operation up there in 1916.) I gave up amateur work when I took charge here three and a half years ago, as it interfered with my work, but after the good work thru amateur radio the other night, I am back in the game for good. I am going to Seattle the first of January and while there I am going to build a 250-watt C.W. transmitter—so you see I am going into it right.

My dad, Mr. P. H. McCue, general manager and vice-president of the Booth Fisheries Co., is here now looking over the damages done to our cannery by the storm. He certainly appreciates the good work you did for us and he is all for amateur radio. He is writing you a letter to show his appreciation.....Allow me to thank you again for the good work. I hope I may have the opportunity of meeting you some time.

Respectfully yours,
A. A. McCue,
Supt. & Mgr., Neah Bay Branch.

As 7GI folded up the letter and put it back in the envelope, he knew that amateur radio is indeed more than a mere plaything.

The Improved "S"-Tube Rectifier

By James L, Jenks, Jr.*

IT is an interesting fact that, during the past fifteen years, the transmitting amateur has been constantly perplexed and harassed in mind as to how he may supply the necessary volts and amperes to his sending-equipment without breaking a bank or committing forgery. In the very early days dry-cells, an army of wet batteries, or even an occasional storage battery, furnished the energy for the famous "squeak box," at that time the very acme of transmitting perfection. A few years later the electrolytic interrupter made its appearance, and city mains supplied the necessary wherewithal for "half-kilowatt transformer coils" and such gentry. Next came the good old transformer and spark gap with its host of relatives in the form of blinking lights, annihilated fuses, uncanny telephone troubles, etc., ad infinitum. And now, with the little transmitting bottles here apparently to stay, the same old problem pops up again—"What shall we use for the necessary D.C.?" To some, a high voltage "B" battery or a motor generator may be the answer, although both have their drawbacks. To the great rank and file, however, the high voltage rectifier, capable of efficient filtering, is the most satisfactory solution.

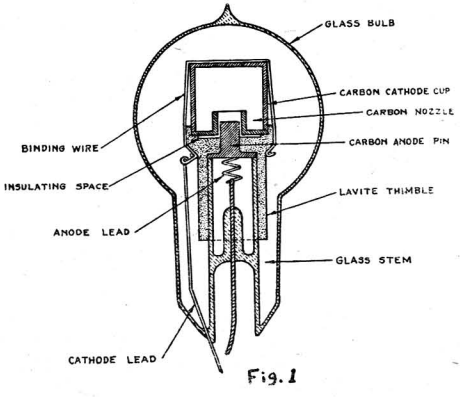

Fig. 1

In *QST*, August, 1922, a new rectifier known as the "S"-Tube was described. This device was of considerable interest for the following reasons:—

1—It would rectify comparatively high voltages without filament or other electron emitting device.

2—Its life was not determined by any one element within its construction, such as filament, etc. In other words, the life of the tube depended largely upon its treatment, and with care, the tube was known to average several thousand hours of service.

3—It was extremely simple to connect up and operate since it was merely necessary to insert a common porcelain lamp receptacle, and connect to the alternating current source. The tube was free from the inconvenience of separate filament lighting supply, sloppy chemicals, magnetic fields, etc.

The chief limitations of the tube, however, were in its voltage and current output. 50 M.A. at 750 volts D.C. was considered the maximum safe output of the old style tube. With the ever-increasing popularity of the 50-watt transmitting tubes, it soon became evident that the original "S"-Tube would not handle the job. Accordingly, late in the spring of 1923, an improved "S"-Tube was developed in the Amrad Research Laboratory, which is now marketed under the title of "'S'-Tube, #4000." This new tube possesses the following advantages:

1—Its voltage and current output has

*—Laboratory Manager, Research Department, American Radio & Research Corporation.

been considerably increased; 100 M.A., D.C. at 1000 volts are now considered a safe operating output.

2—Owing to improved internal construction, temporary overloads can be much better withstood than with the old style of tube.

3—Improved methods of treating and design have lowered the starting voltage and internal losses.

The new tube operates very successfully both in series and in parallel, which means

extended usefulness where extra high voltage or current is required.

A glance at Fig. 1, which is a cross-sectional cut of the tube, shows its extreme simplicity of construction. It consists essentially of a treated carbon cup and nozzle, supported on a thimble-shaped insulator of baked lava. An anode pin projects into the nozzle space, and is insulated from the cathode by means of the lava thimble. One reason for the tube's increased output is the fact that lava maintains its resistivity at very high temperatures. Glass, on the other hand becomes a fairly good conductor when heated above 300 degrees centigrade. The increased simplicity of construction has permitted making the over-all length of the tube considerably less, thereby increasing its mechanical strength. Fig. 2 shows the tube as it appears completely assembled and in a regulation lamp socket.

It has been found to be an excellent source of plate power for all types of tube transmitters, owing to the excellent wave form inherent in its principle of operation. Properly smoothed by filters and chokes, the "S"-Tubes will furnish direct current that can hardly be told from that furnished by a storage battery.[1]

Fig. 3 shows an oscillogram of two "S"-Tubes rectifying 60-cycle A.C. with and without a filter. Note the almost perfect wave form, and absence of reverse current. Frequencies as high as 800,000 cycles have been successfully rectified with the new style tube.

Station "WGI" has been using "S"-Tubes with perfect success for charging a 500-volt Exide storage battery used in phone transmission. High voltage batteries of this sort may be charged direct with no complicated paralleling switch or similar device.

By properly filtering the output of one or two "S"-Tubes, a very satisfactory source of plate-potential for *receiving* sets may be provided, free from all hum or ripple.[2] Such a plate-supply is clean, compact, always ready for use, and amply sufficient to operate a power amplifier where several hundred volts are required.

In conjunction with a high capacity condenser, such as the Mershon Electrolytic Condenser, very heavy currents are made

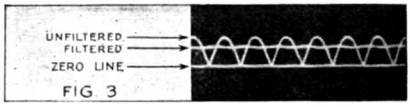

FIG. 3

available for short intervals of time. This type of power is useful for such work as time clocks, relay signals, etc. Two "S"-Tubes, charging four E.M. Condensers in parallel, and having a total capacity of about 120 mfds., will put several amperes through a magnet coil of the proper resistance; and solenoids have been made capable of lifting several pounds by this method.

Chart #1 shows a single "S"-Tube in the process of warming up. It will be

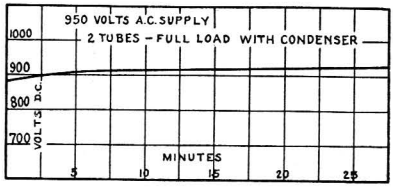

CHART I TEMPERATURE REGULATION

noticed that, when the tube starts cold, the output is somewhat below normal, the voltage drop decreasing in the course of a few minutes as the elements become heated.

Chart #2 shows the remarkable voltage regulation of the "S"-Tube under varying load.

Chart #3 shows two "S"-Tubes in double half-wave rectification with the usual center-tapped secondary. The four curves

[1]—Refer to "Amateur Filter Problems" page 23 of *QST* for August, 1923. This issue can be supplied by the circulation department at the usual price.

[2]Refer to p. 13, *QST*, April, 1923 for full details. It can be supplied by the circulation department at the usual price.

show output under four conditions, namely: *load* with and without condenser, and *no load* with and without condenser.

Chart #4 shows a similar series of curves, but with two tubes in series on

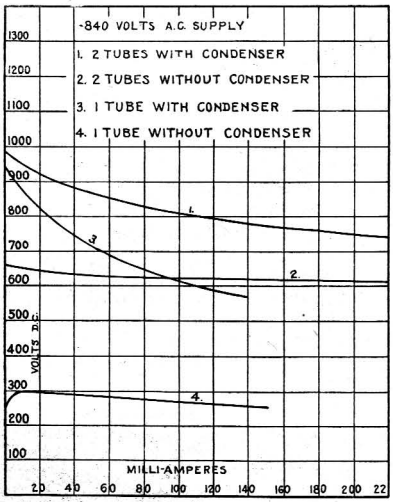

CHART 2 REGULATION 1 & 2 TUBES

each half of the secondary. It will be noted that the so-called "bridge" connection puts two tubes in series for each half-cycle, as does the other connection shown. The

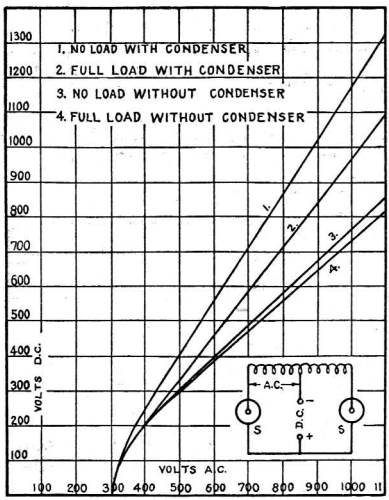

CHART 3 2 TUBES-TAPPED TRANSFORMER

"bridge" connection incidentally is useful where very high voltage is required, or where no center tapped transformer is available. (However the "bridge" connection passes quite a large amount of 60 cycle current. The "center tap" connection passes nothing below 120 cycle hence is easier to filter.—Tech. Ed.)

Chart #5 shows the "S"-Tube operation in parallel. *As the "S"-Tube is purely a gas discharge device, it is necessary to put balancing resistances of from 500 to 1,000 ohms in series with each tube in order to evenly divide the load.*[3] The reason for this will be apparent if one tries to run two-spark gaps in parallel. Invariably, the shorter gap will take all the current unless it is forced to divide by some form of balancing resistance. Ward-Leonard 500-ohm and 1000-ohm wire-wound resistance units are excellent for balancing resistances as are 110 volt tungsten lamps. Use lamps that run cold or at a dull red heat. 25 and 50-watt lamps are also useful when charging "B" batteries.

From the above charts transformers may be designed for any desired output of recti-

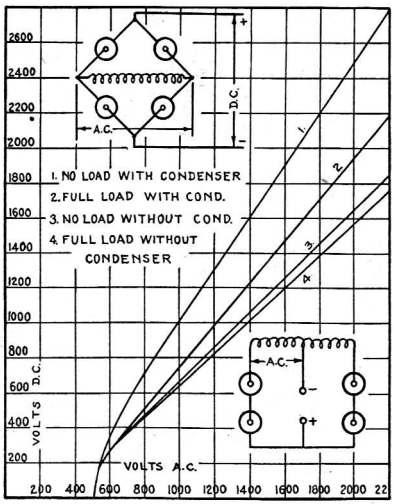

CHART 4 SERIES TUBES BY BRIDGE METHOD OR TAPPED TRANSFORMER

fied D.C. In normal operation the "S"-Tube starts conduction at about 300 volts A.C., and has an internal drop of approximately 150 volts.

The following hints on practical operation may not prove amiss:

Allow the tubes to warm up a few moments before expecting full output, as moderate heat improves conduction.

If applied potentials are too high, the tubes will usually glow or flash over externally, warning the operator to lower the voltage. With smoothing condensers, a tube will sometimes flash over at no-load, but be perfectly steady at full-load, as with high leakage transformers the no-load volt-

[3]—These balancing resistances should be of *metal* so that an excessive current thru one will cause its resistance to rise rapidly. Thus a Ward-Leonard resistance unit or a tungsten lamp is O.K. but a carbon lamp or a water rheostat is not good.

age frequently rises very high. Unless flash-over is prolonged, a tube is rarely injured by this phenomena and, properly observed, it makes an excellent overload indicator.

Unlike thermionic rectifiers there is no limit to the current the "S"-Tube will pass, until breakdown occurs. This is an extremely useful feature since very heavy current may momentarily be drawn without permanent injury to the tube. Should a tube be accidentally overloaded for a prolonged period and cease to rectify, several hours' operation on low voltage and light load will frequently repair the injury. The reason for this is that overloading gives rise to impurities in the gas, which, upon ageing, again disappear, leaving pure gas and renewed service.

In parallel or series operation care should be taken to see that the tubes are connected properly. The tube passes current when entering by way of the anode which is the center contact of the lamp base. The current leaves by way of the cathode, which is connected to the ferrule, or outside of the base. With a split secondary, it is convenient to connect the outside taps to the two anodes, or center terminals of the "S"-Tube, thus making the center tap of the transformer the negative lead, as shown in the diagrams.

In conclusion, it is safe to say that the improved "S"-Tube will find favor with all who wish for a cheap, efficient, fool-proof, high voltage rectifier, which requires absolutely no attention, or auxiliary equipment,

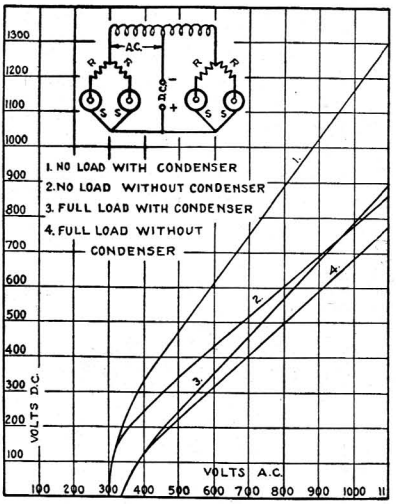

CHART 5 PARALLEL TUBES — TAPPED TRANSFORMER

has nothing to burn out, is durable, very long-lived, clean and compact, and which, when properly filtered, gives a tone that cannot be excelled.

Automatic Radio Relaying

By Porter H. Quinby, 9DXY

WARNING—This article is presented as the record of an interesting stunt, but NOT to encourage general copying of the stunt. Endless trouble would follow if the practice of auto-relaying were to become common, no one would know whom he was hearing, a wild mess would be the final result.

Remember also that it is a violation of the radio laws to sign a call that does not belong to you—no matter how the sending set is being keyed. Don't try to blame it on someone three states away from you.—Tech. Ed.

AUTOMATIC radio relaying devices are usually built around the idea of receiving a signal, amplifying it until it will operate a magnetic key, and then using this key to operate a sending set on a wave very much different from the receiving wave. Such stunts have been used often; perhaps A.R.R.L. members will best remember the twin operation of WWV and NSF during the Fading Tests of two years ago. At that time the signals of WWV were received at NSF, amplified until strong enough to operate a keying relay, and then caused to operate the key at NSF. Because the stations were close together and special tuners were used it was possible to crowd the two waves together; quite regular operation was gotten with WWV on 200 and NSF on 190. The stations were operated when tuned more nearly together than that but some interference followed. Such systems are good only when the received signal is very strong or the re-transmission wave is quite *different from the received wave.* That is the first novelty in the system tested at 9DXY, the re-transmission wave is *the same as the received wave.*

9DXY's Stunt

A sending set with a tuned grid circuit was used and operated as follows: First the switch was closed and normal voltage applied to the tubes, which at once began to oscillate. The variable grid-tuning condenser was then very slowly turned until