Socket-Powered Radio

By

Walter E. Holland

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WHEN the first "B" socket power units appeared on the market about three years ago, it was freely predicted that similar "A" units would be developed and bring about batteryless radio operation from the light socket. It was soon found, however, that for "A" power to operate standard receiving sets with the tube filaments in parallel circuit, the principles and means used successfully for "B" socket power were inapplicable. "A" socket power development followed a different course and the "A" battery is still with us, as a part of the successful "A" socket power unit.

There was an unfavorable reaction on the part of dealers and the public when it was found that the first "B" socket power units had numerous limitations and in many cases developed serious trouble. The rectifier tubes were found to be unreliable and short-lived. The high resistance of the filter choke coils and rectifier, the inadequate output and the lack of proper voltage-regulating means limited the application of the units to a certain few radio sets. There was also much trouble with condensers. These difficulties have all been overcome. Socket-powered radio last season was accepted by the trade and the public alike as "recommended practice." This season it is destined to become "standard."

Present "B" socket power units all operate on the same principle, namely, that of using current directly from the socket by first rectifying it to the direct form and then smoothing out the ripples. The essential elements of this device are a transformer, a rectifier, one or more choke coils, condensers and voltage-regulating means. "B" socket power units made by different manufacturers vary chiefly as to the kind of rectifier used and the method of regulating the output voltage to compensate line voltage variations and to suit the plate requirements of the different tubes in the set.

Means for regulating the output voltage are required so that the desired overall or power-tube voltage may be obtained at different A. C. line voltages over the commercial range of 105 to 125 volts and at different values of load current depending upon the number and kind of tubes in the set. Means are also needed to reduce the overall voltage to the lower voltages required by the other amplifier and detector tubes.

For voltage regulation, different manufacturers use different combinations of variable and fixed resistors and in some cases a voltage regulator tube. With two or more variable resistors to adjust, the chances are that the installer, unless he have uncommon knowledge and good high-resistance meters, will have great difficulty in adjusting the voltages at the several output terminals to the best values. To adjust the voltages properly without a meter is almost impossible because a change in the setting of one resistor necessitates a resetting of the other resistors and if the resistors are changed in the wrong order the results will be bad. On the other hand, if the intermediate plate voltages are set by means of a fixed shunt resistor with taps, the system is too inflexible to take care of ordinary variations in tubes and sets to give best results. The most satisfactory arrangement appears to be a single variable resistor designed to give 70 to 90 volts over a wide range of current for the intermediate amplifier tubes, with a suitable fixed resistor in series to reduce the voltage further as needed for the detector. Calibrated transformer or resistor taps provide a fixed setting to take care of different line voltages and numbers of tubes. With this system it has been found perfectly practicable to adjust the voltages by ear to the best values for any given set. No meter readings need be taken and when the voltages are once set they need never be changed.

The filter condensers have been a source of much trouble in "B" socket power units. Condenser breakdown has been the result, chiefly, of manufacturers using condensers that were not designed to withstand the maximum voltages to which they were subjected in use. In other cases the trouble has been due to improper control of the details of manufacture of the condensers or the use of poor materials as a result of the rapid expansion of condenser production which was required to meet the demand. The standardization of ratings and methods of testing condensers, together with the generous exchange of information by the members of the Condenser Committee of this association, should be very helpful in preventing misapplication and trouble in the future.

Most of the breakdown trouble has occurred where condensers were used with tube-type rectifiers requiring a relatively high transformer voltage for a given output voltage under load. With electrolytic rectifiers, lower transformer voltages may be and are used and condenser breakdown is very rare. Out of approximately two and one-half million condenser sections used in the "B" filter circuit of socket power units by one manufacturer during the past two years, only 250 sections or one one-hundredth of one per cent are known to have broken down in use.

Experience with filter condensers used with different types of rectifier forces the conclusion that the use of a full-wave electrolytic rectifier protects the condensers from strain, not only by lowering the transformer voltage for a given output voltage but by absorbing voltage peaks. A group of electrolytic rectifier cells connected in bridge circuit across the transformer seems to act as an electrical shock absorber in respect to the filter condensers.

The old prejudice against wet rectifiers has been overcome by a type of aluminum rectifier having a harmless electrolyte solution and requiring no additions of water. This type of rectifier is inexpensive and has a guaranteed life of 1650 operating hours. This guarantee is conservative, numerous tests having shown the average life to be well over 2000 hours, or two years of average service. A large number of these rectifiers have been in regular service more than two years without even dropping off appreciably in output voltage. These rectifiers are so reliable, so simple in construction and the manufacture is so easy to control that there are practically no defectives or early failures. Approximately two million aluminum electrolytic rectifier cells of one make are now in service in the "B" circuit of socket power units, yet only about 6 per cent as many have been shipped separately for jobber and dealer stocks and for replacement. The difficulty is to get the dealers to stock them, so small has been the demand for replacement cells to date.

Aluminum electrolytic rectifiers are free of noises such as often develop in certain types of tube rectifier. Connected in bridge circuit for full-wave rectification, they by-pass some of the alternating current which would otherwise get into the output circuit and deliver a form of direct current that is easy to filter. They are efficient and economical of current owing to their low internal resistance and for the same reason will give a flatter voltage curve than tube rectifiers over the range of plate current required for different receiving sets. This better voltage characteristic is important not only in building a "B" socket power unit to operate different radio sets but also in a given set where the volume control is obtained by regulating the filament temperature of one or more radio-frequency tubes. This more-or-less standard method of controlling volume will often vary the total plate current by a large percentage and if the "B" socket power unit has a steep voltage-current characteristic, the plate voltages are likely to vary so much that distortion or inferior reception will result.

It is possible to build "B" socket power units with full-wave electrolytic rectifiers for high output voltages by connecting the direct-current outputs of two or more bridge groups in series. There are now in commercial production "B" and "AB" combination socket power units which will give 180 volts at currents up to 60 milliamperes. The same units will give 220 volts at about 40 milliamperes, thus providing sufficient margin for a 40-volt grid bias in addition to 180 volts for a power tube where it is desired to use the resistance method of grid biasing. These units have safety switch protection and comply with Underwriters' Standards in all respects.

A great deal of experimental work has been done in an attempt to develop an "A" socket power system along the lines of the "B" system, that is, one providing filtered, rectified current direct from the socket. For the large currents required for receiving sets using the standard large tubes with the filaments connected in parallel, the cost of choke coils and condensers needed to properly smooth out the ripples is so great as to be prohibitive. Electrolytic condensers, storage batteries or other forms of electrolytic cell may be substituted for paper condensers in the filter circuit but even then the cost remains much too high. Furthermore, the advantages of a direct-from-the-socket unit with an electrolytic cell filter circuit are not apparent and the performance questionable.

There is also a difficult rectifier problem in such a unit. The rectifier must be of a type that will deliver the total required filament current plus an excess to feed the shunt paths in the filter circuit and it must deliver this current at a voltage considerably in excess of that required by the tube filaments to allow for the voltage drop in the choke coils. Gas-filled rectifier tubes of the Tungar or Rectigon type fulfill the requirements as to current and voltage but unfortunately have the disagreeable habit of developing oscillations which tune in on the radio set and come out of the speaker as noise. Buffer condensers connected across the rectifier will reduce but will not always eliminate the noise.

It has been found that the filament circuit is much more sensitive than the plate circuit to line disturbances or noises and voltage fluctuations. Line disturbances which have little or no effect on the set operation with a "B" socket power unit may cause bad noise when operating with a direct-from-the-socket "A" unit. Likewise the usual small voltage fluctuations in the house current supply which occur at frequent intervals even in the best regulated cities may cause a large increase or decrease in volume with a direct-from-the-socket "A" unit where there would be no perceptible change in volume with a "B" socket power unit under the same circumstances. This great change in volume with a small variation in line voltage is particularly noticeable when using a set with the radio-frequency tube filaments turned down to reduce the volume of a local broadcasting station. Under such conditions, using a direct-from-the-socket "A" unit, the volume change produced by a rise or fall of only one volt in the 115-volt A.C. supply may be so great as to be very annoying while a change of two volts may cause almost complete fading or blasting loudness.

In a direct-from-the-socket "A" unit for paralleled filaments, the transformer, rectifier and other units must of necessity be so large that serious problems are introduced in connection with ventilation to carry off the heat as well as in regard to the prevention of hum from magnetic coupling between the power transformer and the audio transformers or other units of the radio set.

For special receiving sets having the tube filaments connected in series, the problem of providing satisfactory "A" power direct from the socket is somewhat simpler and several such sets with built-in power equipment are on the market. Of these the only ones that have been sold in any quantity are limited to the use of the small low-power tubes. Recently there have appeared similar sets with standard quarter-ampere tubes using certain new types of tube rectifiers as the means of obtaining direct current for both the "A" and the "B" circuits. These rectifiers have yet to prove themselves. The large high-voltage-test condensers and the large choke coils required in the filter circuit are very costly if properly designed and built to stand up under the rather severe operating conditions. It seems to be generally accepted that to use series filaments some compromises in design resulting in less satisfactory performance of the radio set are necessary. The latter fact, together with the many difficulties inherent in a direct-from-the-socket "A" power system, makes it an open question how successful this kind of socket-powered radio will prove.

Radio advance needs to be stabilized. The trade and the public are for complete elimination of batteries only if and when equal performance is realized and new sources of trouble are not introduced. It will pay to make haste less rapidly. Manufacturers who try to reach the ultimate at one leap without going through the usual necessary period of development and testing are courting failure. The successful automobile manufacturers have their proving grounds where new features and models are subjected to every conceivable test before adoption. Even then, as we all know, some mistakes in cars get through. Thorough testing is even more necessary in an industry as intricate and delicate as radio. It is not profitable to rush the development and skimp the testing just to bring out something new ahead of a competitor. It is better to be right than first.

The only proven "A" socket power unit for the operation of standard parallel-filament receiving sets is generally known as the trickle charger type. For convenience this may be called the indirect as distinguished from the direct-from-the-socket type of unit. In the indirect unit a small special type of storage battery stores the energy of light-socket current delivered to it when the radio is out of use by a low-rate rectifier or trickle charger. The battery gives up the stored energy to the filaments and the trickle charger is disconnected when a master switch on the socket power unit is thrown. The master switch is usually connected to control both the "A" and the "B" power as well as the filament circuit of the set and may be either a manual or a magnetic switch. This system of "A" power, of course, is applicable to standard radio sets of all kinds. There can be no hum from ripple or rectifier oscillation in the "A" power and induction troubles are avoided since the alternating current is entirely disconnected from the battery and charger when the radio is in use. The charging transformer and rectifier are kept to a minimum size and cost because the current rate is kept very low by spreading the charging over the entire time between periods of use of the radio.

The success of this type of "A" socket power unit depends largely upon having a battery of proper design. The battery should have perfect sealing and a vent construction that will absolutely prevent any acid spray passing out. The vents should also be designed so that when the solution level becomes low water may be added to the cells without removing the vent caps. The battery container should be transparent for convenience in adding water to the correct level. Space for a relatively large volume of solution above and between the battery plates should be provided to make a "camel battery," that is, one that will go a long time without a drink. Most important of all the battery should have built into it a visible charge indicator that will tell at a glance whether the trickle charger is delivering enough current to it to make up for the current drawn by the tubes so that it will keep charged.

A convenient means of adjusting the trickle charge rate should be provided so that the charging current may be reduced to the lowest point that will keep up the battery as shown by the charge indicator. This will not only save current and prolong the life of the rectifier but will greatly extend the time that the battery will operate without needing water. Where the correct adjustment of the trickle charge rate is possible, a properly designed battery will operate for several months without needing water. It is important to provide for the adjustment of the trickle charge rate over a wide range on account of the great variation in the filament current requirements of different radio sets and in the hours' use of the set by different individuals. The highest charge rate setting should be one that may be used to bring up the battery quickly after two or three successive days of exceptionally long use. Experience has shown that while a trickle charge rate of 0.3 ampere will take care of average requirements, it is necessary to provide a rate of 1.0 ampere to take care of maximum requirements of users of big sets.

Practically the only difficulties that have arisen in connection with the indirect or trickle charger type of "A" socket power unit have been due to the failure of the user to add water to the battery. This was also a problem when batteries were first used on automobiles. In radio as well as in the case of the automobile the difficulty has now been quite generally overcome through education of dealers and the public. The household duties of many women include the frequent watering of plants. It would be no great hardship to extend their household duties to include the as-easily-done watering of a battery once every one to three months.

The indirect type of "A" socket power has been combined very successfully with the "B" socket power system to make a compact single unit. A single transformer large enough to take care of the "A" power requirements is wound with separate "A" and "B" secondaries. When the "A" secondary is loaded, the "B" secondary is not and vice versa. Thus the relatively small cost of the "B" secondary is substituted for the cost of the complete transformer required in a separate "B" unit. The combination results in other economies in the housing and wiring. These "AB" combination units are now being built with relay switches which control both the "A" and "B" power through the operation of the regular switch on the radio set. Such socket power units are especially suitable for use in console models. A receiving set equipped with an "AB" socket power unit of the type described can be sold at a very attractive price.

There are many advantages to the radio set manufacturer in socket power employing the indirect "A" principle. No compromise in set design is required and no special models need be built for operation from the light socket. Parallel-filament sets must be made in any case for battery operation in unelectrified homes and the same identical sets may be sold for light-socket operation. The resulting standardization of production and stock is, of course, of great advantage to any manufacturer but especially to one whose principle it is to give the most for the money. Even where the manufacturer desires to list a completely equipped socket-powered model, there are great advantages in production and cost in using a standard set chassis in combination with a standard socket power unit of the type described. The same model may then be used in an unelectrified home by replacing the socket power unit with batteries.

The larger manufacturers of socket power units have taken care to educate and equip a national corps of service specialists and the set manufacturer using standard socket power equipment may, if he desires, be relieved of all service on power equipment.

To the trade the advantages of selling proven socket power equipment that is nationally known and serviced are equally great. There is too much uncertainty in radio merchandising at best and the wise jobbers and dealers are handling only standard socket power units that have demonstrated their ability to operate properly all standard radio sets and that have also been tested and listed as safe by the Underwriters' Laboratories.

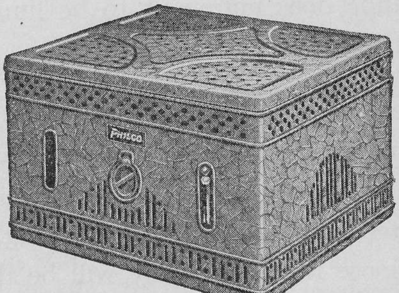
Jobbers and dealers preferably should not be subjected to the burden of stocking one line of radio sets for electrified homes and another line for unelectrified homes. Nor should they be expected to carry special socket power units applicable to only one kind of set.

The demand of the radio public is for convenient and dependable operation of the radio set from the light socket without sacrifice of tone quality or radio performance. The listening public is getting more and more critical of performance and will not tolerate distortion or hum. Quality not only must be retained but must be improved. Furthermore, the public does not want to be limited to low-power or so-called dry cell tubes.

So far, economy of operation has not been a major factor in radio. The prospect has bought the best set he could afford or, in many cases, the set his friends talked about whether or not he could afford it, and has not counted the costs. This is passing, With more and more good sets to choose from, economy will be the deciding factor in many cases.

It is to the advantage of the customer to purchase standard socket power equipment that may be used to operate any good radio set. He is then free to choose his set on its merits alone rather than to choose some special set because it is designed for light-socket operation. He is also free to change to another set if he desires without sacrificing his investment in the power equipment.

Present radio receivers with standard tubes, socket-powered with the present indirect system of "A" power and good rectifier-and-filter "B" power, set a very high standard of performance, convenience and economy. With this high standard established as a criterion, together with the great commercial advantages, it is not likely that A. C. tubes or other new devices will quickly supplant the present tried-and-true system. The A. C. tube, no matter how good it may be in its ultimate development and application, can only closely approach or, at best, equal present standards of performance. It is not within the bounds of probability that it will attain such perfection without going through a long period of quantity production and application.



Philco "AB" Socket Power