "2" DESIGNATES A HEATER OR FILAMENT VOLTAGE OF 2 (NEGLECTING THE .5) AND THE NUMBER OF ELEMENTS AS 3 IN THE 2A3 AND 5 AND THE 2A5. THE LETTER "A" CONVEYS THE MEANING THAT THE TUBE IS TO BE USED AS AN AMPLIFIER. MANY MORE TUBES ARE ALSO CODED ACCORDING TO THIS METHOD, AS YOU SHALL SOON LEARN.

NOW LET US PROCEED WITH THE OPERATION AND APPLICATION OF THE 25Z5. FIRST, WE WILL CONSIDER THE CIRCUIT WHICH IS PRESENTED IN FIG. 12. HERE THE TWO PLATES OF THE 25Z5 ARE TOGETHER CONNECTED TO ONE SIDE OF THE LIGHTING CIRCUIT (THE POSITIVE SIDE, IF A D.C. LINE IS AVAILABLE). THE TWO CATHODES ARE ALSO CONNECTED TOGETHER AND FEED INTO THE POSITIVE SIDE OF THE FILTER SYSTEM. THE NEGATIVE SIDE OF THE LINE IS CONNECTED DIRECTLY TO THE NEGATIVE SIDE OF THE FILTER SYSTEM. IN OTHER WORDS, THE TWO HALVES OF THE TUBE ARE CONNECTED IN PARALLEL SO THAT IN EFFECT, WE HAVE TWO PARALLEL CONNECTED 12Z3 TUBES.

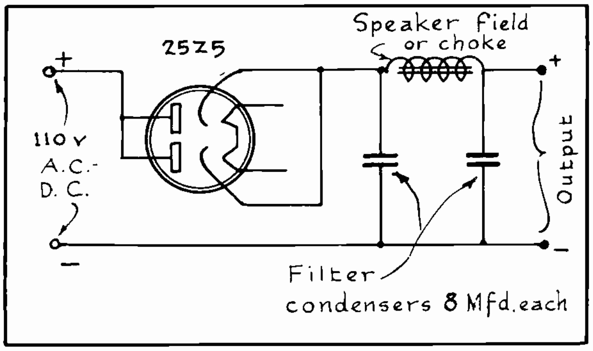

FIG. 12
Parallel Half-wave Rectification.

THE TWO HALVES OF THE TUBE WILL NOW WORK AS ONE AND IF CONNECTED TO A D.C. CIRCUIT, IT WILL ACT LIKE A RESISTANCE OF LOW OHMAGE AND PERMIT THE DIRECT CURRENT TO PASS FROM THE LINE INTO THE FILTER SYSTEM AND "B" CIRCUITS OF THE RECEIVER. IF CONNECTED TO AN A.C. LINE, THE TUBE WILL FUNC-

TION AS A HALF-WAVE RECTIFIER THE SAME AS THE 12Z3 BUT IS CAPABLE OF PASSING A HIGHER VALUE OF "B" CURRENT.

ANOTHER ARRANGEMENT, WHICH IS SOMETIMES USED IS ILLUSTRATED IN FIG. 13. HERE THE TWO PLATES OF THE 25Z5 ARE TOGETHER CONNECTED TO ONE SIDE OF THE LINE WHILE ONE OF THE CATHODES FEEDS THE FILTER SYSTEM CONSISTING OF THE CHOKE AND THE TWO FILTER CONDENSERS AS THE OTHER CATHODE AT THE SAME TIME SUPPLIES THE ENERGIZING CURRENT FOR THE SPEAKER FIELD WHICH IS CONNECTED BETWEEN IT AND THE NEGATIVE SIDE OF THE CIRCUIT. UPON APPLYING AN A.C. INPUT, THE TUBE FUNCTIONS AS A HALF-WAVE RECTIFIER AND DUE TO THE DIVISION OF THE RECTIFIED CURRENT THROUGH THE FILTER SYSTEM AND SPEAKER FIELD, THIS ARRANGEMENT CAN BE CLASSIFIED AS A "SPLIT HALF-WAVE" RECTIFIER.

APPLYING THE 25Z5 AS A VOLTAGE DOUBLER

NOW THE MOST INTERESTING CIRCUIT OF ALL, TO WHICH THE 25Z5 IS ADAPTED, IS PRESENTED TO YOU IN FIG. 14. THE TUBE IN THIS CASE IS KNOWN AS A VOLTAGE DOUBLER.

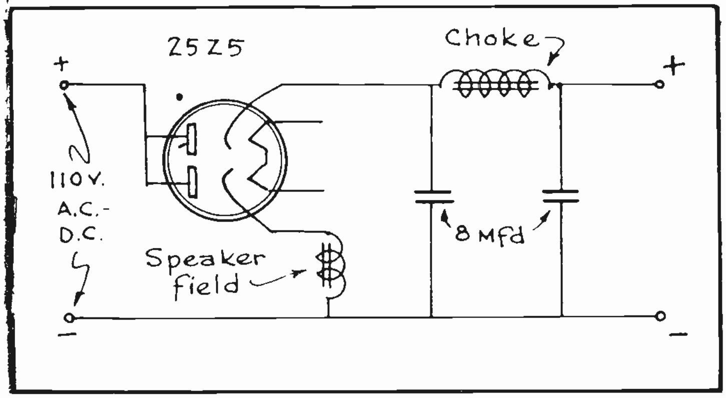

FIG. 13
The Split Half-wave Rectifier.

AT THIS TIME, AN A.C. VOLTAGE IS APPLIED ACROSS THE LEADS X AND Y. WE SHALL ASSUME THAT "X" IS POSITIVE AT ONE PARTICULAR INSTANT OF THE CYCLE, WHILE "Y" AT THE SAME TIME IS NEGATIVE, THEN CONSIDERING ITS OPERATION PURELY FROM AN ELECTRONIC STANDPOINT, WE FIND THAT WITH "Y" BEING NEGATIVE WITH RESPECT TO "X", ELECTRONS WILL FLOW FROM CATHODE 1 TO PLATE 1 OF THE 25Z5 TUBE CAUSING CONDENSER C1 TO BECOME CHARGED.

IT IS ALSO POSSIBLE FOR CONDENSER C1 TO CHARGE THROUGH R AND THE FILTER CHOKE FROM PLATE 1 BUT R IS MUCH GREATER THAN THE TUBE DROP AND THEREFORE THE CONDENSER C2 WILL AT THIS TIME RECEIVE ONLY A SMALL CHARGE AND ITS POLARITY WILL OPPOSE C1 WITH RESPECT TO THE OUTPUT CIRCUIT.

NOW THEN, AS THE LINE POLARITY REVERSES, AND "X" BECOMES NEGATIVE WITH RESPECT TO "Y", ELECTRONS WILL FLOW INTO THE LOWER PLATE OF C2 AND OUT OF ITS TOP PLATE, PASSING FROM CATHODE 2 TO PLATE 2 AND THENCE TO LINE "Y". THIS CHARGING ACTION OF CONDENSER C2 WILL OVERCOME THE OPPOSING CHARGE BROUGHT ABOUT BY THE ACTION OF C1 AS ALREADY MENTIONED. THEREFORE, SINCE THE CHARGE OF CONDENSERS C1 AND C2 WILL NOW BE OPPOSING EACHOTHER DUE TO THE PRESENCE OF R WHICH CONNECTS THEM TOGETHER, WE FIND THAT BY REMOVING R FROM THE CIRCUIT, THIS OPPOSING EFFECT WILL BE ELEMINATED AND THE VOLTAGE AVAILABLE ACROSS THE D.C. OUTPUT TERMINALS WILL BE EQUAL TO THE SUM OF THE VOLTAGE CHARGE UPON CONDENSERS C1 AND C2. FOR INSTANCE, IF THE EFFECTIVE A.C. LINE VOLTAGE IS 110 VOLTS, THEN CONDENSERS C1 AND C2 WILL EACH BE CHARGED TO A PEAK VOLTAGE OF ABOUT 155 VOLTS. (THE PEAK VOLTAGE IS EQUAL TO THE EFFECTIVE VOLTAGE DIVIDED BY THE CONSTANT .707 AS YOU SHALL LEARN IN A LATER LESSON).

HENCE WITH CONDENSERS C1 AND C2 EACH CHARGED TO A POTENTIAL OF 155

VOLTS, THE COMBINED VOLTAGE ACROSS THEM WILL BE 155 + 155 OR 310 VOLTS.

IN AN ACTUAL RECEIVER, WHEN R IS REPLACED BY A NUMBER OF PLATE AND SCREEN-GRID CIRCUITS SO THAT LITTLE LEAKAGE EXISTS, WE WILL BE ABLE TO OBTAIN A D.C. OUTPUT EQUAL TO THE SUM OF THE VOLTAGES DEVELOPED ACROSS CONDENSERS C1 AND C2 DURING BOTH HALVES OF THE LINE'S A.C. CYCLE.

CONDENSERS C1 AND C2 AID THE FILTER CHOKE AND THE FILTER CONDENSER TO PROVIDE A SMOOTH D.C. OUTPUT AND SINCE THE D.C. VOLTAGE AVAILABLE IS EQUAL TO SOMEWHERES NEAR TWICE THE VALUE OF THE A.C. INPUT VOLTAGE, THE TUBE IS NOW SAID TO BE OPERATING AS A "VOLTAGE-DOUBLER". AS THE LOAD CURRENT INCREASE, THE VOLTAGE DROP THROUGH THE TUBE WILL OF COURSE ALSO INCREASE, WITH THE RESULT THAT THE D.C. OUTPUT VOLTAGE WILL BE REDUCED ACCORDINGLY.

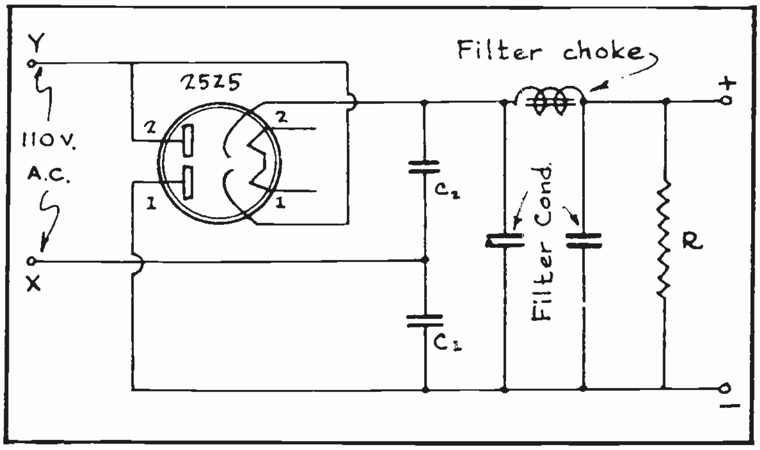

FIG. 14
The Voltage-Doubler Circuit

THIS APPLICATION OF THE 25Z5, AS YOU WILL HAVE NOTICED, WILL AFFORD A HIGH D.C. VOLTAGE FROM AN A.C. LINE WITHOUT THE NEED OF A POWER TRANSFORMER. IN "UNIVERSAL" RECEIVERS, THIS IS QUITE AN ADVANTAGE, FOR WHEN OPERATING THE RECEIVER FROM AN A.C. CIRCUIT, PROVISIONS CAN BE MADE THROUGH A SWITCHING ARRANGEMENT SO THAT THE 25Z5 TUBE WILL AT THIS TIME FUNCTION AS A VOLTAGE-DOUBLER--THE GREATER D.C. OUTPUT THUS MADE POSSIBLE, PERMITTING THE RECEIVER TO BE OPERATED AT GREATER EFFICIENCY.

UNIVERSAL RECEIVER CIRCUIT EMPLOYING THE 25Z5

IN FIG. 15 WE HAVE THE CIRCUIT DIAGRAM OF A FOUR-TUBE RECEIVER USING THE 25Z5 TUBE IN CONJUNCTION WITH A 36, 39 AND 38. IN ADDITION, PROVISION IS ALSO MADE FOR OPERATING THIS RECEIVER BY MEANS OF BATTERIES.

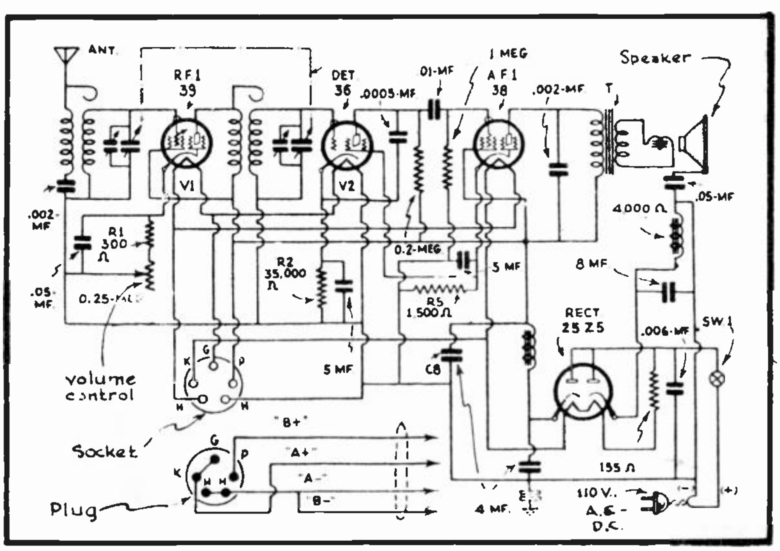

FIG. 15
The Universal Receiver With the 25Z5.

BY STUDYING THIS CIRCUIT DIAGRAM, YOU WILL IMMEDIATELY NOTICE THAT THE HEATER CIRCUITS ARE ALL CONNECTED IN SERIES WITH THE LINE AND A BALLAST RESISTOR OF 155 OHMS. THE 25Z5 IS BEING USED IN THE SPLIT HALF-WAVE RECTIFYING ARRANGEMENT WHICH WAS ALREADY DESCRIBED TO YOU IN THIS LESSON.--THAT IS, THE 4000 OHM SPEAKER FIELD IS CONNEC

TED BETWEEN THE NEGATIVE SIDE OF THE CIRCUIT AND ONE OF THE CATHODES OF THE 25Z5, WHILE THE OTHER CATHODE FEEDS INTO A CONVENTIONAL FILTER CIRCUIT AND FURNISHES THE "B" SUPPLY FOR THE ENTIRE RECEIVER. THE PURPOSE OF THE .006 MFD. CONDENSER, WHICH IS CONNECTED ACROSS THE LINE, IS INTENDED TO BYPASS LINE NOISES. THE REST OF THE CIRCUIT IS CONVENTIONAL FOR THIS TYPE OF RECEIVER. THE GROUND CONNECTIONS IS MADE THROUGH A .01 MFD. FIXED CONDENSER AS SHOWN ON THE DIAGRAM.

AN ADDITIONAL FEATURE OF THE CIRCUIT ILLUSTRATED IN FIG. 15 IS THAT A PLUG AND SOCKET CONNECTION IS ALSO PROVIDED SO THAT THE RECEIVER MAY BE OPERATED WITH BATTERIES AS WELL. TO DO THIS, IT IS ONLY NECESSARY TO CONNECT THE BATTERIES TO THE PLUG AS HERE SHOWN--USING A 6 VOLT STORAGE BATTERY FOR THE "A" SUPPLY AND THREE OR FOUR SERIES CONNECTED 45 VOLT "B" BATTERIES FOR THE "B" SUPPLY AND TO INSERT THE BATTERY PLUG INTO ITS SOCKET. FOR BATTERY OPERATION, THE TUBE HEATERS ARE AUTOMATICALLY CONNECTED IN PARALLEL.

AS YOU NO DOUBT HAVE NOTICED, NO UNIVERSAL RECEIVERS OF SUPERHETERODYNE DESIGN HAVE BEEN INCLUDED IN THIS LESSON. COMPLETE DETAILS CONCERNING THEM, HOWEVER, IS INCLUDED IN A LATER LESSON DEALING WITH THE MORE ADVANCED FEATURES PERTAINING TO SUPERHETERODYNES IN GENERAL..

EXAMINATION QUESTIONS

LESSON NO. 29

1. - WHAT DO WE MEAN BY THE EXPRESSION "UNIVERSAL RECEIVER"?
2. - WHAT ADVANTAGES CAN YOU NAME FOR USING AUTOMOBILE TYPE TUBES IN A UNIVERSAL RECEIVER?
3. - HOW IS IT POSSIBLE TO USE A HEATER TYPE TRIODE TUBE AS A RECTIFIER?
4. - WHY IS IT IMPORTANT NOT TO REVERSE THE LINE PLUG CONNECTION WHEN OPERATING A UNIVERSAL RECEIVER FROM A D.C. LIGHTING SUPPLY?
5. - WHY IS IT ADVISABLE TO INSULATE THE B- SIDE OF A UNIVERSAL RECEIVER'S CIRCUIT FROM THE METAL CHASSIS?
6. - DRAW A CIRCUIT DIAGRAM SHOWING HOW TWO TYPE -37 TUBES MAY BE USED TOGETHER FOR RECTIFYING PURPOSES IN A UNIVERSAL RECEIVER.
7. - DESCRIBE THE CONSTRUCTIONAL FEATURES OF THE 12Z3 TUBE.
8. - DESCRIBE THE CONSTRUCTIONAL FEATURES OF THE 25Z5 TUBE.
9. - WHAT ARE THE OPERATING CHARACTERISTICS OF THE 25Z5?
10. - DRAW A CIRCUIT DIAGRAM SHOWING HOW A 25Z5 TUBE MAY SUPPLY THE "B" CURRENT FOR A UNIVERSAL RECEIVER AS WELL ENERGIZING CURRENT FOR THE FIELD COIL OF A DYNAMIC SPEAKER.

Practical-Technical

TRAINING IN RADIO AND TELEVISION

ESTABLISHED 1905

J. A. ROSENKRANZ, Pres.

NATIONAL SCHOOLS

LOS ANGELES, CALIFORNIA

LESSON NO. 30

AUTOMATIC TUNING SYSTEMS

Up to the present time, your receiver studies have been confined strictly to sets employing MANUALLY operated tuning systems. Receivers of such design are tuned by means of rotating a knob, which in turn swings the dial needle across the scale and rotates the condenser plates to the proper position to bring in the desired station. In this lesson you are going to continue your study of receivers by learning about the theory, operation and maintenance requirements of AUTOMATIC tuning systems, as used on receivers featuring "push-button" tuning, "touch" tuning, and other similar methods.

FIG. 1
MODERN RECEIVER, FEATURING AUTOMATIC TUNING

With the widespread adoption of automatic tuning by every radio manufacturer, and the appeal of this feature to the public as a necessary adjunct to the modern radio receiver, it is important that the trained radio technician be thoroughly familiar with such tuning systems. Therefore, this lesson has been prepared to aid you in applying your present knowledge of radio to the maintenance work as applied to these more modern types of receivers.

An important fact to be considered relative to automatic tuning systems is that they present to the radio service engineer a unique opportunity for the establishment of closer customer-contact, since in many instances the original set-up of selected stations, as well as the maintenance of continued satisfactory automatic operation, is a function which he alone is technically capable of rendering. This naturally means more work for the serviceman.

CLASSIFICATION OF AUTOMATIC TUNING SYSTEMS

In this lesson you are given a complete descriptive review of the various methods used to accomplish automatic tuning. Some of these methods may at first glance appear to be a bewildering complex arrangement of parts, but upon closer study of the subject you will find that the various systems are related, and that it is therefore possible to classify them, as explained in the following paragraphs.

In general, automatic tuning systems may be divided into the following three main groups:

1. - Mechanically-operated manual types.
2. - Motor-operated types.
3. - Tuned-circuit substitution types.

The first and third main classifications may be subdivided still further into the following individual variations: Group 1, consisting of the rotary (telephone dial), cash register, and push-button types; and Group 3, consisting of the trimmer condenser and the iron-core coil types. Fig. 2 will further assist you in acquiring a clearer conception of the chief classifications of automatic tuning systems.

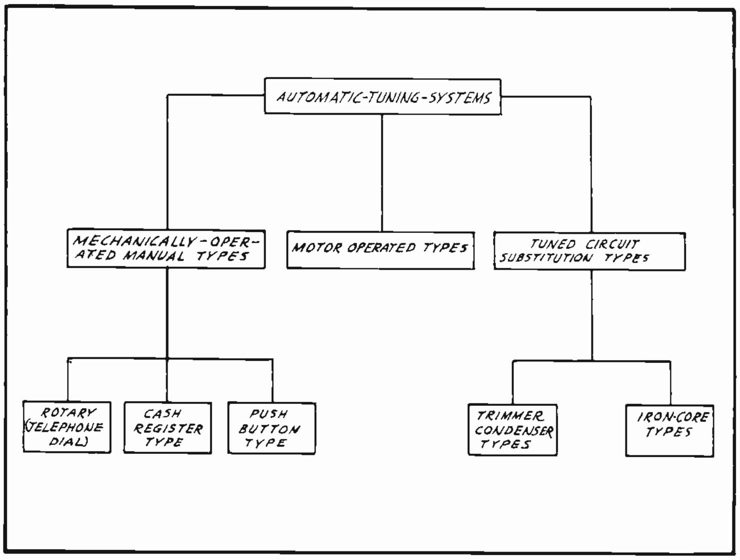

FIG. 2
CLASSIFICATION OF AUTOMATIC TUNING SYSTEMS

So far, we have given you a bird's-eye-view of automatic tuning systems, so that you will have somewhat of an idea of the various types before we go into a detailed study of the different mechanisms and arrangements. With this complete picture in mind, we will now start at the very beginning and progress through this lesson step by step, covering the subject of automatic tuning in detail.

Mechanically Operated Manual Types

As briefly covered in the classification outline, this method of automatic tuning includes all of the devices which permit the variable gang-tuning condenser to be adjusted directly by mechanical effort of the person tuning the receiver so as to "bring in" the desired station.

ROTARY OR TELEPHONE DIAL SYSTEMS

The design of this system is such that stations are tuned-in by applying a procedure similar to dialing a telephone (see Fig.3). This type of mechanism was the forerunner of mechanical automatic tuning, and has found widespread use. In most models of the telephone-dial system, a pin or lever is attached to the inner end of each of the station push-button plungers. The series of button-plungers are usually attached to a dial plate which in turn drives the gang condenser thru a gear-train so proportioned as to allow almost 360 degrees of dial plate rotation.

As the plunger corresponding to the desired station is depressed against spring tension, and the dial plate rotated at the same time, the indexing pin rotates with the dial plate and is arrested in its rotary motion by some form of stop or lock-in device. At the instant that the stop becomes effective the tuning condenser plates will have rotated to the position required to tune-in the station, and designated by the marking on the push-button in use. The precise position at which condenser rotation stops is adjustable by one of several methods that allow for setting-up the receiver to a group of desired stations.

The operating principle of this tuning system will be made more clear after you have studied the constructional details of the system illustrated in Fig. 4, together with the following explanation of this device.

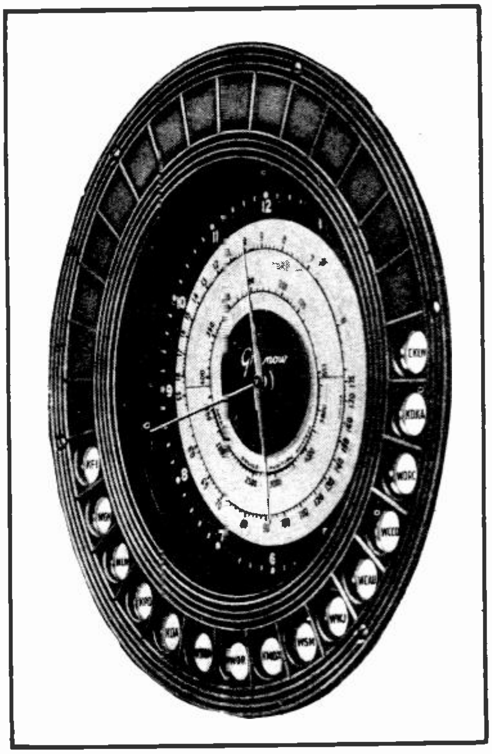

FIG. 3
TELEPHONE TYPE DIAL

TYPICAL TELEPHONE DIAL ASSEMBLY

CONSTRUCTION AND OPERATION: In the assembly shown in Fig. 4, the circular housing, containing the buttons, is directly mounted and fastened to the shaft of the gang tuning condenser. Consequently, when one of the station-selecting button plungers is pushed inward, and the disc-shaped housing rotated, the inserted button crankpin will eventually contact the floating vane, cause a locking action and prevent further rotation of either the mechanism or tuning condenser. The receiver will then be tuned to the station for which the particular button has been pre-adjusted.

INDEXING METHOD: Fig. 4 also illustrates the action of this particular indexing adjustment. In the upper illustration of Fig. 4 the outer ornamental dial plate has been removed for the set-up operations, and has been replaced by a thin metal disc, held in position by the knurled face-nut. This disc is a special service tool that has a single semi-circular notch cut in its periphery so that by rotating the disc to any desired position, and locking it in place, any one button may be moved toward the front while the rest of the buttons are all held in place. Thus the button aligned with the notch of the disc will, under the action of its spring, be moved toward the front sufficiently to allow its serrations (gear-like head) to clear those of the housing. This particular button assembly may then be rotated one way or the other so that the button crankpin will be in the correct position to jam against the locking vane either sooner or later, and when the condenser plates are in the position to tune in the desired station.

THE STATION STOP: As will be seen in the top and center illustrations of Fig. 4, the station-stop arrangement consists of a floating vane, operating between fixed stops. The vane of the stop assembly is so shaped that the center of the button crankpin will be located on a line drawn vertically through the center of the dial mechanism when the crankpin pushes the vane against either stop. In other words, the shape of the vane and its thickness are such that independent of the position of the crankpin, it will be centrally located when approaching the stop from either direction.

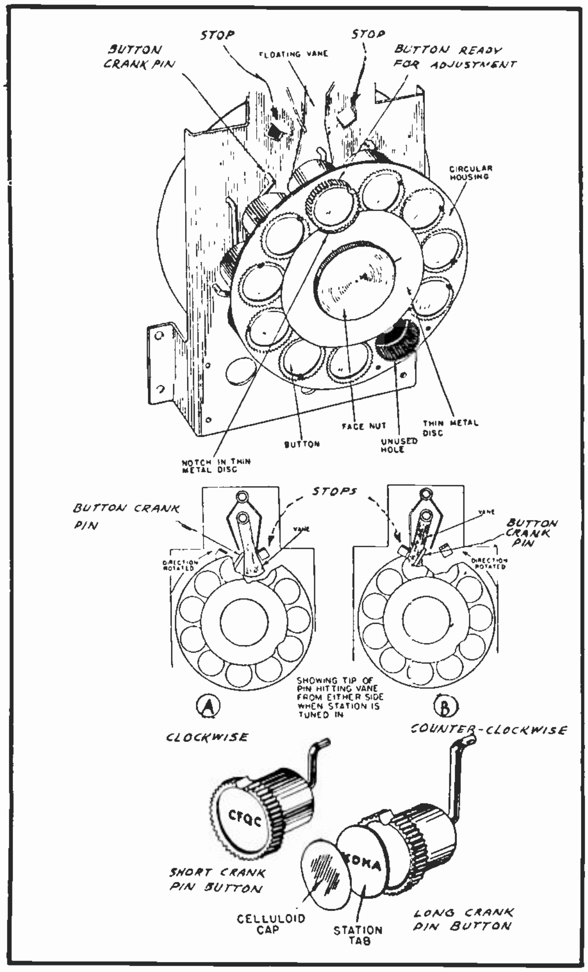

FIG. 4
TYPICAL TELEPHONE DIAL ASSEMBLY

Note also in the top illustration of Fig. 4 that all of the button crankpins, except that of the depressed button, will clear the floating vane by sliding freely over its face, as springs within the button assemblies normally force the button and crankpin outward sufficiently to provide this clearance at all times except when a button is depressed. This feature prevents the crankpins of the unused buttons from dropping into the locking positions.

In this dial assembly, rotation of the mechanism and condenser may be either clockwise or counter-clockwise, as shown in illustrations (A) and (B) of Fig.4. Here it will be observed that (A) illustrates the locking action when tuning the mechanism clockwise, while (B) illustrates the locking action when rotating the mechanism counter-clockwise.

It is of special importance to note in Fig. 4 that each button represents a different station, but that the serrations of each button assembly permit adjustment through a limited range so that an absolute point of resonance can be established for the station selected by each button.

MODIFIED TELEPHONE DIAL ASSEMBLY

CONSTRUCTION AND OPERATION: In the dial assembly illustrated in Fig. 5 the various station selecting buttons are locked in slots cut in the dial disc. This dial disc is locked to the tuning condenser shaft and is free to rotate as a body with the rotor plates of the condenser.

To tune-in a station, the proper button is pushed inward, and the entire dial disc is rotated until the stop pin on the inner end of the depressed button strikes the edge of the floating vane and prevents further rotation. The rotor plates of the tuning condenser will of course move with the dial disc, and will come to rest at the position required to tune-in the desired station. Springs within each of the button assemblies prevent all stop pins, except the one of the depressed button, from striking against the floating vane. The vane furnishes the locking action for either direction of dial rotation, the same as in the system previously described.

STATION BUTTON ADJUSTMENT: Upon referring to Fig. 5, you will observe that the length of the annular slot occupied by each button is such that considerable leeway for adjustment is possible to allow for correct location of the button.

The selection and exact position of the button will depend upon the position of the gang condenser plates at which the desired station is received, and the button position is adjusted in the slot to a corresponding point. In other words, to make an adjustment it is simply necessary to tune the receiver to the desired station by means of the regular tuning knob.

The dial disc will rotate during this procedure because of the cord drive, and will come to rest when the set has been tuned to resonance with the desired station. Having located this point, loosen the locking nut of the station-selecting button which is nearest the vane at this particular instant, and slide this button assembly one way or the other in its slot until its pin jams against the vane. Tighten the locking nut of the button. This button is now so located that it can be used to tune-in the same desired station at any future time.

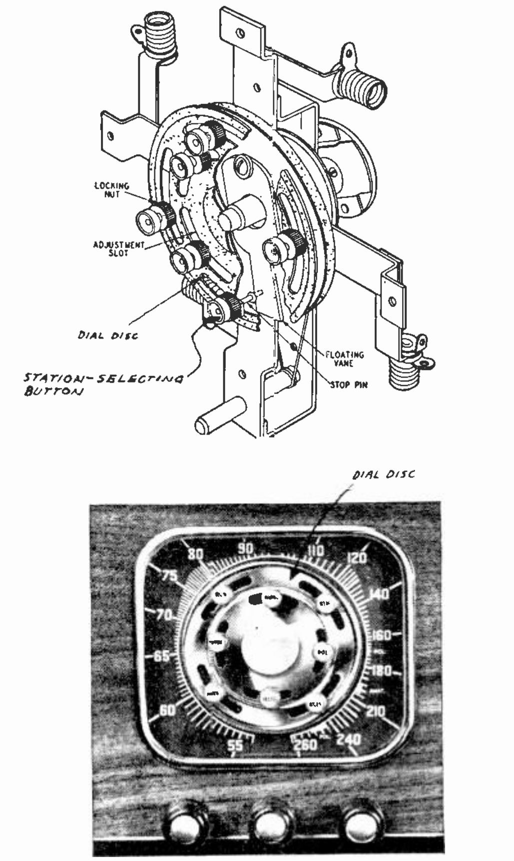

FIG. 5
MODIFIED TELEPHONE DIAL

CASH REGISTER ACTION

In this type of mechanical tuning system, a straight-line downward motion of a key or button, parallel to the tuning panel, rotates the gang tuning condenser by means of cams or levers whose positions are pre-set for the desired station. This action is similar to the manipulation of the keys of a typewriter or cash-register. That is, the action is similar to a keyboard, whereby the motion is made by pressing downward on the station buttons.

This type of tuning system, shown in Fig. 6, consists of a series of "heart-shaped" cams stacked on a shaft attached directly to the gang condenser. These cams are individually adjustable since they can be unlocked from the drive-shaft by a tapered expansion sleeve which is controlled by the locking screw shown in the illustrations.

The tuning levers move through a distance of approximately $1\frac{1}{4}$ inch, and in so doing, turn the cams and the condenser shaft to which they are locked. The stopping point of the lever, cam and condenser is the condenser position at which the desired station will be tuned-in.

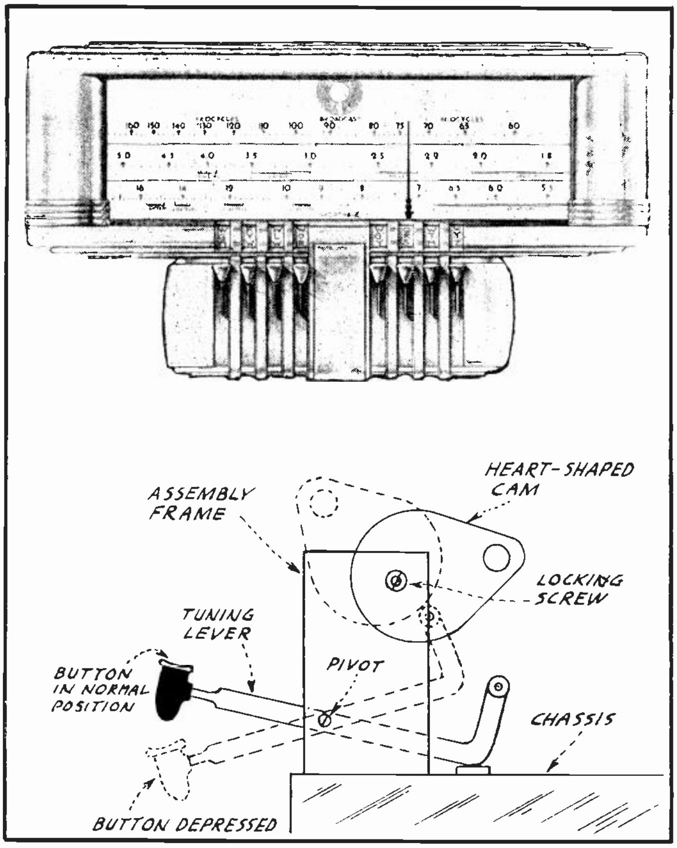

FIG. 6
"CASH REGISTER" TUNING ASSEMBLY

By referring to the diagrammatic illustration in the lower section of Fig. 6, you will observe that when a downward force is exerted upon the button of the tuning lever, the inner (right) end of this lever will move upward, striking against the heart-shaped cam.

If this cam has occupied the position as indicated by the solid line in this drawing, the upward force of the tuning lever will cause it to turn in a counter-clockwise direction until this end of the lever reaches its limit of travel, at which time it will be contacting the "low side" of the cam. The condenser shaft and plates will rotate with the cam.

Each lever actuates an individual cam and thereby controls the setting for one station. Spring action returns the lever to its normal position as soon as the button is released.

As the slope of the cam's contour varies, the position of the cam on the condenser shaft determines how far the condenser shaft will be rotated when the corresponding station-selecting button is depressed.

STATION SET UP: To set up this arrangement for certain stations, the locking screw at the end of the shaft is loosened, and the station-selecting button depressed to the end of its travel, and while holding it down, the station is tuned-in accurately by hand.

This operation is repeated for each of the desired stations by using the separate levers. The locking screw is tightened after this operation.

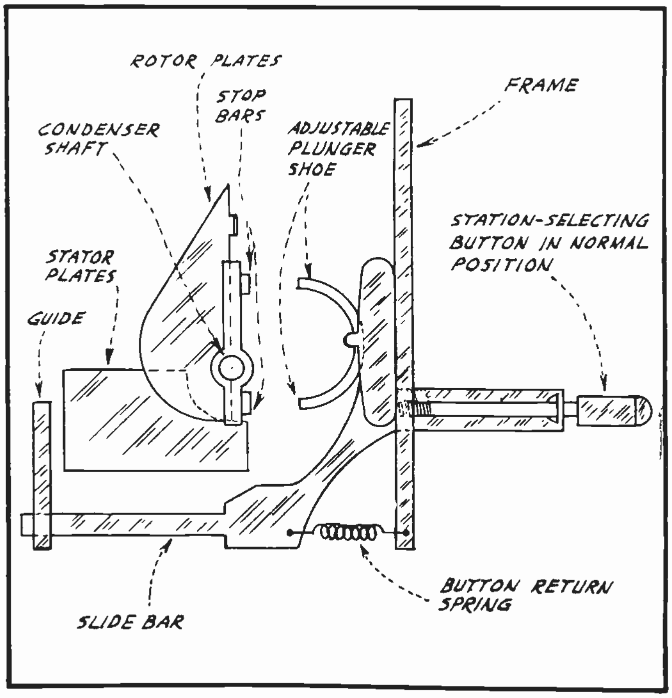

FIG. 7
MECHANICAL PUSH-BUTTON DIAL ASSEMBLY

PUSH-BUTTON ACTION

An end view of a typical mechanically-operated push-button tuning assembly is shown in Fig. 7. In this system the gang condenser and the push-button plunger mechanisms are assembled as one unit. Consequently, when the station button in Fig. 7 is depressed, and its plunger shoe comes in contact with the stop bar that is fastened to the drive-shaft of the rotor plates, the gang condenser will be rotated accordingly, until the button has completed its inward travel, at which time rotation will stop, and the desired station will be tuned-in.

STATION STOP: The station stop consists of two bars running parallel to and also fastened to the shaft of the gang condenser. One of the bars is placed on each side of the rotor shaft. Thus when the station button in Fig. 7 is depressed and its plunger shoe comes in contact with one of these bars, the gang condenser will be rotated, until each of the stop bars strikes an extremity of the plunger shoe. Rotation will then stop and the station will be tuned-in.

The reason for two stop bars is to enable the condenser to be rotated to the desired station position regardless of the rotor-plate position before the desired button plunger is depressed. This is more fully illustrated in the three views appearing in Fig. 8.

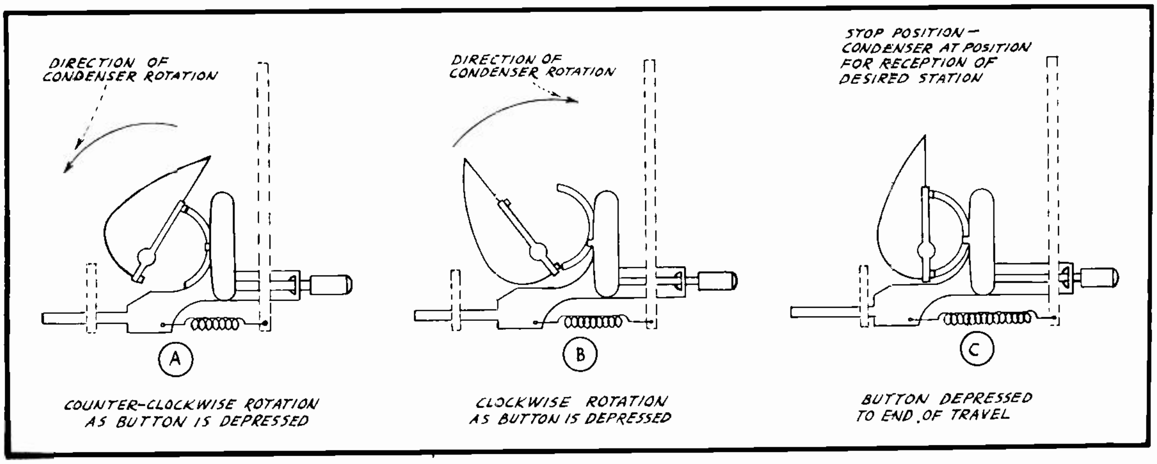

FIG. 8
POSITION OF BUTTON PLUNGERS FOR EITHER DIRECTION OF ROTATION

Upon close inspection of the various views presented in Figs. 7 and 8, you will observe that Fig. 7 shows a station-selecting button in its normal position, while (A) of Fig. 8 shows a button that has been depressed to a point before reaching its end of travel. You will further observe at (A) of Fig. 8, that as the button is depressed, its plunger shoe will first come in contact with the upper condenser stop, rotating the condenser in a counter-clockwise direction until both plunger shoe tips are flush against both condenser stops, as shown at (C) of Fig. 8.

Drawings (B) and (C) of Fig. 8 show the mechanical action when the rotor plates must be turned in a clockwise direction to reach the position for the desired station. You will note at (B) that when such is the case, the lower plunger shoe tip will first strike the lower stop bar and force the condenser plates to turn in a clockwise direction until the stop position (C) is reached.

STATION SET-UP: To set up this arrangement for automatic tuning, the station is accurately tuned-in manually, in the conventional manner. Then a station-selecting button now is loosened by unscrewing it a few turns. The button is then pushed inward to the end of its travel, and the button knob retightened. Depressing this button hereafter will always bring in the same station.

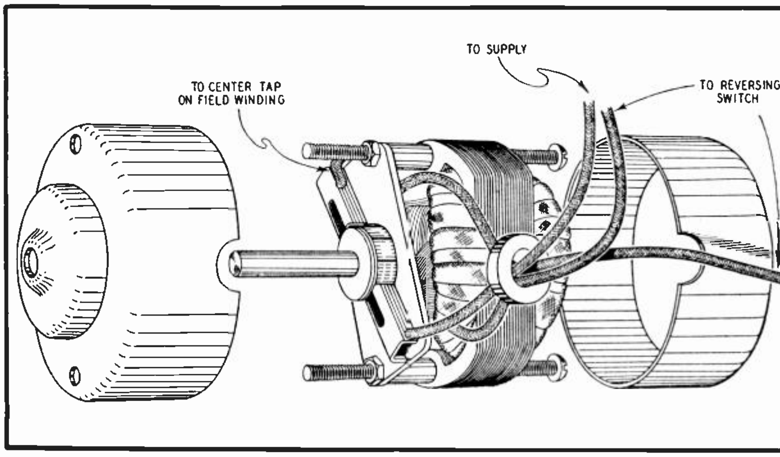

FIG. 9
TYPICAL MOTOR ASSEMBLY

As a precaution to prevent the gang condenser from moving slightly during this operation, one hand should be held on the manual station control knob. Otherwise, when the button shoe comes in contact with the condenser stop bar, the force of the contact might slightly rotate the gang condenser off the position of the pre-tuned station. This operation is repeated at each of the station-selecting buttons for each of the desired stations.

Altogether, there are four or more buttons, which allows a corresponding number of stations to be tuned-in by this method.

The Motor-operated System

In this system of automatic tuning, the variable gang tuning condenser is rotated to a position corresponding to a desired station tuning point by means of a small electric motor. This tuning system,which was the first to be introduced, usually includes an electric motor, a station selector switch or group of selector buttons, and a selecting commutator or other device for stopping the motor at the desired point. Figs. 9 and 10 show cutaway views of typical motor assemblies.

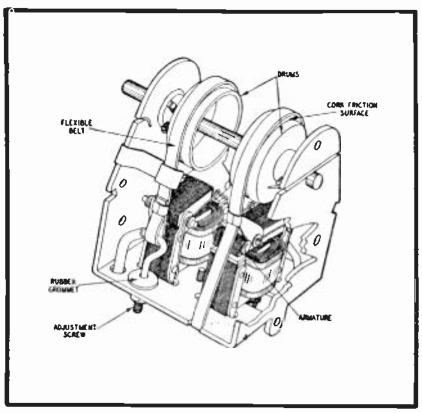

FIG. 10
THE ASSEMBLED MOTOR

A typical four-station motor-tuned system is illustrated pictorially in Fig.11, and its corresponding schematic wiring diagram is shown in Fig. 12. The following description of this system, together with a careful study of Figs.11 and 12, will serve to familiarize you with motor-tuned operation.

The induction type tuning-motor drives the variable gang condenser through a train of gears to which the motor is mechanically coupled by a quick-acting clutch. When the motor is not energized the armature is positioned slightly out-of-center of the motor's magnetic field. It is held in this position by a flat phosphor-bronze spring which also acts as a part of a jack spring switch assembly. When the windings of the motor are energized, magnetic action draws the rotor into the center of the motor's magnetic field, closing the separated parts of the clutch and actuating the jack spring switch.

The clutch performs a dual function in that it relieves the condenser driving system of the load of the motor during manual tuning and also allows the motor to coast to a stop, thereby permitting instant stopping of the gang condenser when the selecting commutator opens the motor circuit.

The selecting commutator is directly coupled to an extension of the variable condenser shaft by means of a universal coupling. In the case illustrated it consists of a series of metal discs, electrically connected to the shaft and driven by means of cupped friction washers.

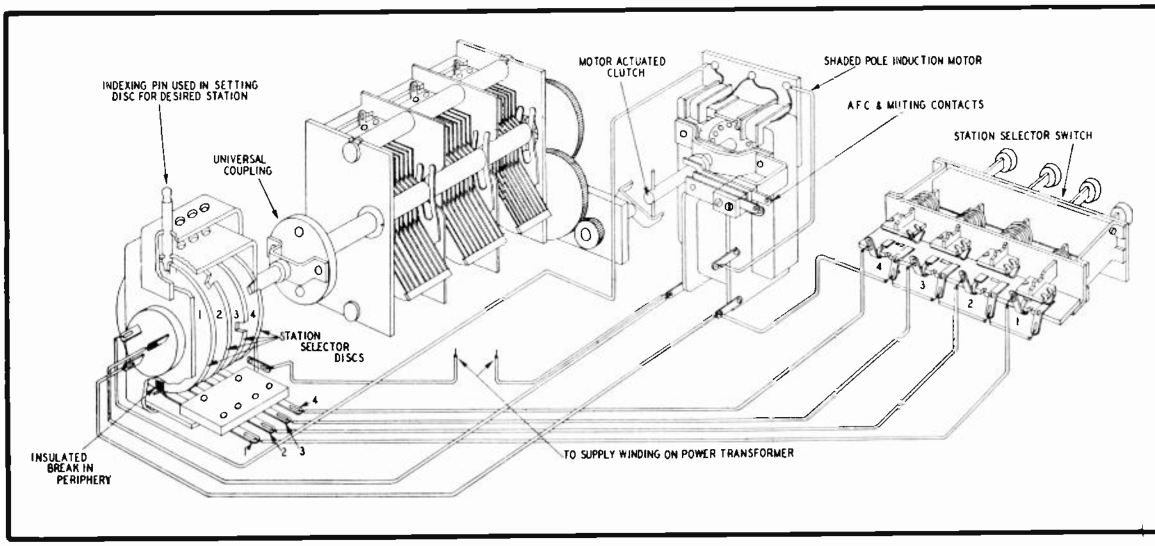

FIG. 11
MOTOR-DRIVEN STATION-SELECTING SYSTEM

A short insulated section or insert is placed in the periphery of each disc and serves to open the circuit when the disc has rotated to such a point where a contacting finger rests upon the insulation. These individual discs may be rotated with respect to their common drive-shaft so as to allow them to be set to positions corresponding to the desired station tuning points, as explained later.

SELECTING THE DESIRED STATION

Selection of the desired station is accomplished by depressing one of the station-selector buttons. A single-circuit switch is actuated by each button, and each of these switches is wired in series with one of the contactor fingers which bear upon one of the station selecting commutator discs. Since the push-button plungers engage a common latch bar, one circuit will be held closed until released by depressing another button.

As will be observed in Fig. 12, the control circuit for any one station is completed through one of the commutator discs and its respective push-button switch, the motor, reversing switch and the motor supply winding on the power transformer -- a ground return wiring system is used. Thus when a station-selector button is pressed, the motor will continue to operate until the insulation insert of the working station-selecting disc comes under the contactor-finger and thereby opens the circuit at the correct station tuning point. In the particular system shown in the illustration, a jack spring switch on

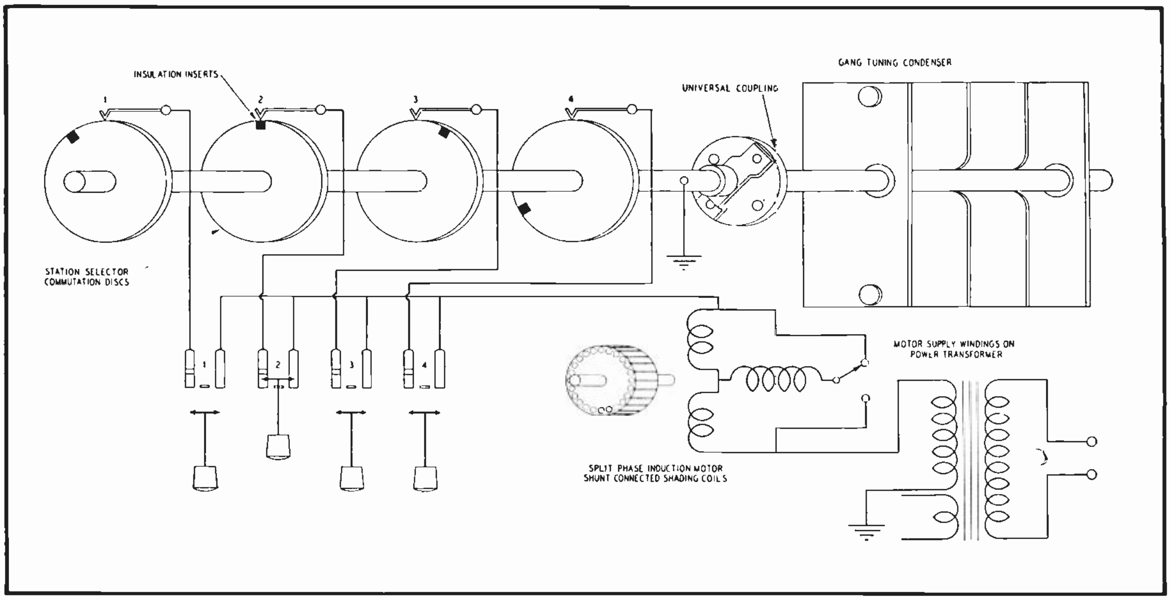

FIG. 12
SCHEMATIC DIAGRAM OF MOTOR-TUNED SYSTEM

the motor clutch silences the audio system of the receiver during the tuning process.

REVERSING THE MOTOR

Since the single-circuit discs cannot select the direction of motor rotation, a motor-reversing switch is attached to the commutator shaft. This switch serves to reverse the motor in the event that the desired station tuning point has not been attained before the gang condenser has reached its limit of travel in any one direction.

STATION ADJUSTMENT

In all motor-driven automatic tuning systems, each push-button is respectively wired to an adjustable station-selector disc, directly coupled to the variable condenser tuning gang. Pressing any of the buttons starts the motor, which in turn engages the tuning drive gear, and slowly rotates the gang condenser. The motor will continue to operate until the insulated segment of the station-selector disc interrupts the motor circuit.

When adjusting the system, any four stations may be chosen. To make an adjustment for one button -- for example, in Fig. 12 -- insert the indexing pin (a service tool) in the bracket hole above station-selector disc #1 as shown in Fig. 11, and push it all the way down to contact the edge of the disc. Tune the receiver very carefully by means of the regular manual (hand-operated) tuning control until you feel the pin drop into the notch of disc #1, and continue turning the hand-operated tuning knob until the dial station-pointer indicates the desired station. Remove the indexing pin -- push-button #1 is now set for electric tuning. The remaining three buttons are set in an identical fashion.

It is important to note that the frictional contact between the station-selector discs and the shaft permits the necessary "slippage" for setting the discs for the various stations in the manner just described. However, the frictional contact offers sufficient "grip" to prevent slippage of the discs on this shaft while tuning normally.

AUDIO SILENCING DURING THE AUTOMATIC TUNING CYCLE

While several variations of this basic system exist, provision is made in practically all of the motor-tuned systems for silencing or muting the audio system of the receiver during the time-interval required by the tuning mechanism to move the gang condenser from one station selection to another. This is necessary to prevent a bedlam of annoying sounds being emitted by the loudspeaker while tuning through the various broadcast channels until the desired station is obtained. The following methods are used to accomplish audio silencing during the automatic tuning cycle.

1. - Short-circuiting the moving coil of the dynamic speaker of the output transformer primary.

2. - Short-circuiting to ground the output of the audio section of the diode detector.

3. - Grounding to the chassis frame an audio grid.

4. - Biasing an audio tube to the cut-off point by applying an excessive negative bias.

5. - Applying a high negative bias to the r-f, converter,or i-f amplifier tubes so as to reduce the receiver sensitivity.

Tuned-Circuit Substitution Systems

The principle of these systems is to substitute pre-set tuned circuits for the usual tuning circuits with which the ganged variable condenser is used. For automatic tuning, control is shifted from the gang condenser to pre-set trimmer condensers (or iron-core tuned coils), mounted adjacent to the switch terminals of a push-button selector switch. The transfer may be accomplished in a variety of ways, either automatically by the selector switch or by a separate change-over switch. In Fig. 13 are shown front panel views of the more common change-over methods.

At (A) of Fig. 13 you are shown a method where the change-over from manual to automatic tuning or vice-versa is accomplished by turning a knob to the required position. Some receivers use an arrangement similar to that shown at (B) of Fig.13, where a single switch may be turned to any one of three positions, offering shortwave reception and broadcast reception by means of manual tuning, and also broadcast reception by means of automatic tuning. A still different method appears at (C) of Fig.13, where the change-over switch is shown in the form of a push-button, and is incorporated

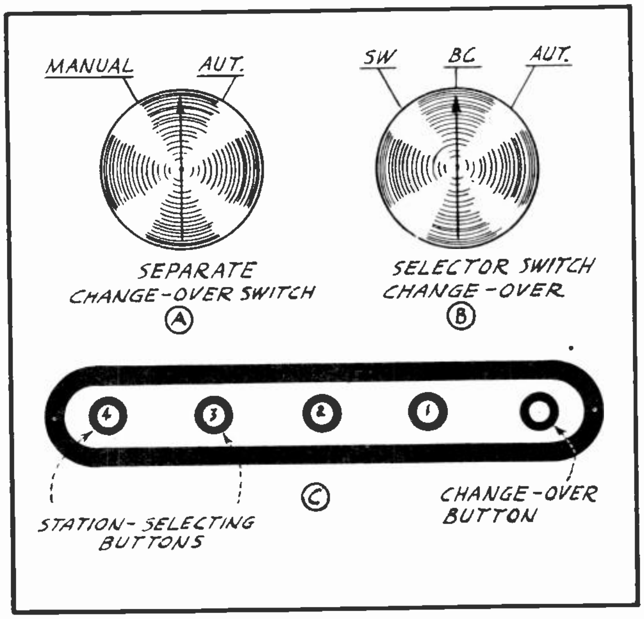

FIG. 13
TYPICAL CHANGE-OVER METHODS

in the same escutcheon (decorative plate) as the station-selecting buttons that are used for automatic tuning.

One outstanding advantage of this type of automatic tuning system is its instantaneous action. That is, response to a desired station occurs immediately upon depressing the station button, and hardly any physical effort is required on the part of the owner when depressing the various buttons.

CONDENSER-TUNED SYSTEM

A typical condenser-substitution system is illustrated pictorially in Fig. 14, while a basic schematic wiring diagram of such a system is shown in Fig. 15. A sectional view of a typical station-selector switch, as used in this system, is shown in Fig. 16.

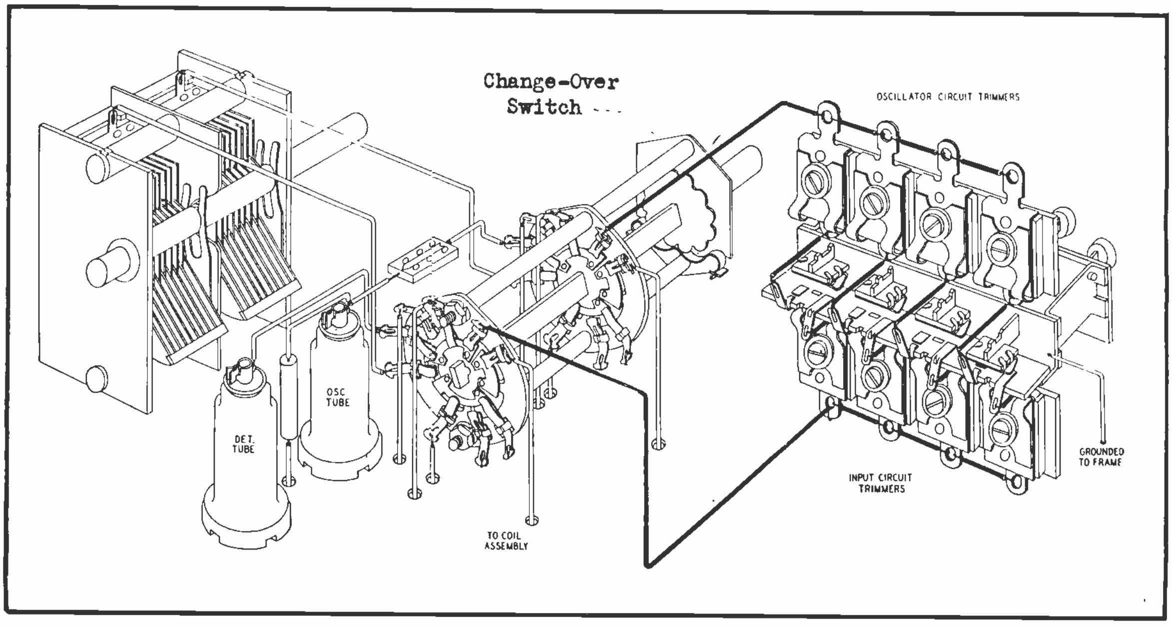

FIG. 14
TYPICAL CONDENSER-SUBSTITUTION TUNING SYSTEM

CIRCUIT DETAILS: The circuit illustrated in Fig. 15 is designed for use in a straight broadcast receiver, and the change-over from manual to automatic tuning is accomplished by special switch contacts built into and as a part of the main push-button selector switch. Such an arrangement corresponds to the escutcheon lay-out shown at (C) of Fig. 13. However, in some receivers the change-over is handled by a separate switch, as shown in Fig. 14 and illustrations (A) and (B) of Fig. 13.

By further referring to Fig. 14, you will observe that the upper bank of trimmer condensers serves to tune the oscillator grid circuits while the lower bank of condensers is used to tune the first detector circuit of a superheterodyne receiver. This particular circuit illustrates ground-side switching, with the high potential side of the trimmer condensers wired in parallel.

OPERATION OF TUNED-CIRCUIT SUBSTITUTION SYSTEMS: By referring to the circuit diagram of Fig. 15, you will observe that when the change-over switch is closed in position #2, in both the detector-grid and oscillator-grid circuits, the two sections of the gang variable tuning condenser are shunted across their respective coils, and when such a connection exists, they will operate in a conventional manner. But when the change-over switch is closed in position #1 in both circuits, the two sections of the gang condenser are disconnected from the tuning circuits, and in their place will be connected two of the small trimmer condensers, depending upon which station-selecting button is depressed.

When such a connection has been established, reception will be limited to the one station for which these condensers have been pre-adjusted. To receive a different station, a different station-selecting button must be depressed.

Due to the dual gang connection of the station-selector switch circuits, simultaneous connection is made for both the first detector and oscillator tuning circuits when only one selecting button is depressed. Although not shown in the diagram of Fig. 15, for the sake of simplicity, provisions are made whereby when transferring from one button selecting circuit to another, the preceding set of dual switch points are automatically opened by action of the selector button switch which is depressed last.

The adjustment and alignment of the trimmer condensers for automatic station selection, will be restricted to stations whose frequencies are within the tuning range of the particular set of trimmer condensers. For instance, if in Fig. 15 button #1 is depressed, only stations operating at some frequency between 1500 and 860 kc can be tuned in by adjustment of these trimmers. Similarly, when button #2 is depressed, the frequency of the desired station must be within the frequency range of that set of trimmer condensers, namely, between 1430 and 800 kc. This is because of the limited capacity coverage of com-

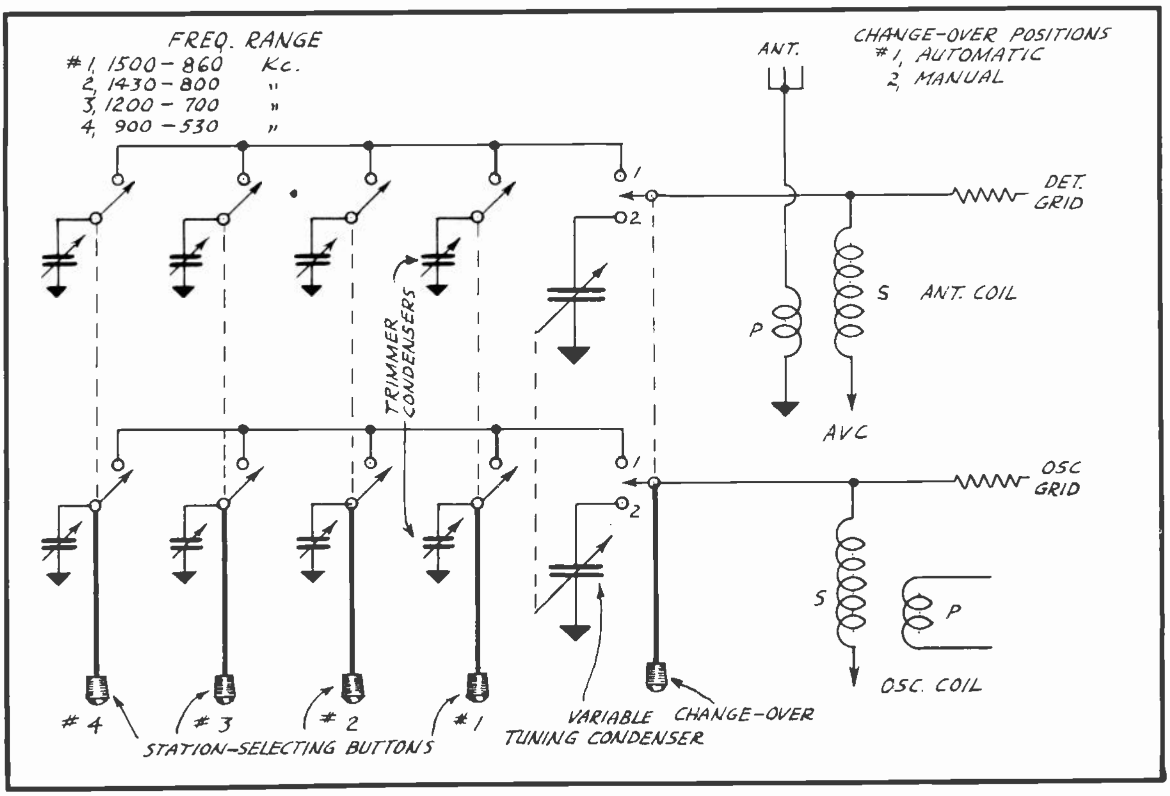

FIG. 15
CIRCUIT DIAGRAM OF TYPICAL CONDENSER-SUBSTITUTION SYSTEM

pression-type trimmer condensers, as explained in the following paragraphs and illustrated in Figs. 17 and 18.

<u>TRIMMER CONDENSER FACTORS:</u> By referring to the frequency ranges designated in Fig. 15 you will observe that the different trimmer condenser sets do not have the same frequency coverage. For instance, trimmer condenser section #1 will tune from 1500 to 860 kc, and section #2 from 1430 to 800 kc, etc.

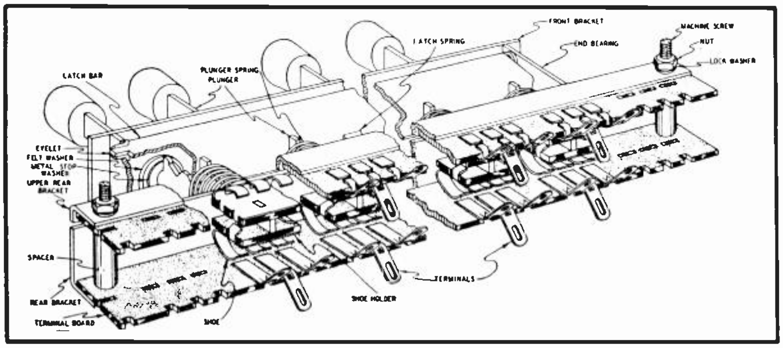

FIG. 16
SECTIONAL VIEW OF TYPICAL PUSH-BUTTON SWITCH ASSEMBLY

The reason for this is that the capacity rating of these condensers is different. Due to the method of constructing compression-type condensers, shown pictorially in Fig. 17, their capacity and consequently their frequency coverage, could never be as great, from minimum to maximum, as that of a variable condenser. So in order to properly cover the broadcast band, some of the trimmer condensers are supplied with three plates and others with as many as seven plates.

It is obvious that a condenser containing seven plates, while being capable of equaling the maximum capacity requirements of the gang variable tuning condenser, would not be able to have a similar minimum capacity value. This is because the small compression-type condenser plates cannot, from a practical standpoint, be opened sufficiently to secure such an effect. In other words, a three-plate trimmer condenser's minimum capacity might be approximately 15 mmf while its maximum capacity might be approximately 90 mmf. On the other hand, a five-plate trimmer condenser might have a capacity range from approximately 50 to 225 mmf, and a seven-plate condenser from 210 to 400 mmf.

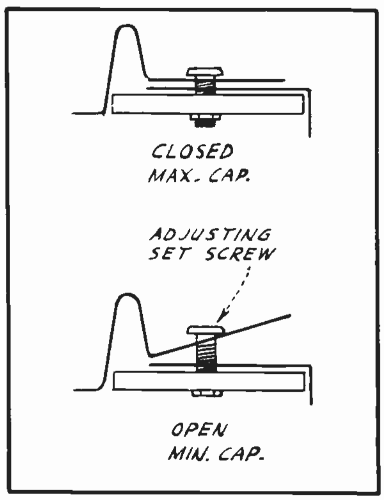

FIG. 17
TRIMMER CONDENSER SETTINGS

By referring to the capacity and frequency chart shown in Fig. 18, you will clearly understand the relation between these frequency coverages and the different sizes of compression-type trimmer condensers, where the number of plates governs the condenser's minimum capacity.

<u>STATION ADJUSTMENT:</u> As is true in all receivers of the superheterodyne type, the adjustment and alignment of the oscillator tuning circuit must be made first, followed by bringing the first detector coil circuit into the proper resonance relation. Similarly, in adjusting all such receivers having automatic tuning features, employing tuned circuit substitution methods, the oscillator adjustment must be made first, followed by adjustment of the first detector circuit.

With these facts in mind the procedure for pre-selecting a given station is as follows:

Place the change-over switch to the position for automatic tuning and press the station-selector button which controls the particular trimmer condenser group that covers the frequency range in which the desired station is obtained; follow this by adjusting the trimmer condenser of the first detector circuit until the station "comes through" clearly.

Instead of using the station signal for this purpose, it is also permissible to tune-in the signal of a test oscillator which has been adjusted to generate a frequency identical to that of the desired station.

DISADVANTAGES OF TRIMMER CONDENSERS

While the trimmer type condenser is the simplest and least expensive for this purpose, it also has its disadvantages, in that all compression-type condensers are far from being "drift proof." Although condensers of this type are "heat cycled" to prevent extensive expansion of the condenser plates, difficulty is still encountered with oscillator circuit "drift."

NUMBER OF PLATES	AVERAGE CAPACITY RANGE	APPROX. FREQUENCY COVERAGE
2	4 TO 50 MMF	1700 TO 1200 KC
3	15 TO 90 MMF	1500 TO 860 KC
5	50 TO 225 MMF	1200 TO 800 KC
7	210 TO 400 MMF	900 TO 530 KC

FIG. 18
CAPACITY AND FREQUENCY RANGES OF AVERAGE TRIMMER CONDENSERS

The term "heat cycled" means that the condenser plates have been subjected to an intense heat, generally in a hot oven, which treatment helps to prevent future expansion of the plates.

By "frequency drift," or simply "drift," is meant that the frequency to which the circuit has been adjusted varies or changes of its own accord and in this way wavers toward either side of absolute resonance. This condition naturally upsets tuning and causes the sounds as reproduced by the speaker to be somewhat fuzzy or harsh in nature.

This difficulty is not so bothersome in the antenna or detector circuits, but it is quite troublesome in the oscillator circuit. Therefore, to overcome this condition that was encountered in the earlier sets of this type -- and even today in some of the less expensive receivers -- an oscillator coil with an iron core was developed for tuning. This arrangement is explained in the following paragraphs.

PERMEABILITY-TUNED OSCILLATOR CIRCUITS

In Fig. 19 is shown a circuit diagram of a typical receiver using compression-type trimmer condensers to automatically tune the antenna or first detector coil circuit, while the oscillator section is individually tuned to a corresponding relation by means of permeability-trimmed oscillator coils. A separate coil is used for each station selected.

<u>CIRCUIT DETAILS</u>: Upon close examination of the circuit diagram in Fig. 19, you will observe that in this arrangement the receiver's regular antenna coil remains in the circuit at all times. When automatic tuning is employed, one of the trimmer condensers is connected across this coil's secondary; the main variable tuning condenser being disconnected from the coil circuit by the change-over switch.

You will further observe in this diagram that when automatic tuning is employed, the regular oscillator coil is entirely disconnected from the circuit, and one of the individually tuned iron-core coils is substituted for it, depending upon which station-selecting button is depressed at the time. The gang variable condenser is also disconnected from the main circuit during this time.

Also notice in Fig. 19 that there is a separate oscillator coil for each station selecting button. These coils are trimmed by permeability action, accomplished in the following manner.

Inserted inside of each coil is a movable portion of Polyiron, a change in the position of which will vary the inductance of the coil, and consequently the frequency characteristic of the coil.

OSCILLATOR COIL ALIGNMENT FACTORS: The stability afforded by the Polyiron (iron-core) method of alignment of the oscillator section, as compared with the usual compression-type of trimmer condenser, makes this system invaluable where oscillator frequency drift is a critical factor.

As in the compression-type trimmer condenser, the frequency range of iron-core oscillator coils is limited. For this reason, it is important that the coil with the right inductance be selected, when adjusting these coils for any particular pre-selected stations. Generally, this can be ascertained by observing the number of turns wound on the different coils. It will be found that some of the coils contained in the assembly will have more turns than others. Naturally, the more

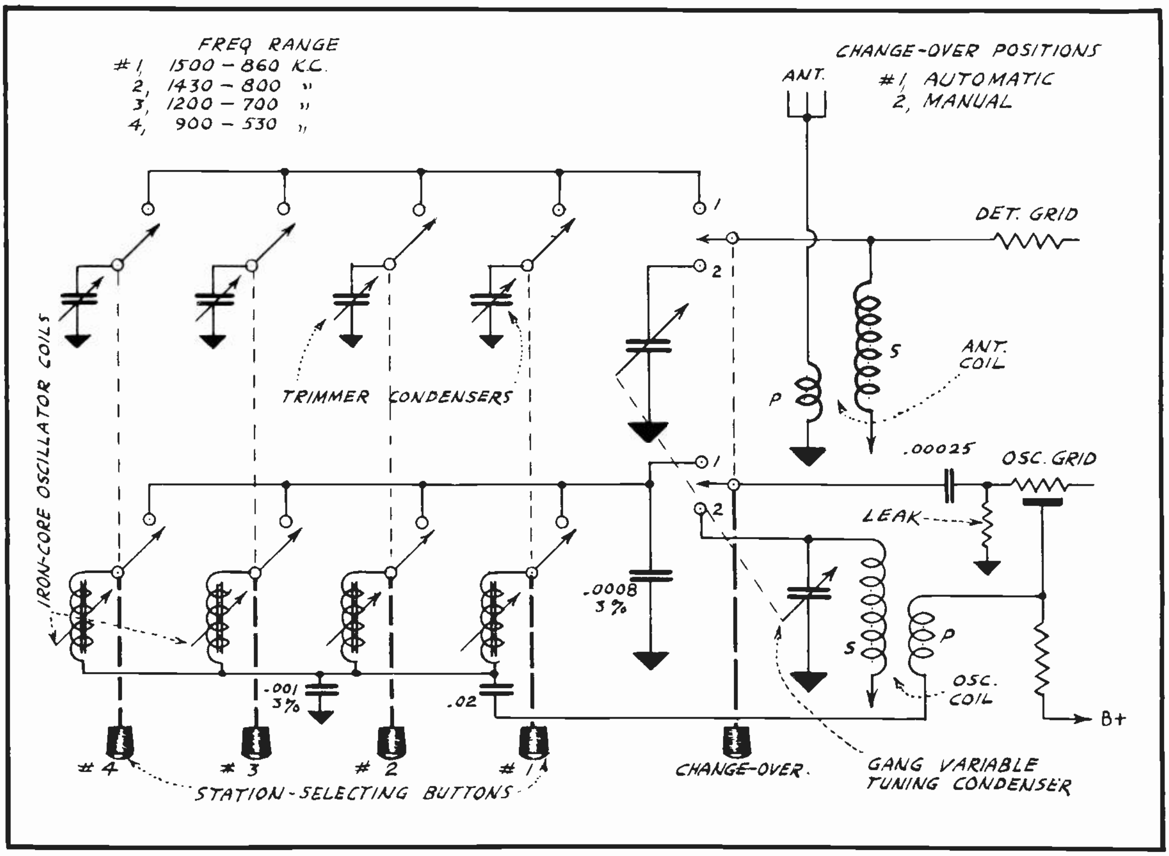

FIG. 19
APPLICATION OF IRON-CORE OSCILLATOR COILS

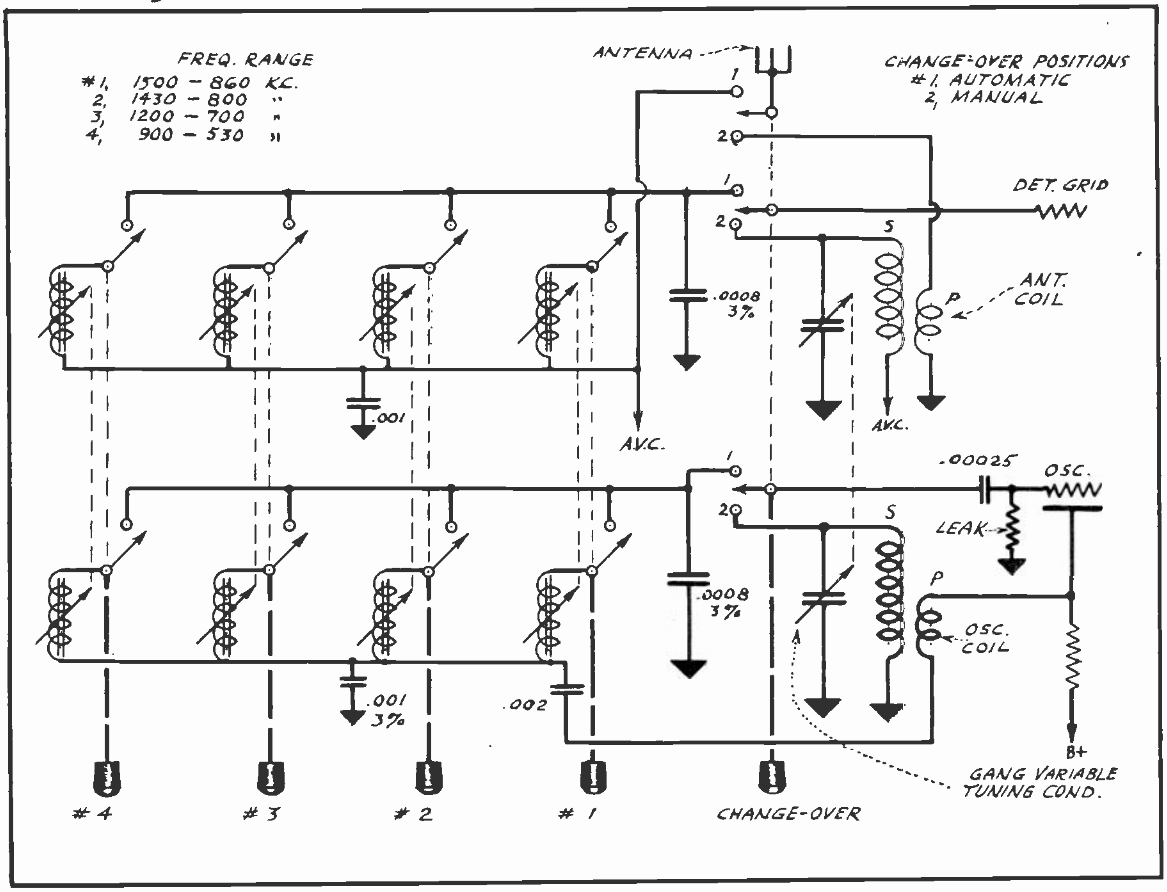

FIG. 20
AUTOMATIC TUNING SYSTEM WITH IRON-CORE COILS THROUGHOUT

turns of wire on the coil form, the lower will be the maximum frequency setting, while at the same time such a coil will not have the necessary minimum value for stations operating in the higher frequency range. These coils are therefore generally assembled according to their proportionate range.

The proper procedure by which to align this system is to first place the change-over switch in the automatic tuning position, and then to adjust the iron-core of the oscillator coil by means of the screw provided,until the desired station is tuned in. This done,bring the antenna or first detector coil circuit into its proper resonance relation by adjusting the set screw of the corresponding trimmer condenser circuit.

GANGED IRON-CORE COIL SYSTEM

Recent developments with permeability trimmed (iron-core) coils in place of trimmer condensers, have resulted in such a coil for the antenna or first detector circuit, as well as for the oscillator section. In Fig. 20 is shown such a circuit arrangement, and in Fig. 21 a two-gang coil and push-button switch assembly.

The particular switch assembly shown in Fig. 21 provides for automatic selection of four broadcast stations, change-over from broadcast reception to shortwave reception, two positions for tone control, and an a-c line switch for turning the receiver on and off. However, in this lesson we are not concerned with automatic tuning features as applied to all-wave receivers, nor with tone controls as designated in

Fig. 21. Both of these items are thoroughly explained in later lessons devoted to these subjects.

CIRCUIT AND ALIGNMENT DETAILS: Unlike the condenser and combination condenser-oscillator coil arrangement, where separate adjustment of the antenna and the oscillator circuits is necessary, here only one adjustment is required for each station selected.

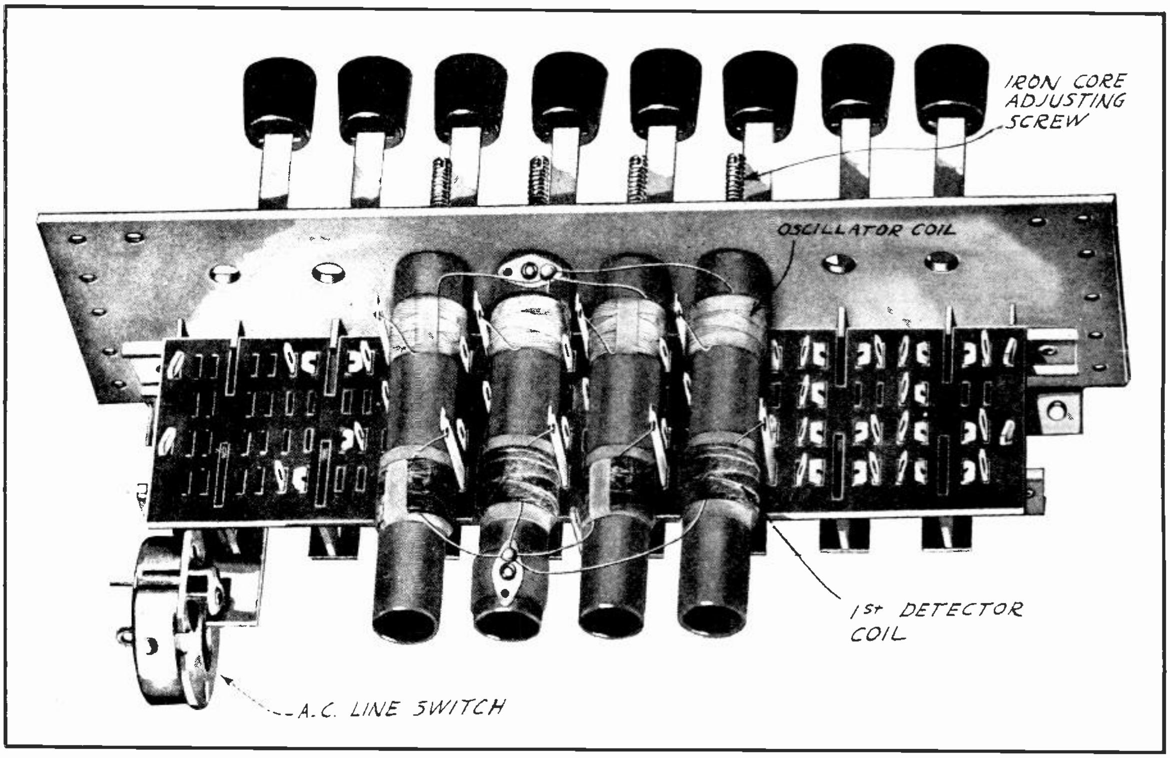

FIG. 21
TWO-GANG COIL AND PUSH-BUTTON SWITCH ASSEMBLY

Upon close examination of Fig. 21, you will observe that the first detector and oscillator windings are both wound on the same coil form. The oscillator winding is placed on the end of the form nearest the front of the assembly, and the first detector winding on the opposite end. Adjustment of both coils for any one station is made simultaneously by varying the position of the iron-core which is inserted inside the coil form. To make this possible, the design of the coils must of course be such that the correct frequency-difference be supplied by the various coil combinations to produce the required intermediate frequency.

To allow for any discrepancies that might result in these dual coil sections, and to secure perfect "tracking" or alignment of the detector and oscillator coil circuits, as well as to increase the tuning ratio, fixed mica condensers of .0008 mf capacity are shunted across each coil. In some receivers one or both of these condensers are adjustable. In either case, the tolerance must be within 3% minus or plus, or less.

TUNED-CIRCUIT METHOD FOR RECEIVERS EMPLOYING 3-GANG VARIABLE TUNING CONDENSERS

All of our explanations which have thus far been presented, relative to the tuned-circuit substitution methods for automatic tuning, have applied only to those superheterodyne receivers which use a two-gang variable tuning condenser, which is more generally the case where this method is employed. Your next step is to learn how this principle is applied to the larger receivers in which a three-gang tuning condenser is employed.

In receivers employing a 3-gang variable tuning condenser, and consisting of an r-f stage ahead of the first detector, the usual practice is to bypass the first r-f stage and to connect the antenna and the automatic tuning circuit directly to the first detector and oscillator stage. In this way the r-f stage is eliminated while the automatic push-button tuning system is in operation, although being 100% effective for manual tuning. The chief reason for resorting to this practice is that automatic tuning features in all three tuned stages would be expensive and would also necessitate considerable work and skill in aligning and balancing in order to get so many substitution tuned circuits to work together correctly.

In Fig. 22 is shown a typical trimmed condenser circuit diagram for sets employing an r-f pre-selector stage and a 3-gang variable tuning condenser. Here you will observe that when the change-over switch is in position #1,the antenna is connected to the primary of the first detector stage coil through the .0005 mf coupling condenser. In this way the r-f stage is not used when automatic tuning is employed, thus simplifying the procedure.

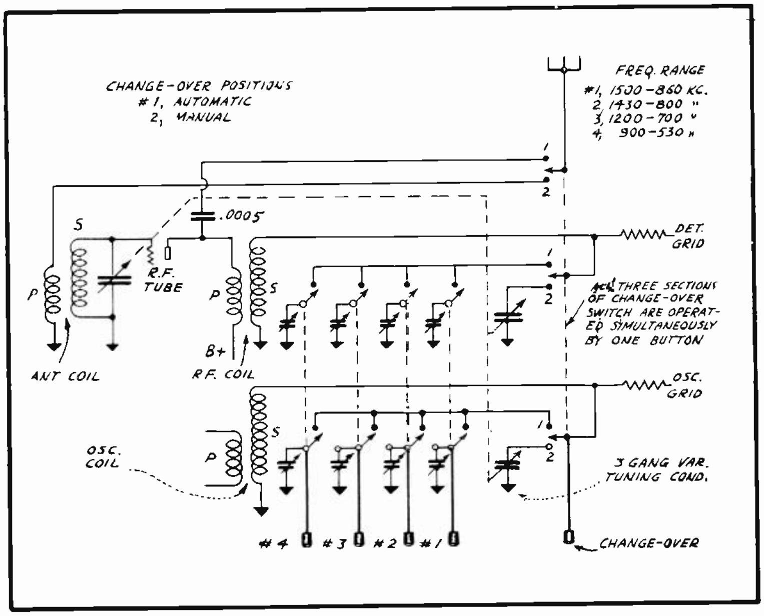

Fig. 22
Circuit Diagram of Typical 3-gang Automatic Tuning System

When manual tuning is employed, the change-over switch in Fig. 22 is closed to position #2, which disconnects the automatic tuning system from the circuit, connects the oscillator and first detector sections of the variable gang condenser into circuit, and also connects the antenna directly to the primary winding of the antenna stage coil.

PERMEABILITY TUNING

Due to the success of iron-core tuned coils in automatic tuning circuits of the type just described, considerable effort has been expended by receiver engineers to adapt these coils to circuits whereby the tuning could be varied from one end of the broadcast band to the other,the same as accomplished by the variable condenser. The idea was to eliminate the variable tuning condenser from the circuit entirely, and to use in its place a ganged group of variable iron-core tuning coils whose tuning range extends throughout the broadcast band. This is known as continuous permeability tuning, and a circuit illustrating this feature is presented in Fig. 23.

Upon inspection of the circuit diagram in Fig. 23 you will observe that two such coils are used,one for the antenna-detector circuit and one for the oscillator circuit. You will further notice that no main variable tuning condenser gang is employed. However, two trimmer condensers are connected across each coil to properly align it. Fixed condensers of .00003 mf value are also shunted across each of these coils to increase the tuning ratio.

Continuous variable tuning of these coils through the standard broadcast band is accomplished by moving the iron-core material in or out of the coil forms. In this particular circuit, an electron-coupled oscillator is employed; this is shown in the diagram by use of the shunt coil. When the iron-core material is moved in or out of the oscillator tuning coil form the inductance, and consequently the frequency coverage of this coil, will change accordingly. Since this coil is connected in parallel with the shunt coil, through the coupling coil, the frequency characteristic of the shunt coil is altered. By properly designing these coils, they were made to tune through the wave band correspondingly, the same as a conventional coil and variable condenser.

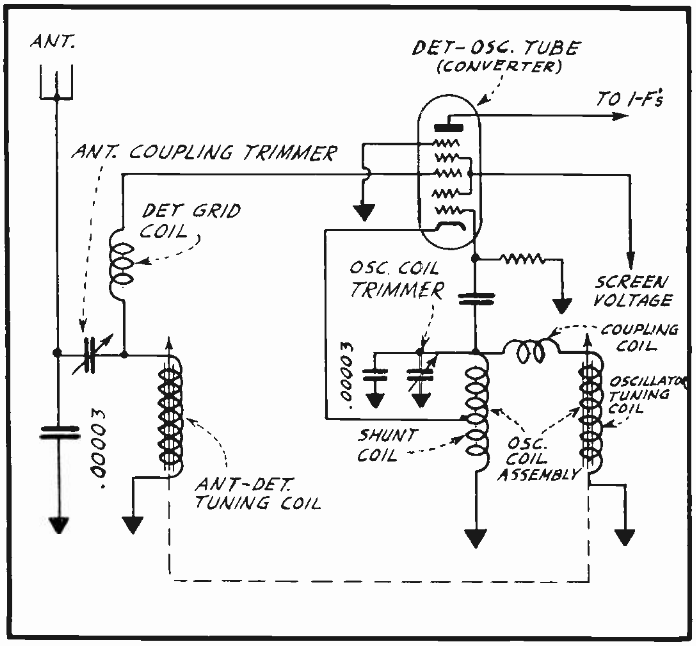

FIG. 23
CONTINUOUSLY-VARIABLE PERMEABILITY-TUNING CIRCUIT

In the detector section, the oscillatory circuit consists of the detector grid coil and the antenna coupling trimmer, the latter serving as an antenna coupling condenser and a tuning compensating condenser. The iron-core tuning coil in this case is connected in a combination series and parallel arrangement with the detector section input. Therefore, by altering the position of the iron core within this tuning coil, the variation in inductance of this coil will be reflected upon the grid coil circuit and will thereby control the frequency characteristic of this circuit, the same as is the case in the oscillator section.

It was also found that these tuning adjustments could be successfully ganged together the same as in a gang variable tuning condenser. This is shown by the dotted lines in Fig. 23.

AUTOMATIC PERMEABILITY TUNING

In Fig. 24 is shown a bird's-eye-view of this tuning assembly. Here it will be observed that rotation of the manual tuning knob will cause the two iron cores to move, through a train of gears and levers, in and out of their respective coil forms simultaneously. Notice especially that one set of tuning coils is employed for the reception of all stations, and not a separate set of coils for each station as was the case in the previously described push-button tuning systems using iron-core coils.

It is only natural that the next step in the development of circuits employing this system would be to adapt them for automatic push-button tuning. This is accomplished by fastening the iron-core material of each coil to a common plunger bar, which is in turn made adjustable to certain pre-set station positions. The method of accomplishing this is also clearly shown in Fig. 24, and in the end-view in Fig. 25.

As will be observed in Fig. 24, five adjustable cams are assembled on the main control shaft -- one for each of the station selecting push buttons. An arm is fastened to each button lever; the latter will come in contact with the flat side of one of the cam-ends when the button is depressed. The cam will thereby be rotated to a vertical position, and its motion stops when the opposite cam-end falls flush against the corresponding side of the button lever arm as shown by the solid line in Fig. 25.

Since the cam is locked to the shaft, rotation of the cam will simultaneously rotate the gear mounted on the end of the common shaft. This will in turn move either forward or backward, the rack plunger

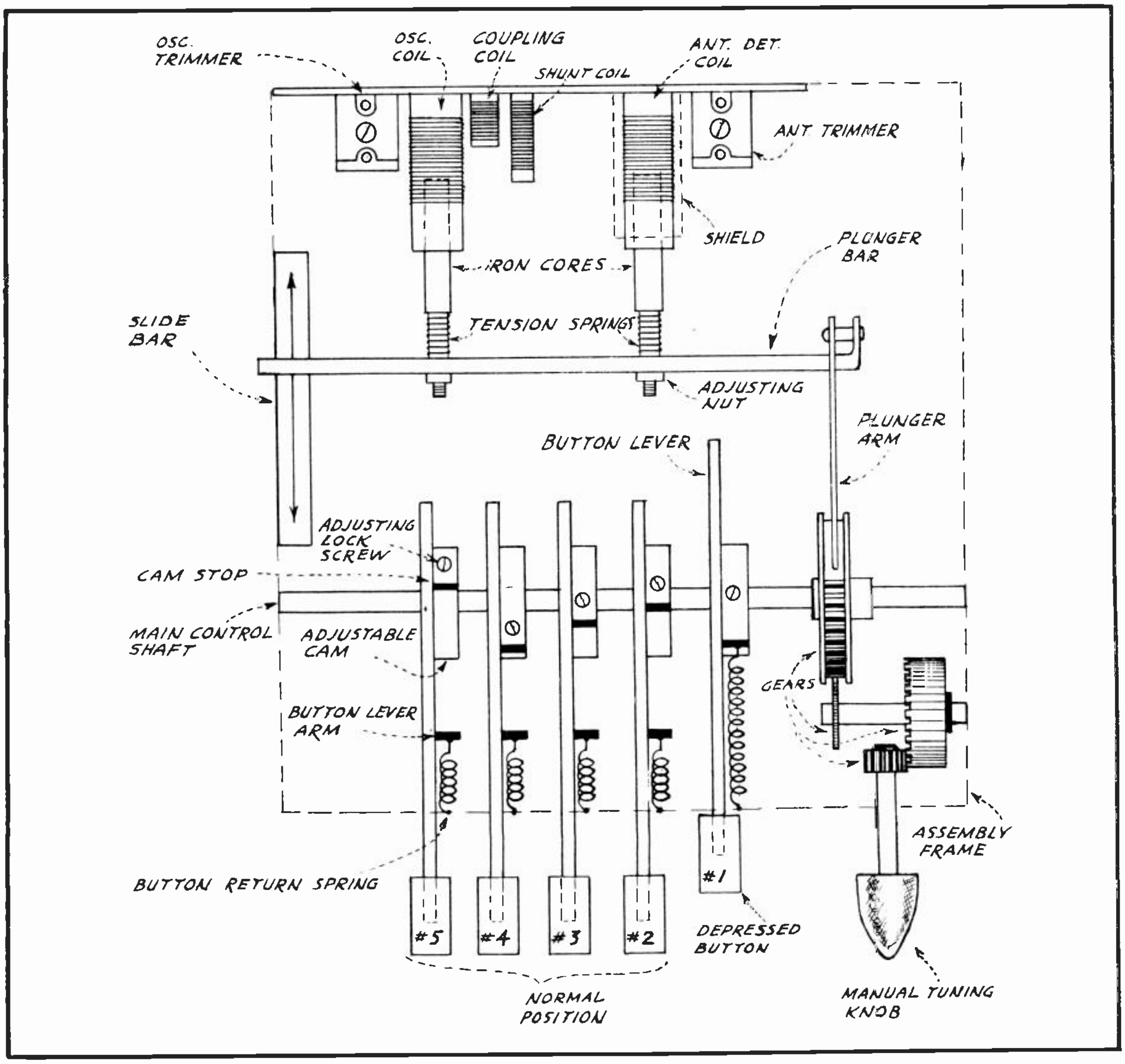

FIG. 24
AUTOMATIC PERMEABILITY-TUNING CIRCUIT

arm that is directly fastened to the plunger bar controlling the movement of the iron-core material. The frequency response of the coils is thereby varied.

STATION BUTTON ADJUSTMENT: To adjust a station-selecting button for a desired station, first tune-in manually the particular station desired. Then loosen the corresponding cam-adjusting lock screw. It is important that the button be held in when loosening or tightening this set screw.

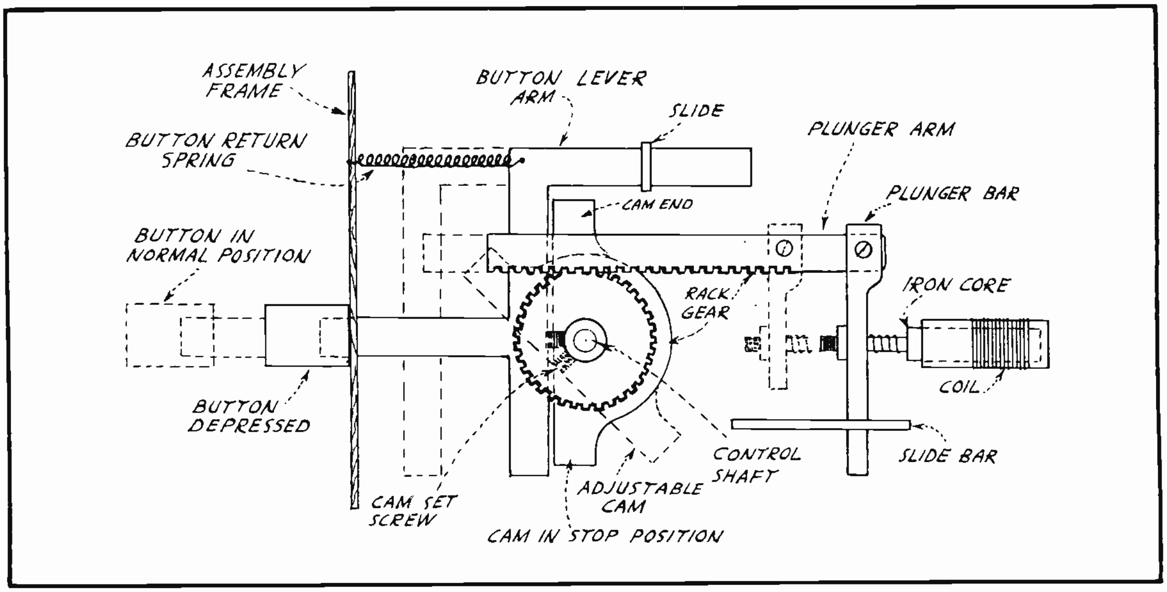

FIG. 25
CUTAWAY END-VIEW OF PERMEABILITY TUNING MECHANISM

In order to secure an accurate set-up, rock the manual tuning knob back and forth slightly until the station is tuned in clearly, and with maximum volume. Do not release the push-button during this time. With the push-button still held down firmly, and the station accurately tuned-in, tighten the lock screw securely and release the button. For other push-button adjustments repeat this same procedure.

SUGGESTIONS FOR SERVICING AUTOMATICALLY TUNED RECEIVERS

The purpose of this lesson, and the presentation of the study of automatic tuning, has been to give you a broad and comprehensive review of the various basic systems now being used. The following general service suggestions as offered are applicable to all makes of receivers featuring automatic tuning and are worthy of consideration.

1. - When setting-up the automatic tuning system for the reception of desired stations, first make certain that the alignment of the i-f and r-f circuits is precise, since the quality of reception and satisfactory signal-to-noise ratio are dependent on precision and resonance.

2. - It is highly desirable to use visual means for alignment of the oscillator and detector circuits when making the adjustment for the desired station to be selected. (The receiver's cathode-ray tuning indicator, an output meter, or other similar device may be used to indicate resonance.)

3. - In making a choice of the stations to be selected, it is important to select only those which are sufficiently above the noise level as to furnish satisfactory entertainment at all times.

   An interesting bit of owner-psychology is involved in the consequences of improper choice of stations. The purchaser of a new automatically-tuned receiver is not acquainted with the phenomena of drift of stations due to temperature, mechanical aging of parts, humidity drift, frequency drift due to voltage instability, etc. Nor is he apt to be sympathetic with the vagaries of fading signals and adjacent channel "chatter."

4. - Allow the receiver to operate for at least fifteen minutes before making the station-selector adjustments. This will allow the radio chassis to attain normal operating temperature, with the voltages at their final values. During this period the oscillator frequency gradually drifts as tuned circuit elements and tubes warm up, and their component parts expand.

   Certain parts of the receiver cause the oscillator to have a positive frequency drift with increasing temperature; other parts cause the frequency to decrease with increasing temperature. These two effects, unfortunately, are not balanced. Although some receivers provide compensating means for this action, yet in spite of this feature, it is wise to allow a reasonable warm-up time to elapse before making the final adjustments.

5. - Make a check-up after a few days have elapsed, to correct any drift tendencies which may have made themselves evident due to mechanical and aging effects. After this second adjustment, most receivers will have reached a final condition of operation which will continue to give satisfactory performance.

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EXAMINATION QUESTIONS

LESSON NO. 30

1. - Name and describe the three principal automatic tuning systems most commonly used at the present time.

2. - (a) What are the two outstanding advantages of the condenser tuned-circuit substitution type of tuning as compared to the other methods?
   (b) What is the main disadvantage of trimmer type condensers as employed in automatic tuning circuits?

3. - What is the procedure for selecting the desired station in tuned-circuit substitution systems?

4. - State briefly the essential difference between the telephone dial type and the cash register type of mechanical tuning.

5. - Describe briefly three change-over methods as used in tuned substitution type circuits, and explain their function.

6. - (a) Why is audio silencing employed in some types of automatic tuning systems?
   (b) Name several methods for accomplishing this.

7. - (a) What is meant by "permeability tuning?"
   (b) What is its chief advantage over other types of tuned circuit substitution systems?

8. - (a) In receivers employing the tuned circuit substitution principle, why are only the mixer circuits generally controlled automatically?
   (b) Draw a circuit diagram showing the usual connections.

9. - In "setting-up" the automatic tuning system for the reception of desired stations, why is it recommended that the receiver first be warmed-up?

10. - What method is usually employed in motor-operated types of automatic tuning systems to adjust the receiver to the desired stations?