Courtesy 1927 ARRL Handbook

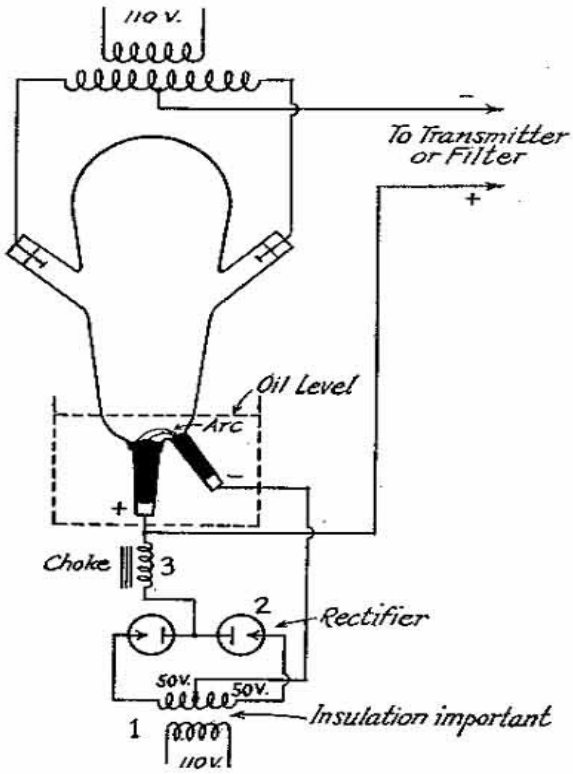
MERCURY ARC RECTIFIERS

Mercury arc rectifiers operate similarly to the gaseous conduction tubes previously described, the operation depending on mercury vapor. A cold mercury arc tube is quite highly evacuated. The arc in mercury vapor takes place between a cold positive upper electrode (anode) and a pool of mercury constituting the lower negative electrode (cathode). This mercury pool is incandescent where the arc strikes and the tube is usually tilted to start the arc. The load of the rectifier usually keeps the mercury pool at a high temperature which is very necessary to keep the arc properly rectifying as if the "hot spot" on the pool is allowed to cool off the arc will go out.

The mercury arc rectifier will handle over six thousand volts and in commercial use mercury arcs are sometimes built to handle much greater potentials. The life of a mercury arc tube is about the same as that of kenotrons—sometimes much greater. At a number of amateur stations tubes have been installed, obtained for little or nothing from the local electric light company that discard them after they begin to operate unsteadily in a series street lighting system. Such tubes will still serve as rectifiers for an amateur plate supply source for UV203A's or for a UV204A for years providing they are once installed correctly at a "ham" station. The efficiency of such rectifiers is very high, there being a negligible drop in plate potential within the tube. The overall efficiency of course is lowered an amount depending on the "keep-alive" circuit used and the instantaneous load values on the tube. Mercury arc rectifiers are easy to filter, too. The device used for keeping the hot-spot

on the mercury pool and the inductance for keeping the tube operating stably will be most of interest to Handbook readers.

The "keep-alive" circuit is necessary for



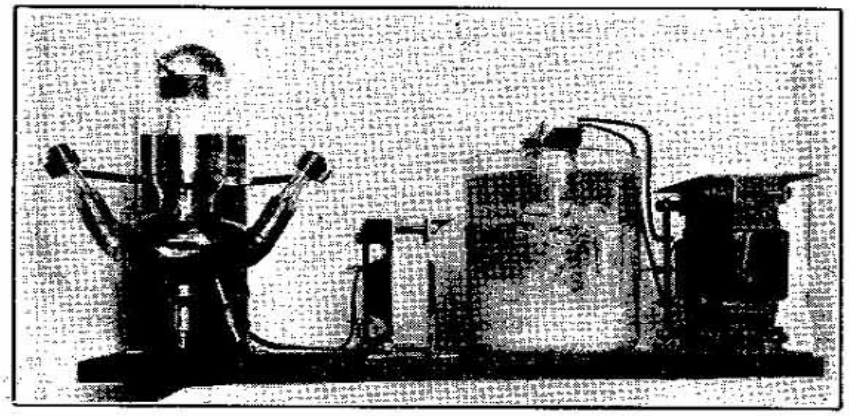
SIMPLEST FORM OF "KEEP-ALIVE" SYSTEM FOR MERCURY ARC RECTIFIERS

using the mercury arc rectifier with amateur transmitting sets for telegraph work. An auxiliary electrode near the base of the tube is ordinarily provided for use in starting the arc by an initial flash on the main pool—and this starting arc is kept in operation continuously by our "keep-alive" circuits so that the tube will be kept filled with mercury vapor even when the key is up as in intermittent telegraph work. The auxiliary and main mercury pools are connected through an inductance coil (to steady the keep-alive arc and prevent it from going out) and rectifier to a source of low voltage alternating current (about 50 volts on either side of the center tap). Tungar or Rectigon tubes such as used in low voltage battery chargers can be used or lacking these an electrolytic rectifier made up in two half-gallon battery jars will prove very satisfactory. In operating the tube the glass next the keep-alive arc gets so hot that you should take the precaution to mount the mercury arc tube in an oil bath to a level somewhat above the mercury pools to protect the glass. Use light gas engine oil of any kind convenient for cooling purposes.

The transformer supplying the "keep-alive" circuit must be well insulated because just as in the case of the filament heating transformer for kenotron rectifiers, the filament circuit of the rectifier is at plate potential above ground. If no one-to-one ratio transformer with a center tapped secondary is available for the keep-alive circuit, a 50-volt supply can be used with four large rectifier jars connected in a bridge arrangement (shown previously).

The choke can be easily built if a spare transformer winding of the necessary inductance is not available. Some resistance in series with the choke will help in limiting the current used in the "keep-alive" circuit to a value which will just keep the arc operating stably, preventing the wasting of power and getting away from the danger of overheating the glass at the auxiliary electrode. The primary of an R. C. A. 75-watt filament heating transformer makes a good choke in an emergency. One amateur used a choke having about 800 turns of No. 18 or No. 20 wire wound on a closed core 1¼" square (cross-section). The primary of some transformer in almost every experimenter's "junk box" will be found to serve in an emergency. The voltage used and the necessary adjustments are not critical.

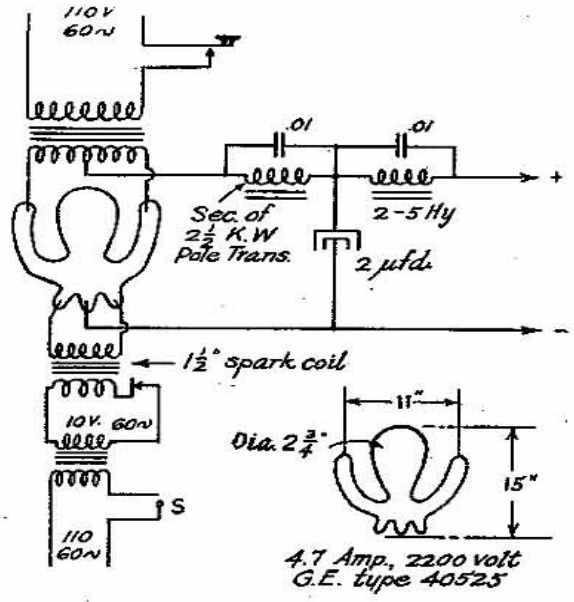
The connections of the mercury arc rectifier in transmitting circuits are just the same as those of any of the other rectifier types we have discussed. Keying in the primary of the plate transformer is very satisfactory although the key may be placed as in any of the other circuits described. The output can be very successfully filtered. We are showing diagrams and photographs



ELECTROLYTIC "KEEP-ALIVE" ARRANGEMENT AT 3CDQ

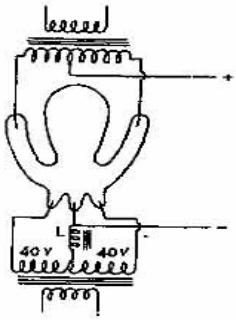
of some rectifiers actually in use at amateur stations employing different "keep-alive" rigs. One man who did not have a 30 to 55 volt alternating current supply available

from transformers, used a 1½" spark coil fed by a step-down transformer This is quite all right if the noise of the vibrator is not objectionable and if the spark coil is husky enough to vaporize mercury. Us-



"KEEP-ALIVE" CIRCUIT USING SPARK COIL AND SHOWING PERMISSIBLE METHOD OF KEYING CONVENIENTLY IF A RELATIVELY SMALL FILTER IS USED

ually it takes a transformer of nearly 200 watts capacity to supply power for vaporizing the mercury and to supply the losses in in the low-voltage rectifying device, the voltage drop in the choke and so on. Most of the stations use the small 220 volt 110 ampere tubes successfully. So many styles and varieties of tubes are available that we cannot be too specific regarding any particular rectifier tube. In general, the tubes are not critical and a little careful experimeting will enable you to get one going at your station. At least one fellow

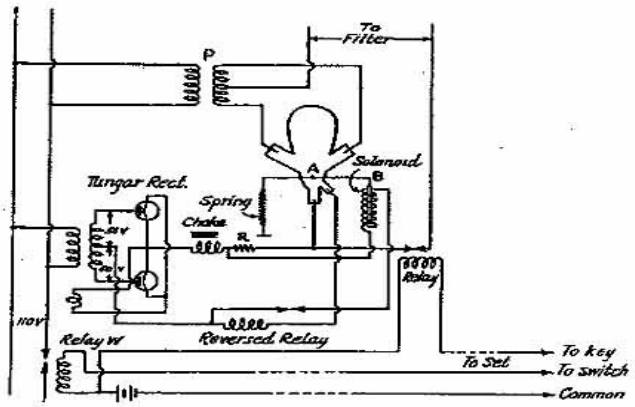


CIRCUIT THAT CAN BE USED WHEN THERE ARE TWO AUXILIARY ELECTRODES (THREE MERCURY POOLS)

Note that no low-voltage rectifier is necessary for maintaining the "keep-alive" arc.

has successfully operated one of the G. E. 10 kilowatt street lighting rectifier tubes (Type 40525) without the low voltage rectifier for the keep-alive circuit. Nevertheless, it will sometimes be desirable to have the rectifier with such a tube as low voltage *direct* current makes an arc stable.

Some of the rectifier tubes that have been used by lighting companies until unsteady operation was observed have a deposit of mercury inside the glass arms. It may be possible to improve the operation by holding the tube rightside up in water and boiling for several minutes to evaporate the deposit getting it back in the main pool where it belongs. Several amateurs have also suggested that a wrapping of tinfoil or wire about these glass arms, being careful not to get the wrapping down too near the main mercury pool, will help to steady operation in old lamps. In handling the tubes remember that mercury is heavy and it must be poured carefully to prevent cracking the tube. If a tube is defective due to a poor vacuum it will not operate. A tube having a good vacuum will give out a clicking sound when the mercury is shaken about carefully so that it splashes a little. If there is much

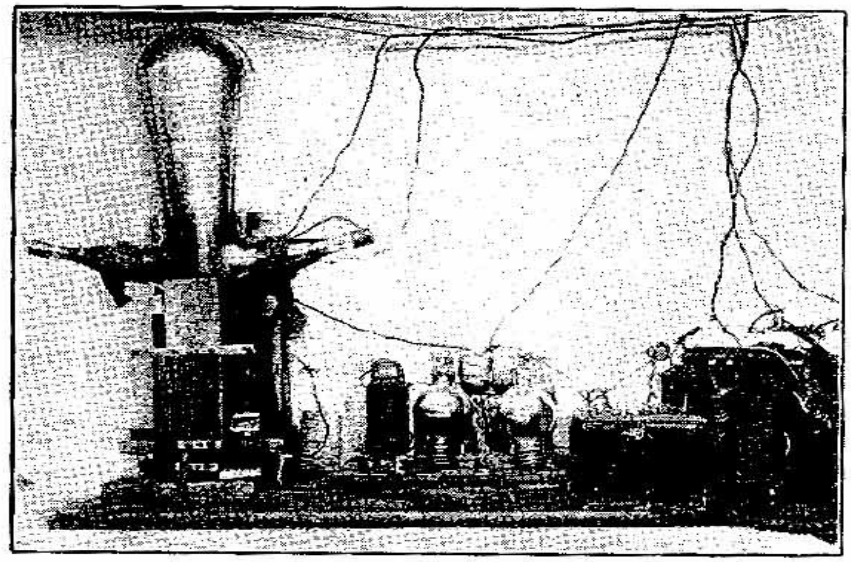


COMPLETE RECTIFIER CIRCUIT AT 3AB
Also showing Remote Control System.

air in a tube the mercury will oxidize on trying to start the arc. In mounting the rectifier tubes the glass should not be clamped so that there is any strain on it as it is almost sure to fracture after a few hours of operation if there is a strain on some part of the glass.

At the station owned by Mr. A. B. Goodall (3AB) of Washington, D. C., the mercury arc rectifier tube is mounted with the oil jar in a wooden frame and remote controlled by the arrangement shown in the photograph and diagram of 3AB. The tube with its frame is pivoted on a line through the center of gravity (point A in the circuit diagram) in a second larger wooden support. A rod B is fastened to the frame

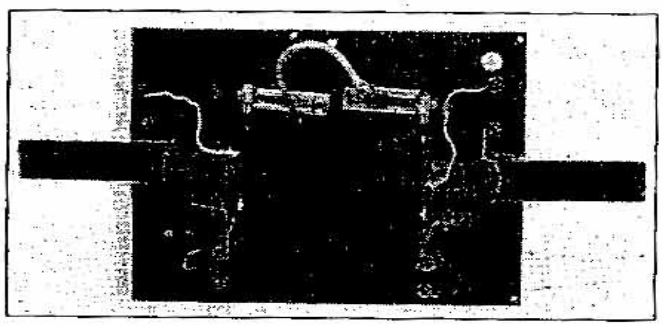
of the tube as shown, a coiled spring pulling down on one end of the rod and an iron solenoid armature of cylindrical shape arranged on the other end of the rod so mounted that when the coil of wire (solenoid) around the armature is energized by the closing of the proper relay, the magnetic pull will tilt the tube. The low voltage rectifier circuit supplies the current for operating the solenoid. In the "keep-alive" circuit is a reverse-connected relay, the contacts of which are held closed whenever there is no current in the circuit leading to the auxiliary electrode. A storage battery controls the power and keying relays. When the switch closes the circuit to relay W, the power transformer P and the Tungar rectifier are connected to the 110-volt mains. The circuit through the solenoid being closed, the current goes through the solenoid windings, pulling down one end of the rod and tipping the tube. The mercury flows over, covering both lower electrodes and allowing current to flow in the "keep-alive" circuit. This energizes the reversed relay, breaking the solenoid circuit so the spring can pull the tube into an upright position striking an arc as it does it. The arrangement is much simpler than the somewhat drawn-out explanation would indicate and 3AB tells us that the outfit has not given the slightest trouble in over a year of use.

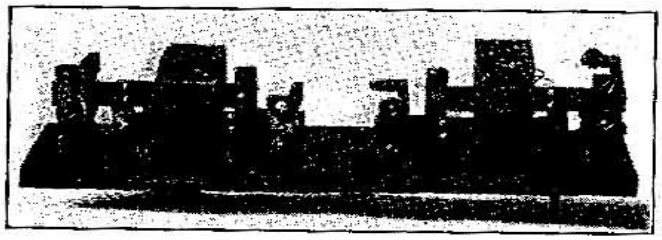


TUNGAR OR RECTIGON "KEEP-ALIVE" ARRANGEMENT AT 3AB
Note the framework supporting the tube and the solenoid used for tilting it by remote control.

SYNCHRONOUS VIBRATING RECTIFIERS

The reader will be familiar with the several makes of vibrating rectifiers sold for boosting the automobile battery. All of these rectifiers have a vibrating reed, usually a steel reed which has been magnetized and which is definitely polarized. Let us assume that the free end is a north pole. This steel reed is mounted at the central point of a W while the arms of the W are made of soft iron on which are mounted coils energized by the alternating current supply source. Before the current is turned on, the soft iron core is not definitely polarized and the pull exerted by the magnetized reed itself is not quite enough to make it move closing the contacts connected to it, especially in view of the fact that it is attracted by each arm of the W equally and in opposite directions. If a current is run through the winding on the core, the core becomes magnetized and one extremity of the W becomes a North pole while the other becomes a South pole. As the free end of our reed was magnetized permanently to be a North pole it will of course be repelled by the adjacent North pole and attracted toward the South pole and it will move toward the





THE UPPER PHOTOGRAPH
Showing a half-wave rectifier of the vibrating type. This rectifier made by 9BRI will handle 2,000 volts. Operating in series, the vibrators will handle higher voltages than a single-break contact will handle.

THE LOWER PHOTOGRAPH
Showing a similarly built full-wave rectifier.

South pole closing a set of contacts. If the current is reversed, the reed will move in the opposite direction closing the other contacts. If alternating current is run through the windings of the soft iron core, the polarity