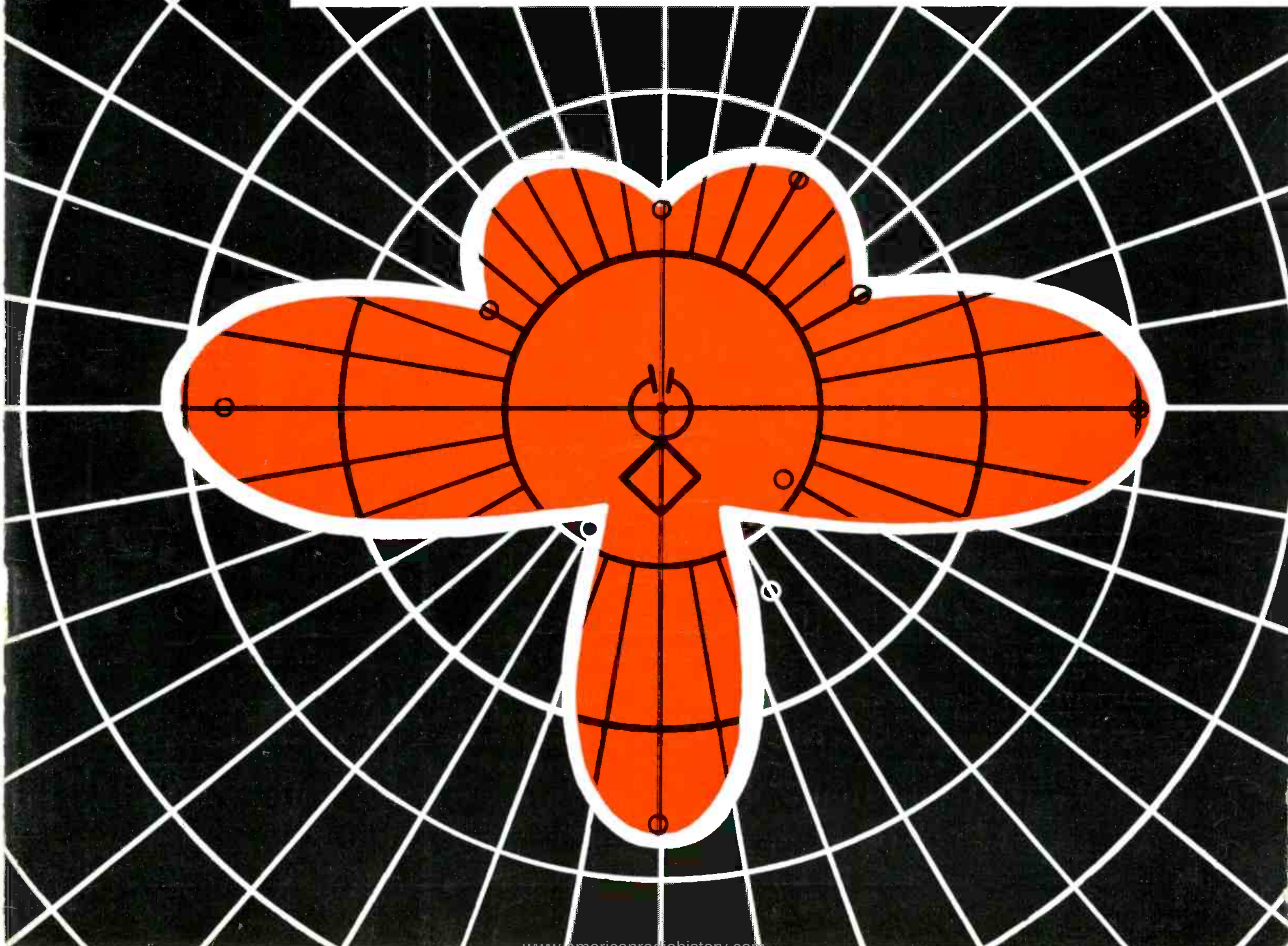
OCTOBER, 1961

# BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

## Needed - MORE FM ANTENNA MOUNTING RESEARCH



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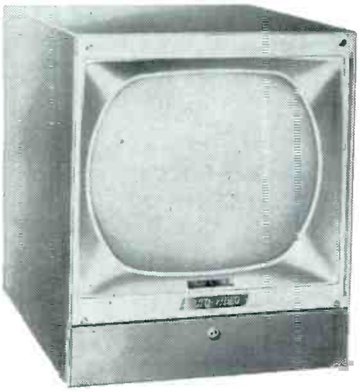

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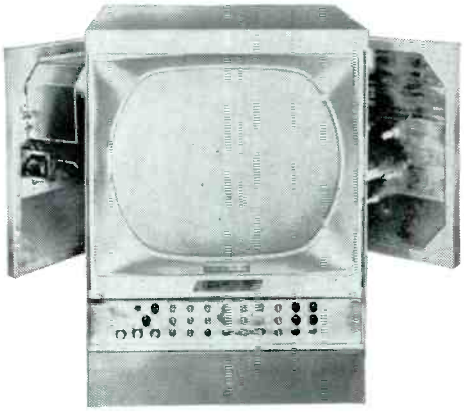

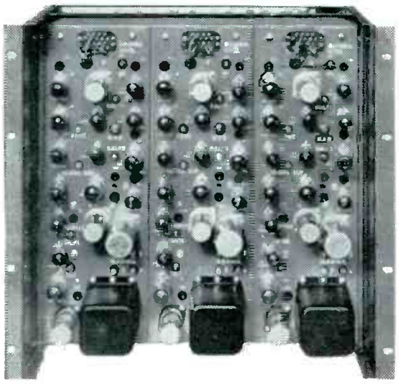

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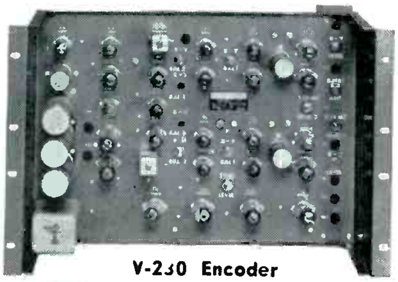

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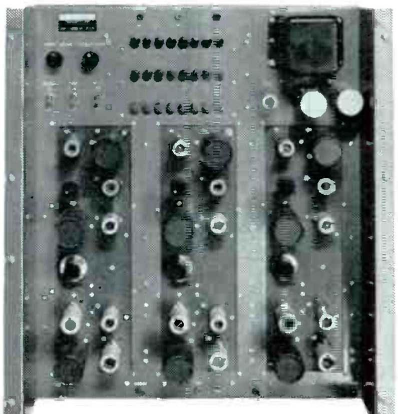

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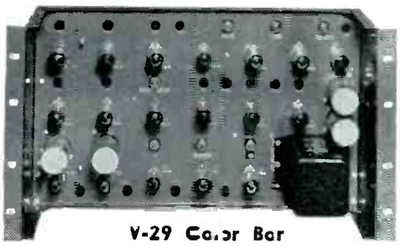

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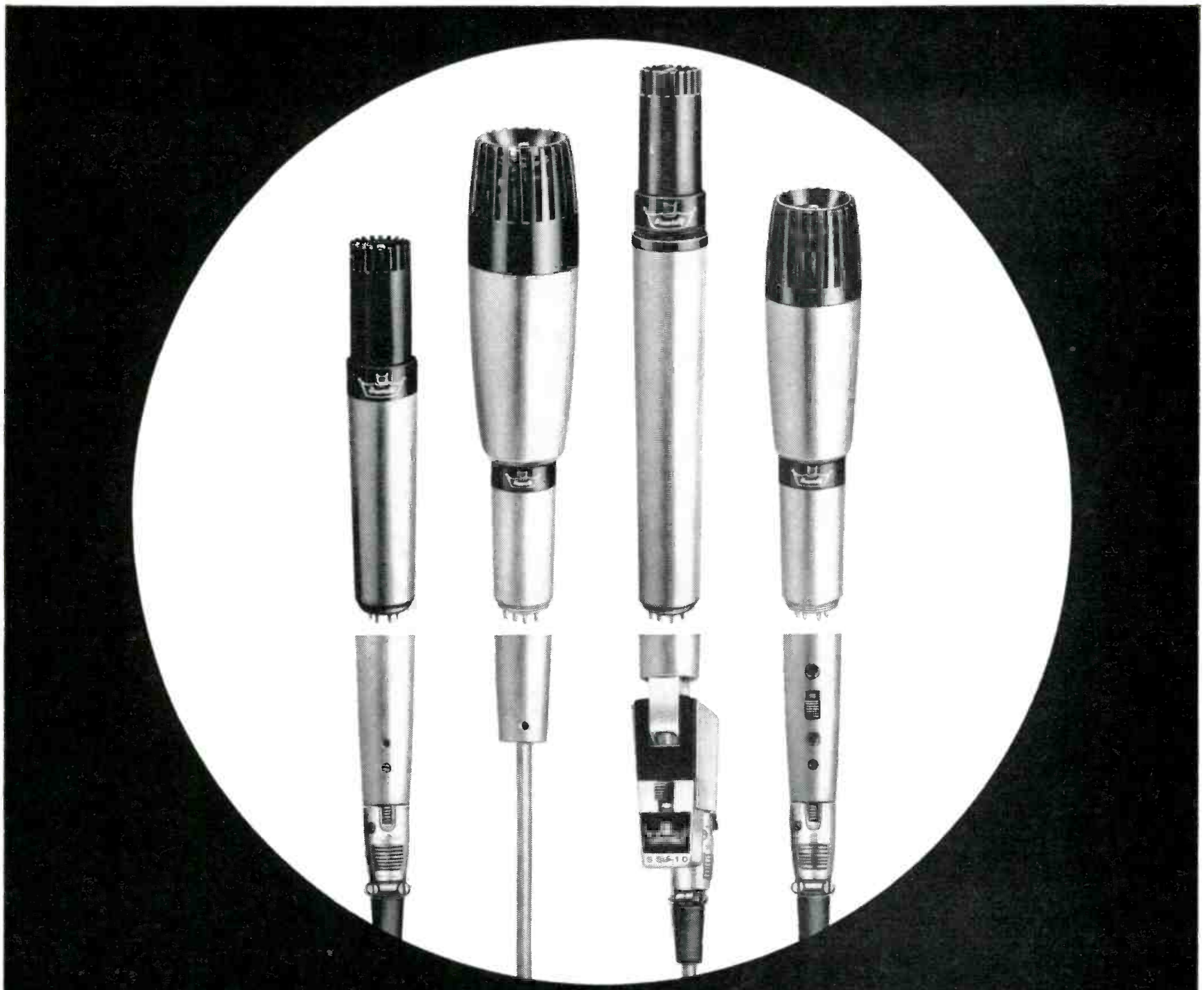

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# BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY ®

**VOLUME 3** **OCTOBER, 1961** **NUMBER 10**


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## Departments



## Cover Story

The pattern represents a severe distortion in radiation from a theoretical non-directional FM coverage. Many factors contribute to this situation, including location of antenna in relation to tower, the size of tower, and guy wire interference. This information is presented in the Journal under the article, "Problems Encountered In Mounting FM Antennas On Various Supporting Structures."


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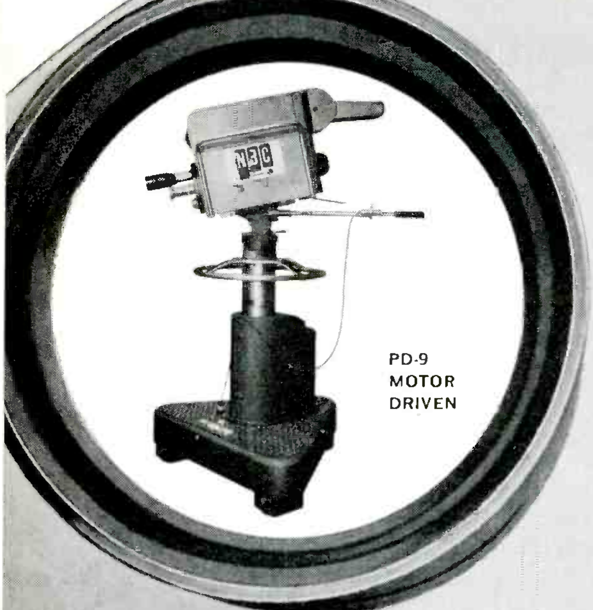


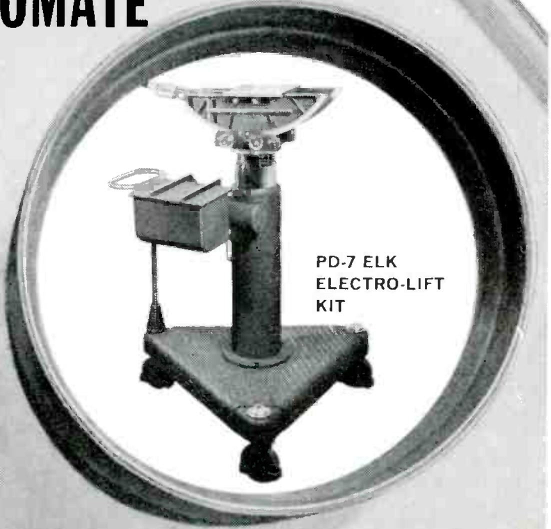


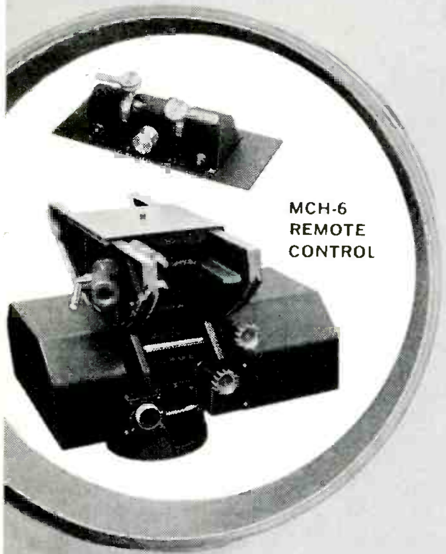


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# Problems Encountered in Mounting FM Antennas On Various Supporting Structures

By John B. Caraway, President
Electronics Research, Inc.
Evansville, Indiana

and William A. Kennedy
Antenna Department
Collins Radio Co.
Cedar Rapids, Iowa

Measurements show how radiation pattern is affected by tower proximity

IN THE YEARS shortly after World War II, there was a considerable increase of interest in FM broadcasting. Towers to support multiple element FM antennas were expensive to the average broadcaster, and it was at this time that Collins Radio Co. began installing FM arrays mounted on the side of existing AM structures. Soon FM antennas were mounted on all types of structures, varying a great deal in stuctural design and size.

Recently, with the renewed interest in the FM broadcasting field, more and more broadcasters are exploring the possibilities of additional revenue from multiplexing services. As a result, the design requirements of the FM antenna are becoming more stringent, particularly with regard to the impedance and radiation properties.

It is the purpose of this article to indicate some of the existing problems regarding structural interference to the desired radiation pattern of an FM antenna. The experimental data that follows is based on measurements from a single element FM antenna. Unfortunately, time prevented measurements on multiple element FM antennas. However, it is known that the performance of an array may vary considerably from that indicated by the single element performance.

### Measured Data

Radiation pattern measurements were made with a single element FM antenna at 100 megacycles. The FM antenna, except in two cases where a "V" antenna was substituted, consisted of a single, capacitively loaded loop, approximately 15 inches in diameter. Free space radiation properties of this type are omnidirectional within 1 db. A non-guyed Blaw Knox tower having a uniform 7-foot square cross section was employed as the supporting structure with the exception of two conditions in which the radiation properties were determined in the presence of a small triangular tower. All data is presented in terms of relative voltage plots.

In Figure 1 the antenna is mounted on the corner of the tower where the diagonal braces of the tower are

**EDITOR'S NOTE:**

*This is a beginning, at least, to find an answer to a vital problem facing FM broadcasting. The directional effects of the pattern due to supporting structures and guy lines have plagued the FM industry for years and will continue to do so until active research, experimenting, and measurements are completed and evaluated. BROADCAST ENGINEERING looks forward to the day when these conditions may be calculated in advance for any given antenna array, on any structure. This Journal is willing to publish all valid data pertaining to this development in the hope of finding a quick, reliable solution.*

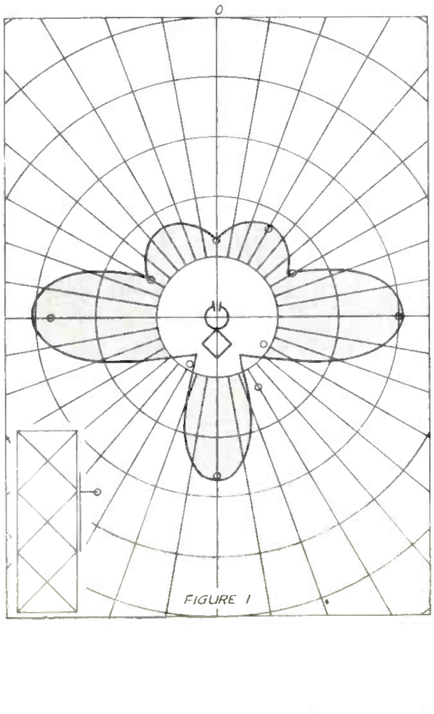



FIGURE 1

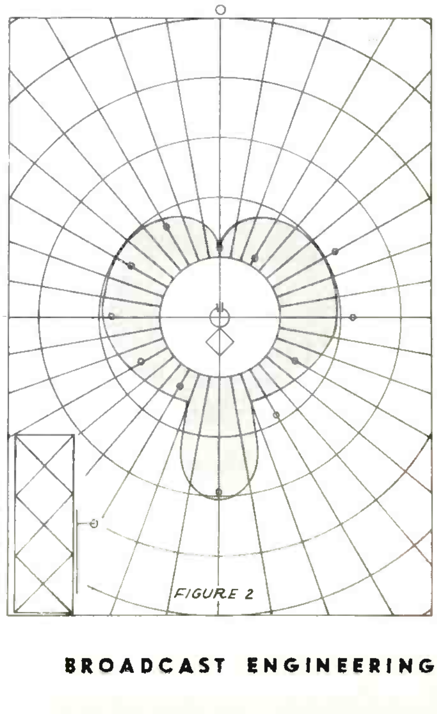



FIGURE 2

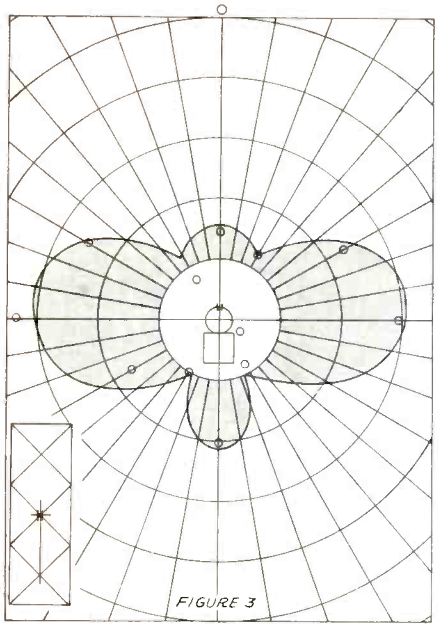


FIGURE 3

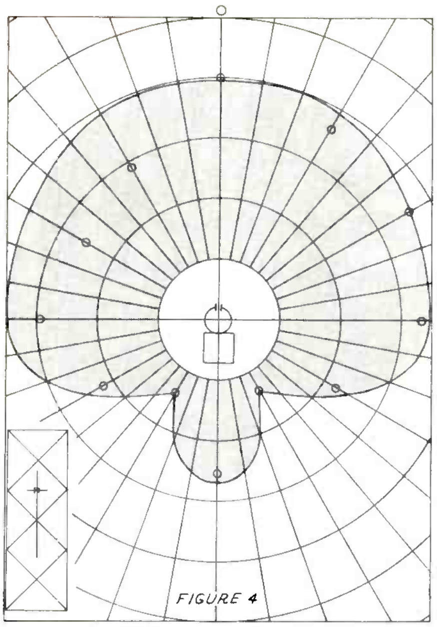


FIGURE 4

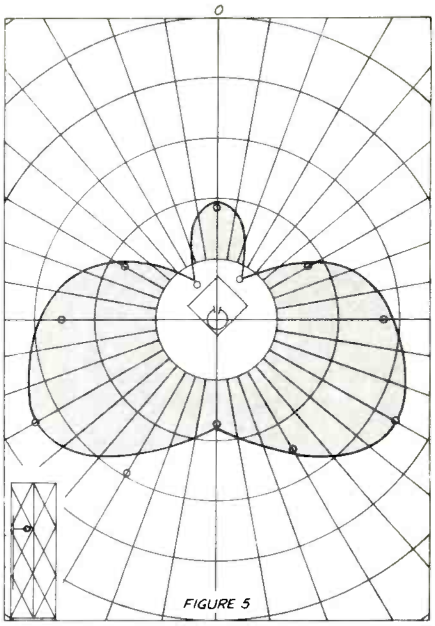


FIGURE 5

joined to the leg. The resulting pattern has rather pronounced deviations from the omnidirectional characteristics of the FM loop antenna in free space. The nulls are approximately 8 db down from the major lobes for this condition.

Movement of the antenna to a distance halfway between the diagonal braces on the corner of the tower gives a noticeable improvement in results. This is illustrated in Figure 2.

In mounting a multielement antenna on a tower of this type, each element most likely will be located, depending on frequency, at varying distances from where the diagonal braces of the tower join the corner leg. The resulting array pattern undoubtedly would be different and determination of its properties cannot be completely predicted from the single element results. Also, this data results from measurements taken at 100 mc and an additional variation with frequency over the FM band of 88 and 108 mc could be expected because of the varying electrical properties of the tower. These points are mentioned here to indicate the great number of variables caused solely by the supporting structure which, in many instances, are not at the complete control of the antenna engineer.

In Figure 3, the 100-mc antenna has been moved around to the flat side or face of the structure at the point where the diagonal braces intersect. Deviation from omnidirectional properties, for this case, are approximately ±5 db.

As experienced with the corner mounting locations, there also is quite pronounced variation with position along the side of the tower. This is evident in Figure 4 where the antenna is located at a point midway between the crossover points of the diagonal braces.

In addition to the indicated variations between side and face mounted locations, there are several mechanical aspects to be considered:

(1) Corner mounting usually positions the antenna or the coaxial line at a point where it interferes with guy wires and causes difficulty

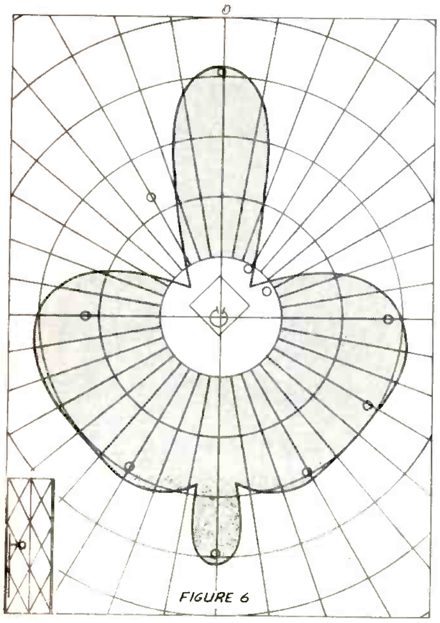


FIGURE 6

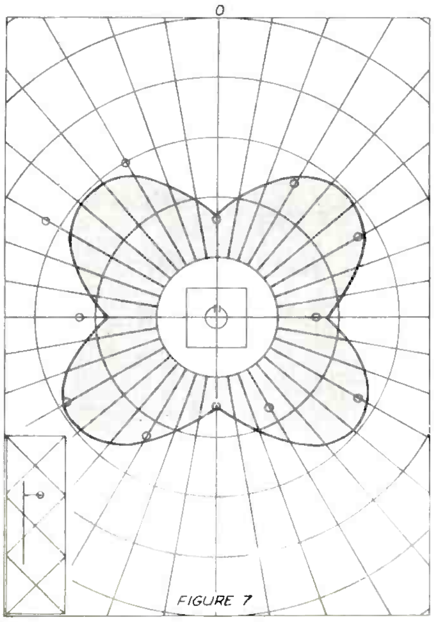


FIGURE 7

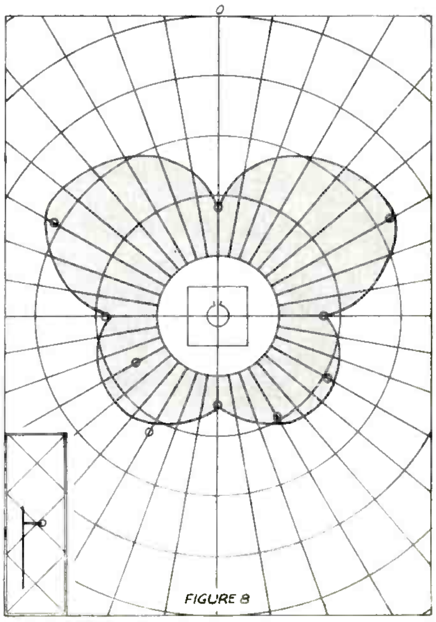


FIGURE 8

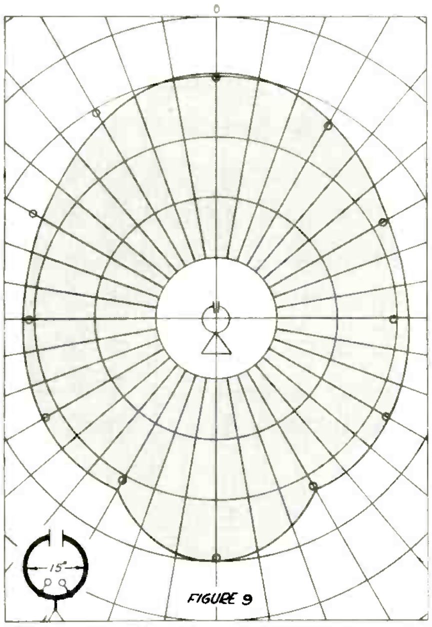



FIGURE 9

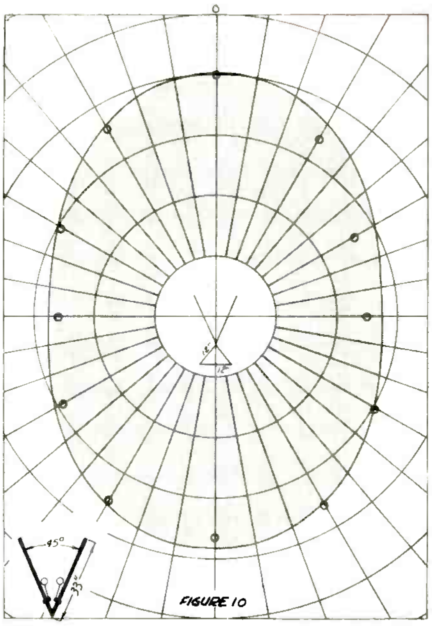



FIGURE 10

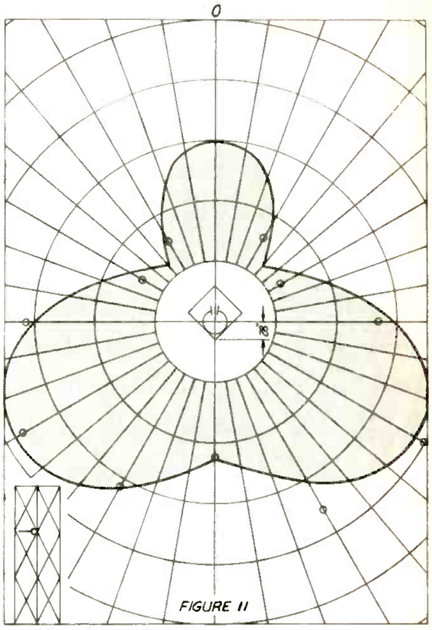



FIGURE 11

in obtaining a rigid mechanical installation. This vertical alignment problem of the antenna discourages the use of the corner leg mount.

(2) The face mount, as shown in Figures 3 and 4, offers the installer a chance to achieve a rigid mechanical job free of guy wire interference, and this, apparently, is the type of mounting more widely used than any other.

Although not usually recommended, in some installations the antenna has been mounted within the tower. This is illustrated in Figure 5 where the antenna is located inside the tower 15 inches from the corner of the diagonal or X-bracing cross. Figure 6 illustrates a similar condition except the antenna was placed midway between the bracing.

Mounting the antenna inside the supporting structure has some mechanical advantages, such as the problem of reducing interference with the guy wire system. Also, in some cases, the wind loading is reduced. As mentioned before, this type of mounting generally is not recommended.

Figures 7 and 8 show the results of varying the positions of the antenna within the structure but with the antenna located symmetrically with respect to the tower. The position indicated in Figure 7 results in the least variation from the desired pattern (omnidirectional within ±2.5 db). It probably is safe to assume that if each element in a multi-element arrangement arrived at identical places throughout the structure with relation to cross bracing, a pattern of this type would result.

The installation of an array within a supporting structure of this type is difficult because the interior of the tower generally is used for

(Continued on page 18)

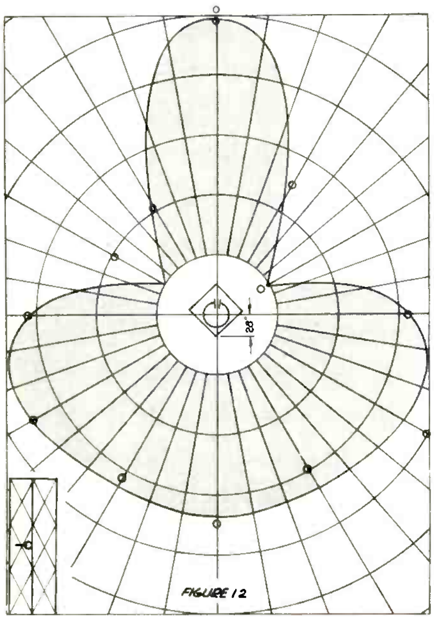



FIGURE 12

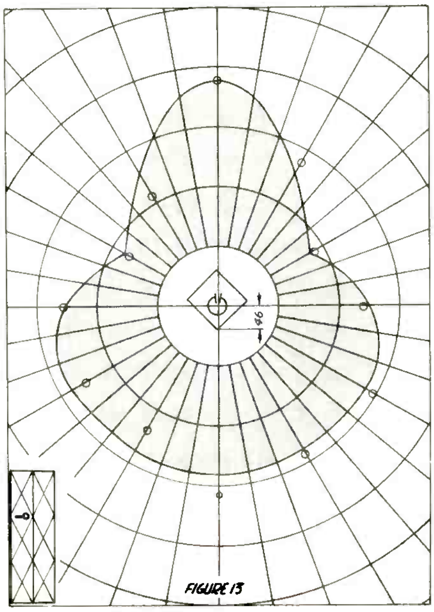



FIGURE 13

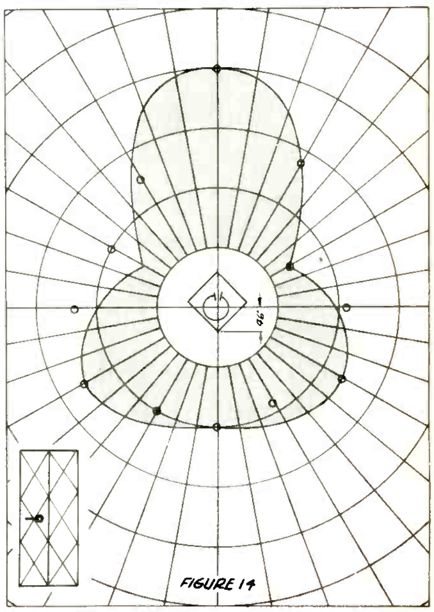
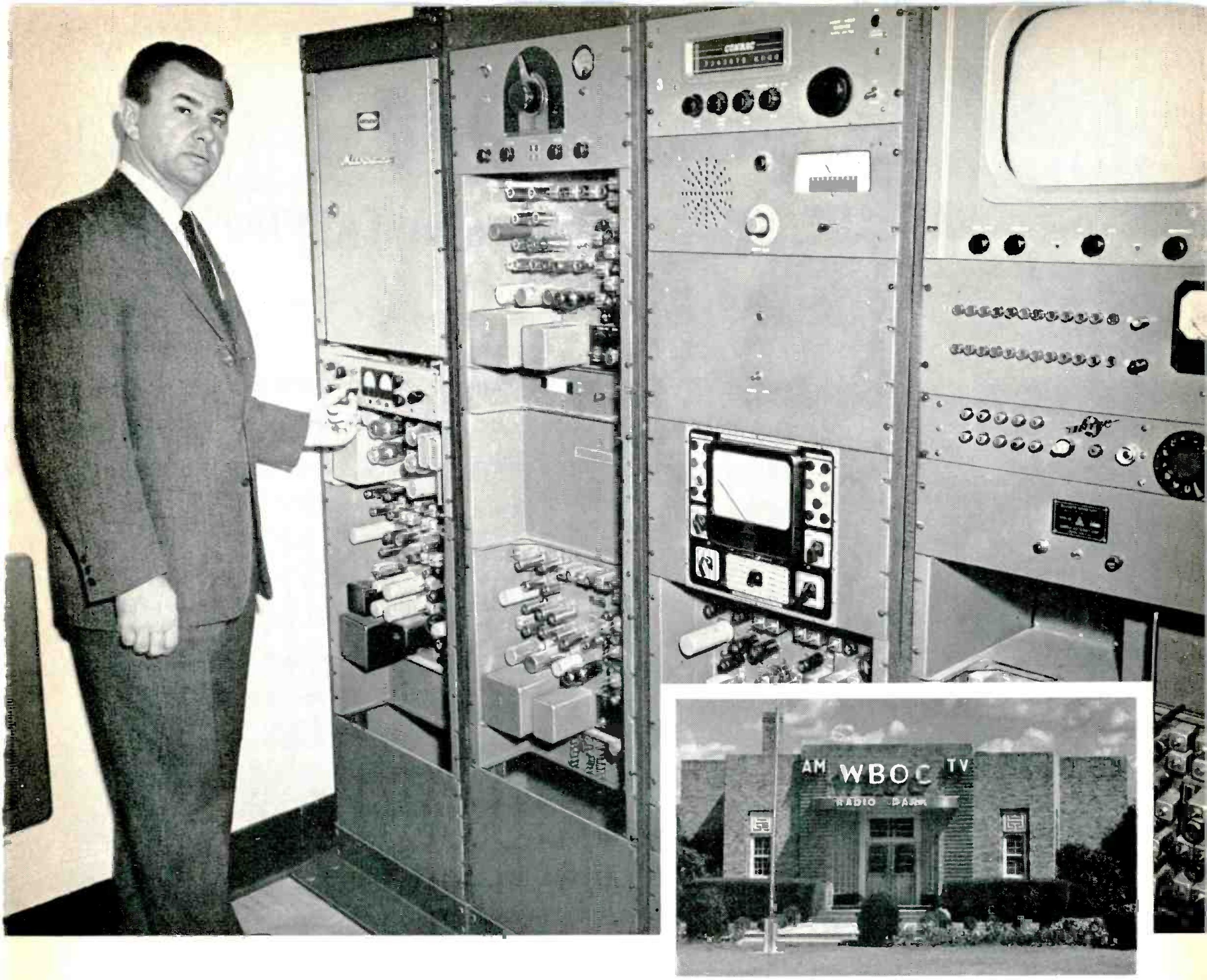



FIGURE 14

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# SATELLITE RELAYS AND BROADCASTING

By J. H. Felker
Assistant Chief Engineer
American Telephone & Telegraph Co.
New York, N. Y.

**Communication expert outlines the plans and problems of tomorrow's world TV repeaters.**

SCIENCE and the telephone business have worked together very closely ever since Alexander Graham Bell's breakthrough in a Boston attic in 1875. The constant search for greater communication capacity led to carrier telephony in the twenties, to coaxial cable systems in the thirties, to microwave in the forties, and long overseas submarine voice cables in the fifties.

The big step in the sixties will, of course, be the use of satellites in microwave communications. Each of these advances has had one thing in common. Each enabled us to get a larger number of circuits over a particular path than we could by previous methods. In carrier telephony, twelve voice circuits on two pairs of wires is common. In a coaxial cable, we get 1,800 voice circuits per pipe, in microwave radio, we get 1,800 circuits per channel and in our first long submarine cables, we got 36 voice circuits.

It may be noted that the submarine cable gives fewer voice circuits than the coaxial cable or microwave radio. Before we deprecate the achievement represented by submarine voice cable, we might remember that it was about 75 years after we had learned how to get a cable under the ocean before we were able to handle even one voice circuit in an underseas cable!

Submarine cables and satellites may seem at the opposite ends of space, yet each require fantastic standards of reliability from electronic parts if they are to be practical. In our cable systems, where the repeaters are almost as inaccessible as they would be in outer space, over 700,000,000 component hours of life have piled up without a single failure. Over 1,500 vacuum tubes have operated two-six years without failure.

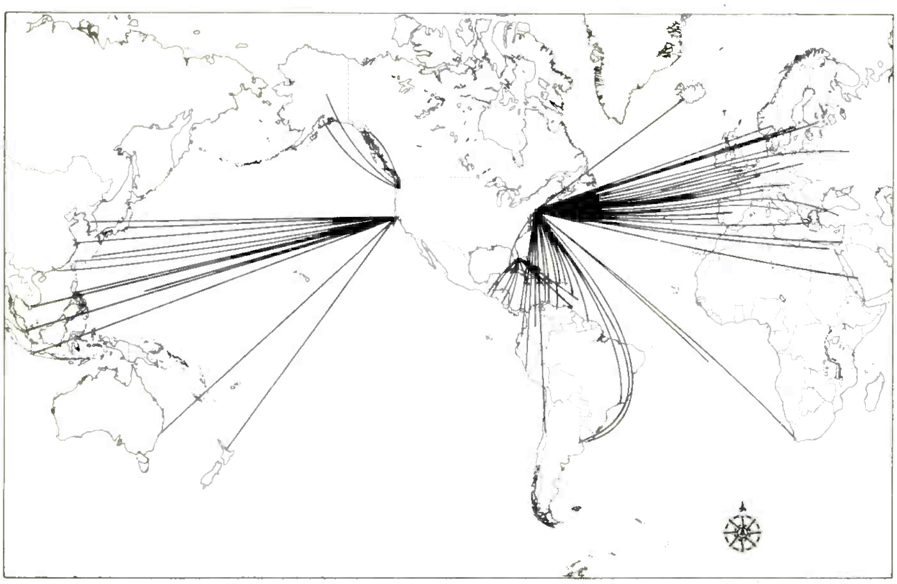


Fig. 1—Countries or areas served by direct circuits.

Figure 1 shows our present overseas network. This network began with cables to Cuba in 1921 and transatlantic voice service in 1927. It has now grown until we and our overseas partners have several hundred million dollars invested. AT&T has business agreements with 163 overseas telephone agencies and administrations. Many of these are with the iron curtain countries. We have always found the simple yardstick of what makes good communication and business sense adequate to resolve differences of opinion. Our arrangements have worked well. We'd like to continue them.

Despite the great step forward taken with submarine cables, we are still lacking the ability to give the full range of services overseas that we do continentally. Submarine cables do not now, or is it likely that they will in the near future, give us sufficient frequency spectrum to transmit commercial quality video signals, whereas microwave radio and coaxial cables do.

Why do we consider it important

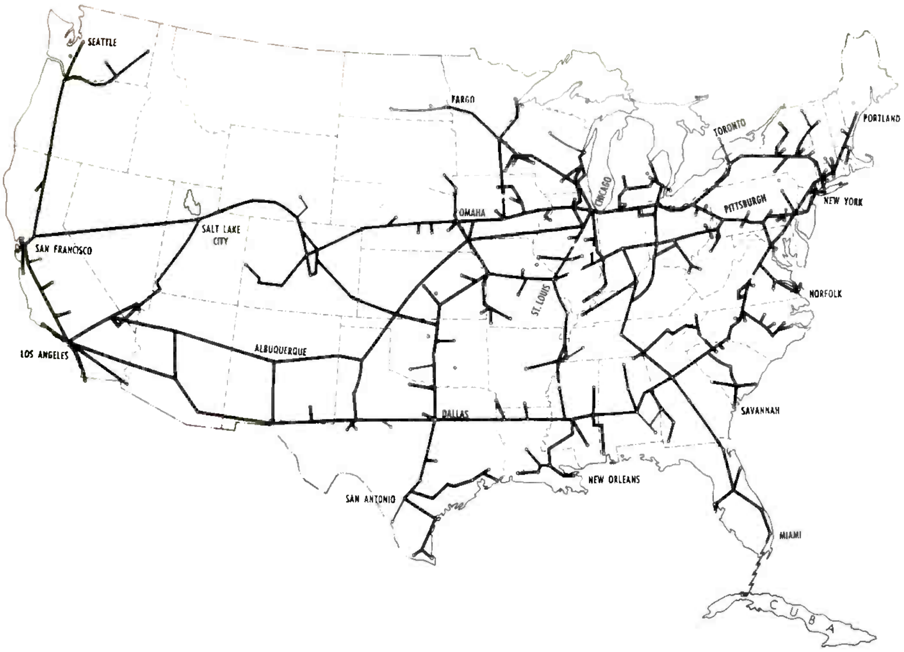



Fig. 2—The continental video network.

to have intercontinental television? Basically, we believe it is important because:

1. Common markets are extending everywhere.

2. International news events often transcend national news in importance.

3. Americans, as business men and as citizens on vacation, travel more these days. Seeing the rest of the world at play and at work is a basic expectation of more and more Americans.

We are so sure of this that the Bell System is willing to take a business risk on it just as it did on TV networking in this country. Some of you may remember that in 1946, in order to stimulate intercity television the Bell System provided facilities to the broadcasters on an experimental basis before anyone could prove that there was a "need" for a transcontinental video network. This bit of history may seem strange when we realize that there are now 83,000 miles of video facilities which we supply to the broadcasters. Figure 2 shows the present video network. One might have expected that video tape recording and transportation by high speed jet would make it unnecessary to have overseas TV. The fact that these same tools have not decreased the use of the television network in the United States argues against there being any substitute for overseas networking.

Clearly, if we were able to extend our video network by microwave radio, we could avoid the bandwidth limitation of submarine cable. George Gilman, in charge of systems engineering at B.T.L. in 1950, directed a study of the economic feasibility of using a string of airplanes carrying microwave repeaters as a means of relaying video across the ocean. Since we did not undertake the venture you may assume correctly that the service did not look economically attractive.

Another way of getting microwave across the ocean would be to build a 475-mile tower out in the middle of the ocean, Figure 3. A repeater on such a tower would provide an optical line of site between New York and Paris. It would permit microwave coverage over even greater distance.

Satellite communication systems are only substitutes for the 475-mile tower in the sky. The rocket is just a cheap way of getting a repeater up there. If a $2 million rocket can replace a 475-mile tower, how much does the rocket cost per foot? The answer is about 80 cents. And anyone in the broadcast business knows that 80 cents a foot for a tall tower is a mighty low price.

It can be argued that it takes many rockets and satellites to have a complete substitute for the tower in the sky. That is true, but the rockets still look cheap in comparison to a tower. As a matter of interest, a rough calculation led to the estimate that a 475-mile tower would have a cost equal to the value of the entire gross national product for 70,000 years.

**The Satellite System**

Having established satellite systems as merely high tower microwave systems, consider how many repeaters might be required and what kind of orbits should be used to establish world-wide communications.

This gets into the number of channels that each satellite can provide which, in turn, becomes a problem of the availability of frequency spectrum.

Because of the very difficult transmission path from satellite to the earth, "bird-to-ground," wide-

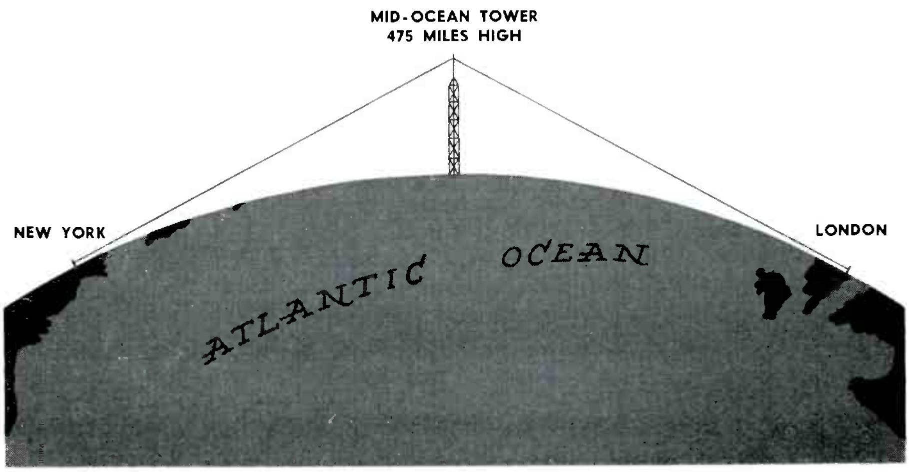
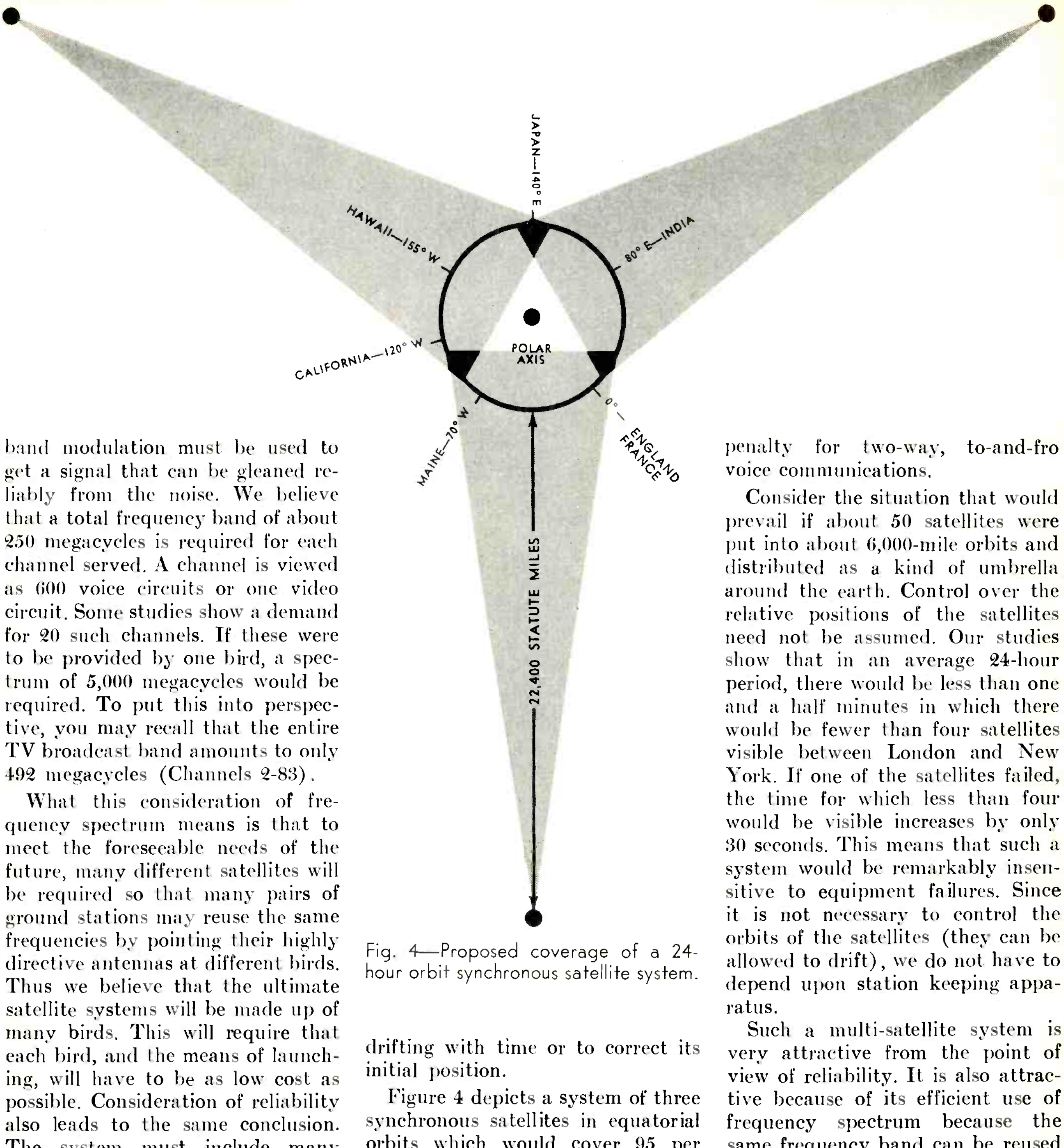



Fig. 3—Microwave across the ocean is out of the question.




band modulation must be used to get a signal that can be gleaned reliably from the noise. We believe that a total frequency band of about 250 megacycles is required for each channel served. A channel is viewed as 600 voice circuits or one video circuit. Some studies show a demand for 20 such channels. If these were to be provided by one bird, a spectrum of 5,000 megacycles would be required. To put this into perspective, you may recall that the entire TV broadcast band amounts to only 492 megacycles (Channels 2-83).

What this consideration of frequency spectrum means is that to meet the foreseeable needs of the future, many different satellites will be required so that many pairs of ground stations may reuse the same frequencies by pointing their highly directive antennas at different birds. Thus we believe that the ultimate satellite systems will be made up of many birds. This will require that each bird, and the means of launching, will have to be as low cost as possible. Consideration of reliability also leads to the same conclusion. The system must include many birds to avoid excessive dependence on any one.

Choosing the orbit for the satellites is a complex matter. The first proposal which our scientists made was for a system of synchronous satellites, satellites that rotate once in 24 hours. A satellite 22,000 miles above the earth has this property. If placed in an equatorial orbit, such a satellite will appear to hover over the same position on the earth's surface. Station keeping facilities, that is a source of motive power, could be used to prevent the satellite from drifting with time or to correct its initial position.

Fig. 4—Proposed coverage of a 24-hour orbit synchronous satellite system.

Figure 4 depicts a system of three synchronous satellites in equatorial orbits which would cover 95 per cent of the earth's surface.

As mentioned earlier, although three satellites will cover 95 per cent of the earth's surface, frequency considerations will undoubtedly require the use of a greater number of satellites. Reliability considerations also lead in the same direction.

As can be seen from the sketch, the synchronous satellites are a long way from the earth. The transmission path from New York to London is increased from around 4,000 to about 44,000 miles. As will be discussed later, this is not without penalty for two-way, to-and-fro voice communications.

Consider the situation that would prevail if about 50 satellites were put into about 6,000-mile orbits and distributed as a kind of umbrella around the earth. Control over the relative positions of the satellites need not be assumed. Our studies show that in an average 24-hour period, there would be less than one and a half minutes in which there would be fewer than four satellites visible between London and New York. If one of the satellites failed, the time for which less than four would be visible increases by only 30 seconds. This means that such a system would be remarkably insensitive to equipment failures. Since it is not necessary to control the orbits of the satellites (they can be allowed to drift), we do not have to depend upon station keeping apparatus.

Such a multi-satellite system is very attractive from the point of view of reliability. It is also attractive because of its efficient use of frequency spectrum because the same frequency band can be reused on each satellite. Furthermore, adding additional satellites, or accepting into the system satellites launched by a foreign partner, is a much simpler matter than it is for any other scheme we know of.

When we face up to the responsibility of using satellites to provide better intercontinental communications than we now have, we discover that the altitude of the satellites is a very important factor. This is because the transmission paths can get so long that the resulting delay interferes with the to-and-fro com-

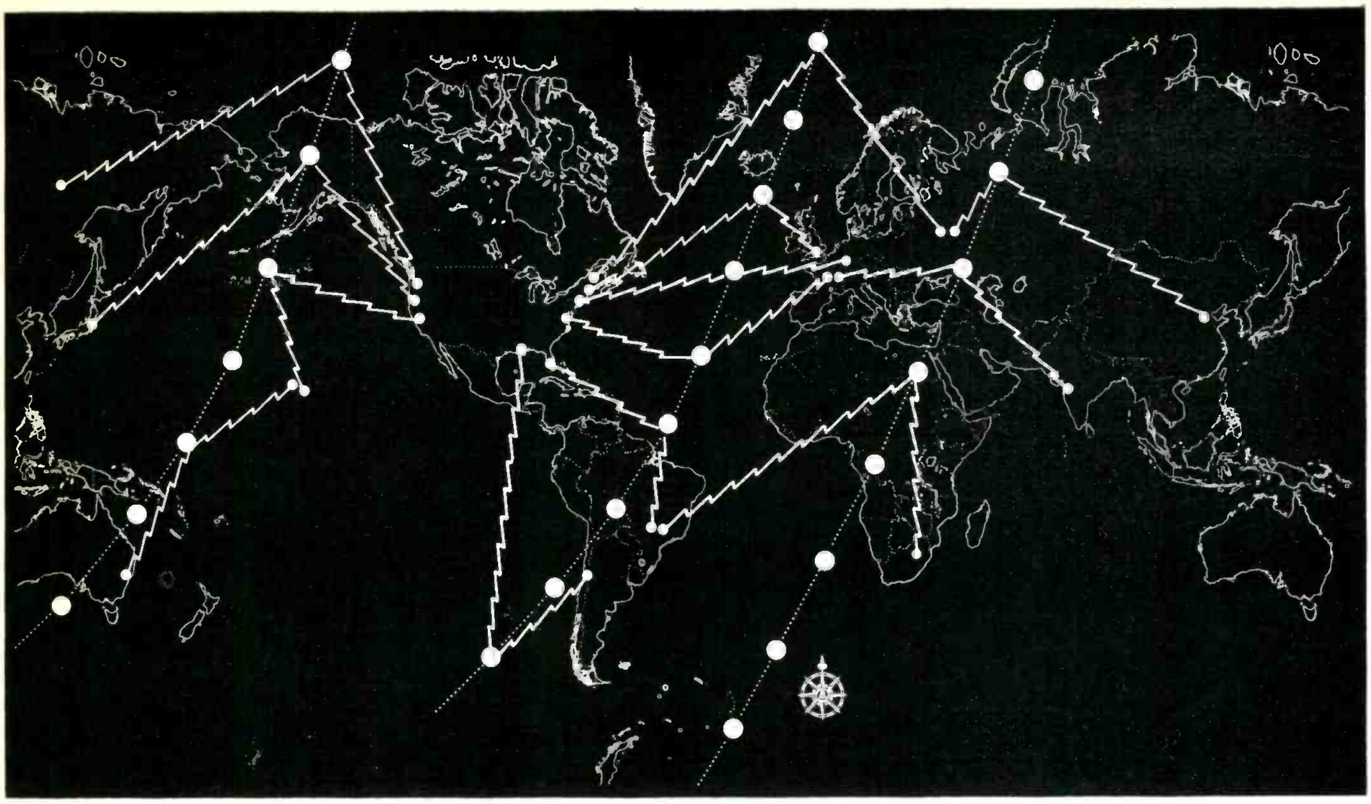


Fig. 5—Global coverage plan.

munication that is the essence of telephone service.

Published statistics show that in a telephone conversation, an average burst of talk is about two seconds in duration. The other party responds in 0.3 second on the average. A speaker must wait the round trip propagation time of the circuit before he knows whether or not the other party has responded. He expects a delay in response of only 0.3 second and the round trip delay adds to this.

Great doubt exists that synchronous satellites will do for two-way telephony because of an inevitable round-trip delay of about 0.6 second for a single satellite system. This would make the average response time 0.9 second or three times as long. Two satellite systems in tandem (which would occur in some world-wide network connections) would mean a round-trip delay of more than a second to be added to the normal response time. In comparison, there is less than 0.2 second delay for a call from Europe to Hawaii via land lines and submarine cable—the longest cable communication now possible.

One would expect that speakers using circuits in which delay increases each speaker's response

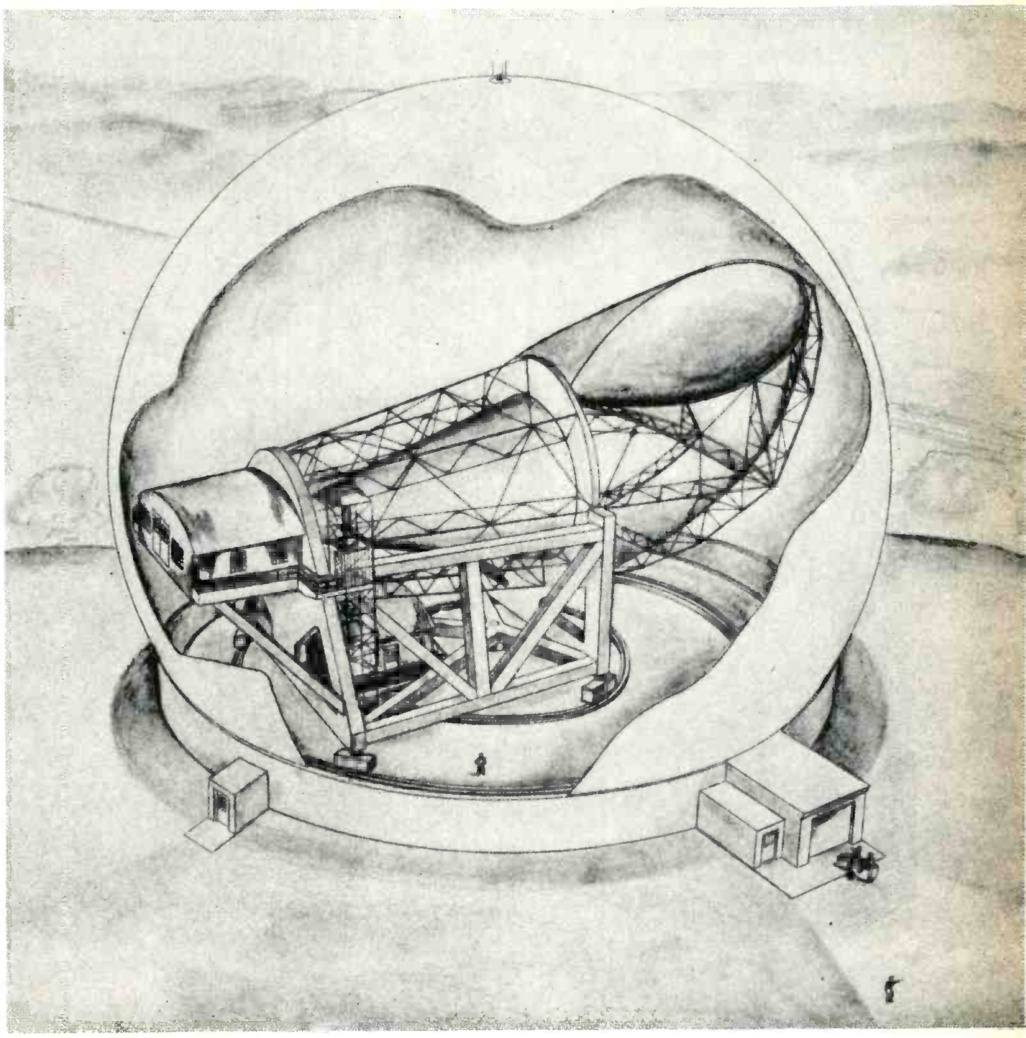


Fig. 6—The AT&T proposed horn reflector—60 x 60 ft.

time, would take longer to carry out their transactions. On the contrary, we find so far, that the speakers hang up sooner than they do on calls over circuits without delay. This indicates to us that the service has been less satisfactory. The issue is not whether customers will put up with delay in their communications' paths. It is rather, will they find the service so useful that they want to use it freely.

In fact, unless satellites give high quality telephone service the rapid growth of traffic predicted for the future will not occur. We know from previous experience that where service is mediocre, growth is slow or non-existent. Anyone in the communications business will confirm the observation that our present level of telephone development in the U. S. is due to the ease and naturalness of the service provided.

There is another aspect to the delay problem that can only be mentioned in passing. All telephone networks create echoes. When delayed, echoes become intolerable. If not suppressed, they can rattle a speaker to such an extent that he can no longer speak. Echo suppressors are, therefore, used on long circuits. Echo suppressors set to work for delays of a few tenths of a second introduce minor degradation. But when set for delays of a half second or longer, the degradation is severe.

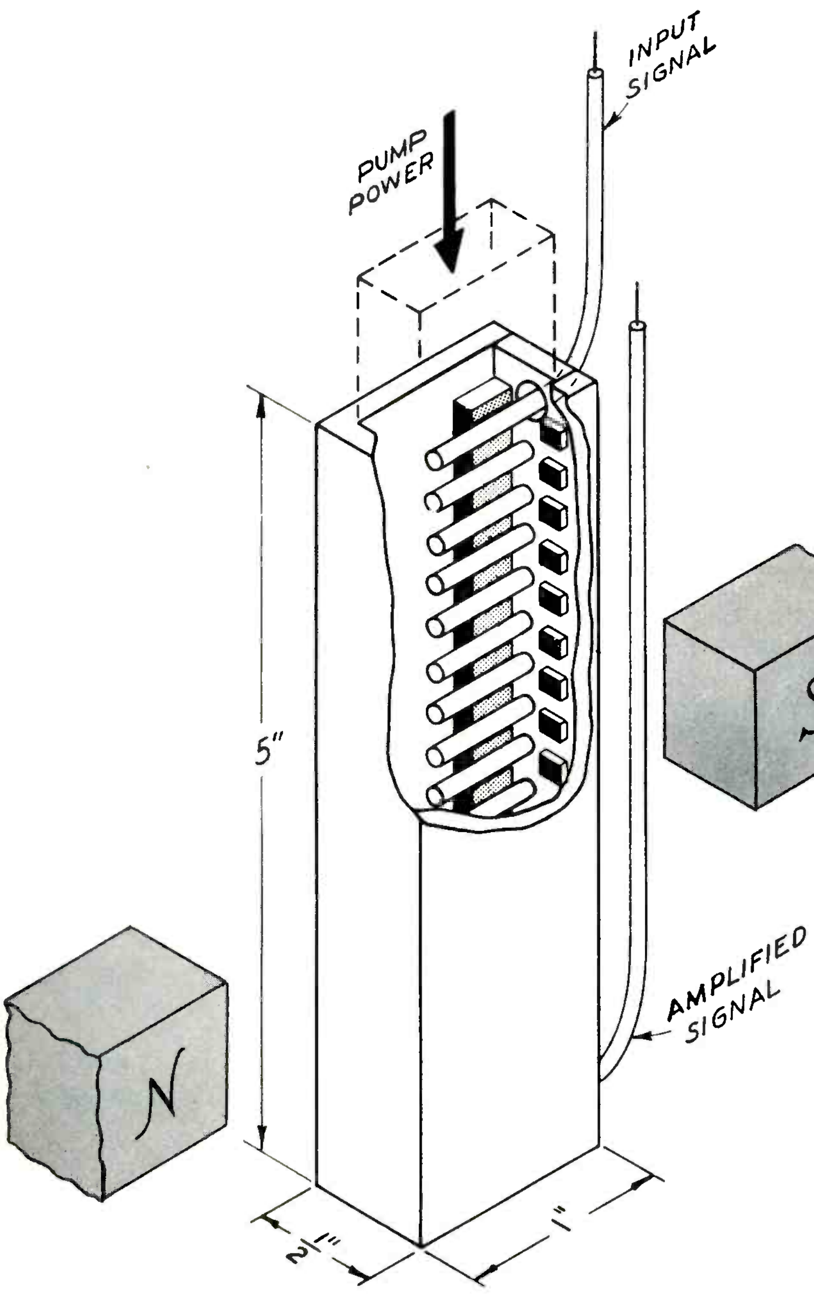


Fig. 7—A simple view of a maser.

The Bell System has long followed the doctrine that new facilities should perform at least as well as the old—preferably better. So, in order to get quality, reliability, and maximum use of the frequency spectrum, our planning has been directed at a system based on many satellites in low-level orbits. A larger number of satellites are required than in a synchronous system, but the satellites are much simpler and frequency spectrum is conserved. Each ground station requires several steerable antennas to change from one satellite to another without interrupting communication. This flexibility insures reliability since it is possible to switch to another satellite when one fails.

Conceivably, suitable propulsion in the satellites could keep them in precise enough orbit for continuous service with fewer satellites. However, planning so far has been mainly for satellites without this station-keeping ability. Our plans may very well change as the art of station-keeping advances and develops the required reliability.

Initially we plan for 30 satellites in about 6,000-mile polar orbits. Even if these orbits are random and uncontrolled, at least one will be visible both in the U. S. and Western Europe except for a period less than two minutes a day. In a different part of the orbit, the 30 satellites also can provide service between the U. S. mainland and Hawaii.

Once the 30-satellite service is established, we could increase international communications with more satellites in the same 6,000-mile orbits so at least two satellites are mutually visible to the two terminals. Add antennas at each ground terminal and you establish two independent communication links via the two satellites between the same terminals. We could repeat this to get three or more satellites mutually visible to increase traffic further. Thus, you can increase traffic without increasing frequency assignments.

Another way to add transmission capacity is to install repeaters for

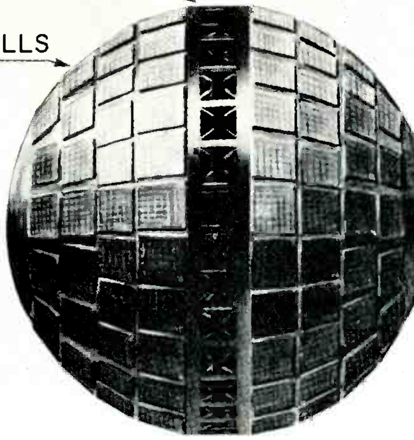



Fig. 8—A proposed communication satellite.

several broadband radio channels in each satellite. This saves in ground installation by using the same antenna for several radio channels. There is an optimum number of channels per satellite to give the cheapest over-all system. It depends on relative costs of satellites (including launching) and costs of antennas. Since we do not know these costs accurately now, we cannot yet definitely determine the optimum.

Our present plans call for satellites with repeaters to handle four broadband two-way radio channels. Each channel could carry 600 telephone signals or one broadcast quality television signal. We estimate that by 1980, we would need 12 broadband two-way channels between the U. S. and Western Europe (including Britain). Thus, in 1980, we will need 50 satellites in orbit to give a high probability that four satellites would be visible to the U. S. and the European countries. This calls for enough frequencies to provide four broadband channels.

This world-wide system is illustrated schematically in Figure 5.

**Design of a Satellite Repeater**

We have been authorized by the F.C.C. to use frequencies in the 4,000 megacycle and 6,000 megacycle range for an experimental satellite system. We have made considerable progress on the development of such a system. At 4,000 megacycles there is a loss of 185 db between an isotropic antenna on the ground and another one 6,000 miles into space. By building a 60 by 60 foot horn antenna, Figure 6, we can get 57 db of gain. We have work under way on a ground station with such a horn antenna at a site near Rumford, Maine, shielded by a range of hills.

The horn antenna when looking at space, sees only space. That is, the horn antenna does not pick up any radiation from the earth. The horn antenna, when used with a maser receiver enables us to get an effective noise temperature of only 20° Kelvin. This is a really remarkable advancement since the best low noise receiver (low noise traveling wave tube) of a few years ago had a noise temperature of about 700 degrees.

In the ground receiver, we will use a traveling wave maser similar to the one we used in our Holmdel space research station that worked with the Echo balloon. Now the operation of the maser is based on some complex ideas, but it is not so complicated when viewed as hardware.

The maser amplifier is a device developed by the Bell Telephone Laboratories in 1956 which makes it possible to amplify exceedingly weak microwave signals without adding any appreciable amount of noise in the process.

The circuit of a traveling wave maser consists essentially of two microwave transmission lines as shown in Figure 7. These lines operate at different frequencies, occupy the same volume, but are electrically uncoupled. One of them, the rectangular waveguide, carries the pump energy which, together with a strong dc magnetic field, places the active material into a state in which it has energy to release. The pump frequency is several times higher than the frequency of the signal we wish to amplify. Typically, for a 6,000 mc signal, we require a pump frequency of 35,000 mc. The corresponding dc magnetic field is 4,000 gauss. The other transmission line takes the form of a comb. It carries the signal to be amplified and slows it down to approximately 1/100 the velocity of light. This lengthens the duration of the time the signal has to interact with the active material and thereby increases the gain available for a given length of structure by approximately the same factor.

The way to think of the ruby material is as a substance with electrons raised to high energy level from which they are released by the signal. This release creates a strengthened version of the signal.

The active material, in the form of the long slab of ruby having a rectangular cross-section, is placed on one side of the comb as shown in the figure, in a region where it interacts with the rf magnetic fields both due to the signal and due to the pump.

On the opposite side of the comb we place an iterated ferrite isolator represented by the small black

*(Continued on page 22)*

| | |
|---|---|
| Area Served | USA |
| Frequency (Channel 52) | 700 MC |
| Satellite Height (Synchronous) | 22,300 Miles |
| Modulation | Vestigial Side-band, AM |
| Satellite Antenna (10 ft.) Gain | 25 DB |
| Ground Receiving Antenna (5 ft.) Gain | 18 DB |
| Ground Receiver Noise Temperature | 3000° K |
| Ground Receiver Noise Figure | 10.5 DB |
| Peak-To-Peak Signal to RMS Noise at Base-band Output | 37 DB |
| Satellite Transmitter Power | 60 KW |

Fig. 9—The requirements if the satellite transmitted television to home type receivers.

# F.C.C. BROADCAST STATION RENEWAL INSPECTIONS

*By George S. Turner*
*Chief, Field Engineering and Monitoring Bureau*
*Federal Communications Commission*
*Washington, D. C.*

Commission representative gives advice for maintaining license grants.

In the 1920's and early 1930's broadcast transmitters consisted of basic components without technical refinements. Many transmitters had a single modulated oscillator stage, without crystal control, coupled directly into the antenna. The only method of maintaining frequency was by beating the carrier against a non-temperature controlled crystal oscillator. In view of the ease with which these transmitters could change frequency certain stations located on the coast and Great Lakes area were required to maintain a listening watch on the marine distress frequency of 500 kc. and sign off in the case of distress. With such crude equipment in the early days, close supervision was necessary and the Commission maintained a special early morning monitoring schedule to observe operations of standard broadcast stations. I recall one instance where a station was found to be exactly on the measured frequency, but unfortunately, when he identified, it was discovered that he was operating on the next channel, 10 kcs. away. In another case the station split the difference and compromised by settling on a frequency just halfway to the next channel. The frequency tolerance at that time was 500 cycles.

Safety measures in the early days were practically non-existent and high voltage was in easy reach of the careless operator. A number of operators were painfully burned and severely scarred; others in not insignificant numbers lost their lives. Stations were oftentimes composite and constructed by the station's chief operator. In consequence he was the only one who knew the idiosyncrasies of the equipment and in his absence unexpected technical problems would develop.

Since most equipment was individually constructed with little uniformity in circuits or component parts, extensive and constant supervision by first class operators was necessary even to keep the equipment in operation, much less to comply with the Department's rules. Frequency inspections by the field force of the Department of Commerce Radio Division and subsequently Federal Radio Commission were necessary to prevent serious interference both to other stations within the standard broadcast band and other services on both lower and higher frequencies. The problem of inspection was, however, much simpler in those days — that is, around 1924 when I signed up with the Department of Commerce as a radio inspector. There were less than 600 standard broadcast stations in operation in those early days and FM and TV problems were to be in the future.

In the very beginning of broadcasting, as many oldtimers will remember, operation was limited to 360 meters for music and like matter, and 485 meters for weather reports. It might be of interest to review briefly a very enlightening observation contained in a delightful book entitled "Microphone Memoirs" written by Credo Fitch Harris, the first general manager of broadcast station WHAS in Louisville, Ky. Mr. Harris writes as follows:

"In the beginning when 360 meters had been assigned to all stations, happily there were only a few and those widely scattered. For, although we did not become aware of it until later, it was impossible to tune those clumsy little transmitters with any

*(Continued on page 28)*

Bureau Chief George Turner addressing the 15th Annual Engineering Conference of the National Assn. of Broadcasters.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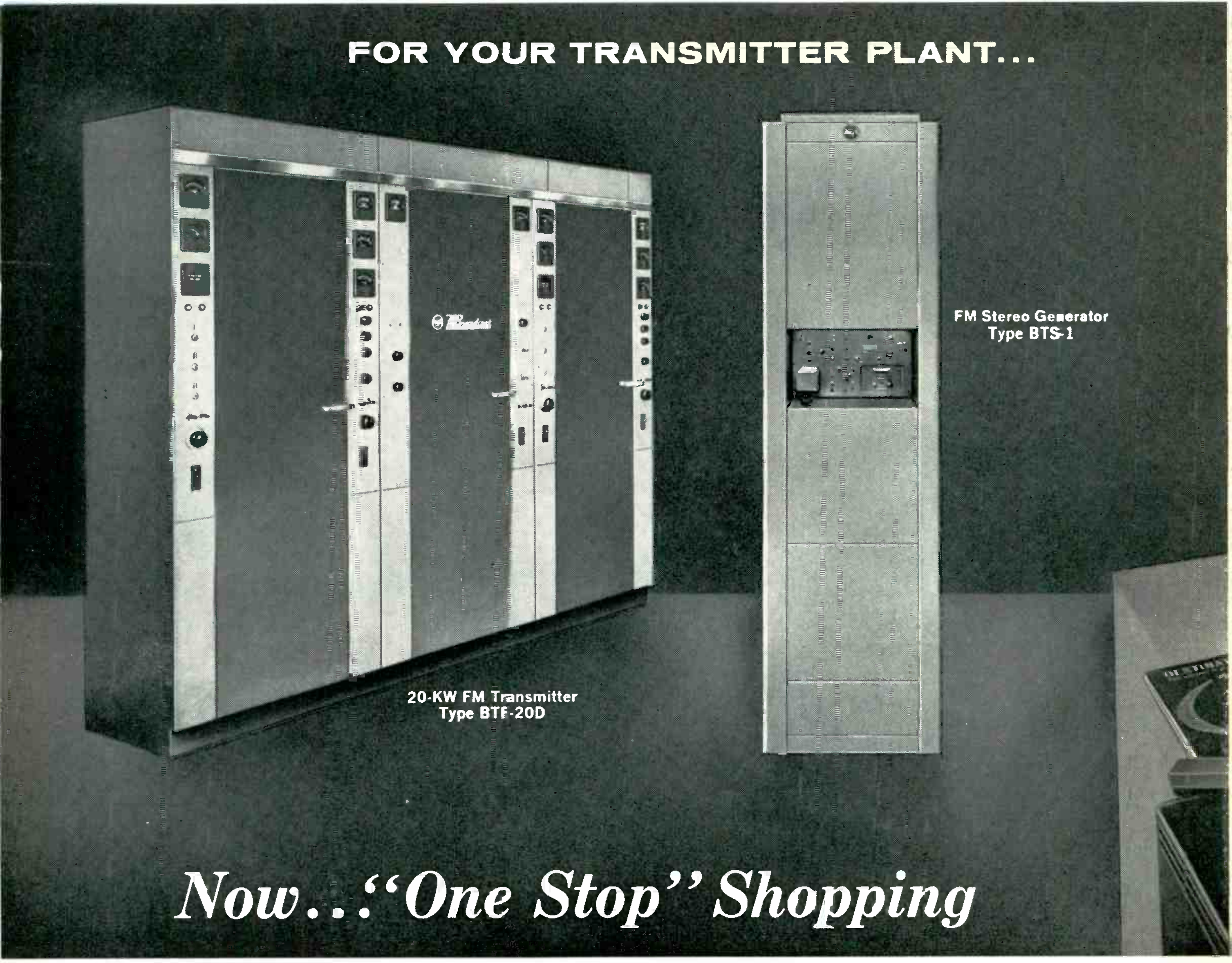


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## Mounting Antennas

(Continued from page 6)

ladders, cross bracing, elevators, etc. No attempt was made to determine what degradation might result from such items.

In all the measurements discussed previously, the supporting structure was large in terms of wavelengths. Actually, the cross-sectional dimensions are greater than one-half wavelength at 100 mc. The result is structural members of resonant length causing, in some cases, severe degradation of the radiation pattern. This effect is reduced considerably for the following two conditions.

Illustrated in Figure 9 is the pattern from a single loop FM antenna mounted approximately 8 inches off a small triangular tower. Because of the smaller cross section, there is less reflection and scattering by the supporting structure. For this case, the FM antenna width is larger than the cross section of the supporting structure. The improvement from previous results is quite evident.

In Figure 10 the radiation pattern of a single element "V" antenna mounted on the triangular tower is shown, and while the results are not as good as those of the ring antenna, it clearly demonstrates that the smaller supporting structure gives improved performance.

In Figure 11 the measured pattern of an FM antenna inside a smaller supporting structure of square cross section is shown, and in Figure 12 the same arrangement of internal mounting is employed but with a variation in the relationship of the antenna to the diagonal bracing. There could be no doubt that this type of mounting is detrimental to the performance of the antenna and should be avoided.

In Figures 13 and 14 additional patterns resulting from mounting the 100-mc FM loop antenna asymmetrically inside the Blaw Knox tower of 7-foot cross section are illustrated. For both cases, the antenna is 46 inches from the corner, but in Figure 14, the relationship is changed with regard to the cross bracing structure.

Although it is beyond the scope of this paper, recent field measurements indicate that, in the case of guyed structures, interference from the guying system may affect the radiation pattern seriously. As a result, it may be necessary, for some installations, to "break up" the guy wires by proper insulating techniques in the near vicinity of the antenna.

Also, because of the close coupling between the supporting structure and the antenna, the impedance properties of the array may be adversely affected. This is particularly true when the supporting structure is larger in cross section than the FM antenna. Experience has shown that it usually is necessary to retune the antenna to secure a low vswr after the installation has been completed. The radiation pattern will not be affected, of course, by this tuning procedure unless the current distribution on the antenna is changed appreciably.

### Conclusions

The data presented here definitely shows that in mounting an FM antenna on the supporting structure the placement of the antenna on, or in, the structure can have effects which greatly impair the performance of the FM antenna. Unfortunately, no formula is available which would enable a broadcaster to predict with reasonable accuracy the pattern that might be expected from installations on a particular type of structure. The best approach is to use a supporting structure of small cross section, which should keep the pattern interference at a minimum. A type of structure that fulfills this requirement is the steel tubular column. Complete actual field strength measurements of the majority of FM installations now broadcasting are not available, therefore hindering the evaluation of existing systems.

It must be realized that the patterns presented here represent an exploratory investigation of this problem. It indicates that a great deal more patterns should be taken before accurate recommendations can be made concerning the mounting of FM antennas. The success of the FM installation will depend largely on how well the antenna is installed and on the environment under which it operates.

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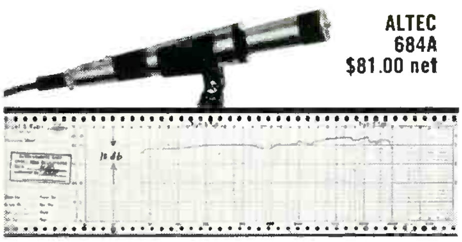

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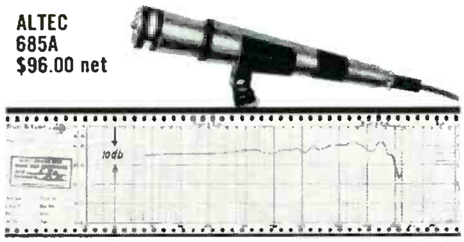

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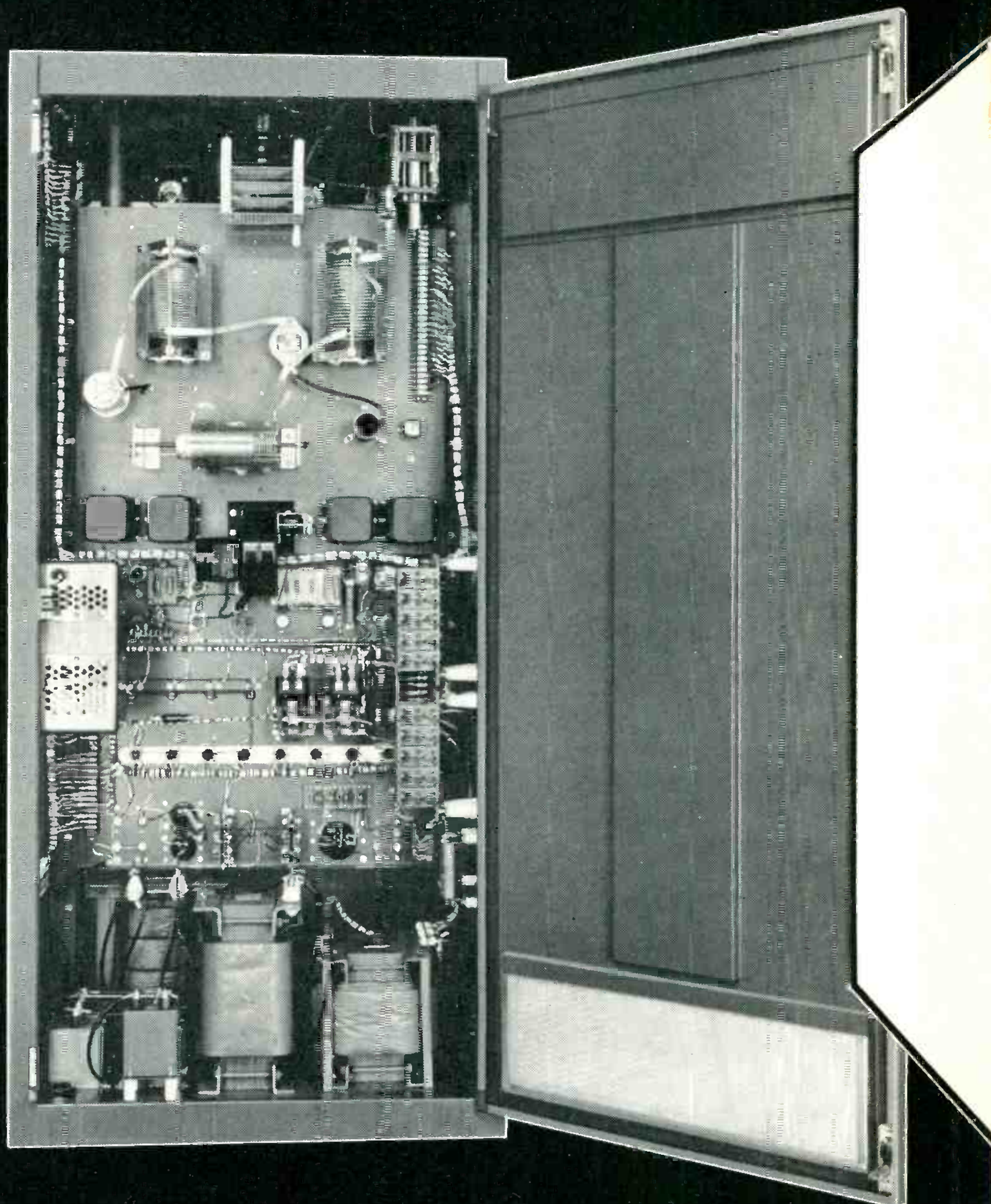

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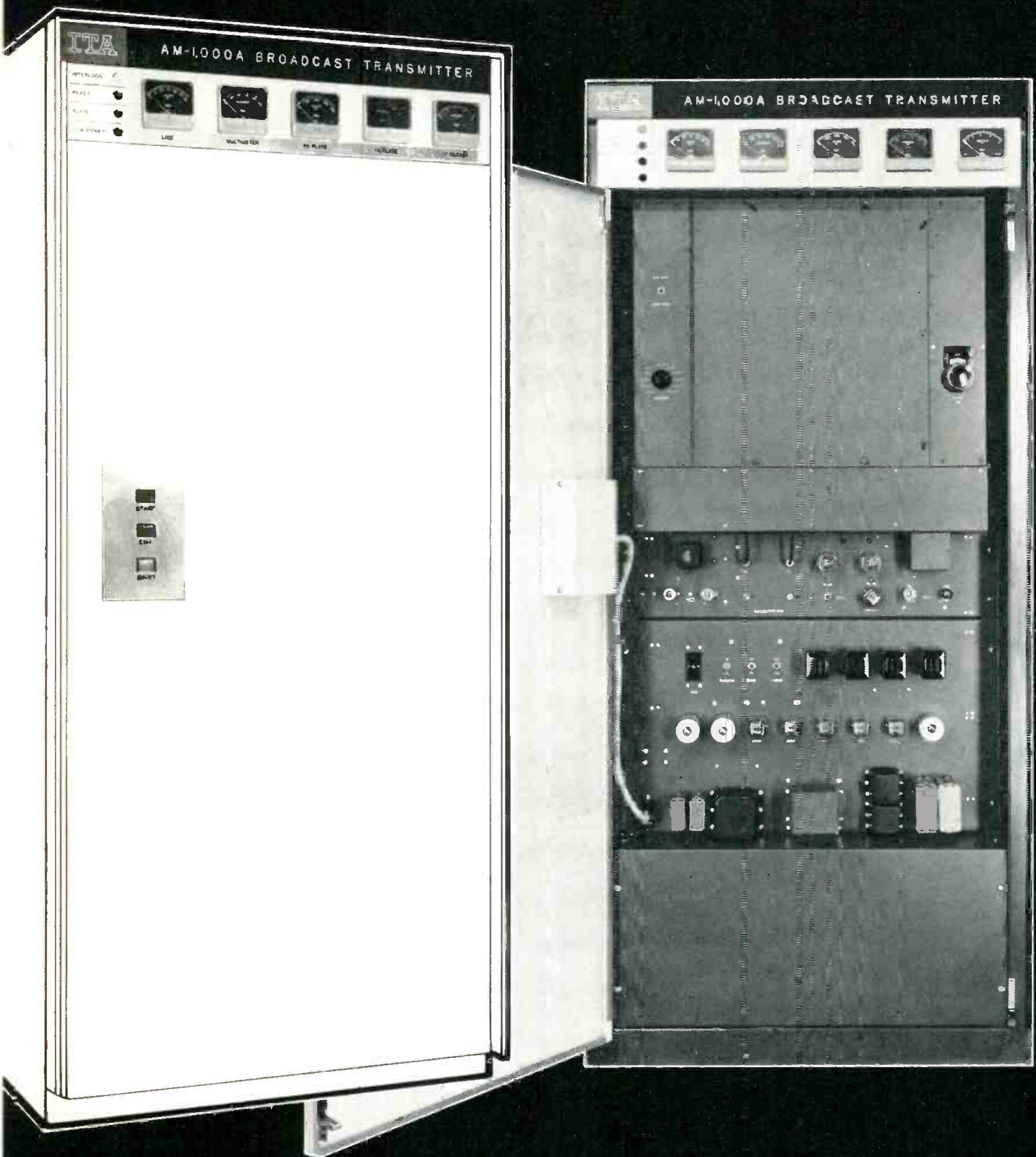


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## Satellite Relays

(Continued from page 13)

wafers. This isolator is adjusted for ferromagnetic resonance at the signal frequency and, therefore, does not interact with the pump. For a signal launched onto this comb and traveling in the forward direction the senses of polarization of the rf magnetic fields are such that the ruby provides gain while the isolator is essentially non-existent. For a signal traveling in the reverse direction the senses of polarization are reversed. Now the ruby does not, while the isolator does, interact with the signal thereby absorbing it strongly. In practice the reverse loss of this amplifier greatly exceeds its gain thus yielding unconditional stability.

A typical traveling wave maser will provide a gain of 25 db, with an effective instantaneous bandwidth of 25 mc. The effective noise temperature of this amplifier is 10° K.

As indicated above, the maser itself is a comparatively simple, compact, and rugged device. However, in order to make ruby amplify it is not sufficient to subject it to a strong dc magnetic field and to microwave pump radiation, but we must also cool it to a very low temperature, namely, that of liquid helium, that is temperatures in the range from 1.5 to 4.2° K. We do this by making use of a closed cycle continuously running helium liquifier.

The success of Project Echo was in no small measure due to the high sensitivity and stable amplification provided by the maser.

To permit launching with contemporary rockets we believe that a satellite should weigh about 100 pounds. The sun's radiation supplies us about 130 watts per square foot of illuminated surface. With solar cells, we can reliably get about 10 per cent of this energy. With a 27-inch satellite, Figure 8, we can get 3,528 solar cells distributed over 55 per cent of the satellite's surface. These will operate a two-watt traveling wave tube and associated circuitry as power amplifiers.

Thus with two watts radiated power from the bird, a path loss of 185 db and a transmit plus receive gain of 57 db and a receiver with a noise temperature of 20 degrees K, how can we get a TV signal from the bird to the ground without noticeable picture impairment? We believe we can do it with wideband frequency modulation.

A conventional wideband FM receiver would pick up a great deal of noise and would have little margin against "breaking." By using feedback to cause a narrow-band intermediate frequency amplifier to track the wideband FM signal, the advantages of wideband FM can be achieved with good margin against breaking. FM with feedback is a process invented at Bell Telephone Laboratories a number of years ago (1933) that waited for years for a transmission problem difficult enough to require its use. It was first used during the Holmdel experiment with the Echo balloon.

What is presented here is merely the skeleton of a truly heroic transmission problem.

The problem of transmitting from the ground to the bird is not so difficult since there is no problem getting adequate power to operate the transmitter on the ground. We plan to use two kilowatts and the same wideband transmission. Narrower band transmission could be used but we prefer wideband transmission up because it:

a. Gives such good transmission that you can use up all your margin in the difficult down path.

b. Permits simpler circuitry in the bird because the bird is only a repeater. It does not have to change the modulation technique.

c. Is far less susceptible to interference and so the same frequencies can be reused more freely.

d. The lower power ground station causes less interference to other stations on the same frequency.

I hope that without going into great detail I have given you a picture of the tour-de-force that a satellite repeater represents. I recognize that I have ignored the Van Allen radiation belt problems that lead us to cover our solar cells with sheets of sapphire, and the many mechanical and thermodynamic problems that must be solved to create a bird that will operate in the hostile space environment for at least ten years.

**Satellite Broadcasting**

This subject is probably of interest to all broadcasters. Here is the way it looks to us.

A satellite broadcasting station should put out a signal that can be received on ordinary home receivers. To avoid requiring home antennas to track a moving satellite, the broadcast station would be operated in a synchronous satellite at 22,000 miles altitude. The transmitting antenna could have no more than 25 db gain if an area the size of the United States were to be covered.

If we assume vestigial sideband transmission in the UHF or VHF band, and a conventional home receiver with a 5-foot dish having 12° beamwidth and 22 db gain, a satellite output power of 60,000 watts, Figure 9, is required.

The contrast between 60,000 watts and the two-watt output of the bird B.T.L. is designing is tremendous. It represents the difference between having to work with a conventional home receiver and a 60-foot horn antenna with a 20-degree Kelvin maser receiver. This in turn represents the difference between a $150 receiver and a receiver costing approximately 10,000 times as much.

With a parametric amplifier (uncooled) in the home receiver, the satellite output could be reduced to 6 kw. This is still beyond the possibilities of the near future.

I have given the above examples not to prove that there is no future for broadcasting via satellites but merely to show that satellites do not today solve all problems.

They do not today make it possible to get television into areas that are not equipped with a network of broadcast stations. They only permit reception at one point with a costly and elaborate receiver that will be economically justifiable only if there is a network to be fed. Neither do satellites permit you to bring good telephone service into areas that do not already have a good terrestrial network. But satellites will economically, and on a sound business basis, bring intercontinental TV to those areas that have local broadcast stations and they will bring expanded high quality circuits into areas where there is a ground network to connect to. And that is a very significant package of problem solving.

# A SOLID STATE VERTICAL

*By The Engineering Dept., Sarkes Tarzian, Inc., Bloomington, Ind.*

Now that the television industry has grown out of its infancy, the requirement for complex switching operations has increased to the point that a need has been created for custom switching devices—which are more sophisticated than standard switchers. The answer has been to eliminate direct switching, either by relay contact or by push-button, through the use of semiconductor components which act as the switching points. In addition, it is desirable to cause the switching time to occur during the vertical blanking interval.

The concept of Vertical Interval Switching is relatively new on the broadcast scene.

The main advantages of switching during the vertical interval are the elimination of switching transients occurring during the picture interval and the speed of the switch, which is less than one miscrosecond. Each of these factors is of particular importance where video recording is involved.

This discussion describes a fully solid state vertical interval switcher recently developed. All circuitry is solid state.

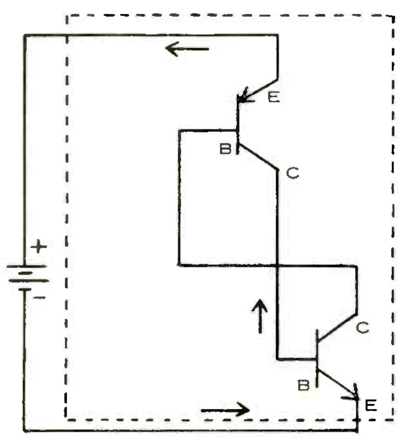
The electronic and mechanical design is of modular type and provides a very high degree of flexibility for packaging any switching system requirement. In standard switchers, the "time" when the video switch occurs is determined by the "time" the physical switch contact is made —whether by relay contact or push-button. Furthermore, even with the best of relays, the time occupied in making the video switch is at least one or milliseconds (this is much longer for push-buttons). In addition, the time occupied in making a subsequent switch to another input is again in the order of milliseconds.

Therefore, in standard switchers, if the video switch should occur during the vertical interval, it would obviously be accidental and the switching time would occupy a greater part of the vertical interval. Further, such switching is usually accompanied by a relatively large transient. These factors degrade the quality of video recording and the imperfections are permanently recorded.

The basic requirement for a Vertical Interval Switcher is to provide a way to (1) cause the video switch to occur at a specific point—regardless of when the physical switch contact is made; (2) reduce the time occupied in making the video switch to microseconds; and (3) eliminate any switching transients when making or breaking the video switch.

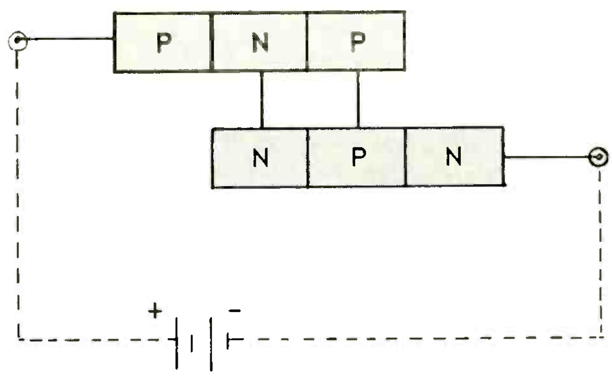
The fundamental distinction of the Vertical Interval Switcher, which accomplishes these objectives, is the Trigger PNPN four-layer diode. The PNPN diode "trigger" is essentially a current device. The four-layer diode can be controlled so that it will be in one or the other of two static states of operation.

The four-layer diode operation can most simply be explained by making an analogy which is represented in Fig. 1. Note that one can assume the four-layer diode to consist of overlapping PNP and NPN semiconductors. When properly biased,




EQUIVALENT CIRCUIT 4 LAYER DIODE

NOTE: THE CENTER JUNCTION IS REVERSED BIASED ALONG WITH THE END PN JUNCTION. THE FIRST PN JUNCTION IS FORWARD BIASED.




BLOCK DIAGRAM 4 LAYER DIODE

Fig. 1

# INTERVAL SWITCHER

## TV Takes Advantage of Electronic Selection

the center PN junction is reverse biased and the outer PN junctions are forward biased. As a result, the four-layer diode can be analyzed as two separate junction transistors. By changing the bias value across the four-layer diode, the four-layer diode will be in a fully conducting state, or turned off, and the point at which this occurs is always the same and can be accurately controlled. With a suitable arrangement of components, this "switching" characteristic can be utilized to great advantage.

The trigger circuit is triggered on and off by a processed vertical drive pulse. The processed vertical drive pulse is routed to the four-layer diode by a combination of diodes which in turn are controlled by dc voltage from the manual push-button. This module is seen in Fig. 2-A.

The PNPN diode release pulse is automatically routed to the "on" circuit when the subsequent video switch point is triggered on. A function switch allows the time position of the video switch to be controlled

**EDITOR'S NOTE:**

*This is the second article on video switching. In last month's Journal the crossbar switcher was presented. Here a different method is employed.*

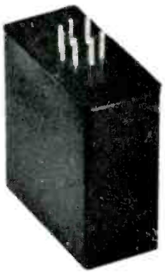


Fig. 2-A—Trigger circuit module.

Fig. 2-B—Diode matrix video switch module.

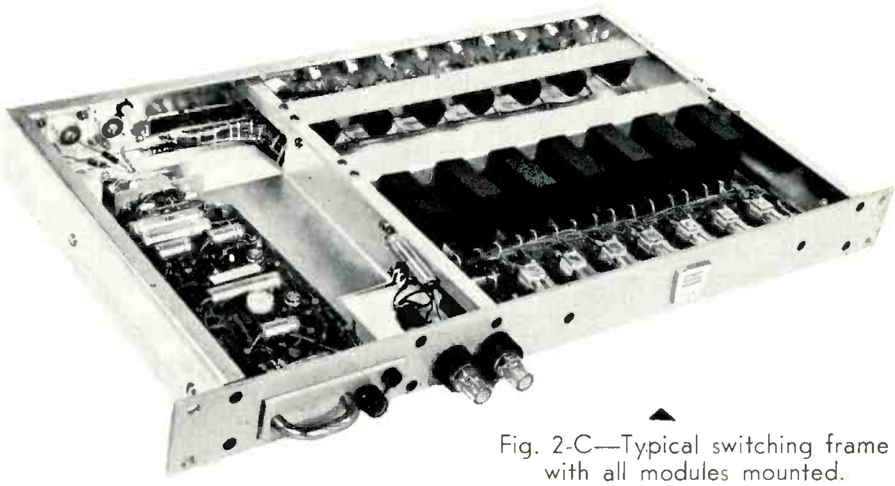


Fig. 2-C—Typical switching frame with all modules mounted.

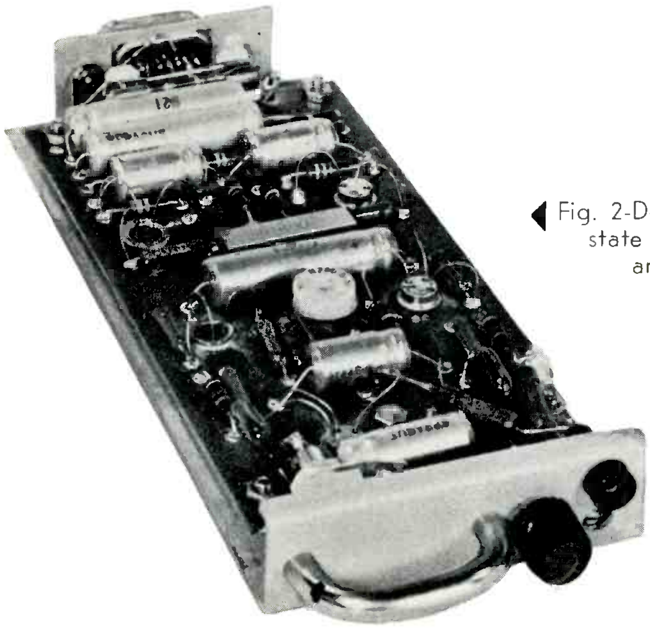


Fig. 2-D—Plug-in solid state distribution amplifier.

at a point in the vertical interval which can be (1) at the first equalizing pulse, (2) the last equalizing pulse following the vertical sync pulse, or (3) at random. A special fail safe circuit automatically switches to random switching in the event a failure of vertical drive should occur. However, even in the random switching mode, the switching time is less than one microsecond.

The time occupied in making the video switch is less than one microsecond. The amplitude of the switch transient is not greater than —10 db as referred to the equalizing pulse amplitude.

The routing of the video signal is completely independent from other circuits.

The diode matrix video switch point is turned off and on by the PNPN trigger and associated circuitry (Fig. 2-B). The isolation between video inputs is greater than 55 db at 3.58 mc.

As indicated previously, the electronic and mechanical design is of modular form. Fig. 2-C illustrates the basic modular frames which can be used in various combinations to provide any complexity of video switcher requirement.

Each switching frame contains seven switching points, including the PNPN trigger, tally function relay, a semiconductor power supply, and provisions for a plug-in distribution amplifier, Fig. 2-D. The switching frame occupies only 1¾" rack space. A 14-input switcher would employ two of these frames. In this example, one distribution amplifier would be used (this distribution amplifier would plug into the second frame and a blank panel used in the first frame). This unit is the switching line output amplifier.

The processing frame occupies 1¾" rack space and has a self-contained semiconductor power supply for feeding all units, regardless of type, which are used with it.

The processing frame can also be used to house three distribution units, thereby providing a highly efficient amplifier combination giving three inputs with nine outputs. It may also be used to house two amplifier units and one sync insertion unit, providing a highly flexible distribution amplifier with provisions for sync insertion. The reader can see many other possibilities in the utilization of the processing frame with different modular units used with it for various applications within a television station. Along with this highly flexible arrangement, the total rack space occupied is only 1¾".

The power supply frame provides both +24V and —24V for all areas of the switcher which do not have built-in supplies. This unit has two power supplies in one frame—each is fully solid state and electronically regulated. Metering is provided for both power supplies. The input and output voltages are fused, with indicator type fuses.

The tally frame houses the pulse processor unit, tally relay panel and semiconductor power supply. All camera switching tally outputs are interlocked through the tally frame. Tally voltages can be any value required for the particular system—or several different tally voltages can be used at the same time.

Fig. 3 is a photograph of the rack mounting switching system modules—the illustration is for a 14 x 6 switcher, including preview switching, dual special effects, switching, dual program switching, and master program switching banks. The switching panel shown in Fig. 4 employes illuminated pushbuttons. The pushbuttons are rated by the manufacturer for a minimum of one million cycles. Tally indicators are provided for the fader controls. Other tally indicators indicate switching mode; that is, random or vertical interval. The function relay in the switching frame provides the pushbutton tally voltage routing control for audio follow video switching and camera tally switching. Provisions are also included at the control panel position for remote control of set-up and sync amplitude.

Figure 5 is a simplified schematic of a Vertical Interval Switcher of moderate complexity.

Here are some of the major performance specifications of the solid state Vertical Interval Switcher:

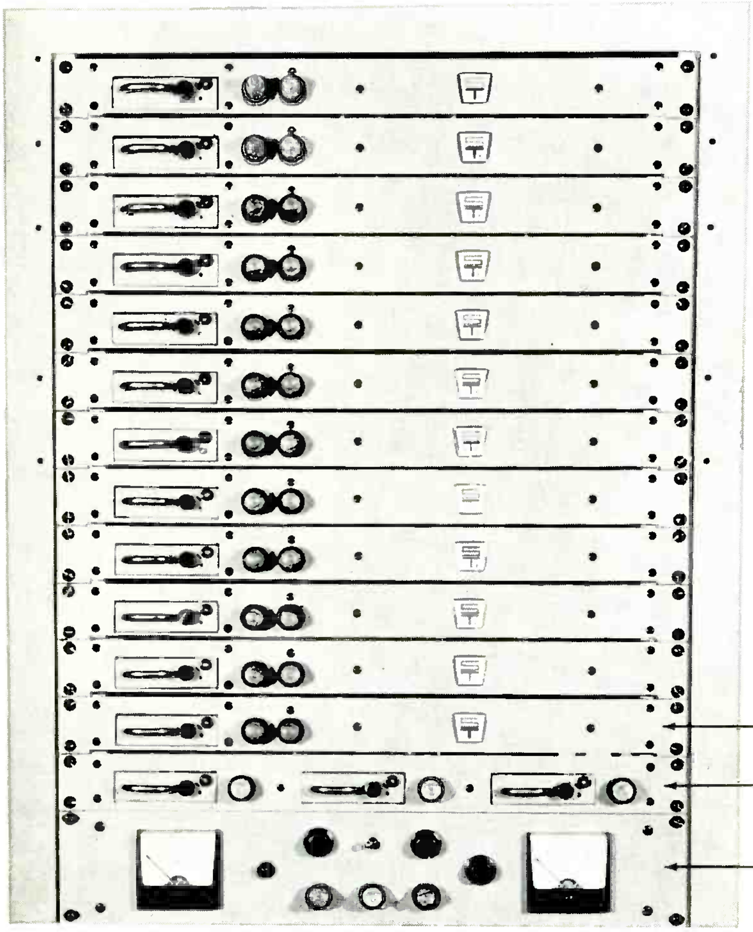



Fig. 3—A complete series of rack mounted switchers and associated power supplies.

| | |
|---|---|
| Frequency response | ±.1 db to 6 mc; ± 1 db to 10 mc; and down 3 db @ 15 mc |
| Differential phase | .5 degree max @ 3.58 mc (Ref 1 V PP) |
| Differential gain | .2% max |
| Phase delay | .02 microseconds @ 3.58 mc (Ref 200 kc) |
| Tilt | 1% max 60 cycle squarewave |
| Switching time | Less than .8 microseconds |
| Video unbalance | 1% max |
| Isolation (between any 2 channels) | 60 db @ 1000 cycles; 55 db @ 3.58 mc |
| Number of inputs | As required |
| Number of outputs | As required |
| Re-entry | As required |
| Number of switching channels | As required |
| Number of input channels | As required |
| Output Impedance | 75 ohms ± ½% sending end |
| Input Impedance | High - bridging; or 75 ohms terminated |
| Gain | Unity gain ± .1 db from any input to output for all video paths. |

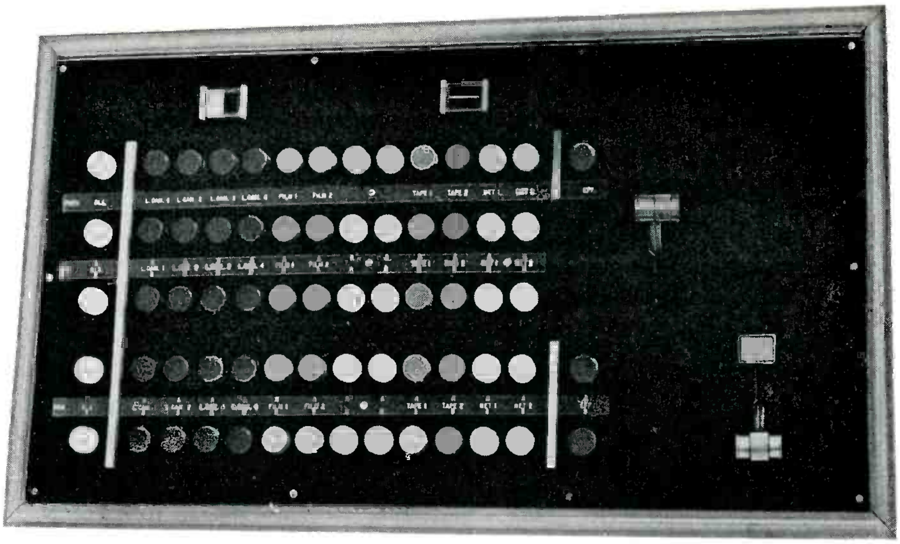


Fig. 4—The custom control panel for the switchers.

Rack space is a premium in every television station. Through the use of the modular design, a relatively complex switcher, say with 14 inputs and 6 outputs, will require less than forty inches of rack space.

The requirements for custom switchers will differ from station to station. The modular design affords a way to create custom designs *without* the station paying a premium price for custom outlay. It also provides a way to expand the system for future growth.

All control panels are finalized in design and function after careful analysis of the desired requirements of function. This will allow all functions as special effects, projection control, and multiplexer switching to be incorporated in the final panel design. All switchers are pre-wired, assembled, and fully tested before installation into the station's system.

The fully solid state switcher is the most advanced design available today. Because all components, including semiconductors, are operated at a maximum of 30 per cent of their rated value, reliability is inherent in the design. Mechanical design is very compact. All circuit functions are entirely electronic in nature, with no moving parts in any of the video switching circuitry. Common units are interchangeable and plug in with complete uniformity between units.

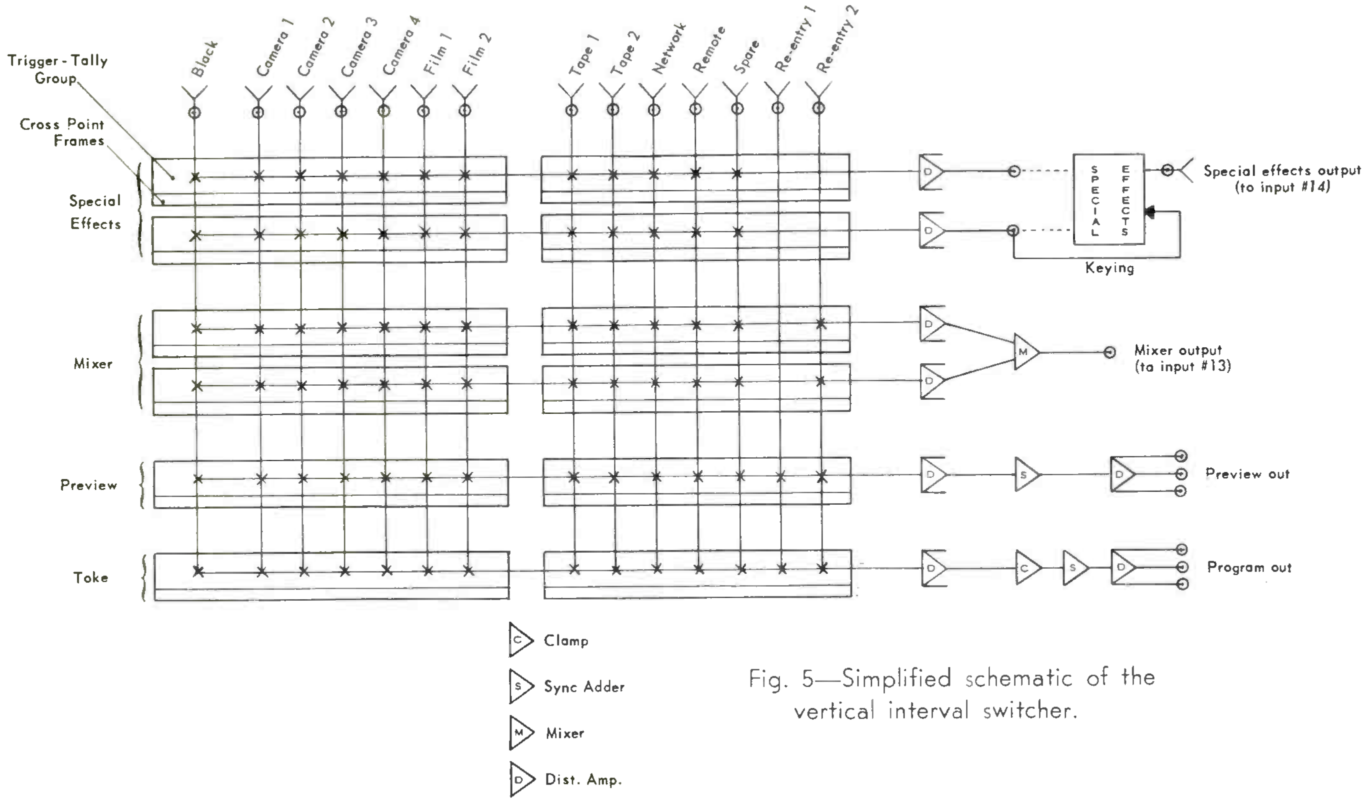



Fig. 5—Simplified schematic of the vertical interval switcher.

## Renewal Inspections

*(Continued from page 14)*

reasonable degree of accuracy, and, because of that, their mutual interference was negligible to the listener.

"The way a transmitter was complacently assumed to be kept on its required 360 meters in those days would be amusing now, or horrifying. A government inspector arrived every four or five months to 'measure' us. He carried a little black box with a meter in it—and perhaps other things, but I never looked. He discouraged looking, so the mystery surrounding it remained profound. He usually placed that box on a chair about eight feet from our transmitter while the apparatus was operating — a distance which was considered safe from the standpoint of interference that might readily be caused by the proximity of a human body.

"In front of the main panel was a large aluminum disk with a center knob, devised by the manufacturer to vary its emitted frequency — similar to a peg for the tuning of a fiddle string which, by turning it one way or the other, raises or lowers the pitch. The supervisor would gravely and thoughtfully turn that knob back and forth, watching his meter in between times.

"During this process his breathing always became labored, his brow puckered—which may have been an individual characteristic or a desire to impress us. He would then take a pencil and make a thin mark on the disk's circumference, announcing solemnly: '360.' Another mark: '485 for the weather.' Without further ado he left, his manner indicating an unexpressed admonition: 'Take care!' If those pencil strokes escaped being rubbed off by an overzealous janitor some early morning, we probably retained an accuracy of five or ten meters, above or under par. Or if they remained long enough for the supervisor's next visit, it was interesting to observe that he invariably rubbed them out himself and put on new ones."

I particularly wanted to review this story from one of radio's well known pioneers and contrast it with the principal subject matter of my report relating to broadcast station inspections as currently carried out.

In so doing, however, we both must keep in mind that not only has life become more complex, but most certainly broadcast equipment operation and regulation has become much more involved also.

As of the end of the fiscal year 1960 there were approximately 3600 standard broadcast stations and 7500 in FM, TV and miscellaneous broadcast services. The problem of enforcement is obvious since there has been only a modest incraese in personnel assigned to broadcast work in the field subsequent to 1930, while the total number of broadcast transmitters of all descriptions has increased nearly twenty fold. This is why, up until recently, instead of making inspections every four to five months apart as Mr. Harris indicated, the Commission was doing well to make inspections of even the principal transmitters in many instances no less than three to five years apart.

Progress in equipment design has greatly reduced early technical enforcement problems such as development of precision frequency control and standardization by use of manufactured equipment which is reliable under normal service conditions. On the other hand, although many technical problems of the early days have been eliminated, new problems have taken their place. These include such technical developments as complex directional arrays, the use of remote control for many installations and I would be less than candid if I failed to mention the employment of the nontechnical operator, or what is oftentimes equally as bad, if not worse, the disc-jockey/announcer type operator.

If I may digress for the moment, I believe we will find it interesting to compare the results of our inspection and measurements of the technical characteristics of TV and AM broadcast stations. Although the equipment at a typical TV broadcast station is far more complex than AM broadcast equipment, we find that general violations of the technical standards are somewhat less common than for AM broadcast stations. For example, on a recent trip of one of the Commission's TV Enforcement Units into the southeastern states, measurements and inspections were made on 23 TV stations. These were very detailed inspections involving measurements of carrier frequencies, bandwidth and modulation level, the characteristics of the synchronizing pulses and other composite video components, and, where color transmissions were being made, measurements of the characteristics of the color signal. Even so, only six of the 23 stations were issued violation notices for technical deficiencies. I believe this is a demonstration of the excellence of the engineering staffs at many of the TV stations, and I feel that many of the AM stations could benefit by the conscientious preventive maintenance commonly performed at TV stations.

Because of this letdown or lack of technical or other supervision by all hands, or because of other reasons less obvious, anyhow, it became apparent to the Commission in the latter part of 1959 from a review of inspection and citation records by the Field Engineering and Monitoring Bureau that there was a growing disregard for engineering rules, operator requirements, and equipment performance standards on the part of many broadcast licensees particularly in the standard AM broadcast service. These deficiencies were formally called to the attention of the Commission and as a result broadcast licensees were informed of the deteriorating technical compliance by means of a public notice dated April 29, 1960. At the same time disclosures of "rigged" programs and action by Congress alerted the Commission to the need for increased activity in non-technical phases of broadcast enforcement.

**Joint Action by Field Engineering and Monitoring and Broadcast Bureaus**

In recognition of their joint responsibility, the Field Engineering and Monitoring Bureau and the Broadcast Bureau have developed a coordinated enforcement program, the salient points of which are: (1) renewal inspections in depth during the last 18 months of the license term consisting of (a) program recording in advance of the station inspections, (b) technical inspection including antenna, transmission lines, ground system, performance of transmitters as well as studio equipment and compliance with the Commission's technical rules, and, (c) inquiry into non-technical areas including sponsorship, identification, hidden ownership, payola, etc., using recorded material for comparison of actual performance against station records; (2) Growing out of renewal inspections performed by the field engineer or as a result of complaints or other information received by the Commission from outside sources, the Broadcast Bureau may send an investigative team to a specific station for detailed analysis of the station's non-technical operation. Additional participation by the field engineer is also available for the purpose of covering current technical performance as required; (3) In addition, prompt submission of technical deficiencies or questionable practices in non-technical areas with recordings are made to the Broadcast Bureau by the Field Engineering and Monitoring Bureau for consideration in renewal license processing or for specific enforcement action.

#### Renewal Inspection Technique

The Field Engineering and Monitoring Bureau in the making of renewal inspections is giving particular attention to the technical performance of AM broadcast stations and more especially in many instances to radiation patterns of directional stations, proof of performance measurements and antenna resistance and monitoring point measurements.

*AM Broadcast Station Directional Antenna Monitoring Points* are checked by our Field Engineers as a part of the renewal inspection of the station to determine whether or not the prescribed radiation pattern is being maintained. In the period immediately following World War II when hundreds of new stations went on the air with directional antennas, it was common to find a majority of these stations operating with field patterns which did not conform to the terms of their grants. In one "horrible example" which I recall, the station's pattern was so poorly adjusted that the field strength at one of the monitoring points was 800 per cent of the specified limit.

Although there has been some improvement over the years in this respect, a considerable number of stations still apparently do not take the monitoring point measurements seriously and thus find themselves the recipients of a violation notice for excessive monitoring point field strengths. In the course of a recent survey of four months' duration, 24 stations were so cited.

Obviously, improper antenna patterns are of concern to all co-channel stations whose own coverage depends in a considerable measure on protection from excessive radiation from other occupants of the channel; and, of course, in some cases an improperly oriented pattern may actually reduce coverage in areas which the station is licensed to serve. In enforcing the pattern limitations, our field engineers have been taught to be sympathetic to the problems of the licensee and to adopt a cooperative attitude in correcting unsatisfactory conditions which exist. In all our enforcement activities, our prime purpose is to help the licensee to help himself to provide the best possible service for the benefit of the public.

*Proof of Performance Measurements* are also frequently made as a part of our renewal inspection program. A considerable number of AM stations apparently experience difficulty in maintaining compliance with the transmitter performance provisions of the Rules especially with regard to audio frequency response and audio distortion. Surprisingly enough, this difficulty seldom shows up in the station's records which habitually indicate that the frequency response, distortion, and carrier hum are well within the limitations; in fact, it sometimes appears that the station's Chief Engineer has "switched transmitters" since the same measurements made by the Commission's engineer often indicate considerably inferior operating characteristics compared with those on file. Since July 1960 our engineers have made equipment performance measurements at 22 standard broadcast stations. Deficiencies of a sufficiently serious nature were disclosed as a result of these measurements to justify issuance of one or more violation notices to 16 of these 22 stations. An example of the deficiencies encountered involve a midwestern station in which the audio frequency response varied over a range from plus 6 to minus 4.2 db from the 1000 cps pattern. Wide variations extended throughout the audio range. This same station was also found to have audio distortion as high as 13 percent at normal modulation levels and the carrier shift likewise exceeded the specified limit. Obviously this station was not providing the quality of service that the public had a right to expect.

*Field Strength Measurments to Determine Coverage* were made at two stations in a western town, both operating with 250 watts power in the same area and in the same general portion of the AM band. Measurements showed that one of the stations was consistently much stronger than the other at the same distance from the antenna even though they should have been approximately equal in strength. The average difference was of the order of two-to-one. The licensee of the station with the poorer coverage expressed great concern and indicated he would take immediate steps to have a consulting engineer check the antenna system to determine the reason for its low radiation effectiveness.

It has been our experience that a significant number of the AM broadcast stations operating with non-directional antennas are providing less coverage than was contemplated by the Commission's Rules or terms of the license. This condition is often due to a deteriorated ground system or to other deficiencies in the radiating system. Of 115 AM stations checked since September of last year, 18 stations had field strengths which were more than 20 per cent below the expected value, and at four stations the field was less than 50 per cent of the expected value. Obviously such conditions as these result not only in reduced service to the public, but in less value received per dollar expended insofar as the program sponsors are concerned, and indirectly in reduced income to the broadcast station. At times, where the Commission engineer has reason to suspect that lower than expected field strength may be due to the use of the improper value of antenna resistance in arriving at the power output, the actual resistance is checked by the Commission engineer. In such cases it is not uncommon to find that the resistance has changed significantly. In one instance this change in antenna resistance was found to be due to changes in tower lighting circuitry after the antenna resistance measurement had been made. Therefore, it would seem that it would behoove the licensee to have antenna resistance measurements checked periodically and especially after changes have been made in the antenna or associated circuitry. I know this must be apparent to most of you, however, it might be desirable to remember that if the transmitter requires, as for example, 1500 watts input to the final to achieve the specified antenna current, and at some later date only 1200 watts is required for the same antenna current, it should be generally quite obvious that some change has taken place in the overall antenna system and that such a change requires investigation.

"The FCC inspectors have just moved in and all hell is breaking loose" is a paragraph heading by an unidentified member of a state broadcast association which very fortuitously but nonetheless unintentionally, I am sure, came to our attention. This was a title used to introduce a very well thought out notice to his membership in regard to the renewal inspection program which had just gotten underway in his state. Those of you who may not have seen this release might be interested in the next four lines of the text:

> **"This is an unashamed alarm! Never in the history of broadcasting has there been such a thorough-going and unrelenting examination."**

Frankly, the information contained in this broadcast association report is very valuable and in fact, I find that this or similar information outlining in considerable detail the nature of our inspection program is being presented before many state broadcast associations. Before this release came to my notice, it was my intention to do the same thing as the unidentified broadcast association author has done, that is, provide in detail the various items which our field engineer specifically covers in the course of his renewal inspections of a broadcast station. However, I will simply incorporate his remarks by reference as a part of my advice and recommendations to you, but with one additional observation—the main points our unknown friend cautions you to look out for are surprisingly enough, in the final analysis, no more nor less than existing rules which have been in the Book of Rules, lo these many years!

Admittedly, it is true, our men are giving broadcast stations a thorough goingover. It isn't quite accurate, however, to say as our unknown friend has said in his release that "this is a white glove inspection." Those of you who have been in the Navy as I have, know what a white glove inspection is. We are not looking for dirt as such. All that we intend to do is to check for compliance with the Rules and with the terms of your license; also, to report on performance as we find it.

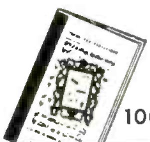
*Areas of Coverage Involving Non-technical Items* are quite well known to broadcasters inasmuch as broadcast station inspections have long included such matters. These are specifically set forth in the Rules under the heading "Other Operating Requirements" and begin with Rule 3.111 and include such items as logs, station identification, mechanical reproductions, broadcasts by candidates for public office, rebroadcasting, and lotteries.

In adidtion, as special matters come to the field inspector's attention, notes are made thereof for referral to the Broadcast Bureau for such further action as may be indicated. The following is an example of such a non-technical item:

> On the basis of recordings made by field offices and monitoring stations, a careful analysis in depth of program practices of a number of broadcast stations indicates several instances where program material and station logs do not agree with material filed with the Commission.

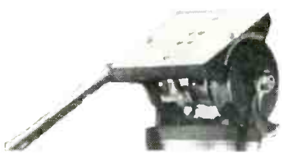
How to make friends and still be an inspector isn't easy. Probably nobody really likes to be inspected. I know when I have gone down to have my car inspected, don't quite make it, and as a result drive out with a red sticker, which means that they have found something wrong, I don't particularly feel like congratulating the officer for being so efficient. On the other hand, on occasion the inspection can turn up a part failure or mechanical deficiency which is so consequential that I cannot help but feel that the inspector has done me a personal favor. To know about this may not only save me a more costly repair bill, but could make it possible for me to have avoided a serious accident. Taking our cue from this, in

















carrying out our inspection work, we also like very much to be able to be of service. In fact, there are many occasions when the type of inspection that we are now performing can be as beneficial to the licensee as a thorough-going survey by a consulting engineer. I hasten to add for the benefit of consulting engineers, we are not attempting to compete, but rather to join forces with them in raising the overall standards of performance within the Broadcast service.

Examples of the kind of inspections from which I feel the broadcaster benefited are as follows:

Station 1—Inspection of this station disclosed that there were nine violation items including important technical irregularities such as operating power more than 10 per cent below licensed power, frequency and modulation monitors defective, no proof of performance measurements, remote meters had not been calibrated, base current ratios were beyond tolerance, phase monitor readings abnormal and the field intensity at three of the check points were well beyond authorized values. It is evident that correction of these deficiencies was in the best interest of the licensee since he was not providing coverage authorized by the Commission and was obviously, through lack of proper control, unable to insure that emission was of satisfactory broadcast quality.

Station 2—Eight discrepancies were noted in this inspection including bypassing of interlocks which exposed high plate voltage, no equipment performance measurements, excessive audio frequency distortion and audio frequency characteristics deviating well beyond authorized tolerance. This equipment was not only dangerous to operating personnel but failed to meet the minimum requirements of the rules as to audio capability.

Station 3—This inspection disclosed that the antenna resistance had decreased from 66 ohms to 52.1 ohms. Therefore, the power output of the transmitter had decreased 21 per cent which meant that the service area of the station had been similarly reduced. The licensee in this case was anxious to take corrective action since the strength of his received signal was increased thereby.

Station 4—Here the importance of audio performance measurements and the need for making thorough technical inspections was most obvious. The audio distortion and frequency response were well beyond the authorized tolerances. In addition, the directional pattern was out of adjustment with three check points exceeding the authorized licensed value by from 35 per cent to 200 per cent. Likewise, the authorized base current and loop current ratios were exceeded by as much as 8.0 per cent and the modulation monitor was defective.

Station 5—A recent inspection disclosed that there were 26 violations of the Commission's rules and four items of non-compliance with the terms of the station authorization. These include citations for inoperative control system, defective high voltage interlocks, wiring was not in accordance with good engineering practice, output power was excessive, phase monitor was inaccurate and field strength measurements at check points were greatly in excess of authorized tolerance.

Friends we were when we entered and friends we were when we departed. We have a handful of letters to prove it. Excerpts from just a few of these letters follow:

(1) "Your department can be very proud of your field inspector. Needless to say, he is a veteran in the field and in my many years in the broadcasting industry, I had heard a great many things about him. I had heard that he was tough and a stickler for perfection. I found him to be of great assistance to me and the other stations under my direction. He found fault with our technical operation, and also criticized our programming department. He substantiated each criticism with direct reference to the FCC rules and regulations. He was extremely helpful regarding improvements to be made as well as providing my engineers on duty with a better understanding of their responsibilities.

"As long as the government has men like your field inspector in its employ, we need never fear of a letdown in the rigid standards required to be maintained by the broadcasters."

(2) "I, for one, hope the Congress

will authorize enough funds to the FCC in order that more frequent inspections might be made. I think this will be helpful to the stations who are anxious to operate a good station and in accordance with the Rules and Regulations. Our station was last inspected in 1958 and many amendments and changes to the Rules have been made since that time. A more frequent inspection would have helped in the proper interpretation of those changes."

(3) "I have always prided myself in trying to give credit where credit is due. This gentleman was extremely kind, courteous, and helpful to me, and I would like for you to know that he is a credit to your agency."

(4) "We are anxious to correct our deficiencies and every effort will be made to do so. We welcome inspections and wish that they could come annually. Negligence in several areas is not an immediate thing but can creep in gradually over a period of many years. We feel that it is to our benefit to be made aware of these violations. That to do so is to the benefit of ourselves, the industry, and to the people of this area."

(5) The following has already been quoted in a state broadcast meeting; however, I think it deserves to receive top level billing such as this meeting affords. Therefore, I am giving it to you as follows: "Some of you, perhaps, have had an inspector in your station in recent weeks. I had the pleasure—and I am sincere—in having a fine gentleman visit me last Saturday afternoon and to say it was a tonic was putting it mildly. It was a routine inspection like we normally have during our renewal year. Let me suggest, if you have not already had your inspection, a friendly attitude on the part of your personnel and yourself."

This year the FCC IS making inspections in depth. We have to draw the line somewhere. Review and keep up to date with the Rules and Regulations. Follow the requirements set down by law and you will not have to worry.

Remember what was said about the old commission inspector those many years ago; "Without further ado he left, his manner indicating an unexpressed admonition. 'TAKE CARE!' "

# Product News

### NEW BROADCAST REMOTE AMPLIFIER

QRK Electronic Products, 445 N. Circle Drive, Fresno 4, Calif., has introduced a new ac-operated, three-channel broadcast remote amplifier.

The new unit features a crystal-controlled monitor receiver designed to permit station monitoring without external receiver or order wires, and a push-to-talk mike mounted behind the panel for line-up communications prior to broadcast.

### GATE AMPLIFIER 40 A

Ron Electric Co., Box 43, Livingston, N. J., has developed a new automatic background quieting amplifier, Gate Amplifier 40 A.

Featuring an electronic design, the amplifier functions to instantaneously key itself on and off with the sound intended for transmission, and is recommended for any audio application requiring the suppression of background noise. A front panel threshold level control is designed to permit precise adjustment of keying level; if desired, the threshold level may be remotely controlled. Attack time is less than 10 milliseconds; release time is adjustable from 0.5 to five seconds.

Frequency response of the unit is maintained within 1 db for frequencies between 50 and 15,000 cps, distortion is under one per cent, and noise is 60 db below plus 8 VU output level, according to the manufacturer. The amplifier is designed for standard rack mounting, 3¼-inch panel space required including self-contained power supply and VU meter.

A relay adaptor unit is available which is said to provide rapid relay on-off switching of auxiliary equipment automatically with the keying of the 40 A amplifier.

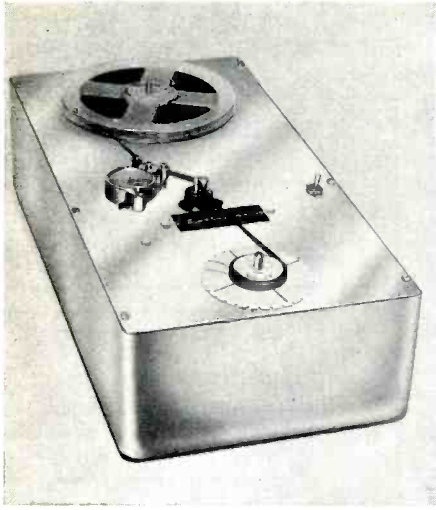


### NEW SWIVELIER UNITS FOR ECONOMICAL TV STUDIO LIGHTING

Swivelier Co., Inc., Dept. 146, 30 Irving Place, New York 3, N. Y., is offering new Swivelier units to provide low cost TV studio lighting.

According to the manufacturer, the two new models are completely redesigned to supply adjustable clamp light fixtures in two power ratings. Model PAR-56, No. 6758, will use 300-watt lamps, and model PAR-64, No. 6767, is designed for 500 watts. Both lamps use grounded, three-conductor power cords with molded plugs, and are also available with two-conductor cords.

The units clamp-attach up to 2 inches flat or cylindrical surfaces, and are protected to prevent scratching of surfaces. They are made with spring-tension sockets, and are adjustable to any position without wing nuts or set screws.



**SPOTMASTER TAPE CARTRIDGE WINDER**

Broadcast Electronics, Inc., 8800 Brookville Rd., Silver Spring, Md., has introduced the Spotmaster tape cartridge winder, model TP-1.

The mechanism will handle all reel sizes and winds tape at 22½ ips, and is designed to fill the need of every station using cartridge equipment.

**RADIO SHACK CORP. ANNOUNCES NEW CONSUMER CATALOG**

The new 1962, 336-page Consumer catalog, published by Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass., contains information on new merchandise, special purchases, and close-outs of nationally advertised components.

# F. C. C. Regulations

**PART 1 — PRACTICE AND PROCEDURE**
**Consideration and Processing of Applications**

At a session of the Federal Communications Commission held at its offices in Washington, D. C., on the 28th day of June, 1961:

The Commission having under consideration its rules pertaining to the processing of applications in the broadcast services;

It appearing that it would be in the public interest to amend the rules to reflect more accurately the manner in which broadcast applications are processed by the staff and particularly to indicate which applications for standard broadcast facilities are placed on the processing line; and

It further appearing that the amendments ordered herein relate to procedure, and therefore that the provisions of section 4 of the Administrative Procedure Act are not applicable; and

It further appearing that authority for those amendments are contained in sections 4 (i) and 303 (r) of the Communications Act of 1934, as amended;

*It is ordered*, That effective July 6, 1961, §§ 1.353 and 1.354 (d) of the Commission's rules are amended as set forth below.

(Sec. 4, 48 Stat. 1066, as amended; 47 U.S.C. 154. Interprets or applies sec. 303, 48 Stat. 1082, as amended; 47 U.S.C. 303)

Released: June 29, 1961.

FEDERAL COMMUNICATIONS COMMISSION,
[SEAL] BEN F. WAPLE,
*Acting Secretary.*

1. Section 1.353 of the Commission's rules is amended to read as follows:

**§ 1.353 Staff consideration of applications which receive action by the Commission.**

Upon acceptance of an application, the complete file is reviewed by the staff and, except where the application is acted upon by the staff pursuant to delegation of authority, a report containing the recommendations of the staff and any other documents required is prepared and placed on the Commission's agenda.

2. Section 1.354 (d) of the Commission's rules is amended to read as follows:

**§ 1.354 Processing of standard broadcast applications.**

* * * * *

(d) Applications other than those for new stations or for major changes in the facilities of authorized stations are not placed on the processing line but are processed as nearly as possible in the order in which they are filed.

# Classified

Advertising rates in the Classified Section are ten cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra. Check or money order must be enclosed with ad.

## EQUIPMENT FOR SALE

**Transmission line,** styroflex, heliax, rigid with hardware and fittings. New at surplus prices. Write for stock list. Sierra Western Electric Cable Co., 1401 Middle Harbor Road, Oakland 20, California. 6-61 tf

**Commercial Crystals** and new or replacement crystals for RCA, Gates, W. E., Bliley and J-K holders; regrinding, repair, etc. BC-604 crystals. Also A. M. monitor service. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 31, Temple, Texas. 9-61 tf

**HV Capacitors,** C-D Ceramic PL Type, excess stock, 1/.050-3/250-2/270-3/350-1/800 MMF. 20 and 30 KV, $20 ea., Weze, Boston. 10-61 1t

**5 kw FM transmitter.** Collins 737, $4,000, Cisler, WLVL, Louisville, Ky. P.O. Box 1644 or call TW 5-1143. 10-61 1t

**QUICK Q AUTOMATIC SPOT ANNOUNCING PLAYER**—recorder units A rugged, compact, self-cueing tape cartridge machine for Radio Broadcasting stations. Saves time, confusion, money on spot commercials — music — announcements — background. The C. H. Alvord Company, 1000 Farmington Avenue, West Hartford, Connecticut. 10-61 1t

**General Radio 650-A Impedance Bridge.** 613-B Beat Frequency Oscillator. Leeds & Northrup Galvanometer. Recording AC Voltmeter. Hewlett Packard 400-A Vacuum Tube Voltmeter. F. D. Fallain, 613 Chandler St., Flint 3, Mich. 10-61 1t

**Used 50 KW Transmitter.** Western Electric 407A-4 in good condition with spares. Priced at one-fourth less than a new transmitter. Can be handled with as little as 10% down. Broadcast Engineering, Dept. BE-4, Kansas City 5, Mo. 8-61 4t

**1 kw FM transmitter** with Gates Exciter and Doolittle Frequency and 600 foot guyed tower. Modulation Monitor. 4 GE 2 bay FM antennas. 500 feet RCA VHF Teflon 3⅛ inch coaxial line. 500 feet RCA UHF Teflon 3⅛ inch coaxial line. 1,000 feet Andrew 552 VHF Teflon 3⅛ inch line line hangers. WEAU-TV, Eau Claire, Wisconsin. Engr. Dept. 10-61 1t

## BUY, SELL OR TRADE

**WANT TO BUY:** Used field strength meter. Chief Engineer, KDEX RADIO, Dexter, Missouri. 10-61 1t

**Will buy or trade** used tape and disc recording equipment — Ampex, Concertone, Magnecord, Presto, etc. Audio equipment for sale. Boynton Studio, 10 BE Pennsylvania, Tuckahoe, N. Y. 4-61 6t



# Professional Services



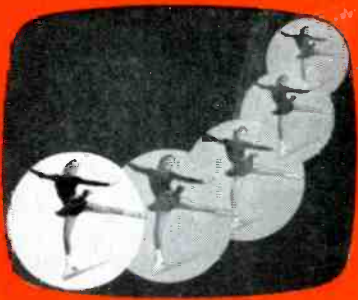
# Advertisers' Index

**FOR EXTRA AUDIENCE AND ADVERTISER IMPACT**

# *Telechrome Special Effects Center*

**THE ONLY SPECIAL EFFECTS GENERATOR WITH "JOY-STICK" POSITIONER AND BUILT-IN FADER**

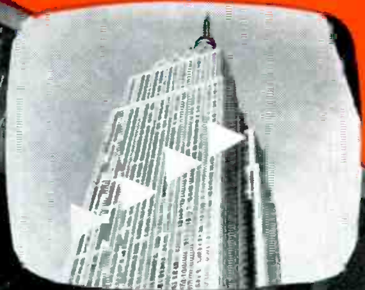
First, Telechrome provided broadcasters with a vastly improved special effects generator to provide a wider variety of dramatic wipes, inserts, keying, and other special effects. Now, Telechrome engineers make available the exclusive "Joy-Stick" Positioner and a built-in fader control to give you a complete, integrated Special Effects Center with previously unobtainable versatility. You can now produce fades—many hundreds more special effects—move wipes, keying, inserts and other effects to any part of the TV screen for truly dramatic TV viewing—from one Special Effects Center. Now, right at your fingertips, you can have a new dimension in program creativity—and for a low cost that will surprise you. See for yourself how Telechrome's Special Effects Center provides profitable extras in advertiser and viewer impact. Contact your Telechrome representative for a free demonstration today.



*Electronic Spotlight*

*Insert Placed at Any Position on Raster*

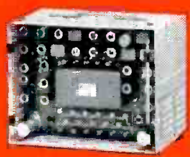
*Add Motion to Standard Wipes*



*Electronic Pointer*

**PORTABLE OR RACK MOUNTED MODELS AVAILABLE.**

**MODEL 490WA1.** *(Top)* Waveform generator. Generates keying signals for different wipes. **MODEL 490SA1.** *(Center)* Switching Amplifier. Combines two picture signals in accordance with applied keying waveform for inserts and fading. **MODEL 490RA1.** *(Bottom)* Remote Control Unit selects and controls desired effects. Designed for console or rack mounting. Easily modified for integration into existing facilities. **Console Unit below: MODEL 490RA1.** Remote Control Unit *(at right hand)*; **MODEL 491** Joy-Stick Positioner *(directly above)* positions inserts at any position on raster, adds motion to standard wipes, serves as electronic spotlight or pointer, etc.



**TELECHROME**

AT THE FRONTIERS OF ELECTRONICS

ELECTRONIC E DIVISION

**TELECHROME MANUFACTURING CORP. • AMITYVILLE, LONG ISLAND, NEW YORK • LINCOLN 1-3600**

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