FM

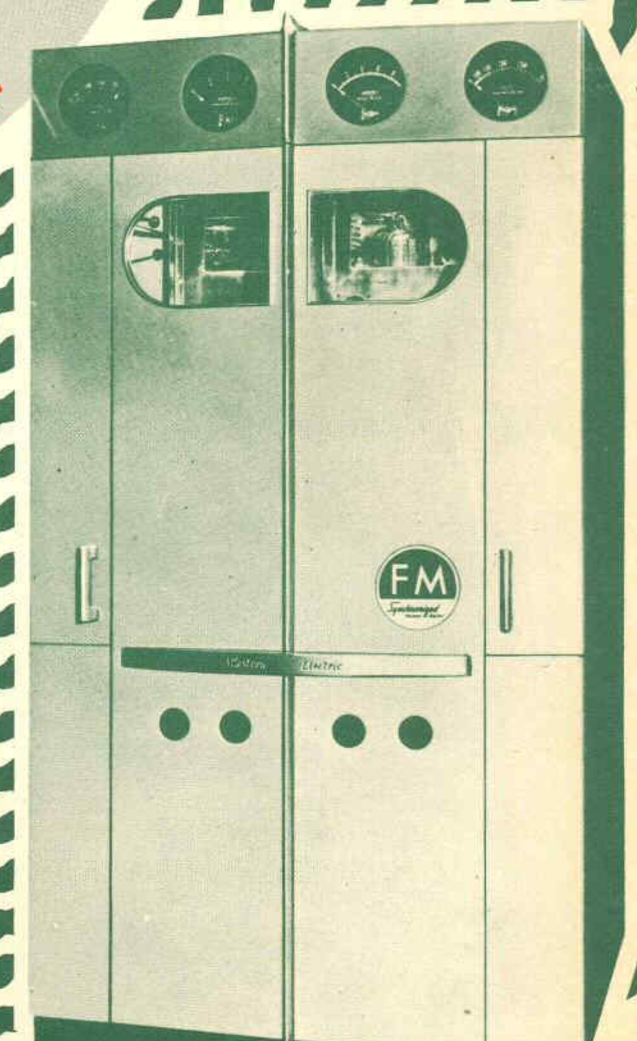
Synchronized
Western Electric

1kw

3kw

10kw

50kw



Western Electric

503B-1 Equipment

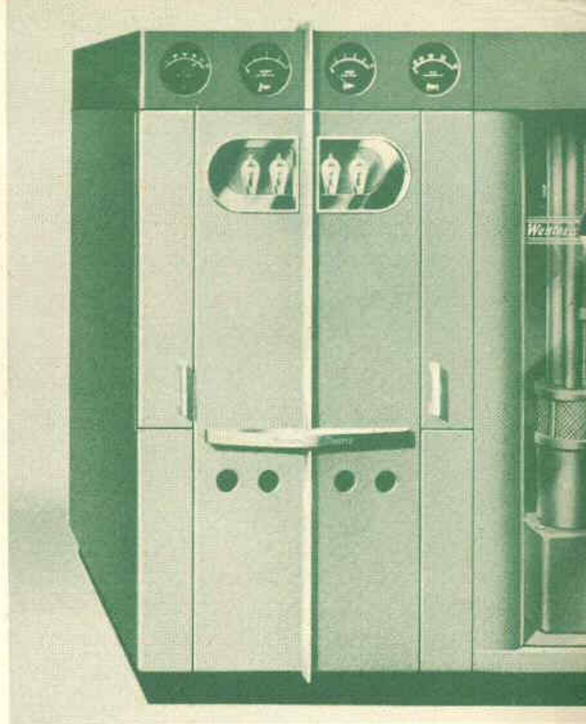
Features

1. The factors and circuit elements which control the modulation capabilities and those that control the carrier frequency stability are completely isolated in their action.

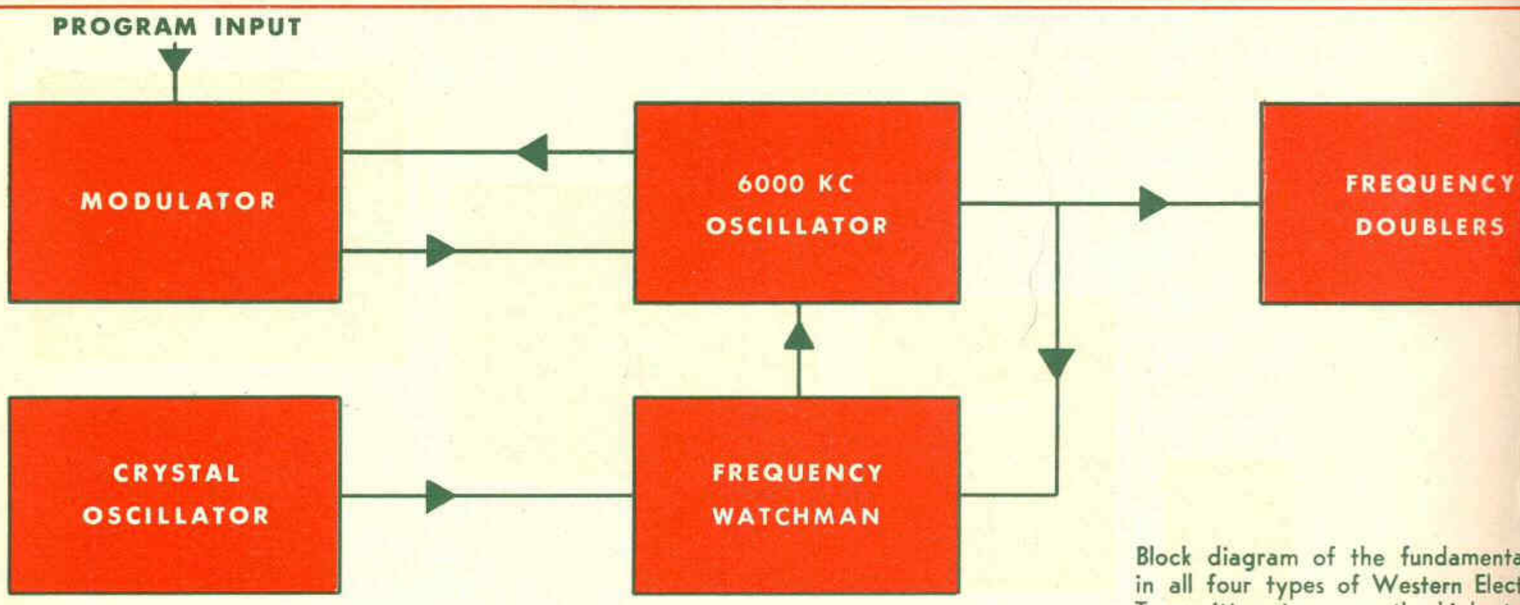
2. The electrical circuits used in the process of controlling a high frequency generator with a stable low frequency oscillator are not in the program transmission path and, therefore, their adjustments do not affect the character of the transmitted wave.

3. The application of a balanced electric oscillator and reactance control tube circuit permits wide frequency excursions while using only a small and linear portion of the reactance control tube mutual conductance-grid bias characteristic.

4. Negative feedback in the modulated oscillator circuit minimizes distortion that otherwise results from amplitude modulation of the wave applied to the reactance control tube grids.



506B-1, 10KW—FM R



Block diagram of the fundamenta
in all four types of Western Elec
Transmitters to assure the highest
the greatest stability.

SYNCHRONIZED FM RADIO EQUI

Frequency modulation holds such promise as a vehicle for high quality noise-free broadcast service that no efforts have been spared by the Western Electric Company in developing a transmitter circuit of extremely low distortion and background noise.

By modulating at a relatively high frequency such as six megacycles, where the phase deviations are large, the difficulty encountered at lower carrier frequencies from phase modulation due to power-supply hum and microphonics is greatly reduced.

With Western Electric's unique system of synchronized frequency modulation, moreover, the complete separation of the two functions of modulation and mean frequency stabilization permits the use of push-pull reactance control tubes for modulating the oscillator, so that ripples in bias or plate supplies do not modulate the frequency. The balanced circuit employed together with other refinements in design permits a frequency excursion of hundreds of kilocycles with very low distortion for all signal frequencies between 30 and 15,000 cycles.

Western

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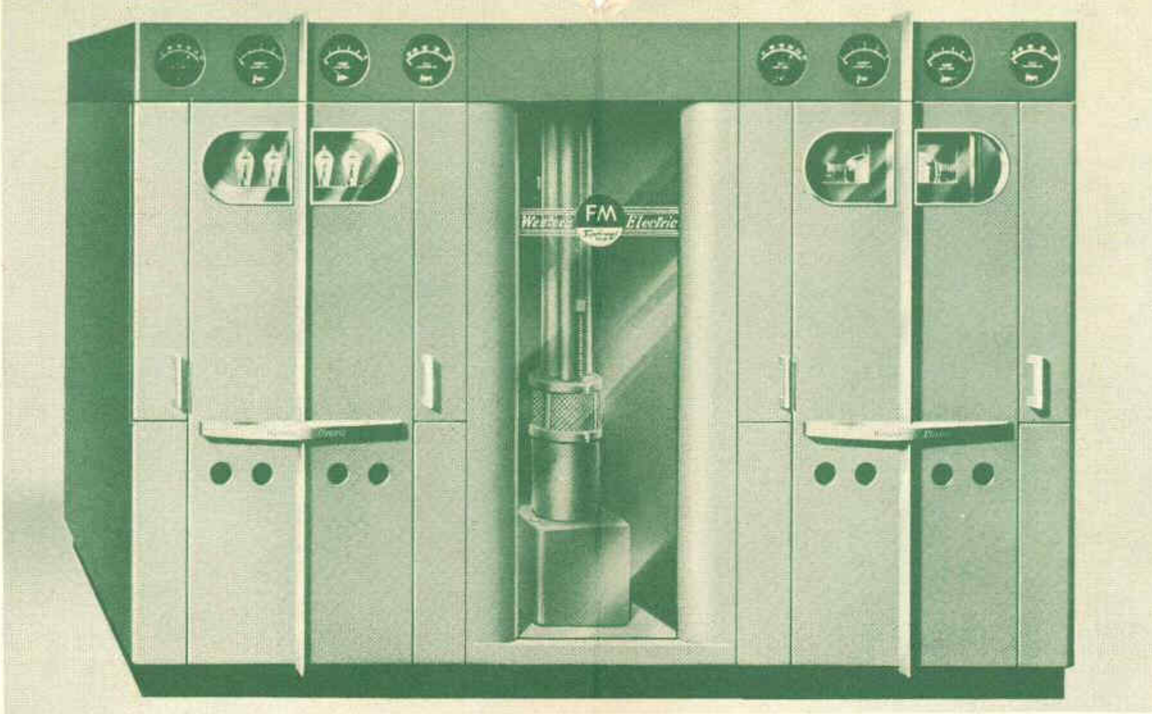

506B-1, 10KW—FM RADIO TRANSMITTER

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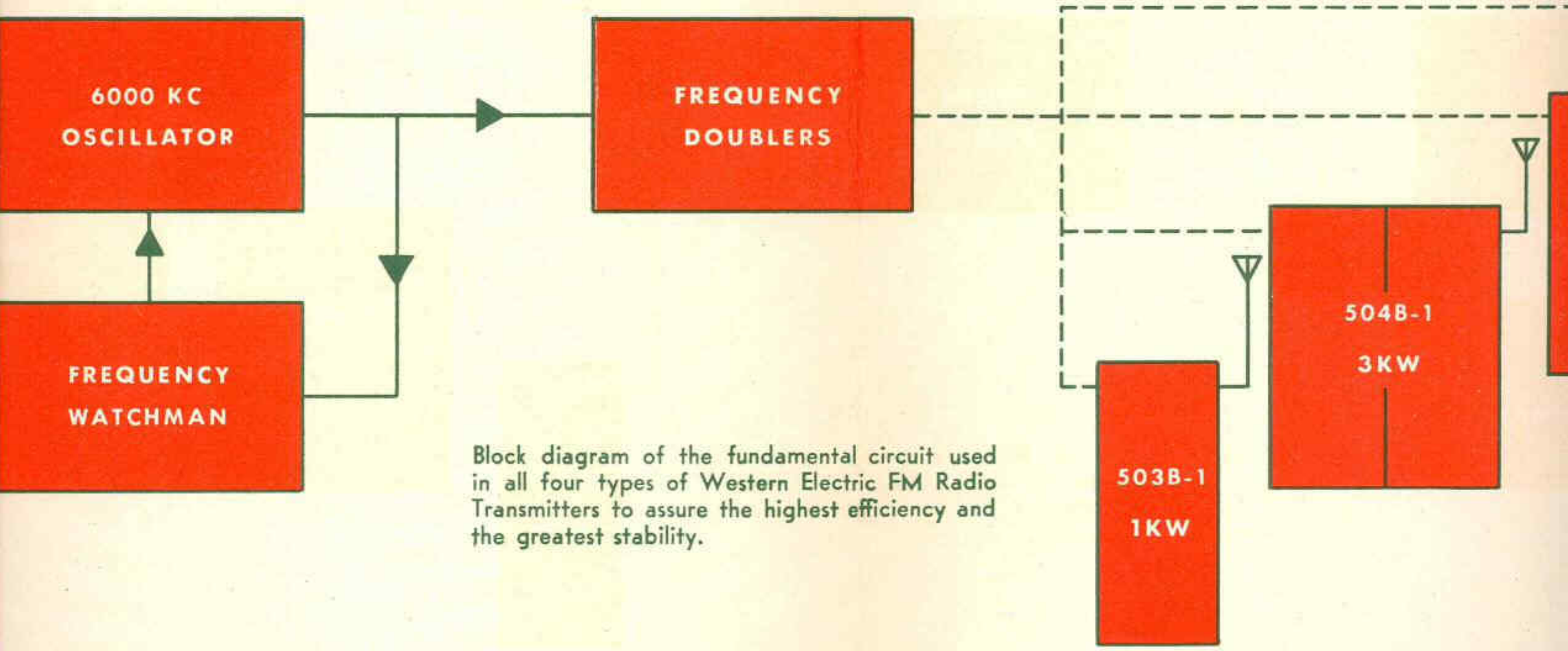

Block diagram of the fundamental circuit used in all four types of Western Electric FM Radio Transmitters to assure the highest efficiency and the greatest stability.

SYNCHRONIZED FM RADIO EQUIPMENT · 1 - 3 - 10 or 50 Kilowat

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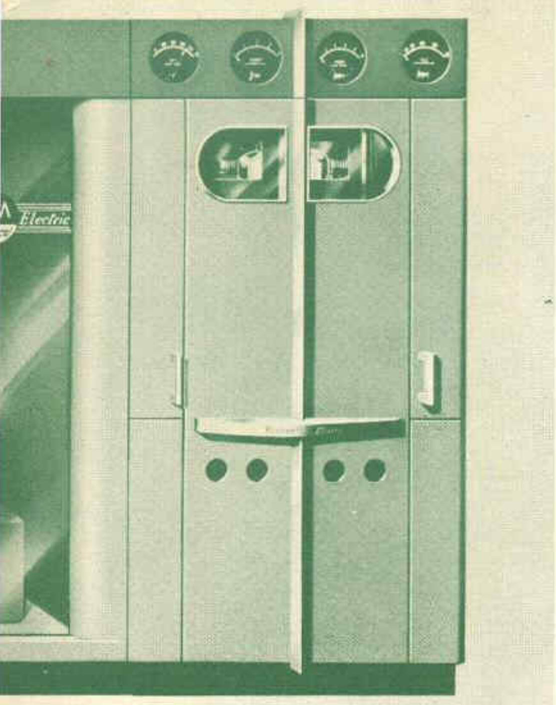
Western Electric



DIO TRANSMITTER

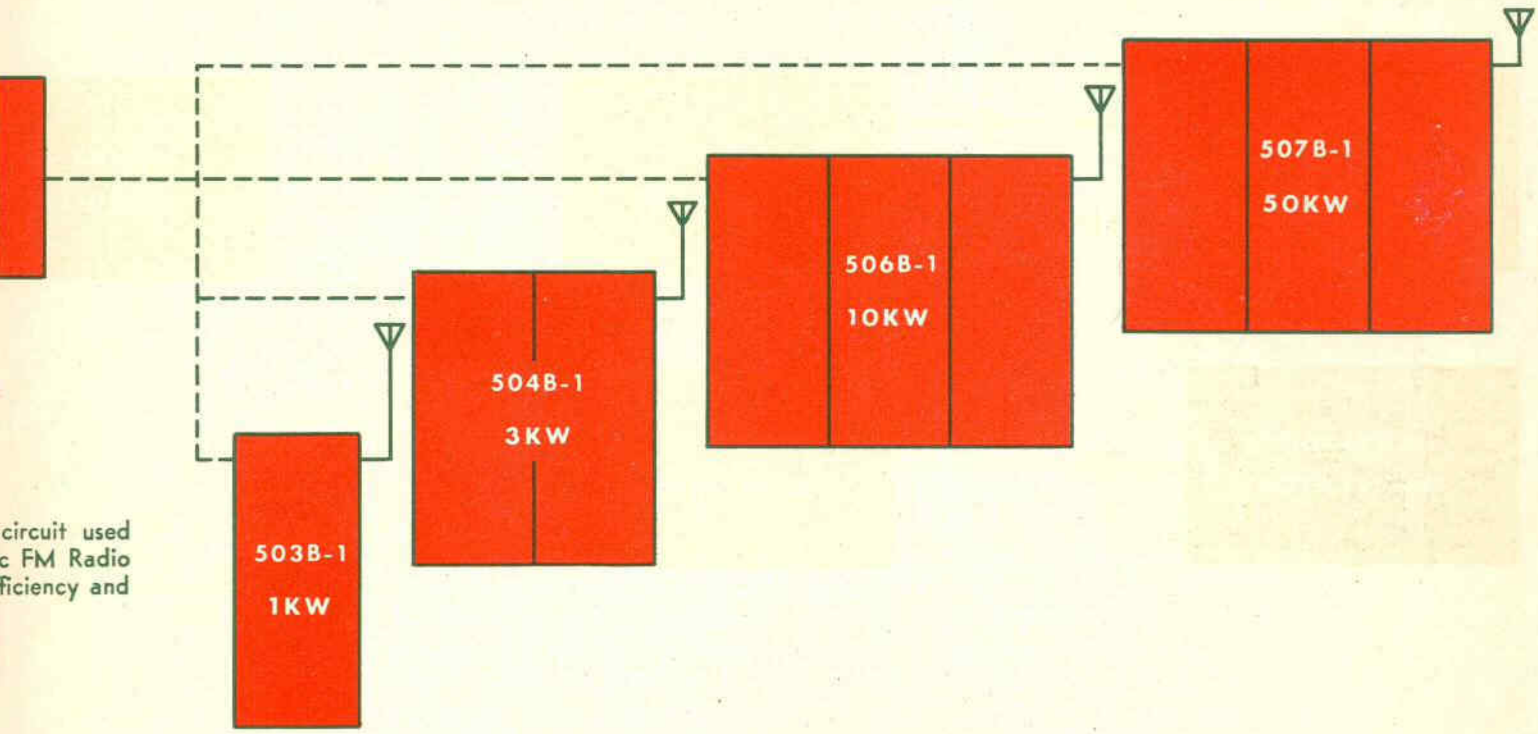
Features

5 Because of (1) to (4) a high degree of linearity is obtained in the modulation characteristics over a frequency deviation range of ± 150 kilocycles. This large linear range obviates the need for critical circuit adjustments to obtain consistently low harmonic distortion over the ± 75 kilocycle range required in practice.

6 The carrier frequency stability is exactly that of a single crystal controlled oscillator and is independent of any other circuit variations.

7 Since the carrier frequency stability is that of a newly developed low temperature coefficient crystal, the need for temperature control equipment is completely eliminated.

8 Coil neutralization of the amplifiers assuring the widest possible band width and low distortion.



circuit used
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ficiency and

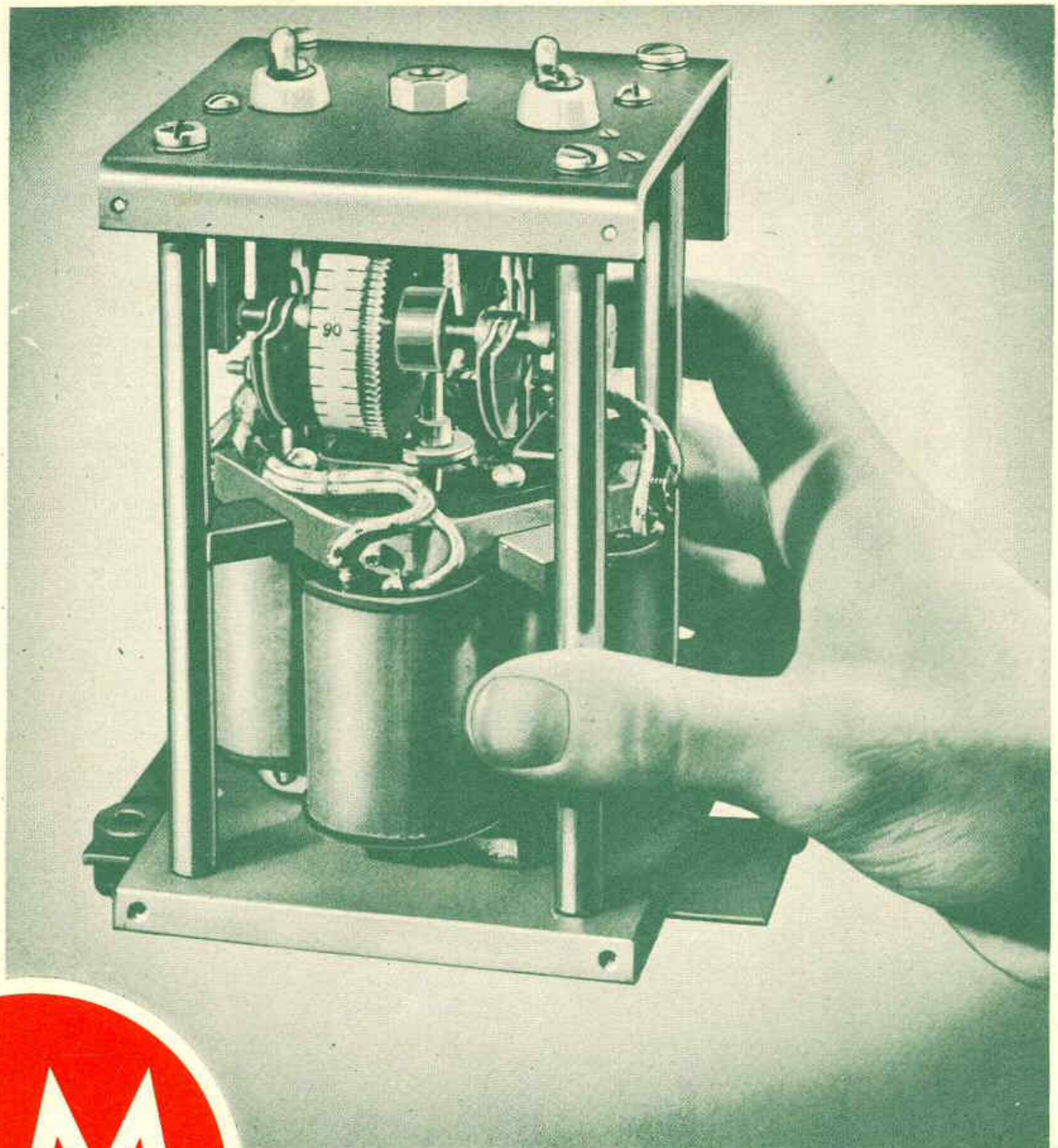
MENT · 1 - 3 - 10 or 50 Kilowatts

These advantages are obtained without sacrifice of crystal oscillator stability of the mean frequency of the transmitted wave. With synchronized frequency modulation the carrier, or mean, frequency is that of a single crystal controlled oscillator and is independent of the variations of any other circuit. The control of carrier frequency is therefore "not dependent upon inductances or capacitors for inherent stability." The frequency tolerance prescribed by the Federal Communications Commission is amply met without the use of any temperature control apparatus.

The mechanical arrangement of the components in these transmitters exemplifies the most modern engineering practices.

Styled by the well-known designer, Henry Dreyfuss, the cabinets housing these transmitters are attractive, well balanced and modern in appearance. They are finished in gray and blue and have black mounting bases. All trim is finished in satin chrome.

Electric



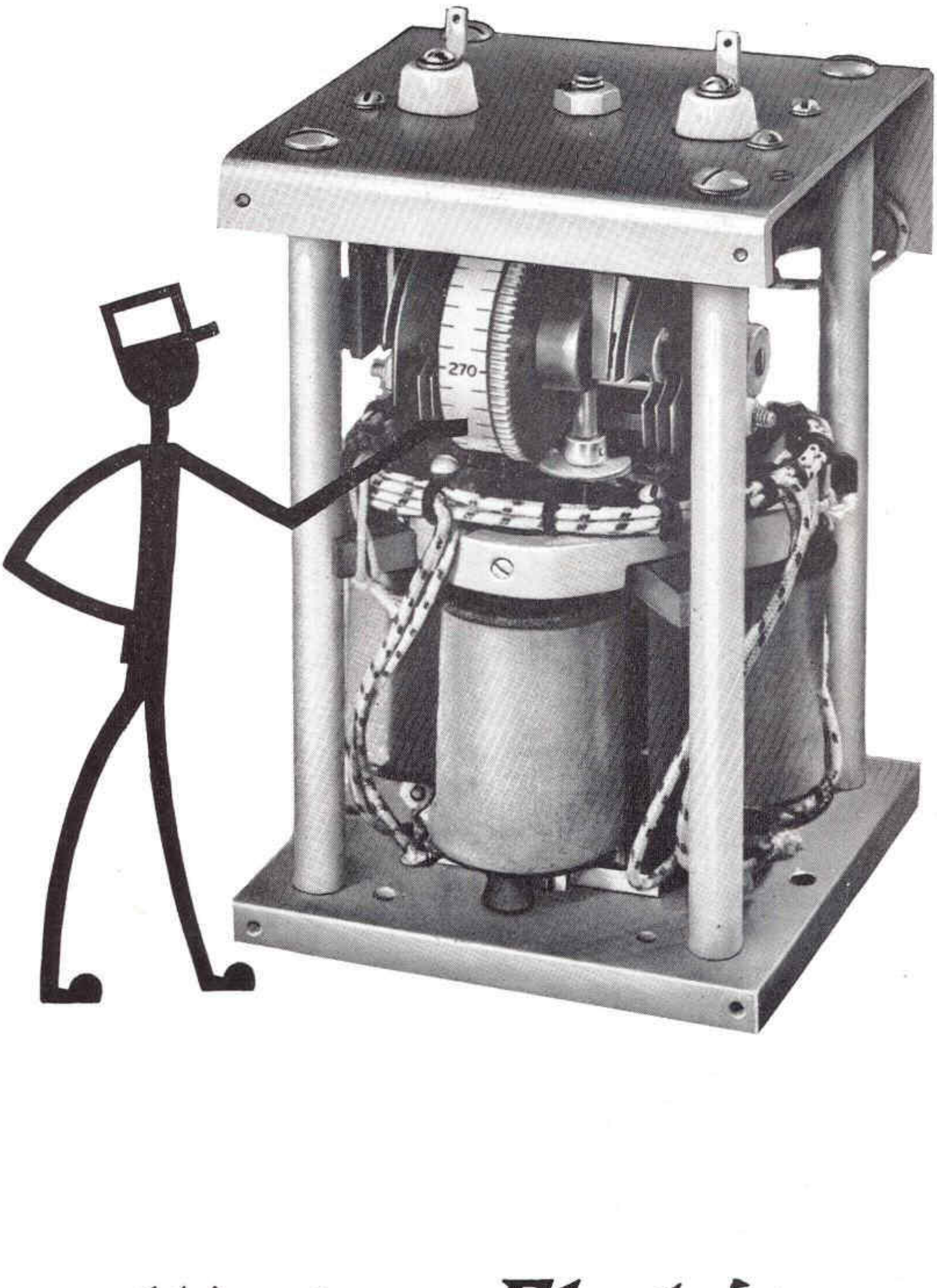
FM WATCHMAN

Western Electric's FM Watchman compensates immediately and automatically for a change in the mean frequency of the modulated oscillator arising from any cause such as temperature changes or even violent disturbances that might arise if tube failures should occur. It eliminates completely the need for frequent checking of the transmitter circuits and manual readjustment of frequency controlling elements.

ASK YOUR ENGINEER

Distributed by Graybar

The Frequency Watchman



Western Electric

The Frequency Watchman

By R. H. Lindsay

Bell Telephone Laboratories

ORDINARILY there is very little of a striking nature about the workings of a radio transmitter that can be demonstrated to an interested observer, even when it is on the air. To be sure, you can listen to the program, but there is nothing about the transmitter to particularly impress you with the fact that a program is going through it, or even that the transmitter is actually putting out carrier current. These facts are largely matters of inference from meter readings, from the glow of vacuum tubes, or from the quiet hum of a cooling fan.

But there is something more than ordinarily impressive in a demonstration of the constant supervision that the "frequency watchman" of a Western Electric FM transmitter exercises over the carrier frequency. He is a very leisurely fellow or very active, depending upon the amount of work he has to do, and his supervision is no less effective while the carrier is swinging back and forth from 75 kc above the normal value to 75 kc below under the influence of modulation, than it is upon the steady carrier without modulation. It is no great trick to arrange both to watch and to hear him at work, although his movements are quite silent, and normally "behind the scenes." And just as you are wondering because of his apparent inactivity whether he is loafing or actually asleep, you are startled at how he springs into action if he is deliberately given a real job to do.

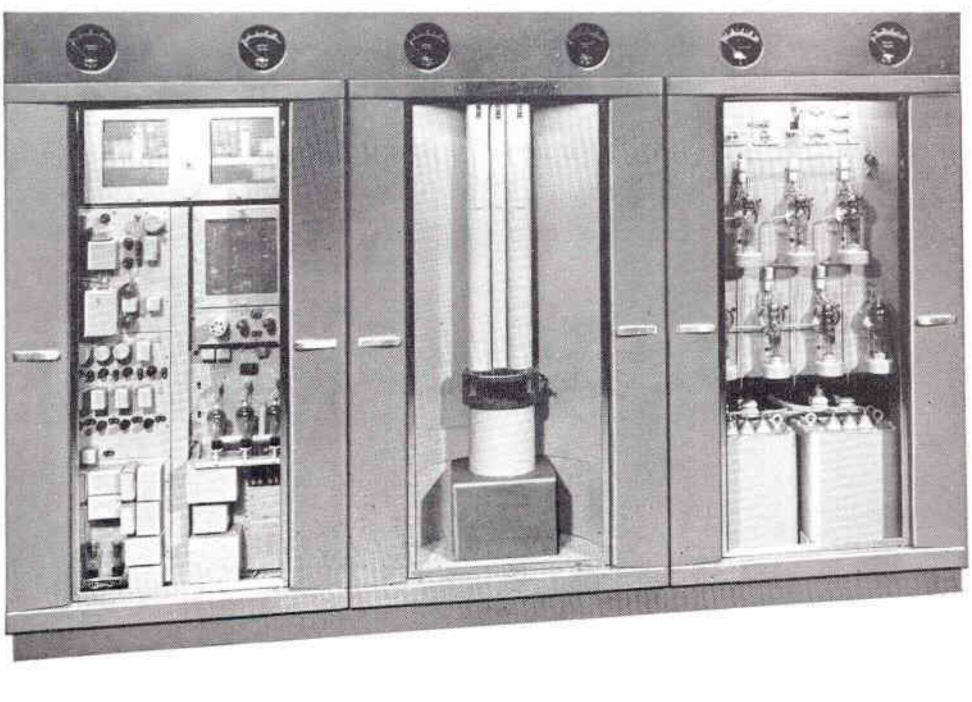
This "frequency watchman" is a small induction motor driving a tuning condenser in the plate circuit of the electric oscillator which generates the carrier frequency, or rather, one-sixteenth of the carrier frequency. This submultiple frequency is doubled four times in following stages, but ahead of these doubler stages a portion of it is fed through a frequency divider circuit which reduces it to 1×2^{-10} or 1/1024 of the frequency generated by the oscillator. This reduced frequency thus falls within the range of 5377 to 6586 cycles for the new carrier frequency range of 88.1 to 107.9 megacycles.

It is the job of our frequency watchman to compare this low frequency with a control frequency generated by a crystal oscillator which is exact with the amazing precision of quartz crystals. For example, at a carrier frequency of 99.3 megacycles, the frequency of the crystal oscillator is 6060.79 cycles. This frequency and that from the transmitter are both fed to the four stator windings of the induction motor in such a manner that if the frequencies are exactly the same no rotating field is produced and the rotor of the motor remains stationary. However, if the frequency of the transmitter differs slightly either high or low, as perhaps it may when the transmitter is started up after an idle period, the field produced by the stator rotates at a rate proportional to the frequency difference and in the proper direction. The rotor of the motor immediately starts to revolve at a proportional speed and changes the capacity of the tuning condenser in the electric oscillator in the proper direction to correct the momentary error. As the process of correction proceeds, the frequency difference becomes smaller, and so also does the speed of the motor until it comes imperceptibly to rest when the error has been eliminated.

So effective is this process of synchronization that the slow drift of frequency to which an electric oscillator is ordinarily subject from several short and long-term causes, such as changes of temperature and aging of parts, can never accumulate but is gradually corrected as slowly or rapidly as it occurs. And so slight or so slow is the rotation of the motor required to make such gradual corrections that under normal operating conditions it always appears to the eye to be entirely at rest.

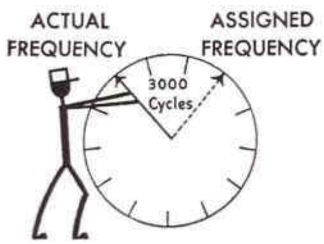
But, to return to our demonstration of how lively the watchman can be if thoroughly aroused, let us open the front door of the transmitter and remove the cover from the motor so that the armature is visible. So that our ears as well as our eyes can follow what is happening, we shall couple a heterodyne frequency meter loosely to the output of the oscillator-modulator unit by means of a single insulated wire. The frequency at this point is one-eighth of the carrier frequency, or twice that of the master oscillator. With the oscillator-modulator and frequency control mechanism operating (these functions not being disabled when the doors are open), the frequency meter is tuned to the desired frequency, $f_c/8$, by adjusting its frequency until the beat note audible in the ear phones is reduced to zero. Then let us give the control for the oscillator tuning condenser a sudden twist, thus deliberately throwing in a frequency error of perhaps 10,000 cycles at the oscillator and 20,000 cycles where we are picking up our sample frequency. With a sharp "tweet" the audible beat passes up beyond the limit of audibility. At the same instant the motor has started to spin, fast enough this time so that we can also detect the slow movement of the tuning condenser plates which it drives

Synchronized frequency control is a feature found only in Western Electric's FM transmitters. This is the 10 KW transmitter, which consists of a high and low power supply and control unit (left); a 10 KW power amplifier (center); a one KW driver and synchronized frequency control unit (right).

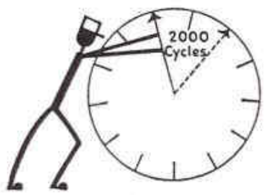


How the Frequency Watchman Works

With the ***Frequency Watchman*** on guard, stability of the Western Electric *Synchronized* FM transmitter is governed by the stability of the low frequency crystal, which varies less than *25 cycles per million* for an ambient temperature range from 40° to 130° F. To demonstrate this split-second control, let's take an extreme case with a far greater deviation than would occur when the transmitter is on the air.

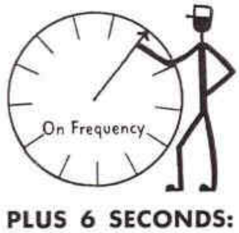


ZERO HOUR: *Starting up after a shutdown, transmitter may be 3000 cycles above or below assigned frequency.* **Frequency Watchman** *goes to work.*



ZERO PLUS 6/10 OF A SECOND: *The* **Watchman**—*in the fraction of a second—has reduced deviation to 2000 cycles.*

ZERO PLUS 3 SECONDS: Frequency Watchman *has now brought actual frequency to within 400 cycles of assigned frequency.*



ZERO PLUS 6 SECONDS: *Transmitter is on its assigned frequency and the* **Watchman** *will hold it there.*

through a worm and gear. And now the beat tone in the head phones is down again within audibility and rapidly drifting lower; and we observe the motor undergoing a corresponding reduction in speed. In another second or two the motor has lost all visible motion as the tone has fluttered out below audible frequency, and the transmitter is back on frequency again. The whole procedure has consumed only several seconds, the exact interval depending on how great a frequency error we introduced when we twisted the tuning condenser control.

The error of 10,000 cycles arbitrarily introduced for the purposes of the demonstration is many times greater than any which could occur except as a possible trouble condition. Yet it is still small as compared with that which the motor is capable of handling. A 10,000-cycle change at the electric oscillator corresponds roughly to a 10-cycle change at the motor, whereas the motor is well able to take care of 50 cycles per second or more.

But the question will now naturally arise: It is all very well to speak of the motor responding to a difference of a small fraction of a cycle between the frequency of the crystal oscillator and the corresponding reduced frequency from the transmitter, but what happens when this latter frequency is jumping up and down under modulation? The answer is that the motor is a practically perfect device for averaging such variations and responding only to the *mean* frequency from the transmitter. Let us see what happens. With the full 75 kc swing at 100% modulation, the corresponding swing at the reduced frequency applied to the motor will be 75000 x 2^{-14} or 7500/16384, which is equal to about 4.6 cycles per second. It must be borne in mind, however, that this frequency change takes place at a voice frequency rate. If it is a 400-cycle tone which is modulating the transmitter, the frequency difference at the motor will be changing from plus to minus 4.6 cycles and back 400 times a second. The inertia of the rotor of the motor is far too great, even if the modulating frequency were as low as 50 cycles, to respond noticeably to such a rapidly oscillating torque. If, however, the modulation process were not symmetrical, so that the positive frequency swing were greater than the negative, then the *average* frequency would be higher with modulation than without it and the motor would definitely respond, attempting to adjust to some unsteady higher average frequency during program modulation, and returning to the normal position in the absence of modulation. On the contrary, the fact that the motor does in reality stand still during modulation demonstrates the

The Western Electric one kilowatt FM transmitter.

symmetrical nature of that process in Western Electric FM transmitters.

It will be seen that the accurate work of the frequency watchman causes the frequency stability of the transmitter to depend entirely on that of the low frequency crystal. This crystal is an X-cut duplex structure, and its range of frequency variation with temperature is less than 25 cycles per million for an ambient temperature range from 40° to 130° F. Thus, the range of frequency variation of a 6000-cycle crystal for the above temperature range would cover less than 0.15 cycle. Since the transmitter frequency is 2^{14} or 16384 times the crystal frequency, the transmitter frequency variation would cover a range of less than 2456 cycles. When it is remembered that the requirement of the Federal Communications Commission permits 4000 cycles (± 2000 cycles) it becomes evident why temperature control is not provided for the crystal. It is not needed.

With the post-war resumption of delivery of Western Electric FM transmitters, many new owners are already joining those who have previously been finding great satisfaction in the alert Frequency Watchman.

FM
Synchronized
Western Electric

NEW
ARC-BACK
INDICATOR

Western Electric

Western Electric's 10 KW FM Transmitter Features Novel Circuit for Unerring Location of Faulty Tube

By N. C. Olmstead

Bell Telephone Laboratories

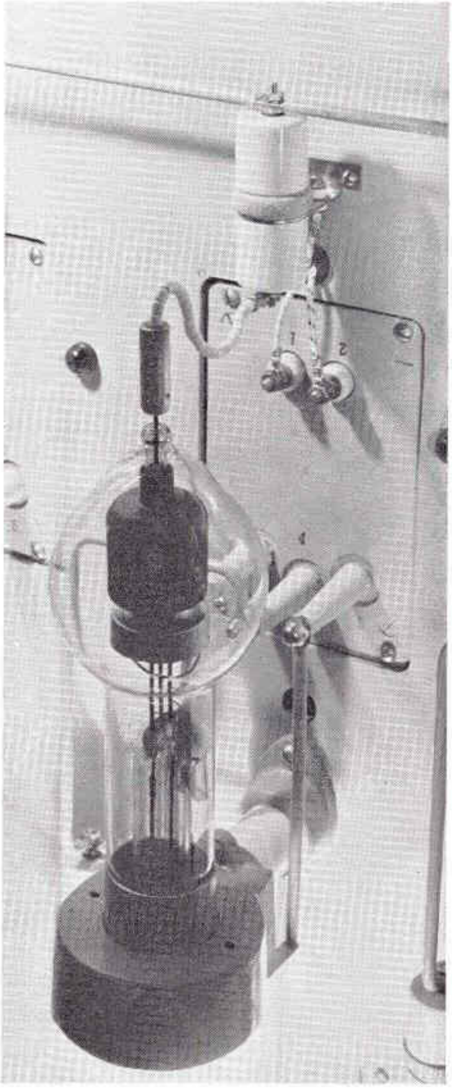
Hot cathode mercury vapor rectifiers for high voltage plate supply in broadcast stations afford high efficiency, excellent regulation, simple installation, and require little maintenance. The phenomenon known as "arc-back" occurring in such rectifiers, though rare under normal conditions, is occasionally annoying because of the uncertainty as to which tube is at fault. With a new circuit just introduced by Western Electric for positive identification of a faulty tube, this uncertainty has been removed and another forward step made in minimizing time off the air.

In an arc-back the tube stops behaving as a rectifier and conducts current in the reverse direction. The trouble may be brought on by improper tube temperature, power line surges, heating from overloads, or old age. An arc-back acts as a short circuit on the a-c supply and will seldom clear until power is shut off from the rectifier. If the tube is faulty the arc-back may recur when power is reapplied. Each arc-back means a program interruption for the station. If the arc-backs persist, it may be necessary to shut down and to locate and replace the bad tube. With a spare tube available in the warm-up position, positive indication as to which tube is at fault permits quick restoration of power.

Requirements for Indicator

Considerations of transformer cost, peak inverse voltage and ripple output have led to the general use of full wave bridge-type rectifier circuits for high voltage supplies in radio broadcasting. In such circuits if one tube arcs back, the reverse current is carried in the forward direction by some other tube in the circuit. The two tubes in series act as a short circuit on the a-c supply. The short circuit current is a very heavy overload on the good tube which is conducting in the normal direction and will overheat its anode. A fraction of a second later the phase of the a-c power reverses, and inverse voltage is applied to the overheated tube which may then arc back also. A third tube then carries the short circuit current and may be sufficiently overheated (in its normal direction) to arc back in turn, so that in the few milliseconds, representing one cycle of the power supply, several tubes in the rectifier may arc back.

To be effective, then, an arc-back indicator circuit must meet several requirements: (1) As the arc-back current in one tube always appears as a forward current in another tube, the indicator circuit cannot operate simply on the magnitude of the tube currents but must sense the direction of the current in the tube. (2) Half the tubes in a bridge-type rectifier have both the cathode and anode at high voltage to ground so that any indicator must be operated at high voltage or provide insulation between the rectifier tube and the indicator circuit. (3) An arc-back may be followed by a string of "sympathetic" arc-backs in any or all of the other tubes, hence, the first tube to arc back must be indicated to the exclusion of the others.



Saturated toroidal transformer — heart of arc-back indicator circuit — shown above mercury vapor tube.

The heart of the arc-back indicator circuit provided in the new Western Electric 10 kw FM transmitter is a small toroidal-wound transformer, shown in the photograph on this page, which provides in a simple manner the necessary insulation between the high voltage tube circuit and the low voltage indicating circuit, and which responds only to reverse current in the rectifier tube—thus meeting requirements (1) and (2) above. This transformer has a single-turn primary consisting of the anode lead of the rectifier tube carried through the center of the toroid in a ceramic bushing.

The secondary consists of a multi-turn toroidal winding on a permalloy tape core, at essentially ground potential, as shown in Figure 1. The core is operated in a saturated condition by passing a biasing current of a few milliamperes d-c through the multi-turn secondary. This bias current is so poled that the normal primary current pulses (the forward current through the rectifier tube) are in a direction to add to the magnetizing force of the bias current. As the bias current saturates the core, the addition of the primary pulses will have relatively little effect on the core flux and will therefore induce little voltage in the secondary winding. However, if the current in the primary is reversed (such as would be caused by an arc-back in the rectifier tube) its effect bucks the magnetization of the bias current and the resulting large flux change will induce a substantial voltage in the secondary winding.

Use of Permalloy Tape

By using permalloy tape for the core of the transformer a magnetization curve is obtained which is very steep for low magnetizing forces and has a very sharp knee, as illustrated in the graph in Figure 2. The steeper the curve up to the knee and the sharper the knee, the greater will be the ratio of output voltages for the same values of reverse and forward current. In the commercial design of this transformer this ratio is between 20 and 30. This difference in output voltage may be used to control a vacuum tube which is biased to be inoperative on the small ouput voltage from the forward current pulses but is operated by the much higher voltages produced by the reverse current.

For the actual indication, a cold cathode three-element gas-filled tube is used. When sufficient voltage is applied to the control electrode of this tube, the resulting ionization permits the gap between the main anode and the cathode to break down. The discharge in the main gap is readily visible and serves as indication that the tube has been fired. If several of these tubes are

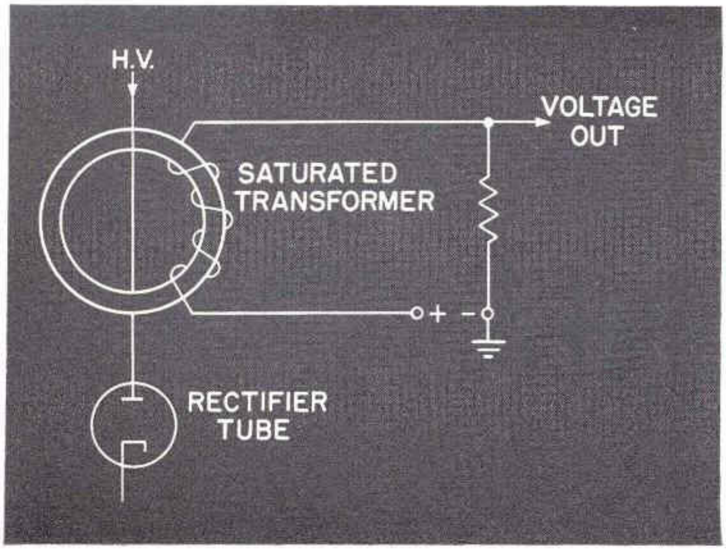


Figure 1 — Toroidal core — saturated by running small d-c through multi-turn secondary at ground potential — is responsive only to reverse currents in tube.

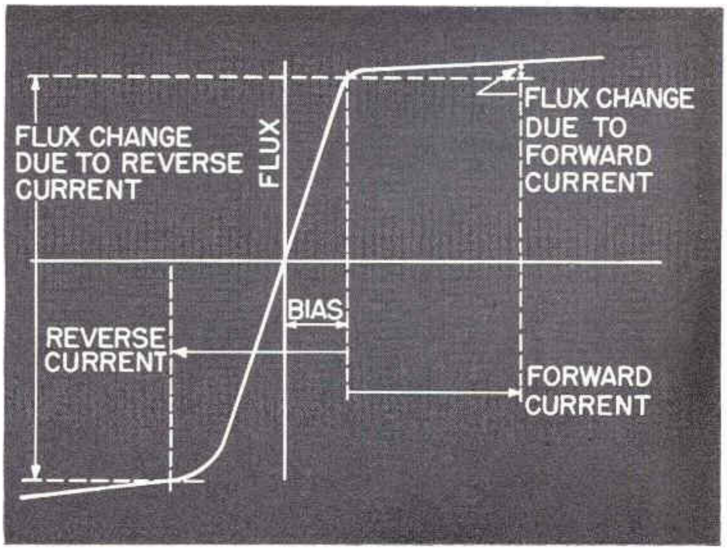


Figure 2 — Graph showing high ratio of sensitivity to reverse as compared to forward currents, achieved by use of saturated permalloy tape for the core.

operated with a common cathode resistor and one tube is fired, the current in the main gap flowing through this common resistor raises the cathodes of all the tubes to a high positive potential. The circuit is so designed that the same amplitude of voltage pulse from any rectifier tube which may arc-back subsequently will not be sufficiently more positive than the cathodes to fire any other indicator tube, hence requirement (3) — identification of the faulty tube to the exclusion of the others—is fulfilled.

As used in the new Western Electric 10 kw FM transmitter, the circuit has been carried a step further. The voltage from the saturated transformer does not operate directly on the indicator tube but is used to trigger a small thyratron tube. The firing of this thyratron in turn fires the indicator tube. The common resistor in the cathode circuit of the indicator tubes blocks all the indicator tubes except the first one to fire. A sensitive relay in the common plate supply of the thyratrons acts to open the a-c power to the rectifier whenever one of the thyratrons is fired. As this sensitive fast-operating relay is the only mechanical link between the saturated transformer and the tripping circuit for the power supply, the time required to remove power in case of an arc-back is greatly reduced as compared with that required when depending on primary overload relays. Power is then reapplied automatically and immediately, as the fast-tripping action has minimized the damage to the good tubes, and the chances of carrying on without further interruption are substantially improved.

By using separate sets of gas tubes in this way for the tripping and indicating functions, the indication is maintained until the operator restores the circuit by manually operating a push button, while the tripping tubes are reset automatically as soon as power is removed and are therefore ready to function again as soon as power is reapplied. Should a second arc-back occur at once, the operator can immediately replace the tube known to be faulty with the heated spare and go back on the air.

The Western Electric 321A Rectifier Tube used in this transmitter, like the well known 315A of the same rating, is noted for long life, and arc-backs are unknown to many of its users. The circuit described here, however, by removing any possible error as to the tube at fault, permits using the tube well beyond the normal time for removal without fear of losing program time, and, in addition, provides faster protection than has ever been possible in rectifiers of this type.

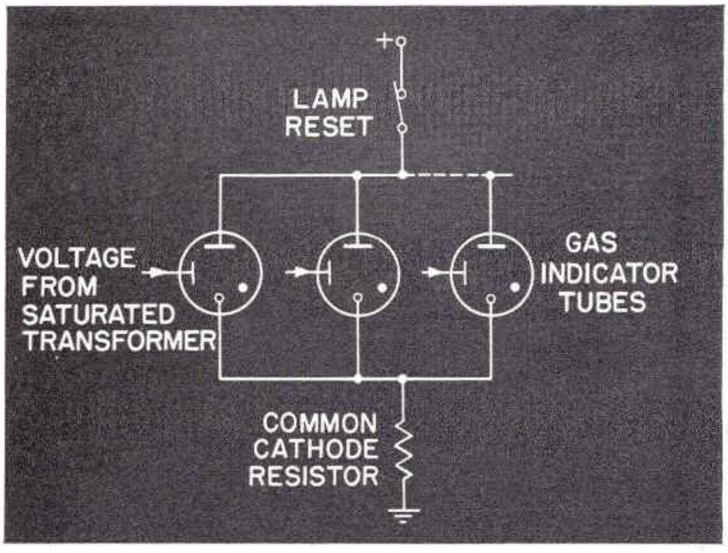


Figure 3 — Schematic showing a common cathode resistor in the indicator tubes which insures that only indicator tube receiving first impulse will be fired.

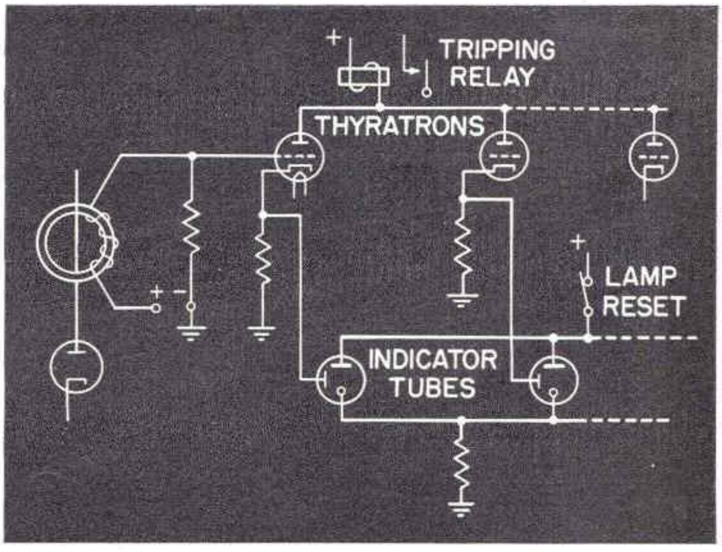


Figure 4 — Schematic shows small thyratrons and tripping relay between saturated transformers and indicator tubes, giving fast protection against arc-backs.

A Grounded Plate Amplifier

USED IN THE WESTERN ELECTRIC

New 506B-1 10 KW FM Transmitter

Western Electric

A Grounded Plate Amplifier New 506B-1 10 KW FM Transmitter

By J. B. BISHOP

Radio Development Department
Bell Telephone Laboratories

WITH the advent of the recent change in frequency assignment to the new band of 88-108 megacycles for all FM broadcasting transmitters Western Electric now offers a new 10-kw transmitter to meet the demand for a reliable high quality, high output power set.

The new Western Electric 506B-1 Radio Transmitter obtains its drive from the 1-kw 503B-1 Radio Transmitter, which is a component of the former, and possesses several novel features which render it unique as a power amplifier in the new frequency range.

The design of high power transmitters for present day FM service presents many problems which for all practical purposes do not exist in the regular AM broadcast band but require even more special consideration at the new FM frequencies than at the old. Of particular importance in this connection are lead lengths and stray capacities to

Fig. 1—The usual form of radio amplifier has a grounded filament and a plate at the radio-frequency potential

ground which result in reactances of the same order of magnitude as are normally required in the tuned circuits associated with input and output and those necessary for neutralizing.

These difficulties have been successfully overcome in the new 10 kw transmitter recently developed by Bell Telephone Laboratories for Western Electric by the use of a new air-cooled tube in a novel circuit arrangement which permits the tube to be used as a grounded plate amplifier and by employing sections of short-circuited transmission lines for the tuning elements.

Because of the inherently large plate to ground capacity of an air-cooled 10 kw tube and the inherently low grid to plate and filament to plate capacities of the new 10 kw air-cooled tube used in the 506B-1 Amplifier it is admirably suited to grounded plate operation with coil neutralization. In particular because of the low inherent filament-ground capacity it is possible to obtain a sufficiently broad tank circuit to insure that all significant sidebands are transmitted with resulting low distortion.

In the usual conventional form of a radio amplifier circuit as shown in Fig. 1 the large stray capacitance between plate and ground results not only in large tuning coil losses but in sharpening the tuning and thus introduces distortion. With the new grounded plate circuit, indicated in simplified form in Fig. 2, the stray plate capacitance to ground is in parallel with the grounding condenser (C1) which is used to block the d-c path to ground of the plate supply, and thus has no effect on the operation of the circuit. Only the capacitance of the filament to ground need be considered with this arrangement, and this capacitance is very much smaller than that between the plate and ground.

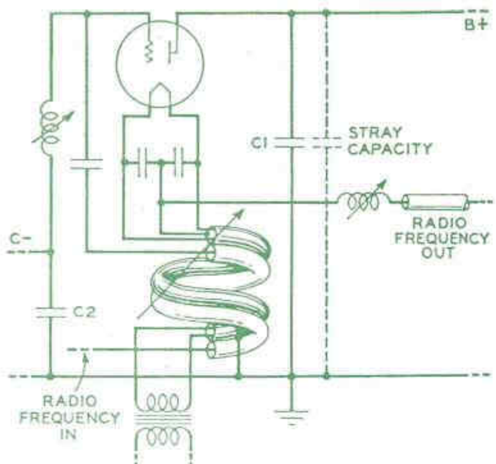


Fig. 2—With a grounded-plate amplifier, the stray plate-to-ground capacitance is in parallel with the grounding condenser, and is thus of no importance

The filament of the tube is at high radio frequency potential and it is very essential to supply filament current without the necessity of operating the filament transformer at this high potential above ground. It is also necessary to supply radio frequency driving potential between the grid and filament from the driver unit, one side of which is grounded. A method of obtaining these two objectives is shown schematically in Fig. 2.

The plate tuning coil of Fig. 1 is replaced in this new circuit by a coil between filament and ground. If this coil be formed by a pair of copper tubes in parallel as indicated in the illustration, the filament leads may be threaded through the bore of one of the tubes, and the grid driving potential supplied through an inner conductor of the other. At the filament end of this coil the copper tubes are connected to the filament through condensers as shown, and the other end of the coil is grounded. Thus, the filament current and grid driving voltage are delivered at the required circuit locations with the sources (driver and filament transformers) maintained at ground potential.

The necessity of being able to adjust the reactance of this inductance introduces numerous mechanical difficulties if an attempt is made to employ a coil as shown schematically in Fig. 2. These difficulties are avoided by the use of a coaxial transmission line whose length may be varied to adjust the net reactance from filament to ground to the proper value required for tuning the output circuit.

The physical arrangement of such a structure to replace the tuning coil of Fig. 2 is shown schematically in Fig. 3A. Here both the grid drive and filament leads are carried through the inner conductor of a variable section of transmission line fitted with a short-circuiting slug which permits the proper adjustment of the net filament ground reactance (C of Figs. 3A and 3B) as outlined above. The output tuning coil (L of Fig. 3A) is likewise a variable length section of transmission line (less than $\frac{1}{4}$ wavelength long and hence inductive in reactance) whose exact value is determined by the position of its short-circuiting slug.

Fig. 3B shows in schematic form the equivalent output circuit and in conjunction with Fig. 3A illustrates the unique manner in which a completely shielded output circuit is obtained without the attending embarrassment of unwieldy lead lengths or exposed coils and condensers. Moreover, it will be observed that the output tuning coil (which is commonly referred to as a "bazooka") provides the very useful function of translating the antenna resistance from the high r-f potential side of the coil to the grounded end which is most convenient when it comes to the matter of an actual installation.

The neutralizing coil, like the other tuning elements previously described, consists of a section of transmission line with the inner conductor connected to the grid and the outer conductor grounded. The position of the short-circuiting slug, therefore, determines the amount of inductance for coil neutralization and is, of course, adjusted to a value such that its inductive reactance just balances the capacitive grid-plate reactance of the tube at the operating frequency.

The physical arrangement of circuit elements employed in the 506B-1 amplifier is no less unique than the extremely straightforward and simple electrical circuits themselves. In fact it is because of the utter simplicity of the electrical circuits that such a neat and simple mechanical arrangement is possible.

The 10 kw air-cooled tube is located in a 9″ diameter cylindrical tube socket at the base of which is an insulated support which makes contact with the fin structure of the air-cooled plate and through which is supplied the d-c plate potential. The entire tube, except for filament and grid connectors, is enclosed by the tube socket and is insulated from it by a silver plated cylinder of Pyrex glass (C1 of Figs. 2 and 3A). The three coaxial tuning elements of Fig. 3A are arranged in a close packed vertical arrangement which extends some three feet above the top of the tube structure which latter, as mentioned above, just projects above the top of the tube socket.

FIG. 3A

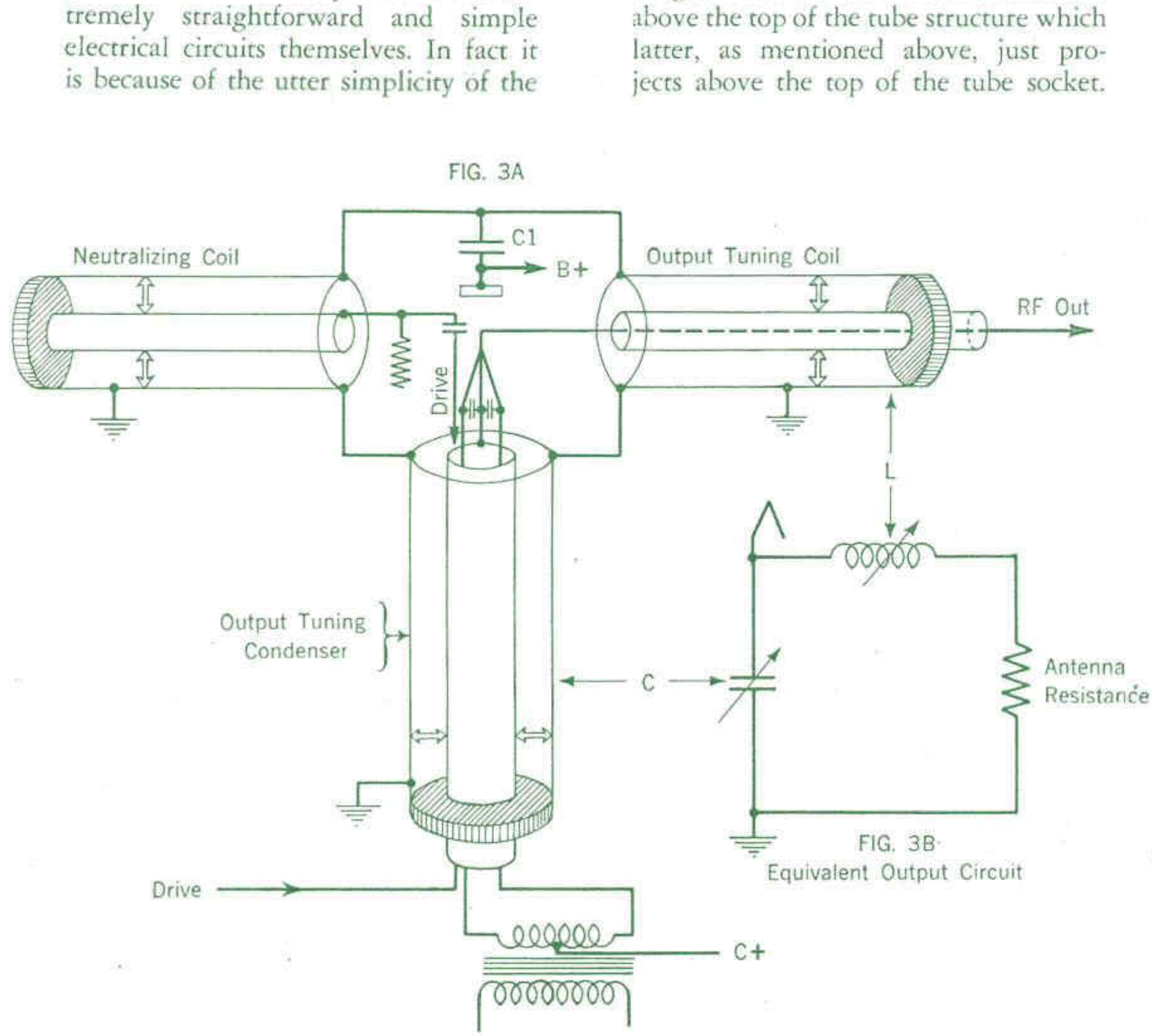


FIG. 3B
Equivalent Output Circuit

Schematic Diagram 506B-1 *Amplifier*

An electrically tight cylindrical screen some 6" high joins the top of the tube socket to the tuning pipes. Thus, the whole structure is completely shielded from the outside and from unwanted interaction between the neutralizing coil, output and input circuits. Moreover, the whole structure is at ground potential and entirely free from hazard to operating personnel.

A blower to supply forced air cooling to the plate and grid structure is located in the base of the amplifier cabinet. The cooling air first passes through the fin structure of the plate and then over the grid and filament seals to the outside.

With these novel features, both electrical and mechanical, the new transmitter is unusual in appearance as well as in design. All tuning and amplifier controls are motor operated to eliminate long or intricate mechanical linkages, and all contactors are controlled by direct current to insure quiet operation. By means of interlocks and time delays, all potentials are applied in the proper sequence at starting, and a complete complement of safety devices provides full protection for the operating personnel. The complete 10-kw transmitter includes the driving unit already referred to, the 10-kw amplifier unit, and a power-supply circuit arranged in a cabinet of similar appearance. This assembly is completely self-contained, and requires a minimum of floor space. Since in the FM field the transmitters are often installed on an upper floor of an office building, the compactness of this design is a distinct advantage.

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